NEVADA FORTRAN™


Includes NEVADA ASSEMBLER™
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We hope you enjoy using NEVADA FORTRAN™ or the Commodore 64. This software runs under CP/M 2.2 Operating System. Here are several other Commodore software packages which you should know about:

NEVADA COBOL™

This updated subset of COBOL was designed for small businesses with a Commodore 64. The four divisions of a COBOL program are reviewed, as well as the applicable Reserved Words. Details on using COBOL are described, along with error codes and messages. A glossary of items is also included.

EASY SCRIPT 64

This is a powerful word processor with table producing capabilities, comprehensive printer controls, easy update facilities, easy document handling, the ability to interact with EASY SPELL 64, and more.

THE WORD MACHINE and THE NAME MACHINE

This is an easy-to-learn and easy-to-use word processing package. Perfect for letters, address lists, memos, and notes, these programs let you overtype, insert, and delete text; personalize form letters; and print in draft, formal, or informal formats.

EASY SPELL 64

Eeasy Spell 64 features the following: the automatic correction of spelling errors, the ability to count the number of words in your manuscript and interact with Easy Script 64, and a built-in 20,000-word dictionary that lets you add words not already stored there.

EASY MAIL 64

With Easy Mail 64, you can easily manage your address files. Label printing is also simplified with Easy Mail's ability to search for specific fields/categories. The program's features include entry, change, or deletion of a file by name or number; the capability to print one or two abreast labels; a HELP screen; and the ability to print a complete printout of all the data in each of your records.

EASY CALC 64

Easy Calc 64 is an easy-to-use electronic spreadsheet which features editing functions and HELP screens. With Easy Calc 64, you can also print bar charts and individually formatted tables.

THE MANAGER

The Manager is a general data file for handling your files.

THE COMMODORE 64 MACRO ASSEMBLER DEVELOPMENT SYSTEM

This package is designed for experienced Assembly language programmers. Everything you need to create, assemble, load, and execute 6500 series Assembly language code is included.
SCREEN EDITOR
The Screen Editor helps you design software by letting you create and edit your own screens. This programming tool is for users with some computer experience.

SUPER EXPANDER 64
This cartridge is a powerful extension of the BASIC language which gives you the commands needed to easily access and implement Commodore's graphics, music, and sound capabilities. You will be amazed at how quickly and easily you can plot pOints and lines; draw arcs, circles, ellipses, rectangles, triangles, octagons; paint shapes with specified colors; read game paddle and joystick locations; create music and sound; display text; split screens to display both text and graphics; and program the function keys.

THE EASY FINANCE SERIES
Commodore is proud to announce an entire series of EASY FINANCE software packages which may solve many of your business and personal needs. The EASY FINANCE series is called "easy" because all of the programs are simple to operate and require no programming experience. Here is a brief description of each:

EASY FINANCE I - LOANS
Calculates 12 different loan concepts including principal, regular payment, last payment, and remaining balance.

EASY FINANCE II - INVESTMENTS
Includes 16 investment concepts. Functions such as future investment value, initial investment, and internal rate of return can be calculated.

EASY FINANCE 111 - ADVANCED INVESTMENTS
This advanced version of EASY FINANCE II, includes 16 more investment concepts. Financial terms are clarified and functions such as discount commercial paper, financial management rate of return, and financial leverage and earnings per share are described.

EASY FINANCE IV - BUSINESS MANAGEMENT
This package helps managers make the right decisions about production, inventory, control, compensation, and much more. Lease purchase analysis, depreciation switch, and optimal order quantity are some of the 21 functions that can be calculated.

EASY FINANCE V - STATISTICS
This includes payoff matrix analysis, regression analysis forecasting, and apportionment by ratios.

Please contact your local Commodore dealer for additional information on other software available for your Commodore computer.

Thank you for owning a Commodore computer. Now that you are a member of the Commodore family, maybe you'd like to expand your computer's family. Here is a list of additional hardware which is compatible with your Commodore computer:

Printers
The 1525E printer is an 80-column, dot-matrix, impact printer for creating printouts and hard-copies from your VIC 20 or Commodore 64. The printer features 30 characters per second print speed and prints graphics and text characters. The 1526 Printer has all of the same features but is bi-directional and has programmable line spacing and a print format interpreter.

1520 Plotter/Printer
This is a four color, high resolution plotter that connects directly to your VIC 20 or Commodore 64 computer. With the 1520 Plotter/Printer you can plot on a piece of paper, the unique color graphics that you have created on your screen using LOGO graphiCS!

Commodore Speech Module
The speech module cartridge comes with a built-in vocabulary of 234 words which are easily programmed into sentences. The module "talks" in a pleasant female or male voice ... it can generate other types of voices with special vocabularies geared to each software package. The speech module works with disk, tape, and also has a slot for accepting plug-in cartridges.

1701/1702 Monitor
This full color monitor is compatible with the VIC 20, Commodore 64, and other computers. The 1701/1702 Monitor features high quality resolution video and a built-in speaker with audio amplifier.

1530 DATASSETTE
The 1530 DATASSETTE is a low cost, highly reliable way to store and retrieve programs and data. It features keys for Play, Record, Fast-Forward, Rewind, and Stop. The 1530 DATASSETTE uses standard audio cassette tapes and allows naming of programs and files, verification of programs, and programmable end of tape marker sensing.

Joysticks and Paddles
Controls for games and entertainment.
1600 Modem
This telephone interface lets you communicate with other computer systems over your telephone line! The modem package includes cassette-tape terminal software, a free password and one-hour subscription to the CompuServe System* and software controls for duplex, baud rate, and parity. There is also an optional adapter available for non-modular phones.

1650 AutoModem
This telephone interface features automatic answer and automatic dial. The modem package lets you communication with other computer systems over the phone lines! It includes cassette-tape terminal with software, a free password and one-hour subscription to the CompuServe System TM* and software controls for duplex, baud rate, and parity. You need a modular phone or adaptor to use this product.

PET 64
This unique machine combines many of the Commodore 64 features with the capabilities of the Commodore PET. However, sprites, color, and sound are not featured on this machine.

SX-64 Portable Color Computers
These new computers are Commodore 64's in a convenient portable style. The model SX-64 (Single disk drive) is an excellent investment for executive business people, as well as affordable for today's students.

PREFACE
NEVADA FORTRAN for Commodore 64 is an 8080180851Z80 version of FORTAN IV. It is a powerful subset implementation of this widely used language. The compiler works from disk (also using the assembler) to produce 8080180851Z80 machine code that executes at maximum CPU speed.

A source program is entered as FORTRAN IV program statements. These statements must follow the conventions outlined in this document. The compiler acts upon the source statements to produce assembly code. At this stage, any mistakes are flagged with error messages. If an error should occur, the source may be corrected at this time and recompiled. After the program has been compiled without any errors, the final step (normally transparent to the user) is to assemble the intermediate code into 8080 object code. The object module is then ready for execution under the CPIM Operating System for your Commodore 64.

This reference manual assumes you already have the knowledge to program in FORTRAN and have read the Commodore 64 CPIM Operating System. An additional list of supplementary materials can be found in the back of this book.

This manual is not a tutorial and will not teach you "how to" program in FORTRAN. However, for the experienced FORTRAN programmer who is already familiar with the CPIM Operating System, this manual provides the necessary tools for using this 3.0 version of NEVADA FORTRAN on your Commodore 64. The manual includes:

- General Concepts and details of FORTRAN programming
- Summaries of system functions and subroutines
- A list of runtime and compile time errors

We hope you enjoy using NEVADA FORTRAN on your Commodore 64.
Files on the NEVADA FORTRAN Data Disk
(Used with the NEVADA FORTRAN program)
FORT.COM is the FORTRAN compiler
FRUN.COM is the runtime execution package
CONFIG.COM is a program to generate the error file and setup compiler and runtime defaults.
ERRORS is the error text file used by CONFIG.

Files on the NEVADA FORTRAN Data Disk
(Used with the NEVADA ASSEMBLER included in back section of this book)
ASSM.COM is the assembler program
RUNA.COM is the runtime loader
LD.ASM is a sample Assembler program

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1 GETTING STARTED

Required Hardware:

- Your Commodore 64 computer
- The Commodore Z80 microprocessor (This is your CPIM cartridge.)
- A Commodore 1541 single disk drive
- A video display monitor such as the Commodore Color Monitor Model 1701/1702

Required Software:

- Commodore’s CPIM Operating System disk
- A text editor. ED.COM is found on your Commodore CPIM Operating System disk.

Throughout our discussion, we will be referring to the following disks:

NEVADA FORTRAN Data disk
Included in your NEVADA FORTRAN software package, this disk should only be read. A listing of the files contained on this disk can be found at the front of this manual. (Consider this to be disk B.)

CPIM Operating System disk
This is your Commodore CPIM Operating System disk that you use with your ZOO cartridge.

CP/M NEVADA FORTRAN Operations disk
This is a disk which you create (Consider this to be disk A.)

Note that you should NEVER write on your NEVADA FORTRAN Data disk. To prevent mistakes from occurring, be sure that this disk is write protected. (Place a standard protection label over the "square corners" notch on the disk.) Before continuing, consult your Commodore 64 CPIM Operating System User’s Guide if you are not familiar with the DIR, ERA, PIP, and STAT commands.

Follow these steps to get started using NEVADA FORTRAN:

1. Use one of your CPIM Operating System disk backup copies to create your CPIM-NEVADA FORTRAN Operations disk. If you don’t have a backup copy of the CPIM Operating System disk, see Section 4.2 The Copy Utility in your Commodore CPIM Operating System User’s Guide.

2. Insert the newly created CPIM NEVADA FORTRAN Operations disk into the disk drive and boot CPIM. After CPIM is booted, the computer automatically displays an 'A>' prompt.
3. Use the CPIM ERA command to erase all of the files except the PIP.COM, STAT.COM and ED.COM files from your newly created NEVADA FORTRAN Operations disk.

4. Now, we will add the FORTRAN files to our newly created disk. Remember, we will refer to the NEVADA FORTRAN Data disk as disk 'B' and the CPIM-NEVADA FORTRAN Operations Disk as disk 'A'.

   Use the PIP command to copy the files from your NEVADA FORTRAN Data disk to the CPIM-NEVADA FORTRAN Operations disk. PIP will prompt you throughout the entire copy process. To invoke the PIP program, input:

   
   PIP

After RETURN is pressed, an asterisk (*) is displayed on the following line. Now, copy and verify the entire FORTRAN disk:

   * A: = B: * , * + V1

The following prompt will then be displayed:

   Insert disk B into drive 0, press return

Insert the NEVADA FORTRAN Data disk and press RETURN. The PIP program will read the first file from the disk. After a short period of time, the following prompt will be displayed:

   Insert disk A into drive 0, press return

Insert the CPIM-NEVADA FORTRAN Operations disk and press RETURN. The PIP program will now write onto the disk. This process will continue until the entire NEVADA FORTRAN Data disk is copied onto the CPIM-NEVADA FORTRAN Operations disk. Upon completion, an asterisk will appear.

   PIP can be terminated at any time by pressing RETURN after any asterisk (*) prompt. We suggest now placing your NEVADA FORTRAN Data disk in a safe place. You will not need it unless something happens to your Operations disk. Depending on how much program development you do, it may be wise to backup your CPIM-NEVADA FORTRAN Operations disk at least once a day.

   NOTE: The NEVADA ASSEMBLER, ASSM.COM, must be on the NEVADA FORTRAN Operations disk.

---

**GENERATING THE ERROR FILE FORT.ERR**

In case a problem occurs in your program, error messages are very important to help you understand what the problem is. The program CONFIG reads the text file ERRORS which contains the compiler error messages. These messages may be changed but can only be one line long. Also, the first two characters are the error number followed by a blank and the text of the error message. To generate the error file, just enter CONFIG at the CPIM prompt and reply Y to the question about generating the error file. You will then be asked to specify which drive contains the file ERRORS and which drive the file FORT.ERR is to be written to. Reply with a valid drive letter (A for one disk systems). You must generate the error file as it is not supplied on the disk. This only needs to be done once or whenever any of the error text is changed.

**CONFIGURING THE FORTRAN SYSTEM**

The CONFIG program also allows you to set certain default values in both the compiler and the runtime package. Just enter carriage return (or ENTER) to leave the default as it is, or enter the new default value. You will be asked to enter the drive that contains the compiler (FORT.COM). The default sizes of the parameters that can be changed with an OPTIONS statement can be modified along with the character used to delimit hexadecimal constants in strings. You will also be able to specify if your system console can handle lowercase letters. Enter Y if it can or N if it cannot.

Next, certain parameters in the runtime package can be set. You must first specify which drive contains the runtime package (FRUN.COM). The method that the runtime package performs CPIM console 110 can be specified as either CPIM function 1 & 2, CPIM function 6 (for CPIM rev 2.0 only) or direct BIOS calls. Specifying CPIM functions 1 & 2 allows you to use control-P to send a copy of your FORTRAN output to the printer. You will also be able to specify if your system console can handle lowercase letters during program execution. Enter Y if it can or N if it cannot.

After creating FORT.ERR you can erase the files CONFIG.COM and ERRORS if you need the disk space.
2 COMPILING AND EXECUTING A PROGRAM

CREATING A PROGRAM
A program is created using the text editor ED.COM. The name of the FORTRAN source program should have the filename extension of .FOR, such as PROG.FOR. Refer to section 3 for a detailed description of the format of each source statement. After the program is created with the text editor, it is later, in a separate step, compiled.

RUNNING THE COMPILER
The general format of the command to compile a FORTRAN program is:

```
FORT U:PGM.LAO SOPTIONS
```

where:

FORT is FORT.COM, the FORTRAN compiler
PGM is the FORTRAN source program to compile and has the extension .FOR. However, the .FOR extension should not be included when specifying the program name in this command.
U: is the drive where PGM.FOR is located (if not present, the default drive is used).
L is the drive for the listing as follows:

- A-P uses that drive for the listing
- X listing to CPIM console
- Y listing to CPIM LST: device
- Z do not generate a listing

The listing will have the same filename as the source file but with the extension .LST.

A is the drive for the intermediate assembly file as follows:

- A-P uses that drive
- Z do not generate an assembly file.

The assembly file will have the same filename as the source file but with the extension .ASM. This file is usually deleted by the FORTRAN compiler.

O is the drive for the final object program as follows:

- A-P uses that drive
- Z do not generate an object file

The object program will have the same filename as the source file but with the extension .OBJ.

Notes:
If Z is specified in either the assembly or object drive position, no object program will be generated.
If the three drive specifiers are not specified, then the default drive will be used.
The files FORT. ERR and ASSM.COM must be present on the default drive when the compiler is run.
If the O is not specified as Z, then the assembly file will be automatically assembled and the intermediate .ASM file will be deleted. If Z is specified, then the file will not be assembled and the intermediate .ASM will remain on the disk.
COMPILe OPTIONS

Options that affect the compilation of the FORTRAN program can be specified on the command line by preceding the option string with a dollar sign ($). For example:

FORTU:PGM.LAO $NP2

Here is a summary of Compile Options:

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<th>Description</th>
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<tr>
<td>N</td>
<td>No assembly or object file will be produced.</td>
</tr>
<tr>
<td>P</td>
<td>The listing file (if specified) will be paginated (66 lines to a page). Each new FORTRAN routine will start on a new page.</td>
</tr>
<tr>
<td>1</td>
<td>Source statements will be blank padded to 64 characters.</td>
</tr>
<tr>
<td>2</td>
<td>Source statements will be blank padded to 72 characters.</td>
</tr>
<tr>
<td>H</td>
<td>Used in conjunction with the P option to suppress the heading in the listing.</td>
</tr>
<tr>
<td>C=XXXX</td>
<td>Specifies the maximum number of COMMON blocks that may be defined in the program to be compiled; default is 15.</td>
</tr>
<tr>
<td>B=XXXX</td>
<td>Specifies the size of the input statement buffer; default is 530 characters and the buffer must be large enough to contain a complete statement (first record plus all continuations).</td>
</tr>
<tr>
<td>M=XXXX</td>
<td>Specifies the memory address at which blank COMMON will end, i.e., blank COMMON will be allocated downward in memory from the specified address. The address specified must be in hexadecimal. This option is useful for forcing blank COMMON to be allocated at the same address in memory for passing data between routines that CHAIN to each other.</td>
</tr>
</tbody>
</table>

* NOTE: Normally source statements are not blank padded. This may cause a problem where blanks are wanted inside a literal string and the string is started on one statement and continued over one or more continuation statements. Without the pad option, the trailing blanks may be lost (of course you could break the continued literal into several, making sure that there is a quote after any blanks at the end of the statement). For example:

```
WRITE (1,10)
10 FORMAT ('THIS IS
 *A TEST')
```

Produces:

```
THIS IS A TEST
```

without blank padding and

```
THIS IS A TEST
```

with blank padding.

If the last form is desired, then this could be written as:

```
WRITE (1,10)
10 FORMAT ('TEST
 **A TEST')
```

to produce the same results as with the blank padding specified.

Here are some examples using Compile Options:

```
FORT MYPROG $C=20
```

Compiles MYPROG.FOR from the default drive, generating MYPROG.ASM, MYPROG.LST and MYPROG.OBJ on the default drive and allowing for the definition of up to 20 COMMON blocks.

```
FORT B:READ.XCD $P2
```

Compiles READ.FOR from drive B, generating READ.ASM on drive C and the listing to the console. The listing will be paginated and source statements will be padded to 72 characters.

```
FORT TEST.YZZ $P
```

Compiles TEST.FOR from the default drive, no .ASM or .OBJ file will be produced but a paginated listing will go to the CPIM list (LST:) device.

```
FORT UPDATEBZ $PH
```

Compiles UPDATEFOR from the default drive, generating UPDATEASm on drive B, a paginated listing minus the heading line to the console and no .OBJ file.
EXECUTING A PROGRAM
Once the object file has been produced, the program can be executed by simply typing:

   FRUN u:filename

where u: is optional and if not present, the default drive is used. The FORTRAN runtime package, FRUN occupies memory from 100H to 3FFFH. It will load the program to be executed starting at 4000H. The program is then executed and continues until either it terminates normally or a runtime error occurs.

Example
To compile and run the program GRAPH.FOR, the commands would be:

   FORT GRAPH (listing, object to default disk)
   FRUN GRAPH (will execute the program)

CREATING A COM FILE
A CPIM .COM file can be created that contains a copy of the runtime package and the program to be executed. This has the advantage that just the filename need be entered to execute the program. Each program generated in this way will be at least 16K in length, that being the size of the FORTRAN runtime package. To create a COM file just add .C to the end of the FRUN command. The command to turn GRAPH.OBJ into GRAPH.COM would be:

   FRUN GRAPH.C

Then to execute it, all that is needed is the command:

   GRAPH

3 THE FORTRAN LANGUAGE
THE FORTRAN CHARACTER SET
The FORTRAN character set is composed of the following characters:

   The letters:

   The numbers:
   0,1,2,3,4,5,6,7,8,9

   The special characters:
   blank
   = equal sign (for replacement operations)
   + plus sign
   - minus sign
   * asterisk
   / slash
   ( left parenthesis
   ) right parenthesis
   , comma
   . decimal point
   $ dollar sign
   # number sign
   & ampersand
   \ backslash

NOTE: Lowercase letters will be converted to uppercase except when lowercase appears in string literals.

The following is a list of the meanings of the special characters used in this version of FORTRAN:

   $ Preceding a constant with a dollar sign indicates that it is a hexadecimal constant.
   # Preceding a constant with a number sign indicates that it is a hexadecimal constant that is to be stored internally in binary format.
   & The & has two functions:
   If used in a FORMAT statement, the character following the ampersand is interpreted as a control character (unless it is also an &). Used to indicate that a statement label is being passed to a SUBROUTINE for use in a multiple RETURN statement.
   \ A constant enclosed in backslashes in a character string is assumed to be the hexadecimal code for an ASCII character.
FORTRAN PROGRAM STRUCTURE

A FORTRAN program is comprised of statements. Every statement must be of the following format.

1) The first 5 columns of the statement are reserved for a statement label. This is a 1 to 5 digit number and is optional; however, if the statement is branched to from another part of the program, a label must be present.

2) The sixth column is used to indicate a continuation of the previous statement. Continuation is indicated by placing any character except a BLANK or ZERO in this column.

3) Columns 7 through 12 are used for the body of the statement. This is anyone of the following statements which will be described later. All statements are terminated by a <CR> (Carriage Return) or semicolon (not enclosed in a character string) in the case of multiple statements per line. A statement may be of any length, but only the first 72 characters are retained during compilation. Statements will be processed until the carriage return is encountered. The character positions between the carriage return and character position 72 will NOT be padded with BLANKS as some FORTRAN systems will do, unless the 1 or 2 option is specified. This means that if a character string is started on a line, and must be continued, the continuation logically starts immediately after the last character of the previous line.

4) Columns 73 through 80 are used for identification purposes and are ignored.

5) A comment line is indicated by placing a C in column 1. A comment line has no effect on the program and is ignored. It is only used for documentation purposes.

Example:

Column 0123456789
WRITE (1,2)
2 FORMAT ('THIS IS AN
* EXAMPLE CHARACTER STRING')

This outputs: THIS IS AN EXAMPLE CHARACTER STRING

Uppercase and lowercase letters can be intermixed in a FORTRAN statement. Lowercase letters are retained ONLY when they appear between QUOTES or are in the H FORMAT specification in a FORMAT statement. Otherwise, they will be converted to uppercase internally. Thus, the variable QUANTITY, quantity, and QuAnTiTy present the same variable.
FORTRAN PROGRAM PREPARATION
A FORTRAN source program is prepared using one of the available CPIM text editors. The FORTRAN file must be in the following format:
Position 1...5...0...5...0...5...0...5
  OPTIONS

FORTRAN program

END
OPTIONS
  SUBROUTINE X
FORTRAN routine
END

All FORTRAN routines are required to be compiled at one time.

THE COPY STATEMENT
A FORTRAN program can contain COPY statements. The COPY statement contains the word COPY followed by at least one blank, followed by the FILENAME to be inserted at that point. COPY files may contain complete programs or just sections of programs. Copied files may not themselves contain COPY statements.

Example
  DIMENSION A(1)
  COPY ALLDEFS
  READ (1,10) I
  A=1
  T=5
  CALL ADDIT
  STOP
END
COPY B:ADDIT

THE OPTIONS STATEMENT
This is an optional statement of each program and/or subprogram which is to be compiled. If present, the OPTIONS statement must appear as the first statement in the main program and prior to the SUBROUTINE or FUNCTION statement in each subprogram. The options statement allows the specification of various parameters to be used by the compiler during compilation of a particular routine. The options that are specified on an options statement are only in effect for that routine and revert back to the default unless an OPTIONS statement appears on subsequent routines.

Here is a summary of available options:

<table>
<thead>
<tr>
<th>Options</th>
<th>Descriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>A=n</td>
<td>n is a decimal number which indicates the maximum number of arrays. Default is a maximum of 15; each entry requires 4 bytes. This default can be changed using the CONFIG program.</td>
</tr>
<tr>
<td>B</td>
<td>The FORTRAN source statement is included in the assembly file as a comment.</td>
</tr>
<tr>
<td>D=n</td>
<td>n is a decimal number which indicates the maximum allowable nesting of DO loops. Default is 5, each entry requires 4 bytes. This default can be changed using the CONFIG program.</td>
</tr>
<tr>
<td>E</td>
<td>Instructs the compiler to list, as comments, a reference table equating user symbols, constants, and labels to internally generated ones.</td>
</tr>
<tr>
<td>G</td>
<td>Instructs the compiler to list all compile errors as error numbers, instead of explicit error statements. See the Appendix for a list of error numbers and their meanings.</td>
</tr>
<tr>
<td>1=n</td>
<td>n is a decimal number specifying the depth that IF-THEN-ELSE's may be nested. The default nesting is 5. This default can be changed using the CONFIG program.</td>
</tr>
<tr>
<td>L=n</td>
<td>n is a decimal number indicating the number of allowable labels. The default is 50. Each entry requires 6 bytes. (n may be greater than 255). This default can be changed using the CONFIG program.</td>
</tr>
<tr>
<td>N</td>
<td>Check for FORTRAN errors only. Do not output an assembly code file.</td>
</tr>
</tbody>
</table>
0= n n is a decimal number which indicates the maximum number of operators ever pushed on the internal stack while doing a prefix translation of input expression. Note functions and array subscripting require a double entry. Default is 40; each entry is 2 bytes long. This default can be changed using the CONFIG program.

P = n n is a decimal number which indicates the maximum number of variables and/or constants ever pushed on the internal stack in evaluation. Default is 40; each entry is 2 bytes long. This default can be changed using the CONFIG program.

Q This option must be used whenever the program expects to trap runtime errors. It causes code to be generated for handling user trapping of runtime errors.

S = n n is a decimal number indicating the number of allowable symbols. The default is 50. Each entry requires 8 bytes (n may be greater than 255). This default can be changed using the CONFIG program.

T = n n is a decimal number indicating the maximum number of temporary variables that are available during EXPRESSION evaluation. Default table size is 15; each variable requires 1 byte. This default can be changed using the CONFIG program.

X Instructs the compiler to generate code which will give explicit runtime errors. In this mode, each statement has an extra 5 bytes of overhead to keep track of the statement number of the statement currently being executed.

Example

$OPTIONS X,G,S= 200,L= 100

Options used will be:

EXPLICIT runtime errors will be generated
EXPLICIT compile errors are not generated
The SYMBOL table has room for 200 symbols, and
The LABEL table has room for 100 statement labels.

Note: n is less than or equal to 255 unless otherwise stated.

4 NUMBER SYSTEM

The following section details how numbers are handled in NEVADA FORTRAN.

Numbers are stored internally as a 6 byte BCD number containing 8 digits, a one byte exponent, and a sign byte. This allows for the number to range from -1.000000E-127 to 0.99999999E+127. The sign byte contains the sign of the number; 0 indicating a positive number and 1 indicating a negative number. The exponent is stored in excess 128. A one for the sign of the BCD number indicates a negative number. The number ZERO is stored as an exponent of zero; the rest of the number is ignored.

All numbers in FORTRAN are stored in the following format:

```
9 9 9 9 9 9 9 9 0 S F F
```

BCD NUMBER :Sgn :Exp

NUMBER RANGES

Integer variables and constants can have any value from -99999999 to +99999999. Real variables and constants can take any value between -0.99999999E-127 and 0.99999999E+126. Integer variables and constants are stored internally in the same format.

CONSTANTS

A constant is a quantity that has a fixed value. A numerical constant is an integer or real number; a string constant is a sequence of characters enclosed in single quotes. A logical constant has a value of .TRUE. or .FALSE.

Here is a more detailed description of each type of constant:

Numerical Constants

Numerical constants can be either integer or real. For example:

<table>
<thead>
<tr>
<th>Type</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integer</td>
<td>1,3099, 70</td>
</tr>
<tr>
<td>Real</td>
<td>1.34, 5.98, 1.4E10</td>
</tr>
</tbody>
</table>

A hexadecimal constant can be specified by preceding the number with a dollar sign. A hexadecimal constant is converted internally into an integer and stored that way. The maximum value for a hexadecimal constant is $FFFF.
Example
$8050
1=1000
z= - $CCOO

Another way to specify a hexadecimal constant is to precede the constant with a # sign. This way of representing a hexadecimal number differs in that the number is NOT converted to integer format and is stored in binary in the first two bytes of the constant. The number is stored high byte followed by low byte.

Example'

#ODOO
i=#127F

$805F is stored internally as: 328630000085
#805F is stored internally as: 5F 80 00 00 00 00

String Constants
A string constant is specified by enclosing a sequence of characters in single quotes. A single quote within a character string must be represented by TWO quotes in a row (with no space between these two quotes). By specifying a hexadecimal number within backslashes, any character (even unprintable ones) can be generated.

Example

'This is a string constant'
'This string constant' 'contains a single quote'
'Good \21\' is equivalent to 'Good'
'\7F\' is equivalent to a rubout

Warning: Never include \0\ as part of a string constant as that character is used internally to indicate the end of a string.

NOTE: The character used to delimit a hexadecimal number (default is \) can be changed using the CONFIG program.

Logical Constants
The two logical constants are .TRUE. and .FALSE.. Numerically, .FALSE. has the value 0 (zero) and .TRUE. has the value 1. However, any non-zero value will be considered as .TRUE.. Logical operations always return a value of 0 or 1. These logical constants can be assigned to any variable, but are usually used as part of a logical expression.

Example
1=.TRUE.
1=( (J .and. .TRUE.)

VARIABLE NAMES
A variable is a symbolic name given to a quantity which may change depending upon the operation of a program. A variable consists of from one to six alphanumeric characters the first of which must be a letter. There are four types of variables available: INTEGER, REAL, DOUBLE PRECISION and LOGICAL.

An INTEGER variable is a variable that starts with I, J, K, L, M or N by default or explicitly typed INTEGER through the use of an INTEGER or IMPLICIT statement.

A REAL variable is a variable that starts with a letter other than I, J, K, L, M or N by default or explicitly typed REAL through the use of a REAL or IMPLICIT statement.

A DOUBLE PRECISION variable must be explicitly typed DOUBLE PRECISION with a DOUBLE PRECISION or IMPLICIT statement.

A LOGICAL variable must be explicitly typed LOGICAL with a LOGICAL or IMPLICIT statement.

TYPE SPECIFICATION
There are three Type Specification statements that can be used to override the default types of variables. Remember that variables that begin with the letters I, J, K, L, M, N (unless changed by an IMPLICIT statement) will be of type INTEGER. All others will be of type REAL. The Type Specification statement overrides the default type of a variable.

Note: An array can also be specified in a Type Statement.

Example

INTEGER A,ZOT,ZAP(10)
REAL INT
LOGICAL LOG1,LOG2

A more detailed description of each Type Specification follows.

Integer
The general format of the INTEGER statement is:

INTEGER v1,v2

The INTEGER statement is used to explicitly override the default type of the variable. Should a variable occur in the declaration string, the type is automatically set to integer. This works for both subscripted and nonsubscripted variables. A variable can appear only ONCE in a type specification statement.

Example

INTEGER MODE,K453,NUMBER(40),MAXNUM
INTEGER ZAPI
Logical

The general format of the LOGICAL statement is:

    LOGICAL v1,v2

The LOGICAL statement is used to override the default specification and type a variable as Logical. A logical variable's value is interpreted as:

- .TRUE. if the variable has a non-zero value.
- .FALSE. if the variable has a zero value.

Example

    LOGICAL FTIME,LTIME
    LOGICAL FLAG

Real

The general format of the REAL statement is:

    REAL v1,v2

The REAL statement is used to explicitly override the default type of the variable. Should a variable occur in the declaration string, the type is automatically set to REAL. This works for both subscripted and nonsubscripted variables. A variable can appear only ONCE in a type specification statement.

Example

    REAL ALPHA,BETA(56),INIT,FIRST,ZAPIT,HI

Double Precision

The general format for DOUBLE PRECISION statement is:

    DOUBLE PRECISION v1,v2

The DOUBLE PRECISION statement is used to explicitly override the default type of the variable. When a variable occurs in the declaration string, the type is automatically set to REAL. This works for both subscripted and nonsubscripted variables. A variable can appear only ONCE in a type specification statement.

Example

    DOUBLE PRECISION ALPHA,BETA(56),INIT,FIRST,ZAPIT,HI
    DOUBLE PRECISION VALUE1,VALUE2

WARNING: Even though the DOUBLE PRECISION statement is supported, double precision arithmetic is NOT. All DOUBLE PRECISION variables will be treated as if they were REAL. A warning will be issued each time a DOUBLE PRECISION statement is encountered.

DATA STATEMENT

The DATA statement is used to initialize variables or arrays to a numeric value or character string. The general format is:

    DATA list/n1,n2 .../list1/n1,n2

where list is a list of variables (or array elements) to be initialized and n1, n2... are numbers or strings (constants) that the corresponding item of list will be initialized to. An exception to this is the array name. If only the name of the array (no subscripts) appears in list, the whole array will be initialized. It is expected that enough constants will be listed to completely fill the array. If not enough constants are supplied to fill the entire array, then portions of the array will be undefined.

Subprogram arguments may not appear in list. When a DATA statement is encountered during compilation, it is stored in memory and ALL DATA statements are processed when the END statement for the particular routine is encountered. If there are more DATA statements than can be stored in the available memory, a fatal compile error will result and compilation will terminate. Since DATA statements are processed when the END statement is encountered; errors in a DATA statement will be printed after the END statement. These errors will include the four digit FORTRAN assigned line number and the variable in the DATA statement being processed when the error occurred.

Example

    DIMENSION B(3),C(3)
    DATA A11,B1,2,31,C13*01
    DATA LIST/THIS IS A CHARACTER STRING1

The above statement will assign the value 1 to A and the values 1 to B(1), 2 to B(2) and 3 to (B3). The asterisk is used to indicate a repeat count. Thus, the array C will be set to zeroes. An error will result if a variable in a DATA statement is not used elsewhere in a program.

NOTE: The other form of the DATA statement:

    DATA A,B,C11,2,31

is not supported by NEVADA FORTRAN and must be rewritten as:

    DATA A11,B12I,C131
COMMON BLOCKS
The COMMON block declaration sets aside memory (variable space) to be shared between routines (SUBROUTINES, FUNCTIONS and the main program). COMMON blocks are associated with a name which is used by each declaring routine to point to a specific COMMON block.

The general form of a COMMON statement is:

```
COMMON Iname111ist1 Iname2/list2
```

where namel and name2 are the COMMON block names associated with the corresponding list1 and list2.

Example

```
DIMENSION X(100)
COMMON /ZZZ/ FIRST,LAST,X
CALL ADDEM
END

SUBROUTINE ADDEM
REAL NUMBER
COMMON /ZZZ/ F,L,NUMBER(100)
END
```

An array declaration may be included in a COMMON statement as shown in the subroutine above. The use of COMMON blocks allow data to be passed to and from a subprogram, but without passing it as arguments (in a heavily called routine, this method can save execution time). If an array is to be included in a common declaration, it must either be declared previously or declared in the COMMON statement.

If the name is omitted or the name is null (i.e. /) then it is called blank COMMON.

Example

```
COMMON A,B,C,D
COMMON / A,B,C,D are equivalent statements
```

Blank COMMON differs from named COMMON in the following ways:
1) Variables in blank common are allocated their actual memory addresses at runtime and therefore cannot be initialized with a DATA statement.
2) Blank common is allocated at runtime directly below the BDOS (at the top of the TPA) in CPIM or at a user specified address. To override the default placing of the blank common block in memory, use the M=E compiler option when the program is compiled. If the size of blank common blocks is the same, then blank common can be used to pass data between routines that CHAIN as the blank common variables will occupy the same place in memory.

NOTE: The name of a named COMMON block must be different from any SUBROUTINE or FUNCTION name.

IMPLICIT STATEMENT
The IMPLICIT statement is used to change the default INTEGER, REAL, DOUBLE PRECISION and LOGICAL typing.

The general format of the IMPLICIT statement is:

```
IMPLICIT type (range), type(range)
```

where type is INTEGER, REAL, LOGICAL, or DOUBLE PRECISION. Range is either a single letter or a range of letters in alphabetical order. A range is denoted by the first and last letter of the range separated by commas.

Example

```
IMPLICIT INTEGER (Z),REAL (A,B,C,D,E,G),INTEGER (M-S)
```

An IMPLICIT statement specifies the type of all variables, arrays and functions that begin with any letter that appears in the specification. Type specification by an IMPLICIT statement may be overridden for any particular variable, array or function name by the appearance of that name in a type statement.

The IMPLICIT statement must appear before all other statements in a particular routine: that is, immediately after the SUBROUTINE or FUNCTION statement or before the first statement of the main program.

WARNING: Even though the DOUBLE PRECISION specification is supported, double precision arithmetic is NOT. All DOUBLE PRECISION variables will be treated as if they were REAL. A warning will be issued each time a DOUBLE PRECISION statement is encountered.
5 EXPRESSIONS

An expression is a combination of variables, functions and constants, joined together with one or more operators.

Arithmetic Operators
- ** or ** or Exponentiation
- * Multiplication
- / Division
- + Addition
- - Subtraction

Comparison Operators
- .EQ. Equal to
- .NE. Not equal to
- .GT. Greater than
- .LT. Less than
- .GE. Greater than or equal to
- .LE. Less than or equal to

Logical Operators
- .NOT. Logical negation
- .AND. Logical and
- .OR. Logical or
- .XOR. Logical exclusive or

The .NOT. and unary minus (-) operators preceded an operand. All other operators appear between two operands.

HIERARCHY OF OPERATORS

The following is the table of operator hierarchy and the correct FORTRAN symbolic representation to be used in coding:

<table>
<thead>
<tr>
<th>Hierarchy</th>
<th>Operators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highest</td>
<td>System and User Functions</td>
</tr>
<tr>
<td></td>
<td>** OR (up arrow)</td>
</tr>
<tr>
<td></td>
<td>* and /</td>
</tr>
<tr>
<td></td>
<td>+ and -</td>
</tr>
<tr>
<td></td>
<td>.LT., .LE., .NE., .EQ., .GE., .GT.</td>
</tr>
<tr>
<td></td>
<td>.NOT.</td>
</tr>
<tr>
<td></td>
<td>.AND.</td>
</tr>
<tr>
<td></td>
<td>.OR. and .XOR.</td>
</tr>
<tr>
<td>Lowest</td>
<td>Replacement (=)</td>
</tr>
</tbody>
</table>

EXPRESSION EVALUATION

FORTRAN expressions are evaluated as follows:
1. Parenthesized expressions are always evaluated first, with the innermost set being evaluated first.
2. Within parentheses (or whenever there are none) the order of expression evaluation is:
   a. FUNCTION references
   b. Exponentiation
   c. Multiplication and Division
   d. Addition and subtraction
3. Operators of the same precedence are evaluated from left to right during expression evaluation.

Example

A + 1 + Z*5 will be evaluated as:

```
((A + (1 + (Z*5)))
```

VAL*Z + (T + 4)*16*X* Y will be evaluated as:

```
((VAL*Z) + ((T + 4)*16) + (X*Y))
```

NOTE: Operators of equal precedence are executed from left to right.

INTEGER OPERATIONS

A fundamental difference between INTEGER and REAL arithmetic operation is the manner in which rounding occurs. If you were to divide 3.0 by 2.0 using floating point arithmetic, the answer would be 1.5. However, if the same operation were to be performed using integer arithmetic, 3/2 would equal 1.

Note: In using integer arithmetic, the fractional part of the number is truncated. Another example is in the multiplication of two real numbers. For example, 2.9 times 4.8 equals 13.92. However, in integer mode the result is 13. Also, no more than 8 digits of accuracy are maintained. Should more than 8 digits be generated by an integer operation, a runtime error of INT RANG will result.

Example

```
6/3 = 2 (NOTE: no fraction is retained) and 7/9 = 0
```

99999999+ 5 =? integer overflow
REAL OPERATIONS

Unlike integers, Real operations have a precision of eight significant digits plus an exponent (base 10) between -127 and +127.

Example
\[ \frac{12}{6} = 2.0 \]
\[ 15.0/2 = 7.5 \]
\[ 1.12 = 0.5 \]

LOGICAL OPERATIONS

Logical operations are unlike INTEGER and REAL operations in that they always return a value of zero (0) or one (1). All the logical operations will return a one for a TRUE condition. However, any NON-ZERO value will be interpreted as TRUE. If the logical operation is a logically true statement, the result is a one; if the statement is false, a zero is returned.

Example
\[ A = 1 \text{ .GT. } 2 \text{ (FALSE) } \] A would evaluate to 0  
\[ A = 1 \text{ .EQ. } 1 \text{ (TRUE) } \] A would evaluate to 1  
\[ A = 1 \text{ .LT. } 2 \text{ (TRUE) } \] A would evaluate to 1

The relational operator abbreviations in the previous table represent the following operations:
\[-LT.\text{ Less Than} \]
\[-LE.\text{ Less Than or Equal To} \]
\[-NE.\text{ Not Equal To} \]
\[-EQ.\text{ Equal To} \]
\[-GE.\text{ Greater Than or Equal To} \]
\[-GT.\text{ Greater Than} \]
\[-AND.\text{ True only if both operands are true} \]
\[-OR.\text{ True if either operand is true} \]
\[-XOR.\text{ True if operands are different} \]

Example
\[ \text{IF } (A \text{ .EQ. } B) \text{ GO TO 500} \]
\[ \text{IF } (A \text{ .EQ. } B) \text{ OR } (A \text{ .EQ. } D) \text{ STOP} \]

Logical variables can also be used in assignment statements:
\[ A = A \text{ .AND. } B \]
\[ I = (A \text{ .OR. } B) \text{ XOR.} (\text{T .EQ. 35.4} ) \text{ OR.} (\text{T .EQ. 39}) \]

The following logical operators are also available, as listed in the following truth charts,

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>R</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

MIXED EXPRESSIONS

Here is a summary of the standard Fortran rules for mixed mode expressions.

<table>
<thead>
<tr>
<th>Expression</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integer &lt;op&gt; Integer</td>
<td>Gives an integer result</td>
</tr>
<tr>
<td>Real &lt;op&gt; Integer</td>
<td>Gives a real result (with the integer being converted to real before the operation is performed)</td>
</tr>
<tr>
<td>Real &lt;op&gt; Real</td>
<td>Gives a real result, with the integer being converted to REAL before the operation is performed</td>
</tr>
<tr>
<td>Integer = Real</td>
<td>Causes truncation of any fractional part of real and an error if the truncated result is outside the range of integers</td>
</tr>
<tr>
<td>Real = Integer</td>
<td>Causes integer to be converted to real</td>
</tr>
</tbody>
</table>

In general, in a mixed expression, integers are converted to real before the operation takes place, giving a real result (unless both operands are integer).

Note: <op> represents one of the operators: + - / .
6 CONTROL STATEMENTS

Here are several different statements that control the execution flow of a FORTRAN program.

GO TO statements
- Unconditional GO TO
- Computed GO TO
- Assigned GO TO

IF statements
- Arithmetic IF
- Logical IF
- IF-THEN-ELSE

DO
CONTINUE
PAUSE
STOP
CALL
RETURN
- Explicit RETURN
- Multiple RETURN

UNCONDITIONAL GO TO STATEMENT

The general format of the unconditional GO TO is:

```
GO TO n
```

where n is a label on an executable statement.

The unconditional GO TO statement performs a transfer of control to the statement number specified as the object of the branch. If the statement number does not exist, an undefined label error will occur. This error is detected during compilation.

Note: Labels on FORMAT statements in most FORTRAN systems may not receive transfer of control. This is not true in this implementation of FORTRAN. FORMAT statements act the same as a CONTINUE statement which will be discussed later.

Example
```
GO TO 10
GO TO 400
10 CONTINUE
400 FORMAT (1X)
```

COMPUTED GO TO STATEMENT

The general format of the Computed GO TO is:

```
GO TO (n1, n2, ..., nm), i
```

The Computed GO TO statement works in a manner similar to the GO TO statement. However, one of the distinct advantages is that under program control, you may direct which statement is the next to be executed, based on the value of i. The computed GO TO works as follows:

Example
```
GO TO (1, 5, 9, 167, 4, K2)
GO TO (44, 28), J
GO TO (51, 6, 7, 1, 46), M
GO TO (1, 1, 1, 2, 2), LOOT
```

Present Value
Next Executed
of Variable Statement

<table>
<thead>
<tr>
<th>Statement</th>
<th>Present Value</th>
<th>Next Executed</th>
</tr>
</thead>
<tbody>
<tr>
<td>GO TO (1, 5, 9, 167, 4, K2)</td>
<td>K2 = 5</td>
<td>4</td>
</tr>
<tr>
<td>GO TO (44, 28), J</td>
<td>J = 1</td>
<td>44</td>
</tr>
<tr>
<td>GO TO (51, 6, 7, 1, 46), M</td>
<td>M = 4</td>
<td>1</td>
</tr>
<tr>
<td>GO TO (1, 1, 1, 2, 2), LOOT</td>
<td>LOOT = 3</td>
<td>1</td>
</tr>
</tbody>
</table>

If the value of i exceeds the number of statement labels in the Computed GOTO, a runtime error COM GOTO will be generated. If the value of i is less than 1, a runtime error will also be generated.

ASSIGNED GO TO

The general format of the assigned GO TO is:

```
GO TO v, (n1, n2, ...)
```

where v is the variable used in an ASSIGN statement and n1, n2 are statement labels.

Example
```
ASSIGN 20 TO LABEL
IF (KNT .GT. 10) ASSIGN 10 TO LABEL
```

ASSIGN

The general format of the ASSIGN statement is:

```
ASSIGN n TO v
```

where n is the statement label to be ASSIGNed to v. The ASSIGN statement assigns a statement label to be used in conjunction with the ASSIGNED GO TO statement.

Example
```
ASSIGN 20 TO LABEL
IF (KNT .GT. 10) ASSIGN 10 TO LABEL
```

Then
```
GO TO LABEL,(10, 20)
```
ARITHMETIC IF STATEMENT

The Arithmetic IF allows the programmer to evaluate an expression which may be any combination of INTEGER, REAL, or LOGICAL operators. Based upon the expression's relationship to zero, control is transferred to one of three specified statements.

The general form of the Arithmetic IF is:

\[
\text{IF } (e) \text{ n1,n2,n3}
\]

where \(e\) is an arithmetic expression which when evaluated is used to determine the next statement to be executed.

\[
\begin{align*}
\text{If } e: & \\
<0 & \rightarrow \text{n1} \\
=0 & \rightarrow \text{n2} \\
>0 & \rightarrow \text{n3}
\end{align*}
\]

Example

\[
\begin{align*}
\text{IF (A) 1,2,3} \\
\text{IF (BETA \cdot \text{SIN(BETADEGREE)}) 100,150,432} \\
\text{IF (A-1) 1,1,99} \\
\text{IF (.NOT. FLAG) 1,5,7}
\end{align*}
\]

LOGICAL IF STATEMENT

The general format of the Logical IF is:

\[
\text{IF (e) s}
\]

The logical IF statement operates as follows:

1. The expression \(e\) is evaluated, and a logical result is derived: 
   .TRUE. or .FALSE. (numerically 1 or 0, respectively).

2. Depending on the value which is derived, one of the following two conditions occurs:
   - If \(e\) is evaluated as .TRUE., then the statement \(s\) is executed, and once the IF has completed, transfer is then passed to the next consecutive statement.
   - If \(e\) is evaluated as .FALSE., the statement \(s\) is NOT executed and control is then passed to the next sequential executable statement.

The statement \(s\) can be any statement other than an END, another Logical IF or a DO.

Example

\[
\begin{align*}
\text{IF (DEGREE .EQ. 100) WRITE (1,*) RADIANS} \\
\text{IF ((A.EOF. 12.0) OR (LOOP .LE. 500)) RETURN} \\
\text{IF (SIN(30)/WHERE - .00005 .LT. 00004) STOP} \\
\text{IF (A, NE. B) GO TO 500} \\
\text{IF (A, EQ. 1) GO TO (1,2,3),J} \\
\text{IF (VALUE .EQ. 6) IF (J) 99,33,67} \\
\text{IF (A,GE. 500)J = i+20/8} \\
\text{IF (FLAG) A = 2*A + 5}
\end{align*}
\]

IF-THEN-ELSE

The general format of the IFTHEN-ELSE statement is:

\[
\text{IF (e) THEN} \\
\text{statement 1} \\
\text{statement 2} \\
\text{ELSE} \\
\text{statement 3} \\
\text{statement 4} \\
\text{ENDIF}
\]

The IFTHEN-ELSE is an extension of the logical IF with two additions:

There can be more than one statement to execute if the IF is true.
There is the provision of specifying one or more statements to be executed if the IF is false.

The ENDIF is required to indicate the end of the complete IF THEN-ELSE statement.
To indicate an IFTHEN-ELSE, the \(s\) part of the logical IF is replaced with the THEN statement. All statements between the THEN and the matching ELSE or ENDIF will be executed if the specified condition is true. All statements between the ELSE and ENDIF will be executed if the specified condition is false. The ELSE is optional and if the condition is false, all statements between the THEN and ENDIF will be skipped.
If no ELSE condition is to be specified, then the THEN can be terminated with an ENDIF. For example:

```plaintext
IF (e) THEN
    statement 1
    statement 2
ENDIF
```

The statements to be executed can be any statement including another IF-THEN-ELSE.

Note: THEN, ELSE and ENDIF are individual statements terminated by either a carriage return or semicolon.

Example

```plaintext
IF (I .EQ. 0) THEN
    L= K+ 1
    K=I
ELSE
    K=0
ENDIF

IF (J .LT. 7) THEN
    LL= L+ 1
ELSE
    IF (A .EQ. B) THEN
        Q=0
        D=N
    ELSE
        TYPE 'ERROR'
        STOP
    ENDIF
ENDIF
```

**DO-LOOPS**

The general format for a DO loop is:

```plaintext
DO n i = m1,m2,m3
```

The DO loop is the basic loop structure in FORTRAN. It works in a manner similar to the FOR-NEXT loop in BASIC. The DO Loop works as follows:

- The i is set to the value of m1.
- After each pass through the loop (which ends with the statement labelled n), the stop value, m3 is added to i. If the m3 term (step value), is omitted, then the stop value is assumed to be one. Unlike other versions of FORTRAN, the i and m terms do not have to be INTEGER values and the step may be negative. This allows fractional increments of the DO loop index, i. The ability of a negative increment, m3, allows the loop to step in a downward direction. If the step value is positive, the loop continues until the value of i is greater than that of m2. If the step value is negative, the loop continues until the value of i is less than that of m1. The n in the DO loop specifies the range of the DO loop. This is the statement number of the last statement of the DO loop.

Irrespective of the relation of the initial and ending values, the DO will always be executed once.

Note that 2 or more DO loops may end on the same statement.

DO loops may not terminate on GO TO, STOP, IF-THEN-ELSE, END or RETURN statements. A common way to terminate a DO is with a CONTINUE statement.

Example

```plaintext
DO 800 I= 1,100
DO 1 J = I,END,.005
DO 99 A= START,END,AINCR
   20 CONTINUE
DO 10 J=3.99
   10 CONTINUE
```
CONTINUE STATEMENT

The format of the CONTINUE statement is:

    CONTINUE

The CONTINUE statement is an executable FORTRAN statement. It generates no code and is generally used as the terminal statement of a DO loop.

Example

    DO 100 i=1,50

    100 CONTINUE

The CONTINUE statement simply serves to mark the range of the DO. It is also used for transfer of control, i.e. you can GO TO it.

ERROR TRAPPING

Normally, when an error occurs during the execution of a FORTRAN program, a runtime error message will be generated. However, using the ERRSET and ERRCLR statements, it is possible to control and trap runtime errors.

The general format of these statements is:

    ERRSET n,v
    ERRCLR

where n is the label of the statement to go to if a runtime error occurs. And v is the variable to contain the error code of the runtime error that occurred.

The ERRSET statement causes control to be transferred to the statement labelled n when a runtime error occurs. No runtime error message will be printed if the error is trapped with an ERRSET statement. The ERRSET statement can only be used if the Q option was specified on the OPTIONS statement for the routine in which the error occurred. If an ERRSET or ERRCLR statement is encountered and the Q option was not specified, a compilation error will be generated.

The value placed in the variable v corresponds to the runtime error that occurred. Here is a summary:

<table>
<thead>
<tr>
<th>Valued v</th>
<th>Runtime Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Integer overflow</td>
</tr>
<tr>
<td>2</td>
<td>Convert error</td>
</tr>
<tr>
<td>3</td>
<td>Argument count error</td>
</tr>
<tr>
<td>4</td>
<td>Computed GOTO index out of range</td>
</tr>
<tr>
<td>5</td>
<td>Overflow</td>
</tr>
<tr>
<td>6</td>
<td>Division by zero</td>
</tr>
<tr>
<td>7</td>
<td>Square root of negative number</td>
</tr>
<tr>
<td>8</td>
<td>Log of negative number</td>
</tr>
<tr>
<td>9</td>
<td>Call stack push error</td>
</tr>
<tr>
<td>10</td>
<td>Call stack pop error</td>
</tr>
<tr>
<td>11</td>
<td>CHAINLOAD error</td>
</tr>
<tr>
<td>12</td>
<td>Illegal FORTRAN logical unit number</td>
</tr>
<tr>
<td>13</td>
<td>Unit already open</td>
</tr>
<tr>
<td>14</td>
<td>Disk full</td>
</tr>
<tr>
<td>15</td>
<td>Unit not open</td>
</tr>
<tr>
<td>16</td>
<td>Binary 1/0 to system console</td>
</tr>
<tr>
<td>17</td>
<td>Line too long on READ or WRITE</td>
</tr>
<tr>
<td>18</td>
<td>FORMAT error</td>
</tr>
<tr>
<td>19</td>
<td>Input/Output error in READ or WRITE</td>
</tr>
<tr>
<td>20</td>
<td>Invalid character on input</td>
</tr>
<tr>
<td>21</td>
<td>Invalid input/output list</td>
</tr>
<tr>
<td>22</td>
<td>Assigned GOTO error</td>
</tr>
<tr>
<td>23</td>
<td>CONTROL/C abort</td>
</tr>
<tr>
<td>24</td>
<td>Illegal character input</td>
</tr>
<tr>
<td>25</td>
<td>File operation error</td>
</tr>
<tr>
<td>26</td>
<td>Seek error</td>
</tr>
</tbody>
</table>

If more than one ERRSET statement is executed in a routine, then the last one executed is the one in effect. If a runtime error should be trapped with an ERRSET statement, the ERRSET statement is automatically cleared.
The ERRCLR statement clears the effect of the last executed ERRSET statement. The ERRCLR and ERRSET statements must be in the same routine.

Example

```
OPTIONSQ
  ERRSET 10, CODE
  ERRCLR
  STOP
  10 TYPE 'ERROR, ERROR CODE = ', CODE
END
```

**CONTROL/C CONTROL**

At the beginning of each READ or WRITE statement, the state of the CONTROL/C abort flag is tested. If the CONTROL/C abort flag is set, then the console is tested to see if CONTROL/C has been hit. If CONTROL/C has been hit, then one of two actions will occur:

- If there is an ERRSET in effect, the error branch will be taken with a CONTROL/C error.
- A runtime error of CONTROL/C will be generated.

The user has control of the CONTROL/C flag through the CTRL ENABLE and CTRL DISABLE statements. CTRL ENABLE sets the CONTROL/C flag and allows a CONTROL/C from the console to abort the program. CTRL DISABLE resets the flag and causes the CONTROL/C to be ignored.

Example

```
DO 1 I = 1, 100
  IF (I .EQ. 50) CTRL DISABLE
1  TYPE I
END
```

The previous program will only abort if CONTROL/C is entered while the first 50 numbers are being typed.

When program execution starts, the CONTROL/C flag will be set which allows CONTROL/C to abort the program.

Note: The CONTROL/C error, if enabled, can be trapped with an ERRSET statement. However, the CIN function will return a control-C to the caller, regardless of the setting of the CONTROL/C flag.

**TRACING**

There are two statements that are used to trace a program:

```
TRACE ON
TRACE OFF
```

When program execution begins, tracing is initially off and must be explicitly turned on. Once tracing is on, it remains on until the program terminates or a TRACE OFF statement is executed. The effect of both trace statements is global over the whole program. Therefore, tracing does not have to be turned on in each subroutine.

The trace function will output the line number of the FORTRAN statement before execution, only if the X option was specified on the options statement for this routine. Otherwise, the program will be traced only up to the entrance to the subroutine. It should be noted that the line number for any entrance to a subroutine (either SUBROUTINE or FUNCTION) will always be output as ????? regardless of the state of the X option.

Example

```
IF (FLAG .EQ. 0) TRACE ON
  TRACE OFF
DO 1 I = 1, 100
  IF (I .EQ. 50) TRACE ON
1  TYPE I
```
DUMP STATEMENT
The general format of the DUMP statement is:

DUMP /ident/ output list

where ident is up to a ten character identifier for this DUMP statement and output list is a standard WRITE output list that may contain variables, constants, character strings, array elements, array names and implied DO loops.

The DUMP statement is used to display information when a runtime error occurs that is not trapped by an ERRSET statement.

More than one DUMP statement may be executed in a routine and the last one executed is the one that will be output on a runtime error. Each subprogram may contain its own DUMP statement, but only the last DUMP statement executed in a particular routine will be saved and output if a runtime error occurs.

Example

DUMP I AFTER-DIVI 'Index after divide is ',',K

A= K/I

END

will cause the dump statement to output if I is zero.

7 PROGRAM TERMINATION STATEMENTS
The following section details the various program termination statements.

PAUSE STATEMENT
The general format of the PAUSE statement is:

PAUSE 'any char string'

This statement causes the program to wait for any input from the system console. To continue execution, press any key on the system keyboard. If the character string option is specified, the string will be displayed on the system console. The string is enclosed in single quotes ('). To output a quote, two quotes in a row must be entered; e.g. ('outputs as ('). The quotes surrounding the text are not displayed.

Example

PAUSE
PAUSE 'DATA OUT OF SEQUENCE, IGNORED'
PAUSE 'THIS IS A SINGLE QUOTE (')
ISUM=O
DO 10 1=1,10
   ISUM = ISUM + I
10 IF (ISUM .EQ. 5) PAUSE 'SUM = 5'
CONTINUE
STOP
END
**STOP STATEMENT**

The general format of the STOP statement is:

```
STOP 'any char string'
STOP n
```

When a STOP statement is executed, termination of the executing program will occur. If the character string is specified, it will be printed on the system console when the statement is executed. After the character string is output, the program terminates and returns to CPIM. The string is enclosed in single quotes. To output a quote, two quotes in a row must be entered. The quotes surrounding the text will not be output.

In the second form, n is a one to five digit integer number that will display. The n is optional.

To terminate a program without the STOP being typed on the console, use the EXIT subroutine.

**Example**

```
STOP 'PROGRAM COMPLETE'
STOP 1267
STOP 'ERROR OCCURRED, CHECK OUTPUT'
IF (ERROR .NE. 0) STOP 'ERROR'
IF (FLAG .AND. STOPIT) STOP 'ALL DONE'
```

**END STATEMENT**

The format of the END statement is:

```
END
```

This is a required statement for every FORTRAN routine. It is used by the compiler to indicate the end of one logical routine. If an END statement is executed, then the message STOP END IN - XXXXX will be output to the system console, with XXXXX being replaced by the name of the FORTRAN routine in which the END statement was executed and the program will terminate.

---

**8 ARRAY SPECIFICATION**

An array is a collection of values that are referenced by the same name and the particular element is specified by a subscript.

Subscripts can be real, integer expressions, or constants and will be truncated to an integer value after the expression is evaluated.

Every array that is to be used must be dimensioned. Also, an array may have from one to seven dimensions.

**Example**

If GRADE has 3 elements then:

- GRADE (1) refers to the first element
- GRADE (2) refers to the second element
- GRADE (3) refers to the third element

**NOTE:** Subscripted variables cannot be used as subscripts. Thus GRADE (A(I)) is invalid, where both GRADE and A are arrays.

**DIMENSION STATEMENT**

The general format for a DIMENSION statement is:

```
DIMENSION v(n1,n2,...,nm),..
```

Where v is the array name and N1,N2,.. are the size of each of the dimensions of the array v.

The DIMENSION statement is used to define an array. The rules for using the DIMENSION statement are as follows:

- Every subscripted variable must appear in a DIMENSION statement whether explicit (in a dimension statement) or implied (in a REAL, DOUBLE PRECISION, INTEGER, LOGICAL or COMMON statement) prior to the use of the first executable statement.
- A DIMENSION specification must contain the maximum dimensions for the array being defined.

The dimensions specified in the statement must be numeric in the main routine. However, in subprograms, the subscripts may be integer variables. Hence, the following statement is valid only in a SUBROUTINE or FUNCTION:

```
DIMENSION A(I,J)
```

In the case where the dimensions of an array are specified as variables, the value of the variable at runtime will be used in computing the position within the array to be accessed.
All arrays passed to subprograms must be DIMENSIONED in the subprogram, as well as in the main program. If the arguments in the subprogram differ from those in the main program, then only those sections of the array specified by the DIMENSION statement in the subprogram will be accessible in the subprogram.

The number of dimensions specified for a particular array cannot exceed seven.

No single array can exceed 32,767 bytes in size (5461 elements).

Note: The following is a method that can be used to get around the size limit of arrays. Allocate the large array in a named common block as 2 or more sequential arrays. Use just the first array and subscript out of it as necessary. The way that common blocks are allocated will assure you that the arrays are allocated sequentially in memory. For example, if you want an array of 7000 elements, it can be defined as:

```plaintext
COMMON /DUMMY1 TABLE(4000), TABLE1(3000)
```

Then, you would just use the array TABLE. To access the 4945th element, just use TABLE (4945) (which is actually the 945th element of TABLE1).

Example

```plaintext
DIMENSION GUN(S,E)  (this statement is valid only in a subprogram as it uses variable dimensions).
DIMENSION A(2,2),B(10)
DIMENSION ZIT(10)
REAL ABLE(10)
LOGICAL FUNCT(100)
DOUBLE PRECISION ARR(10),B(8),A(SIZE)
DIMENSION A(3,2,3),C(10),ZOT(10,10)
INTEGER SWITCH(15)
```

"A" would require 3*2*3*(6) = 108 bytes
"C" would require 10*(6) = 60 bytes
"ZOT" would require 10*10*(6) = 600 bytes
"SWITCH" would require 15*(6) = 90 bytes

In calculating the memory used by an array, multiply each of the dimensions times each other, then times 6. The result will be the number of bytes used by the array for storage.

**WARNING:** No subscript range checking is performed at runtime.

---

**SUBSCRIPTS**

Subscripts are used to specify an entry into an array (i.e., the value specified in the subscript is the element of the array referenced). Subscripts may be INTEGERS, REAL (fractions are truncated), LOGICAL expressions, or any other valid expression. Expressions are evaluated as previously explained in the EXPRESSION section.

Example

```plaintext
ZIT(8)
ABLE(5)
```

```plaintext
ORANGES(I + 5 - (K^10)/12)
```
9 SUBPROGRAMS
Subprograms provide a means to define frequently used sections of code that can be considered a unit. FORTRAN provides the means to execute these subprograms whenever they are referenced.

There are 3 types of subprograms supported in this version of FORTRAN:

- SUBROUTINE subprograms
- FUNCTION subprograms

Built in library functions

The major differences between FUNCTIONS and SUBROUTINES are listed below:
- FUNCTIONS are used in expressions, while SUBROUTINES must be called.
- FUNCTIONS require at least one parameter; SUBROUTINES do not require any.
- The name on the FUNCTION statement must be the object of a replacement statement somewhere in the FUNCTION; this is not the case for a SUBROUTINE.

WARNING: If a constant is passed as an argument in either a CALL or FUNCTION reference, and the corresponding parameter in the SUBROUTINE or FUNCTION is modified, then the value of the constant that was passed will be changed, and remain that of the new value.

NOTE: All SUBROUTINES and FUNCTIONS must be compiled at the same time.

SUBROUTINE STATEMENT
The general format of the SUBROUTINE statement is:

```
SUBROUTINE name(list)
```

The SUBROUTINE statement is used to identify the beginning of a logical routine. This statement is required at the beginning of every SUBROUTINE. The list that is to receive the values being passed to the subroutine is optional if no parameters are to be passed.

Example
```
SUBROUTINE ADDIT (RESULT,X,Y)
RESULT=X+Y
RETURN
END
```

FUNCTION STATEMENT
The general format of the FUNCTION statement is:

```
FUNCTION name(list)
```

A FUNCTION statement is used to define a logical routine as a FUNCTION. The type of result of a FUNCTION can be specified by preceding the FUNCTION with REAL, DOUBLE PRECISION, INTEGER, or LOGICAL; or the name of the FUNCTION may appear in a type statement within the FUNCTION.

Example
```
FUNCTION SWAP (A)
SWAP=A
RETURN
END
```
```
FUNCTION SWAP (A)
SWAP = IFIX(A)
RETURN
END
```
```
FUNCTION SWAP (A)
INTEGER SWAP
SWAP=AI2
RETURN
END
```
```
DOUBLE PRECISION VALUE(WHAT14*7 + 5
VALUE= WHAT14*7 + 5
RETURN
END
```

CALL STATEMENT
The general format of the CALL statement is:

```
CALL name(list)
```

The CALL statement is used to transfer control to a SUBROUTINE. List specifies the parameters to be passed to the SUBROUTINE and may be omitted if no parameters are to be passed.

The number of parameters in a CALL and SUBROUTINE statement referring to the same subprogram must be the same. Otherwise, a runtime error will result.

Example
```
CALL XSWAP (NUM1,NUM2,TOTAL)
```
```
CALL XSWAP
```
```
CALLXSWAP
```
RETURN STATEMENT

There are two types of RETURN statements:

Normal RETURN
Multiple RETURN

Normal RETURN
The format for a normal RETURN is:

RETURN

The RETURN statement is used to terminate execution of a subprogram whether it is a FUNCTION or a SUBROUTINE. Return is transferred to the next statement following the CALL statement, or in the case of a FUNCTION, return is transferred back to the point where it was called with the value of the FUNCTION returned. A RETURN statement is not valid in the MAIN routine and will cause an error during compilation if encountered in the MAIN routine.

Example

SUBROUTINE ZERO(I,J)
  1=0
  J=0
  RETURN
END

FUNCTION ZZ(VAL)
  COMMON IA,A,B,C
  ZZ=A+ BIC- VAL
  RETURN
END

Multiple RETURN
The general format of the Multiple RETURN statement is:

RETURN I

This variation of the RETURN statement is used to transfer back from a SUBROUTINE to a point other than the statement that immediately follows the CALL. The I in the RETURN is the name of a variable in the argument list of the subroutine and must have been passed as a label in the CALL. The CALL statement that invokes a routine that contains a multiple return must pass the label as one of the parameters. The statement label is indicated in the argument list by preceding the label with an ampersand (&).

Example

CALL X(&1,Y,2,&2)

SUBROUTINE X(I,A,IC,J)
  C THE FOLLOWING RETURN WILL TRANSFER TO THE
  C STATEMENT LABELLED '1' IN THE CALLING PROGRAM.
  C
  RETURN I
  C THE FOLLOWING RETURN WILL TRANSFER TO THE
  C STATEMENT LABELLED '2' IN THE CALLING PROGRAM.
  C
  RETURN J
END

NOTE: Multiple RETURNS are only valid for SUBROUTINES.

BLOCK DATA SUBPROGRAM

The BLOCK DATA subprogram is used to initialize variables in named COMMON. The BLOCK DATA subprogram must contain no executable statements. It may contain only declaration statements for specifying variable types, array dimensions, COMMON blocks and DATA statements.

Example

BLOCK DATA
  INTEGER FIRST,LAST
  COMMON /ONE! NAMES(100) /TWO/ FIRST,LAST
  DATA FIRST 11/, LAST101
  DATA NAMES 11,2,0,4,5,6,7,8,9,10,90*999991
END

NOTE: The variable in named COMMON can be initialized in any routine. The BLOCK DATA subprogram appears only for compatibility with other FORTRAN systems.
10 INPUT/OUTPUT

The following  is some information concerning NEVADA FORTRAN 110.

GENERAL INFORMATION

Input/Output (1/0) under FORTRAN may take one of the following forms:

  Standard Formatted 110
  Free Format 1/0
  Binary 1/0

In standard formatted 1/0, input and output is defined in terms of fields which are right justified on the decimal point, with zero suppression. In a FORMAT statement, no more than three levels of nested parentheses are allowed (outer set and two nested inner sets).

Free Format 1/0 is used as in BASIC. All the values are entered using commas (,) or carriage returns to delimit the numbers.

Binary 110 is a third option that allows passing of large files between FORTRAN programs, with the minimal amount of wasted disk space. Each variable written in binary format uses six bytes of disk space.

FORTRAN logical units 0 and 1 are dedicated to console input and output and cannot be either opened or closed. An attempt to open or close 0 to 1 will result in a runtime error. Logical unit 0 is used for console input and logical unit 1 is used for console output.

Binary 110 cannot be specified for logical units 0 or 1 and doing so will result in a runtime error.

There are two special 1/0 statements:

  TYPE
  ACCEPT

Both of these are followed by a standard 110 list. TYPE is equivalent to WRITE (1,* ) and ACCEPT to READ (0,*). This is just a convenient method of doing console 1/0.

Example

  TYPE I,J,(A(I),I=1,10)
  ACCEPT 'INPUT THE MAX COUNT',COUNT

A RUNTIME FORMAT can be specified for any formatted 1/0 statement by substituting an ARRAY name for the FORMAT number. At runtime, the array is assumed to contain a valid FORTRAN FORMAT (complete with its outer set of parentheses).

This allows a FORMAT statement to be input at runtime and then to be used in either READ or WRITE statements within the program. Thus, a particular FORMAT can be changed at runtime instead of having to recompile the program. The FORMAT should be input using an A6 format specification as imbedded blanks (added if using less than an A6) will cause a runtime error.

Example

  DIMENSION FORM(10)
  READ (0,10) 'ENTER DATA FORMAT A FORM,10A6'
  10 FORMAT (10A6)

  READ (4,FORM) A,B,C

  WRITE (5,FORM) R1,R2,R3

110 LIST SPECIFICATION

The 110 List is used to specify which variables are to be READ or WRITTEN in a particular 1/0 statement. The list has the same form for both READ and WRITE statements. The list can be composed of one or more of the following:

  Simple (non-subscripted) variable
  Array element
  Array name
  Implied DO loop
  Literal
  Constant (WRITE only)

The above types are combined to form the 1/0 list specification. The implied DO loop is used mainly to output sections of one or more arrays and functions in the same way as does a regular DO loop. An example of an implied DO loop is:

  WRITE (1,*) (F(I),I=1,3,1)

It should be noted that the outer parentheses and the comma preceding the DO index are always necessary when using an implied DO loop. Nested DO loops can also be used. Each loop must be enclosed in parentheses. An example follows:

  WRITE (1,*) (J,F(I,J),I=1,4,J=1,3,2)

The inner DO (I) is performed for each iteration of the outer DO (J). Note that other than array elements can be included within the range of an implied DO. Implied DO's can be nested to any depth, each within its own set of parentheses.
LITERALS (character strings enclosed in quotes) can be used in any WRITE statement and in READ statements that reference the system console. The literals can be used as prompts for input or identification on output.

Example
WRITE (1,*) 'A= ', A
TYPE 'The answer is ', ANS
WRITE (5,3) X = ', X
READ (0,*) 'A= ', A,' B= ', B
ACCEPT 'Enter quantity ', QUANT

NOTE: An attempt to use a literal in a READ statement that doesn't reference the console will result in an INPUT ERR runtime error.

READ STATEMENT
READ(unit, ,format) {END = end} {ERR = error} 1/0 list
The READ statement is required in order for the user to do input through the FORTRAN system. If a unit number of 0 is used, there is no need to open this file as it is assumed to be system console input.

Note: Do not use one as the logical unit. It is reserved for the system console output. Any other unit number must first have been opened by the user through the OPEN or LOPEN subroutine.

The FORMAT entry may take one of the following forms:
The FORMAT number is the label on the FORMAT statement which is to be used.
An asterisk (*) in the FORMAT entry indicates that input is to be free format. The exact format of the output depends on the value of the number being output and is determined at runtime.
Binary input is assumed if the FORMAT entry is left blank (or not specified).
If an array name is specified, that array contains the FORMAT to be used.

END = is the label to which transfer of control is to be made should an end-of-file condition be encountered. ERR = is the label to which control will be transferred, should an error other than end-of-file occur during input, such as a bad sector. The ERR = does not handle input format errors (such as a decimal point in an integer field). Use ERRSET to handle these input errors. 1/0 list is the string of variables which accept the data to be read.

Example
READ (0,2) A
Read from the system console the variable 'A' under FORMAT number 2

READ (0,*) A
Read from the system console the variable 'A' in free format.

READ (4) A
Read from logical file 4, the variable A in binary.

READ (4**END = 10) A
Read from logical file 4, the variable A in free format. Should end-of-file be encountered, go to statement label 10

READ (4,**END = 10, ERR = 100) A
Read from logical file 4, the variable A in free format. If an error occurs, go to statement label 100

READ (4**ERR = 100) A
Read from logical file 4, the variable A in binary format. If an error occurs, go to statement label 100.

NOTE: The END = and ERR = parameters are optional and can appear in any order.
WRITE STATEMENT
WRITE (unit,format) (END = end) (ERR = error) 1/0 list

The WRITE statement is used to output to either disk files or the console. It performs a function that is the opposite of the READ statement. The 1/0 list is specified exactly the same as for the READ statement with the exception that a string can always be used in the 1/0 list. However, the END = serves no function and will never be used by the WRITE statement.

Example
WRITE (1,2) I,J,PAY,WITHOLD
WRITE (1) (1,= 1,10)
WRITE (10,*). THIS
WRITE (6,12,END = 99,ERR = 66) LOOP,COUNT

MEMORY TO MEMORY 110STATEMENTS

The ENCODE and DECODE statements allow 1/0 to be performed to or from a specified memory location. This allows data in memory to be read (using DECODE) with perhaps a different format code depending on the data itself. The ENCODE statement is similar to a WRITE statement in that data is formatted according to the specified format type. However, with ENCODE, instead of being output to a file, data will be placed in memory at the specified location for further processing.

DECODE statement

The general form of the DECODE statement is:

DECODE (variable,length,format) 1/0 list

The DECODE statement is similar to a READ statement in that it causes data to be converted from external ASCII format to internal FORTRAN type. Variable is either an unsubscripted variable name or an array name. Length is the number of bytes to process for this READ starting at variable. If multiple records are required by the 1/0 list, successive records of length will be retrieved from memory. Input records will be blank padded to the right end as necessary, as in a READ statement. FORMAT is either an asterisk for free formatting or the number of a FORMAT statement.

Example
DIMENSION A(15)
READ (1,10) A
10 FORMAT (15A6)
    DECODE (A,80,11) KNT1,KNT2,CNT3
11 FORMAT (110,13,F10.5)

ENCODE statement

The general form of the ENCODE statement is:

ENCODE (variable,length,format) 1/0 list

The ENCODE statement is similar to a WRITE statement in that it is used for a memory to memory formatted WRITE. Variable is either an unsubscripted variable name or an array name. Length is the number of bytes (or characters) that the output record is to contain. If the number of characters generated by the ENCODE statement is less than length, then the record will be blank padded to length. If the number of characters in the generated record is greater, successive records of length character will be placed in memory starting at variable. FORMAT is either an asterisk for free formatting or the number of a FORMAT statement.

Example
DIMENSION A(15)
ENCODE (A,80,*) (1,= 1,5)

FORMAT STATEMENT AND FORMAT SPECIFICATIONS

The general form of the FORMAT statement is:

n FORMAT (s1,s2, ...sn)

The FORMAT statement is used in FORTRAN to do formatted input and output. Through the use of this statement, the programmer has the ability to select the fields in which to read, or specify the columns on which to write. It is the use of this statement which gives FORTRAN its 1/0 power. On FORMATTED input, blanks are treated as zeros except when reading in A format. A constant enclosed in backslashes (i.e. VA) can be used to enter a binary constant from a string within a FORMAT statement.

If a number cannot be written in the specified field width, then the entire field will be filled with asterisks(*) to indicate the error condition.

Note: Some FORTRAN will print a negative number even when there is not enough room to place the negative sign in the field. The negative sign will simply be omitted. In this case, NEVADA FORTRAN will fill the field with asterisks. Using asterisks to fill a field that is not large enough to output a number, applies on all output specifications.

A zero will always be printed as 0.0 under a F, E or D field specification. If a field is printed as 0.000... this indicates that the digits have been truncated because the D portion of the field specification was not large enough.
All floating numbers output using the F, E or D (and G with a floating point number) specifications will be rounded to the appropriate number of digits specified by the D portion of the field specifier.

A-Type (Aw)
The A-Type specification is used to perform the input of alphanumeric data in ASCII character form. Up to six ASCII characters may be stored per variable name. However, this is entirely under program control. For example the user may choose to store only one character per variable in a dimensioned array, in order to do character manipulation. Characters are stored in the variable left justified and zero filled. On output, these padding zeros will be printed as blanks. It is not advisable to perform any arithmetic operations on a variable that contains character data as unpredictable results may occur. A format code of A6 is the maximum field width for both input and output.

Example  
10 FORMAT (A10,110,A6)

D-Type (Dw.d)
The D-Type format is treated exactly the same way as the E format code, except on output, a D is inserted into the number instead of an E. On input, they are treated exactly the same.

E-Type (Ew.d)
The E-Type specification is another method of performing I/O with floating point (real) numbers. It is through this specification that the programmer may perform I/O using an exponential format. That is a mantissa followed by an exponent of ten. As with the F type, the decimal point is assumed to be at the indicated position if not overridden in the input field. The exponent part of the input number can be omitted, in which case it is treated as if it were an F type specification. The number will be printed as d digits followed by the letter E, exponent sign, and a three digit exponent. The d part cannot be zero for output.

Example  
Output
E9.2  O.00E+ 000
E9.2  0.12E + 004
E10.0  invalid

Input
E10.0  1000.
E9.2  1.23E + 004
E9.2  O.

NOTE: Data can be read in the F format using the E or D format specification without causing an error.

When the E format is used for input, the data must be right justified in the field. If it is not, then the blanks appearing in the exponent field will be interpreted as zeros.

F-Type (Fw.d)
The F-Type specification is one of several specifications for performing I/O with floating point numbers. The digit portion of the decimal number works the same as in the I-Type format. The fractional part of the number is always printed, including trailing zeros. During input, the decimal point is assumed to be at the indicated position, unless explicitly overridden in the input field. The number ZERO will always print as 0.0 (with the decimal point aligned where specified) regardless of the field width or decimal digits specified. Remember to consider the decimal point and negative sign of the number when specifying the width of the output field.

Example  
Output
F4.1  32.2
F7.5  0.00001
F3.0  7.
F7.2  bbb4.50

Input
F7.2  b4.5bbb
F2.1  70
F7.5  bbbb001
F4.1  32.2

NOTE: The b is used to indicate a blank position. During input, the F field specifier reads w characters. If a decimal point is not read in the field, a decimal is inserted d digits from the right. A decimal point in the input field overrides the field specifications.

G-Type (Gw.d)
The G-Type can be used on either input or output and for both integer and real values where wand d have the same meaning as in the E, D and F type formats. The G format is treated as follows:

Output
If the output element is of type integer, then the format code used will be lw.
If the output element is of type real, the actual format code used depends on the value of the number being output.

\[ Ew.d \text{ will be used if the number is outside the range of} \quad 0.1 < = \text{number} < 10^\ast d, \quad \text{or} \]
\[ F(w - 5).d,5X \quad \text{if} \quad 1 < = \text{number} < 1 \]
\[ F(w - 5).(d -1),5X \quad \text{if} \quad 1 < = \text{number} < 10 \]

\[ F(w - 5).1,5X \quad \text{if} \quad 10^\ast (d - 2) < = \text{number} < 10^\ast (d -1) \]
\[ F(w - 5).0,5X \quad \text{if} \quad 10^\ast (d -1) < = \text{number} < 10^\ast d \]

In general, in this range:
\[ F(w - 5).(d - (\text{exponent of number})),5X \]

Input

If the input element is of type integer: lw, then the format code used will be lw.

If the input element is of type real: Ew.d, then the format code used is Ew.d.

Example

A=5.67
WRITE (1,34) A
34 FORMAT (G10.5)

READ (0,9) A
9 FORMAT (G9.3)

I-Type (lw)

The I-Type specification is used as a method of performing I/O with integer numbers. On input, the number must be right justified in the specified field with leading zeros or blanks. On output, the leading zeros are replaced by blanks and the number is right justified in the field.

Example

10 FORMAT (10110)

K-Type (Kw)

The K-Type format code is used to transmit data in hexadecimal format. Each byte of internal memory occupies 2 hexadecimal characters. If w is less than 12 characters (6 bytes/variable, 2 hex characters/byte), the hexadecimal characters will be either input or output starting from the low order memory address (beginning of the variable).

Example

WRITE (1,99) 1
99 FORMAT (K12)

will output the line:

100000000081

L-Type (Lw)

The L-Type specification is used with LOGICAL variables, where w is the width of the field. On output, the letter T or F is printed (for .TRUE. or .FALSE. respectively). The T or F will be right justified in the field. On input, the field is scanned from left to right until a T or F is found. The T or F can be located anywhere in the field and all characters that follow the Tor F in the remainder of the field are ignored. If the first character found is not a Tor F, an error will be generated. If the input field is completely blank, then a .FALSE. value will be used.

Example

LOGICAL WHICH
WRITE (1,11) WHICH
11 FORMAT (8L10)

T-Type (Tw)

The T-Type code can be used on both input and output. It is used to move to an explicit column within the input or output buffer. W specifies an absolute column number that the next character is to be read from (on input) or to be placed upon (on output). The first column number is 1. On input, the T format code can be used to re-read a particular set of columns in different format codes in the same read statement. Tabbing beyond the end of the input record causes the input record to be blank padded. On output, the output cursor can be moved back (to the left) over text already inserted into the output buffer, thus causing text already there to be overwritten with new data. Tabbing beyond the maximum character inserted into the output buffer will cause blanks to be inserted into the output buffer to the indicated column. The maximum value of w is 255.
Example

WRITE (1,56) I,LOT

56 FORMAT (110,T50,14)
   J = 1234
   WRITE (1,34) J
34 FORMAT (,$$$$$$$$$$$$$$$,T5,14)
will produce:
$$$$$$1234$

X-Type (wX)
The X-Type specification is used to space over any number of columns with a maximum of 255 character positions. The w may have any value from 1 to 255.

On output, the columns spaced over will be set to blanks. On input, w characters of the input record will be skipped.

Example
10 FORMAT (10X,110,3X,15)
99 FORMAT (1X,'THIS IS A LITERAL',5X,$$$$$)

Z-Type

Only used for output, the Z-Type specification indicates to the system that a carriage return/line feed is not to be written at the end of the record. The Z specification is ignored on input.

Example
   WRITE (1,10)
10 FORMAT ('INPUT X :Z')
   READ (0,*) X

I-TYPE (!)
The I-Type specification is used to cause I/O to skip to the next record. During input, this causes a new input record to be read even though the previous one was not fully used. On output, the slash will cause the current line to be written out to the associated file.

Example
54 FORMAT (1101)
   WRITE (1,100) 1,20,45
100 FORMAT (132/13)
will generate

1
20  45

Repeating field specifications

A field specification can be repeated in a FORMAT statement by preceding it with the number of times that it should be repeated. Thus 4110 is the same as 110,110,110,110
The following FORMATS are equivalent:

10 FORMAT (314,2F10.4)
10 FORMAT (14,14,14,14,14,14,14,14,14,F10.4)

A single field specification or a group of field specifications can be enclosed in parentheses and preceded by a group count. In this case, the entire group is repeated the specified number of times.

The following FORMATS are equivalent:

19 FORMAT (14,2(13,F4.1))
19 FORMAT (14,13,F4.1,13,F4.1)

The FORMATS:

10 FORMAT (15,2(13,F5.1))
10 FORMAT (15,F5.1,13,F5.1)

execute exactly the same for output, but differ for input. In a FORMAT without group counts, control goes to the beginning of the FORMAT statement for reading or writing of additional values.

In a FORMAT with group counts, additional values are read according to the last complete group.

Example
   READ (2,10) KNT,(Z(I),I = 1,KNT)
10 FORMAT (151(F10.5))

The 15 specification will be used once and the array values will be read using the F10.5 specification.

Group counts can be nested to a maximum depth of two. Thus:

10 FORMAT (2(15,3(110))) is ok, while
10 FORMAT (2(15,3(110,2(11)))) is not legal.

String Output

Character strings are written using a FORMATed write. The string to be written is enclosed in SINGLE QUOTES (') and may not contain a backslash (\).

To output a single quote within the string, two single quotes in a row must be entered. The string format type is only valid on output and if used with a READ will result in a runtime error being produced.

A character string can also be specified using the H (or Hollerith) field specification. This is an awkward method of specifying a character string, as the number of characters in the string must be specified in front of the H. The H type should be avoided as it can lead to problems.
The hexadecimal code for any character (except 0) can be inserted in a string by enclosing it in backslashes (\). The backslash character can be changed using the CON FIG program.

Placing an ampersand (&) in front of a character in a string causes the character to be treated as a control character. To output an ampersand, two ampersands in a row must be used.

Example

WRITE (1,46)
46 FORMAT ('THIS IS A TEXT STRING')
65 FORMAT (21HTHIS IS A TEXT STRING)
48 FORMAT ('This is an exclamation point '21 !')
generates: This is an exclamation point!
99 FORMAT ('This is a control L: &L')
generates: This is a control L: (followed by a control/L)
11 FORMAT (This is an ampersand: &&)
generates: This is an ampersand: &

FREE FORMAT 110

Input

FREE format input is similar to BASIC. Blanks in this mode of input are ignored completely. Numbers are entered in any format (F, D, I or E) and can be intermixed as desired. Numbers must be separated from each other by a comma or a carriage return. A comma may appear after the last number on an input line and is ignored if present. If the I/O list specifies more variables than there are in an input record, succeeding records will be read until the last is satisfied. Blank input records and blanks imbedded in numbers are ignored in this mode. The last number in any input record does not have to be followed by a comma.

Output

With FREE format output, the exact output format used depends on the type of the variable or constant being output. An integer will result in an I type format being used, and a real will use a G-type. (The actual format used in this case depends on the value being output).

Example

ACCEPT I
ACCEPT 'PLEASE ENTER ID NUMBER',ID,'HOW MUCH',AMOUNT
READ (0,*) A,B,C
TYPE THE RESULTING VALUE IS ',VALUE
WRITE (0,*) THE RESULTING VALUE IS',VALUE
TYPE '1 + 1 = ',2

FREE format I/O can also be used to any file, not just the console. The file must first be opened using either the OPEN or LOPEN routine. Then, specifying an asterisk as the FORMAT number will perform free format 110 to the specified file.

Example

CALL OPEN (2,'INFILE')
CALL OPEN (4,'B:FILE')
CALL OPEN (3,'LST:')
READ (2,*) (A(i),i = 1,10)
WRITE (3,*) (A(i),i = 10,1,-1)

BINARY 110

BINARY I/O provides a quick and efficient means of transferring information to and from a file. The variables are READ or WRITTEN in BINARY format. That is, six bytes for each item in the I/O list. WRITE causes the item in the I/O list to be written exactly as it is stored in memory without any additional conversion. READ does the opposite, reading six bytes directly into the I/O list item. No conversion or check is made on the data being read.

Example

WRITE (1,1,= 1,100)
WRITE (*ERR = 66) ARRAY
READ (*END=99) VALUE
READ (1) THIS,IS,IT

NOTE: The binary READ and WRITE transfers six bytes from the file specified directly to the variable in the I/O list. No check on the validity of the data is performed and the user should be sure that the variable contains valid numerical data before any arithmetic operations are done on the variable. An end-of-file is indicated by either the physical end of the file or a six byte field of all FF (hex). This is the value that ENDFILE will place at the end of a file that has had binary writes performed on it.

REWIND STATEMENT

The general format of the REWIND statement is:

REWIND unit

The REWIND statement is used to position the file pointer associated with unit to the beginning of the file. Essentially, this statement closes and then re-opens the file at the beginning.

Example

REWIND 3
REWIND INFILE
REWIND OUTF
BACKSPACE STATEMENT
The general format of the BACKSPACE statement is:

    BACKSPACE unit (,error)

The BACKSPACE statement is currently not implemented and will produce a message to that effect if encountered at runtime.

ENDFILE STATEMENT
The general format of the ENDFILE statement is:

    ENDFILE unit

The ENDFILE statement is used to force an end-of-file on unit. Any data that existed beyond the point in the file where the ENDFILE was executed will be lost.

Note: The ENDFILE file statement will also CLOSE the specified file. Essentially, ENDFILE is equivalent to closing the file.

Example

    ENDFILE 4
    ENDFILE FILE

GENERAL COMMENTS ON FORTRAN 110 UNDER CP/M
The OPEN or LOPEN subroutine is used to associate a file with a FORTRAN logical unit. Eight files are available, numbers 0 through 7 with 0 being permanently open and associated with input from the CP/M console, logical file 1 also is permanently open and associated with output to the CP/M console. Logical files 0 and 1 cannot be opened or closed. Additionally, any logical unit associated with the CP/M console (through the use of the filename CON) cannot have binary 1/0 done to it, cannot be rewound (using REWIND), endfiled (using ENDFILE) or seeked (using the SEEK routine).

A file that is going to be written on should first be deleted, using the DELETE subroutine before the file is opened. The OPEN routine does not delete a file as it does not know what type of 1/0 will be performed on it.

The CLOSE routine will not place any end-of-file indicator in a file that was written to; the ENDFILE statement must be used to write an end-of-file indicator to a file. The ENDFILE statement will write the normal CP/M end-of-file indicator (control-Z) if the file specified in the ENDFILE has been written to and no binary 1/0 was done to the file. If binary 1/0 has been done to the file, then an end-of-file of six bytes of FF (hex) will be written instead. If a file is written and then read without being ENDFILEd, it is possible to encounter unwritten data of unknown characters that may cause an error during the READ (illegal character, end-of-file, etc.) All files that are written to should be ENDFILEd.

When SEEKing within a file, remember that it is a BYTE position that is specified in the call to SEEK. Each record written to a file will contain a carriage return and line feed appended to the end of it. Remember that the carriage return and line feed MUST be included in the count of characters that make up a record. If SEEKing on a record, it is up to the user to insure that each record written contains the same number of characters. If the records do not contain the same number, SEEKing can become a very complicated task.

SPECIAL CHARACTERS DURING CONSOLE 110
Entering a CONTROL-X during input from the CP/M console will cancel the current line and echo an exclamation point (!) followed by a carriage return and line feed.

End-of-file from the CP/M console is indicated by a CONTROL-Z being entered as the first character of an input line during console 1/0.

Entering a DELETE (7F hex) or CONTROL-H will erase the last character entered.
The following list of FORTRAN subroutines and functions are available:

**SUBROUTINE Name**
- BIT
- CHAIN
- CIN
- CLOSE
- CTEST
- DELAY
- DELETE
- EXIT
- LOAD
- LOPEN
- MOVE
- OPEN
- OUT
- POKE
- PUT
- RENAME
- RESET
- SEEK
- SETIO

**FUNCTION Name**
- CALL
- CBTOF
- CHAR
- COMP
- INP
- PEEK

For details as to the parameters required, see the following descriptions of the individual routines.

If the error is present in the CALL statement and a CPIM error should occur, return will be to the statement following the call and error will contain the appropriate error code as listed below. If an error is present and the routine completes successfully, then a zero will be returned for error. However, if error is not specified and the routine encounters an error, the program will terminate with a runtime error.

The following is a list of possible errors that may be returned through the optional error parameter.

- 0 = OK
- 1 = Specified file not found
- 2 = Disk is full
- 3 = End-of-file encountered
- 4 = New filename for RENAME already exists
- 5 = Seek error
- 6 = Seek error (but file is closed)
- 7 = Format error in CHAIN or LOAD file

**AVAILABLE FORTRAN SUBROUTINES**

**BIT**

CALL BIT(variable,bit displacement,'S' 'R' 'F' 'T',value)

The BIT subroutine allows the setting (S), resetting (R), flipping (F), or testing (T) of individual bits.

The bit at bit displacement from the start of variable will be set if S is specified; reset if R is specified; flipped (1 will become 0 and 0 will become 1) if F is specified; and, finally, the value of the selected bit will be returned in value if T is specified. Value must be present only for T. Displacement is specified starting with the leftmost bit.

**Example**

CALL BIT(ZAPIT,O,'S')
CALL BIT(ZAPIT,O,'F',VALUE)

**CHAIN**

CALL CHAIN (’program name' (error))

The CHAIN routine is used to load in another program overwriting the existing one in memory. This is NOT an overlay. The program that issues the CALL CHAIN will be overwritten by the new program. If the program name specified does not exist, and an error was not specified, a CHAIN FL runtime error will be produced. If the format of the program name file is incorrect, program execution will be terminated. The new program to be loaded is assumed to have the .OBJ extension. The CHAIN routine will NOT close any files that may be open. Thus, the new
routine will be able to use the same files as the routine that issued the CHAIN without having to reopen them.

Example

    CALL CHAIN ('GRAPH')
    CALL CHAIN ('NXTPGM',ERROR)
    CALL CHAIN (NEXT)

CIN
The CIN routine enables the user to obtain a single character from the system console. The character is returned as the left most byte of variable. The left most bit of value read will be zeroed. The other 5 bytes of variable remain unchanged.

Example

    C WAIT FOR A CARRIAGE RETURN (ODH) FROM THE CONSOLE
    C BEFORE CONTINUING.
    80   CALL CIN(CHAR)
         IF (COMP(CHAR,#ODOO,1) .NE. O) GO TO 80

In the above example, #DOOO must be specified like this as the # operator stores the number as OD 00 00 00 00 00 in memory. This forces the hex value of a carriage return (OD) to be placed in the left most byte for the COMP routine.

CLOSE

    CALL CLOSE(unit)

The CLOSE routine is used as a method of closing FORTRAN files which were previously opened through the OPEN and LOPEN routine. Once the file has been closed, the file number is then available for reuse.

Example

    CALL CLOSE(3)
    CALL CLOSE (FILE)

CTEST

    CALL CTEST (status)

The CTEST routine is used to test the status of the system console. A zero is returned in status if there is no character ready to input on the system console. A one is returned if there is a character.

Example

    C WAIT IN A LOOP UNTIL A CHARACTER IS HIT ON THE
    C SYSTEM CONSOLE, THEN CHECK THE CHARACTER FOR A
    C LINE FEED (OAH) BEFORE CONTINUING.
    10   ARAND= .3478
    10   ARAND = RAND (ARAND)
    CALL CTEST (STATUS)
    IF (STATUS .EQ. O) GO TO 10
    C
    C CHARACTER HIT, READ IT
    C
    CALL CIN(CHAR)
    IF (COMP(CHAR,#OA00,1) .NE. O) GO TO 10

DELAY

    CALL DELAY(wait time)

The DELAY routine enables the user to implement a time DELAY of 111000 of a second to 655.36 seconds. Wait time must be in range of 0 to 65535 with 0 being the maximum delay time, 1 being the shortest and 65535 being 11100 less than O. This time is based on a 2 MHZ 8080 processor.

Example

    CALL DELAY(10)
    CALL DELAY (HOWMUCH)
    CALL DELAY (WAIT)

DELETE

    CALL DELETE ('file' {.error})

The DELETE routine is used by the FORTRAN user to remove a file from the CPIM system. Note that once a file is deleted it cannot be recovered. No error is generated if the file does not exist and the error is not present.

Example

    CALL DELETE('OUTFILE')
    CALL DELETE('OUTFILE',ERROR)
    CALL DELETE (FILE)
EXIT CALL EXIT
The EXIT routine will terminate execution of the FORTRAN
program in the same manner as the STOP statement, except that
EXIT does not output STOP to the system console.
Example
CALL EXIT

LOAD
CALL LOAD('file to 10ad',load-type(.,error))
The LOAD routine is used to load either a standard CPIM .HEX file
or a NEVADA ASSEMBLER .OBJ file. If load-type is non-zero, then
the type of the file to be loaded will be .HEX. If load-type is zero, then
the type will be .OBJ. This routine can be used to load
assembly language routines into memory that can then be
accessed through the CALL function. No check is made during
the loading process to see whether the object code being read
into memory overlays the program or runtime package.

It is left up to the user to insure that it does not occur. Normally,
the routine package occupies memory from 100H to 4000H. If the
file to load does not exist and an error is not specified, a CHAIN
FL runtime error will be produced. If the format of the program
name file is incorrect, program execution will be terminated.

Example
CALL LOAD ('ASMFILe',O)
CALL LOAD ('ASMOBJ',1,ERROR)

LOPEN
CALL LOPEN(unit,'file' {,error})
This subroutine is functionally the same as OPEN in that it
associates a FORTRAN unit with a CPIM file except that the first
character of all output records will be processed as the printer's
carriage control. This is usually used for a listing device such as a
printer. The first character of the record will not be output to the
file but processed as follows:

<table>
<thead>
<tr>
<th>First Character</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>+</td>
<td>overprint the last record</td>
</tr>
<tr>
<td>blank (space)</td>
<td>single skip</td>
</tr>
<tr>
<td>0</td>
<td>double skip</td>
</tr>
<tr>
<td>-</td>
<td>triple skip</td>
</tr>
<tr>
<td>1</td>
<td>page eject</td>
</tr>
</tbody>
</table>

If none of the above characters are present, then single-line
spacing will be assumed. Overprinting is implemented by only
generating a carriage return at the end of the line (not followed by
a line feed). A page eject generates a form feed character (OCH).

The output device that finally prints the output from this file must
respond in the following manner:

- ODH (carriage return) - return to beginning of line
- OAH (line feed) - space 1 line, do not return to
  beginning of line
- OCH (form feed) - space to the top of the next page

A carriage return must cause the line to be printed on a line
oriented device.

Example
CALL LOPEN (2,'LST: ')
C
C PAGE EJECT TO TOP OF NEW PAGE
C
WRITE (2,1)
1 FORMAT ('1THIS SHOULD BE ON THE TOP OF A NEW PAGE')
C
WRITE (2,2)
2 FORMAT ('1ONE BLANK LINE ABOVE THIS ONE'
 1+ '1THIS LINE WILL OVERPRINT THE ONE ABOVE'
 1+ ' 5X:THIS LINE WILL HAVE 2 LINES ABOVE IT')
STOP
END
MOVE

CALL MOVE(count,from,displacement,to,displacement)

The MOVE routine allows direct access to memory for both reads and writes. The count specifies the number of bytes to be moved. The arguments from and to specify either a memory address to be used or a character string to be moved. Which interpretation of, from, and to is based on the respective displacement. If the displacement is negative, then the associated from or to specifies an address to be used in memory access. If the displacement is positive, then the from or to that is associated with it is a string.

Example

CALL MOVE(2,A,-1,$CCOO,-1)
This MOVES 2 bytes from the address specified by A to address CCOO(HEX).

CALL MOVE(6,'STRING',0,$CCOO,-1)
This MOVES 6 bytes of the string 'STRING' to address CCOO(HEX).

CALL MOVE(1024,$CCOO,-1,A,0)
This MOVES 1024 bytes from address CCOO(HEX) to the address of A.

NOTE: The DOLLAR ($) sign indicates a hexadecimal constant. This hexadecimal constant is converted to floating point notation internally.

OPEN

CALL OPEN(unit,'file' [,error])

The OPEN routine is used to open a CPIM file the user may wish to access. The unit and file are required entries. If the CPIM file does not exist and error is not specified, then the file will be created. However, if error is specified and the file does not exist, the appropriate CPIM error code will be returned and the file will not be opened.

There are two special filenames that are recognized by the OPEN routine:

CON: Used to specify either CPIM console input or output

LST: Used to specify CPIM list device

Example

CALL OPEN (3,'CON: ')
WRITE (3,' A = ',A

will output the text to the system console. Files opened with the name CON: can also use a literal in an input statement such as:

CALL OPEN (4,'CON: ')
READ (4,' ') 'INPUT QUANTITY ',QUANT

Output can be directed to the CPIM LST device by opening the file LST: as in the following example:

CALL OPEN (2,'LST: ')
WRITE (2,' ') (i,i = 1,123)

To open a disk file, just the filename needs to be specified such as:

CALL OPEN (4,'C:FILE.BAS')
CALL OPEN (2,'DISKFILE')
CALL OPEN (3,'B:INPUT')
READ (3,' ') VALUE
WRITE (2,22) VALUE

22 FORMAT (F10.4)
WRITE (4,55)
55 FORMAT ('THIS LINE WILL BEWRITTEN TO THE FILE')

To open a file and check if the file exists, the optional error parameter must be specified such as:

CALL OPEN (3,'INPUT',IERERROR)
IF (IERERROR .NE.O)THEN
TYPE 'CANNOT OPEN INPUT FILE'
STOP 'RUN ABORTED'
ENDIF

NOTE: The filename (whether a character string or array name) is defined as terminating when:

13 characters are encountered
A NULL is encountered

OUT

CALL OUT (port,value)

This routine allows access to the 8080180851280 output ports. Value will be converted to an 8 bit number and output to port.

Example

CALL OUT(10,1)
CALL OUT (PORT,10)
CALL OUT (CONTROL,BITVL)
POKE
CALL POKE(memory location,value)
This routine allows changing of memory locations. Value will be converted to an 8 bit quantity and stored at the location specified by memory location.

Example
CALL POKE (0,34)
CALL POKE (1,PEEK(1)+ 1)
The last example will increment the contents of memory location 0001.

PUT
CALL PUT(value)
The PUT routine is used to output a character to the console without the FORTRAN system interpreting it. Using this routine, it is possible to do such things as control the position of the cursor. Value must be a number or variable and cannot be a string.

Example
CALL PUT(27) will clear the screen on an ADM 3A
CALL PUT(61) will output an A

RENAME
CALL RENAME('old file','new file',{ error})
The RENAME routine will rename old file to new file. A runtime error occurs if old file does not exist and error is not specified or new file already exists.

Example
CALL RENAME ('OLD','NEW')
DIMENSION OFILE(2),NFILE(2)
READ (0,1) OFILE,NFILE
1 FORMAT (2A612A6)
CALL RENAME (OFILE,NFILE,ERROR)

RESET
CALL RESET
The RESET routine is used to inform CPIM that a disk has been changed at runtime. This routine must be called if a disk is changed and you wish to write on the new disk. If the RESET routine is not called, then a BDOS: RIO will occur and the program will abort if a write is attempted on the changed disk. This routine will prompt for a change in disk and wait for the change to occur. Also, all open files on the disk to be changed should be closed (using the CLOSE routine) before RESET is called. The programmer is responsible for closing the files. They can be done as follows:

Example
CALL CLOSE (4)
CALL CLOSE (5)
C
C THE "RESET" ROUTINE WILL PROMPT FOR THE CHANGE
C
CALL RESET

SEEK
CALL SEEK (unit,position ,{ error})
The SEEK routines allow random positioning within a file. The file associated with unit will be positioned to position which specifies a displacement in bytes from the beginning of the file. If error is specified, there are two possible values that may be returned on a seek error. A five indicates a seek to a part of the file that doesn't exist, and a six indicates a seek to an extent of the file that does not exist. The difference between the two is that if error code six is returned, the file associated with unit is closed. The file will have to be re-opened before it can be used again.

Example
CALL SEEK (FILE,IPOS*10+ 4)
CALL SEEK (3,100,ERROR)
SETIO
CALL SETIO(new 1/0)
This routine allows changing how the runtime package performs console I/O. The default method is setup using the CONFIG program, however it can be changed as follows:
new 1/0 = 0 to use direct BIOS 1/0
new 1/0 = 2 to use CPIM function 1&2
new 110 <> 0 or 2 to use CPIM function 6 (should be used with CPIM 2.x only).

The use of CPIM functions 1&2 permits the use of the control-p ability of CPIM to echo all the console output to the LST device. Use of other options will bypass this ability.

Example
CALL SETIO (2)
CALL SETIO (10)

Available FORTRAN Functions

CALL
A = CALL(address,argument)
The CALL function causes execution of assembly language routines that have been loaded into memory (usually by the LOAD subroutine). Address is the memory location to be CALLed. Argument will be converted to a 16 bit binary number and then passed to the called routine in both the BC and DE register pairs. The assembly routine places the value to be returned in register pair HL. The return address is placed on the 8080 stack and the CALLed routine can just issue a standard RET instruction to return to the FORTRAN program.

Example
CALL LOAD ('ASMFILE',1)
A = CALL ($DEOO,VALUE)

CBTOF
A = CBTOF(from,displacement (8-bit))
The CBTOF function is used to convert either a 16 bit or 8 bit binary number to its equivalent floating point value. The number to be converted is located at from + displacement if displacement is positive. If displacement is negative, then from contains the address to be used. The number is assumed to be a 16 bit value (stored in standard 8080 format) unless 8-bit is present, in which case it will be assumed to be an 8 bit value. The binary number is considered to be unsigned.

Example
BIOS= CBTOF($0006,1)- 3
gets the base address of the CPIM BIOS jump table by reading the 16 bit address at location 0001 and subtracting 3 from it.

CHAR
A = CHAR(variable,displacement)
The CHAR routine is used to return the numerical value of an ASCII character located at variable + displacement where displacement is a byte displacement from the beginning of variable. For example:

Example
A='ABCDEF'
B = CHAR(A,0) returns 61
B = CHAR(A,1) returns 62
B = CHAR(A,5) returns 66

COMP
A = COMP(string1,string2,length)
The COMP routine is used to compare character strings in the following manner:
A = COMP('string1' , 'string2' ,length).
The strings will be compared on a byte basis for a byte count of length. The routine returns the following:
- 1 if string1 < string2
  0 if string1 = string2
  +1 if string1 > string2
INP

\[ A = \text{INP}(\text{port}) \]

This routine allows access to the 8080 input ports. This is a function whose value is the current setting of the input port specified by port. No wait is done using the INP routine. It will return the current value that the input port contains.

Example

\[ 1 = \text{INP}(10) \]
\[ 10 \text{ IF (INP(CONSOLE) } \neq \text{ O)GO TO 10} \]
\[ \text{VALID} = \text{INP(CLOCK)} \text{ .AND. 48} \]

PEEK

\[ A = \text{PEEK(memory location)} \]

The PEEK routine is used to read an 8 bit value from a memory location. The byte at the address specified by memory location will be returned as the value of the function.

Example

\[ \text{BIOS} = (\text{PEEK}(1) + \text{PEEK}(2) \times 256) - 3 \]

This is equivalent to the example of using CBTOF.
INTRODUCTION TO NEVADA ASSEMBLER

The assembler translates a symbolic 8080 assembly language program "source code" into the binary instructions "object code" required by the computer to execute the program.

The assembler operates on standard CP/M text files. Each line of a normal text file consists of the characters of that line followed by a carriage return (0DH) and a line feed (0AH).

When the assembler is invoked, it is loaded into memory starting at location 100H. It processes the source code file in two passes.

On the first pass, it builds a symbol table containing all of the labels defined in the source program. The symbol table begins at the memory location immediately following the assembler; each entry in the table is seven bytes long. Certain errors may be detected during the first pass, causing error messages to be output to an error file (usually the console). On the second pass, the object code is generated and usually output to an object code file. In addition, a formatted listing of both source and object code may be output to a listing file and the symbol table may be output to a file. Any errors detected during this pass cause messages to be output to the error file.

To abort the assembly process at any time, press the CTRL and C keys.

After the assembly runs to completion and no errors are detected, the resulting object code file (type .OBJ) can be executed by typing RUNA and its name.

EXAMPLE:
RUNA PROG  loads and executes a file called PROG.

OPERATING PROCEDURES

HARDWARE REQUIREMENTS

Your Commodore 64 Computer
The Commodore Z80 microprocessor
A Commodore 1541 single disk drive
A video display monitor such as the Commodore color monitor model 1701/1702

SOFTWARE REQUIREMENTS

Commodore’s CP/M Operating System disk

FILE TYPE CONVENTIONS

Assembly source code files .ASM
COBOL source code files .CBL
FORTRAN source code files .FOR
Object code run time files .OBJ
Printer listing files .PRN
Symbol table listing files .SYM
Error files .ERR
Work files .WRK

GETTING STARTED

Refer to the Getting Started section in your Commodore 64 NEVADA FORTRAN manual.

EXECUTING THE ASSEMBLER

The assembler is invoked by a CP/M command with the following formats.

FORMAT-1:
ASSM file <CR>

FORMAT-2:
ASSM file[.uuu u$#LP0] <CR>
DESCRIPTION:
where:

file = [unit:] source-file-name
The name of the source code input file. This parameter must be present; all others are optional.

[ ] = optional parameters
unit: disk drive unit letter. If this parameter is not included the default drive is used.

u = the disk drive unit letter or the letter "X" for output to the console, or the letter "Z" for no output.

- for position one.
   This single character code, if present, represents the drive onto which the listing file is to be written. If this argument is absent, then the listing will be written on the default drive. Also, if the character is an X, the listing will be sent to the console. If the character is a Z, then no object code file will be produced.

- for position two.
   The second letter of the file type represents the drive for the object (.OBJ) file. If this argument is absent, then the file will be written on the default drive. If this character is a Z, then no object code file will be produced.

- for position three.
   The third letter of the file type represents the drive for the error (.ERR) file. If this argument is absent, the console will be used to display the errors. This argument must be followed by a space or carriage return.

- for position one of the second set.
   The first letter of the second set of arguments represents the drive for the symbol (.SYM) file. If this argument is absent, no symbol table file will be produced.

<$options>
Various assembler options may be controlled by following the $ with one or more of the following option specifiers. The list of options is terminated by a carriage return. For those options that may be preceded by + or -, the + is optional and will be assumed if absent.

+L The source file has line numbers in column 1-4 of each line.

- L The source file has no line numbers.

If neither of these is specified, the assembler will examine the first line to determine if the file has line numbers.

# Instructs the assembler to generate its own line numbers in the listing in place of those in the source file (if any).

P Instructs the assembler to paginate output to the listing file. The file name of the source code file will be printed on the top left-hand corner of each page. A page number will be printed on the top right-hand corner of each page. If a TITL pseudo-operation occurs in the source code, a one- or two-line title will be centered at the top of each page.

0,1,2, or 3 Specifies the spacing on the listing:
0 = no additional spacing
1 = 72 column output
2 = 80 column output (default)
3 = 132 column output

S Specifies output symbol table in format for SID.

EXAMPLES:
  ASSM TST
  ASSM TST.AAX AS- L#P0

STARTUP
To assemble your program, type ASSM and the source file name. The first thing that happens is the copyright message is displayed on the screen and the disk drive(s) begins working. When the assembly process is complete, a message will be displayed and machine control will return to the operating system.

A> ASSM source-file <CR>
NEVADA ASSEMBLER (C) COPYRIGHT 1982
ELLIS COMPUTING, INC.
REV 2.1 ASSEMBLING
NO ASSEMBLY ERRORS. 4 LABELS WERE DEFINED.
A>
EXECUTING THE _OBJ FILE

To execute the program, type RUNA and the file-name. The assembly process creates a file with the extension type of (.OBJ). This object program file will be loaded into memory and executed.

A>RUNA file-name

There are several options that also can be specified with the RUNA command.

RUNA file-name [ZLC]
Z = zero memory before loading the .OBJ file.
L = load the program but don't execute it. Control returns to CP/M.
C = create a .COM file for later execution. Control returns to CP/M. Remember .COM files always begin execution at location 100H.

Example:
A>RUNA PROG.ZC  this will zero memory and create a file named PROG.COM.
A>RUNA PROG.L  this will load PROG but not execute it.

NOTE: These object code files (.OBJ), if properly orged (assembled with proper origin), can also be loaded and executed by the NEVADA COBOL and NEVADA FORTRAN run time packages. However, NEVADA COBOL and NEVADA FORTRAN generated type (.OBJ) files cannot be converted to (.COM) files by RUNA because of runtime package requirements. Please see the Nevada FORTRAN manual for the procedure to generate a FORTRAN (.COM) file.

MEMORY USAGE

The ASSEMBLER program is read into memory starting at location 100H and uses all memory available up the bottom of CP/M.
The runtime package RUNA loads into memory at location 100H and relocates itself to just below CP/M and then begins loading your program.

TERMINATION

The normal termination of the assembly is signaled by the display of the following messages and returned to CP/M.

NO ASSEMBLY ERRORS. 4 LABELS WERE DEFINED.

A>
The assembly process can be interrupted at any time by pressing the CTRL and C keys.

14 STATEMENTS

INTRODUCTION

An assembly language program (source code) is a series of statements specifying the sequence of machine operations to be performed by the program.

Each statement resides on a single line and may contain up to four fields as well as an optional line number. These fields, label, operation, operand, and comment, are scanned from left to right by the assembler, and are separated by spaces. The assembler can handle lines up to 80 characters in length.

LINE NUMBERS

Line numbers in the range 0000-9999 may appear in columns 1-4. Line numbers need not be ordered and have no meaning to the assembler, except that they appear in listings. Line numbers may also make it easier to locate lines in the source code file when it is being edited. The disk and memory space required for normal text files will be increased by five bytes per line if line numbers are used; this may become significant for large files.

If line numbers are not used, the label field starts in column 1 and the operation field may not start before column 2. If line numbers are used, they must be followed by at least one space, so the label field starts in column 6 and the operand may not start before column 7.

Once the starting column for the label has been established, the same format must be followed throughout the file: either all of the lines or none of the lines have line numbers. Any other file(s) assembled along with the main file (using COPY pseudo-operation) must conform to the format of the main file.

Example of source statements with line numbers:

Column
1234567
0001 LABEL ORA A  label field must start at column 6.
0002 JNZ NEXT    operation field starts at column 7
0003 ;           (minimum).
0004 LOOP MOV A,B operation field starts one space after
0005 * label.

Example of source statements without line numbers:

Column
1234567
LABEL ORA A  label field must start at column 1.
JNZ NEXT    operation field starts at column 2 (minimum).
LOOP MOV A,B operation field starts one space after label.
LABEL FIELD
The label field must start in column 1 of the line (column 6 if line numbers are used). A label gives the line a symbolic name that can be referenced by any statement in the program. Labels must start with an alphabetic character (A-Z,a-z), and may consist of any number of characters, though the assembler will ignore all characters beyond the sixth; e.g., the labels BRIDGE, BRIDGE2, and BRIDGET cannot be distinguished by the assembler. A duplicate label error will occur if any two labels in a program begin with the same six letters.

A label may be separated from the operations field by a colon (:) instead of, or in addition to, a blank.

The labels A, B, C, D, E, H, L, M, PSW, and SP are pre-defined by the assembler to serve as symbolic names for the 8080 registers. They must not appear in the label field.

An asterisk (*) or semi-colon (;) in place of a label in column 1 (column 6 if line numbers are used) will deSignate the entire line as a comment line.

OPERATION FIELD
The operation field contains either 8080 instruction mnemonics or assembler pseudo-operation mnemonics. Appendix 1 summarizes the standard instruction mnemonics recognized by the assembler, and Appendix 4 lists several references to consult if more information on the 8080 machine instructions is needed.

Assembler pseudo-operations are directives that control various aspects of the assembly process, such as storage allocation, conditional assembly, file inclusion, and listing control.

An operation mnemonic may not start before column 2 (column 7 if line numbers are used) and must be separated from a label by at least one space (or a colon).

OPERAND FIELD
Most machine instructions and pseudo-operations require one or two operands, either register names, labels, constants, or arithmetic expressions involving labels and constants.

The operands must be separated from the operator by at least one space. If two operands are required, they must be separated by a comma. No spaces may occur within the operand field, since the first space following the operands delimits the comments field.

Register Names
Many 8080 machine instructions require one or two registers or a register pair to be deSignated in the operand field. The symbolic names for the general-purpose registers are A, B, C, D, E, Hand L.

SP stands for the stack pointer, while M refers to memory location whose address is in the HL register pair. The register pairs BC, DE and HL are designated by the symbolic names B, D, and H, respectively. The A register and condition flags, when operated upon as a register pair, are given the symbolic name PSW.

The values assigned to be register names A, B, C, D, E, H, L, M, PSW and SP are 0, 1, 2, 3, 4, 5, 6, and 6, respectively. These constants, or any label or expression whose value lies in the range 0 to 7, may be used in place of the pre-defined symbolic register names where a register name is required; such a substitution of a value for the pre-defined register name is not recommended, however.

Labels
Any label that is defined elsewhere in the program may be used as an operand. If a label is used where an 8-bit quantity is required (e.g., MVI C,LABE), its value must lie in the range - 256 to 255, or it will be flagged as a value error.

If a label is used as a register name, its value must lie in the range 0 to 7, or be 0, 2, 4, or 6 if it designates a register pair. Otherwise, it will be flagged as a register error.

During each pass, the assembler maintains an instruction location counter that keeps track of the next location at which an instruction may be stored; this is analogous to the program counter used by the processor during program execution to keep track of the location of the next instruction to be fetched.

The special label $(dollar sign) stands for the current value of the assembler's instruction location counter. When $ appears within the operand field of a machine instruction, its value is the address of the first byte of the next instruction.

Example:

FIRST EQU $  
TABLE DB ENTRY  
*  
*  
LAST EQU $  
TABLN EQU LAST-FIRST  

The label FIRST is set to the address of the entry in a table and LAST points to the location immediately after the end of the table. TABLN is then the length of the table and will remain correct, even if later additions or deletions are made in the table.
CONSTANTS

Decimal, hexadecimal, octal, binary and ASCII constants may be used as operands.

The base for numeric constants is indicated by a single letter immediately following the number, as follows:

- D = decimal
- H = hexadecimal
- O = octal
- Q = octal
- B = binary

If the letter is omitted, the number is assumed to be decimal. Q is usually preferred for octal constants, since 0 is so easily confused with 0 (zero). Numeric constants must begin with a numeric character (0-9) so that they can be distinguished from labels; a hexadecimal constant beginning with A-F must be preceded by a zero.

ASCII constants are one or two characters surrounded by single quotes ('). A single quote within an ASCII constant is represented by two single quotes in a row with no intervening spaces. For example, the expression "\"A\"", where the two outer quote marks represent the string itself, i.e., the single quote character. A single character ASCII constant has the numerical value of the corresponding ASCII code. A double character ASCII constant has the 16-bit value whose high-order byte is the ASCII code of the first character and whose low-order byte is the ASCII code of the second character.

If a constant is used where an 8-bit quantity is required (e.g., MVI C,10H), its numeric value must lie in the range 0 to 255 and it will be flagged as a value error.

If a constant is used as a register name, its numeric value must lie in the range 0 to 7, or be 0, 2, 4, or 6 if it designates a register pair. Otherwise, it will be flagged as a register error.

Examples:

- MVI A,128 Move 128 decimal to register A.
- MVI C,10D Move 10 decimal to register C.
- LXI H,2FH Move 2F hexadecimal to registers HL.
- MVI B,303Q Move 303 octal to register B.
- MVIA,Y Move the ASCII value for Y to register A.
- MVI A,101B Move 101 binary to register A.
- JMP OFFH Jump to address FF hexadecimal.

EXPRESSIONS

Operands may be arithmetic expressions constructed from labels, constants, and the following operators:

- + addition or unary plus
- - subtraction or unary minus
- * multiplication
- / division (remainder discarded)

Values are treated as 16-bit unsigned 2's complement numbers. Positive or negative overflow is allowed during expression evaluation, e.g., 32767 + 1 = 7FFFH + 1 = 32768 and - 32768 - 1 = 7FFFH = 32767. Expressions are evaluated from left to right; there is no operator precedence.

If an expression is used where an 8-bit quantity is required (e.g., MVI C,TEMP+ 10H), it must evaluate to a value in the range - 256 to 255, or it will be flagged as a value error.

Examples:

- MVI A,255D/10H- 5
- LDA POTTS/256*OFFSET
- LXI SP,30*2+ STACK

High- and Low-Order Byte Extraction

If an operand is preceded by the symbol <, the high-order byte of the evaluated expression will be used as the value of the operand. If an operand is preceded by the symbol >, the low-order byte will be used.

Note that the symbols < and > are not operators that may be applied to labels or constants within an expression. If more than one < or > appears within an expression, the rightmost will be used to determine whether to use the high- or low-order byte of the evaluated expression as the value of the operand. That is, the rightmost < or > is treated as if it preceded the entire expression, and the others will be totally ignored.

Examples:

- MVI A,>TEST Loads register A with the least significant 8 bits of the value of the label TEST.
- MVI B,<0CC00H Loads register B with the most significant byte of the 16-bit value CC00H, i.e., CCH.
- MVI C,<1234H Loads register C with the value 12H.
- MVI C,>1234H Loads register C with the value 34H.
COMMENT FIELD

The comment field must be separated from the operand field (or operation field for instructions or pseudo-operations that require no operand) by at least one space. Comments are not processed by the assembler, but are solely for the benefit of the programmer. Good comments are essential if a program is to be understood after it is written or is to be maintained by someone other than its author.

An entire line will be treated as a comment if it starts with an asterisk (*) or semicolon (;) in column 1 (column 6 if line numbers are used).

Examples:

0001   * is input ready?
0002   LOOP IN STAT input device status
0003   AN I 1 test status bit
0004   JZ LOOP wait for data
0005   * data is now available

If listing file formatting is specified in the ASM command ($F = options contains 1, 2, or 3), the comment field must be preceded by at least two spaces to ensure proper output formatting. Furthermore, instructions and pseudo-operations requiring no operand must be followed by a dummy operand (a period is recommended).

Examples:

MVI A,10 comments
RZ comments

15 PSEUDO-OPERATIONS

Pseudo-operations appear in a source program as instructions to the assembler and do not always generate object code. This section describes the pseudo-operations recognized by the NEVADA ASSEMBLER.

In the following pseudo-operation formats, <expression> stands for a constant, label, arithmetic expression constructed from constants and labels. Optional elements are enclosed in square brackets [ ].

Equate

<label> EQU <expression>

This pseudo-operation sets a label name to the 16-bit value that is represented in the operand field. That value holds for the entire assembly and may not be changed by another EQU.

Any label that appears in the operand field of an EQU statement must be defined in a statement earlier in the program.

Examples:

BELL EQU 7 The value of the label BELL is set to 7.
BELL2 EQU BELL *2 The label BELL2 is set to 7*2.

Set Origin

[<label>] ORG <expression>

This pseudo-operation sets the assembler’s instruction location counter to the 16-bit value specified in the operand field. In other words, the object code generated by the statements that follow must be loaded beginning at the specified address in order to execute properly. The label, if present, is given the specified 16-bit value.

Any label that appears in the operand field of an ORG statement must be defined in a statement earlier in the program.

If no origin is specified at the beginning of the source code, the assembler will set the origin to 100H. If no ORG pseudo-operation is used anywhere in the source program, successive bytes of object code will be stored at successive memory locations.

Examples:

* ORG 4000H Determines that the object code generated by subsequent statements must be loaded in locations beginning at 4000H.
* START ORG 100H Determines that the object code generated by subsequent statements must be loaded in locations beginning at 100H.
This pseudo-operation specifies the entry point address for the program, i.e., the address at which it is to begin execution. If a program contains no XEQ pseudo-operation, the object code file will contain a starting address of 100H. If more than one XEQ appears in a program, the last will be used.

An example of the difference between ORG and XEQ is that a program whose first 100 bytes are occupied by data will have an ORG address 100 bytes lower in memory than its XEQ address.

Example:

XEQ 100H  The entry point address for the assembled program is set to 100H.

Define Storage  [<label>]  DS <expression>
 [<label>]  RES <expression>

Either of these pseudo-operations reserves the specified number of successive memory locations starting at the current address within the program. The contents of these locations are not defined and are not initialized at load time.

Any label that appears in the operand field of a DS or RES statement must be defined in a statement earlier in the program.

Examples:

SPEED DS 1  Reserves one byte.
DS400  Reserves 400 bytes.
RES 177Q  Reserves 177 (octal) bytes.

Define byte  [<label>]  DB <expression>  [<expression>, ..]

This pseudo-operation sets a memory location to an 8-bit value. If the operand field contains multiple expressions separated by commas, the expressions will define successive bytes of memory beginning at the current address. Each expression must evaluate to a number that can be represented in 8 bits.

Examples:

DB1  one byte is defined.
DB OFFH,303Q,100D,11010011B,3*BELL,-10  multiple bytes.
TABLE DB 'A','B','C','D',0  multiple bytes are defined.

Define Word  [<label>]  DW <expression>

This pseudo-operation sets two memory locations to a 16-bit quantity. The least significant (low-order) byte of the value is stored at the current address and the most significant byte (high-order) is stored at the current address + 1.

Examples:

SAVE DW 1234H  1234H is stored in memory, 34H in the low-order byte and 12H in the high-order byte.
YES DW 'OK'  The ASCII value for the letters 'O' and 'K' is stored with the 'K' at the lower memory address.

Define Double Byte  [<label>]  DDB <expression>

This pseudo-operation is almost the same as DW, except that the two bytes are stored in the opposite order: high-order byte first, followed by the low-order byte.

Example:

FIRST DDB 1234H  1234H is stored in memory, 12H in the low-order byte and 34H in the high-order byte.

Define ASCII String  [<label>]  ASC <ASCII string>#
 [<label>]  ASCZ <ASCII string >#

The ASC pseudo-operation puts a string of characters into successive memory locations starting at the current location. The special symbols # in the format are "delimiters"; they define the beginning and end of the ASCII character string. The assembler uses the first non-blank character found as the delimiter. The string immediately follows this delimiter, and ends at the next occurrence of the same delimiter, or at a carriage return.

The ASCZ pseudo-operation is the same except that it appends a NUL (00H) to the end of the stored string.

Examples:

WORDS ASC "THIS IS AN ASCII STRING"
ASCZ "THIS IS ANOTHER STRING"
The Conditional pseudo-operation enables listing of conditional source code even though no object code is being generated because of a false IF condition. The assembler will not list such conditional source code if this pseudo-operation is not used.

**Copy file**

`COpy [<unit:>]<file-name>`

This pseudo-operation copies source code from a disk file into a program being assembled. The code from the copied file will be assembled starting at the current address. When the copied file is exhausted, the assembler will continue to assemble from the original file. The resulting object code will be exactly like what would be generated if the copied source code were part of the original file, but the COPY pseudo-operation does not actually alter any source file.

A copied file may not copy another file. And, all files that are accessed by the COpy pseudo-operation must be of the same format as the main source file, i.e., either having or not having line numbers. The files must be type (.ASM).

**Examples:**

```
COPY FILE1
COPY B:FILE2
```

**Listing Control**

`NLST`  
`LST`  

The NLST pseudo-operation suppresses all output to the listing file. Object code will still be output to the object code file and the lines containing errors will still be output to the error file. The LST pseudo-operation re-enables output to the listing file.

**Listing Title**

`TITL <first line>"<second line>`

If the P option is specified in the ASM command, the one- or two-line title specified by this pseudo-operation will be printed centered at the top of each page of the listing.

**Page Eject**

`PAGE`

If the P option is specified in the ASM command, this pseudo-operation causes a skip to the top of the next page of the listing.

**End of Source file**

`END`

This pseudo-operation terminates each pass of the assembly. Only one END statement should be in the file or files to be assembled, and it should be the last statement encountered by the assembler. Since an end-of-file on the source code input file will also terminate each pass, the END statement is unnecessary in most cases.
16 ERROR CODES AND MESSAGES

ASSEMBLER COMMAND ERRORS
A number of console messages may be generated in response to errors in the ASM command. When an error of this sort occurs, the assembly is aborted and control returns to CP/M.

EXPECTED NAME The source code input file name is missing.

ILLEGAL OPTION An unrecognized option specifier follows $.

91 ERROR IN EXTENDING THE FILE
92 END OF DISK DATA - DISK IS FULL
93 FILE NOT OPEN
94 NO MORE DIRECTORY SPACE - DISK IS FULL
95 FILE CANNOT BE FOUND
96 FILE ALREADY OPEN
97 READING UNWRITTEN DATA

ASSEMBLY ERRORS
If a statement contains one of the following errors, there will be a single letter error code in column 19 of the line output to the listing and/or error files. An error detected during both the first and second pass of the assembler will be flagged twice in the listing(s). If the error is not an opcode error, NULs will be output as the second and, if appropriate, third bytes of object code for that instruction. If the error is an opcode error, the instruction will be assumed to be a three-byte instruction, and three NULs will be written to the listing and/or error files. The error codes are:

A ARGUMENT ERROR An illegal label or constant appears in the operand field. This might be
• a number with a letter in it, i.e., 2L
• a label that starts with a number, i.e., 3STOP
• an improper representation of a string, i.e., "A" in the operand field of a statement containing the ASCII pseudo-operation.

D DUPLICATE LABEL The source code contains multiple labels whose first five characters are identical.

L LABEL ERROR The symbol in the label field contains illegal characters, e.g., it starts with a number.

M MISSING LABEL An EQU instruction does not have a symbol in the label field.

O OPCODE ERROR The symbol in the operation field is not a valid 8080 instruction mnemonic or an assembler pseudo-operation mnemonic.

R REGISTER ERROR An expression used as a register designator does not have a legal value.

S SYNTAX ERROR A statement is not in the format required by the assembler.

U UNDEFINED SYMBOL A label used in the operand field is not defined, i.e., does not appear in the label field anywhere in the program, or is not defined prior to its use as an operand in an EQU, ORG, DS, RES, or IF pseudo-operation.

V VALUE ERROR The value of the operand lies outside the allowed range.
APPENDIX A - STATEMENT SUMMARY

ACCEPT input list
- Reads values from the system console and assigns them to the variables in the input list.

ASSIGN n TO v
- Assigns a statement label to a variable to be used in an Assigned GO TO.

BACKSPACE unit
- Positions the specified unit to the beginning of the previous record.

BLOCK DATA
- Begin a BLOCK DATA subprogram for initializing variables in COMMON.

CALL name(argument list)
- Call the subroutine passing the argument list.

COMMON /label1/list1 /label2/list2
- Declares the variables and array that are to be placed in COMMON with the various routines.

CONTINUE
- Causes no action to take place, usually used as the object of a GOTO or DO loop.

COPY filename
- The specified filename is inserted into the source at the point of the COPY statement.

CTRL DISABLE
- Disables program termination by control/c from the console.

CTRL ENABLE
- Enables program termination by control/c from the console. Control C being enabled is the default.

DATA /var1/const1 ,const2/var2/const1 ,c2 /
- Initializes the specified variable, array element or arrays to the specified constants.

DIMENSION v(n1,n2,...),v2(n1,n2,...)
- Sets aside space for arrays v and v2.

DO n i = n1,n2,n3
- Executes statements from DO to statement n, using i as index, increasing or decreasing from n1 to n2 by steps of n3.

DOUBLE PRECISION v1,v2,...
- Declares v1, v2, etc, to be DOUBLE PRECISION variables.

DUMP /id/ output list
- When a runtime error occurs, displayed id and items in output list.

END
- This statement must be the last statement of every routine.

ENDFILE unit
- Write an end-of-file at the current position of unit.

ERRCLR
- Clears the effect of the ERRSET statement.

ERRSET n,v
- When a runtime error occurs, control goes to the statement labelled n with variable v containing the error code.

FORMAT (field specifications)
- Used to specify input and output record formats.

FUNCTION name(argument list)
- Begins the definition of a function subprogram.

GOTO n
- Transfer control to the statement labelled n.

GO TO v,(n1,n2,_,),v
- The COMPUTED GOTO transfers control to n1 if v= 1, n2 if v= 2, etc.

GO TO v,(n1,n2,_,)
- The ASSIGNED GOTO transfers control to statement n1, n2,... depending on the value of v. V must have appeared in an ASSIG N statement.

IF (e)n1,n2,n3
- The arithmetic IF transfers control to n1 if e< 0, n2 if e = 0 or n3 if e>0.

IF (e)statement
- The logical IF executes statement if the value of expression e is true (non-zero).

IF (e) THEN statement1 ELSE statement2 ENDIF
- The IF-THEN-ELSE executes blocks of statements _ statement1 if e is true, or blocks of statements - statement2 if e is false.

IMPLICIT type(letter list)
- Changes the default type of variables that start with the letters in the letter list.

INTEGER v1,v2,...
- Declares v1, v2, etc, to be integer variables.

LOGICAL v1,v2,...
- Declares v1, v2, etc, to be logical variables.

PAUSE 'character string'
- Suspends program execution until any key is hit, displaying PAUSE and character string.
READ (unit,format(,ERR = ) (.END = )) input list
Reads values from unit according to format and assigns them to the variables in input list.

REAL v1,v2, _
Declares v1, v2, etc, to be real variables.

RETURN
Returns control from a subprogram to the statement following either the call or the function reference.

RETURN i
The multiple return statement returns control from a subprogram to statement i in the calling routine.

REWIND unit
The file associated with unit is closed, then reopened at the beginning of the same file.

STOP 'character string'
Terminates program execution and displays character string on the system console.

STOPn
Terminates program execution and displays n on the system console.

SUBROUTINE name(argument list)
Begin the definition of a subroutine subprogram.

TRACE OFF
Turns statement tracing off.

TRACE ON
Turns statement tracing on.

WRITE output list
Displays the value of the variables in output list on the system console.

variable = expression
Assigns the value of the expression to the variable.

Write (unit,format(,ERR = ) )output list
Writes the values of the variable in output list to unit according to format.

APPENDIX B - SUMMARY OF SYSTEM FUNCTIONS

<table>
<thead>
<tr>
<th>Name</th>
<th>Function</th>
<th>Arg</th>
<th>Result</th>
<th>Argument</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABS</td>
<td>Absolute (x)</td>
<td>1</td>
<td>real</td>
<td>real</td>
</tr>
<tr>
<td>ALOG</td>
<td>Log Base e (x)</td>
<td>1</td>
<td>real</td>
<td>real</td>
</tr>
<tr>
<td>ALOG10</td>
<td>Log base 10 (x)</td>
<td>1</td>
<td>real</td>
<td>real</td>
</tr>
<tr>
<td>AMAX0</td>
<td>Maximum &lt;255</td>
<td>either</td>
<td>either</td>
<td></td>
</tr>
<tr>
<td>AMAX1</td>
<td>Maximum &lt;255</td>
<td>either</td>
<td>either</td>
<td></td>
</tr>
<tr>
<td>AMINO</td>
<td>Minimum &lt;255</td>
<td>either</td>
<td>either</td>
<td></td>
</tr>
<tr>
<td>AMIN1</td>
<td>Minimum &lt;255</td>
<td>either</td>
<td>either</td>
<td></td>
</tr>
<tr>
<td>AMOD</td>
<td>Remainder (x/y) 2</td>
<td>real</td>
<td>real</td>
<td></td>
</tr>
<tr>
<td>ATAN</td>
<td>Arctangent(x) 1</td>
<td>real</td>
<td>real</td>
<td></td>
</tr>
<tr>
<td>ATAN2</td>
<td>Arctangent(y/x) 2</td>
<td>real</td>
<td>real</td>
<td></td>
</tr>
<tr>
<td>BIT</td>
<td>Bit handling 3/4</td>
<td>either</td>
<td>either</td>
<td></td>
</tr>
<tr>
<td>CALL</td>
<td>Execute asm pgm 2</td>
<td>either</td>
<td>either</td>
<td></td>
</tr>
<tr>
<td>CBTOF</td>
<td>Convert to real 2/3</td>
<td>real</td>
<td>both</td>
<td></td>
</tr>
<tr>
<td>CHAR</td>
<td>Character value 1</td>
<td>either</td>
<td>character</td>
<td></td>
</tr>
<tr>
<td>COMP</td>
<td>Compare strings 3</td>
<td>either</td>
<td>either</td>
<td></td>
</tr>
<tr>
<td>COS</td>
<td>Cosine(x) 1</td>
<td>real</td>
<td>real</td>
<td></td>
</tr>
<tr>
<td>DIM</td>
<td>Positive difference 2</td>
<td>real</td>
<td>real</td>
<td></td>
</tr>
<tr>
<td>EXP</td>
<td>e ’ ’(x) 1</td>
<td>real</td>
<td>real</td>
<td></td>
</tr>
<tr>
<td>FLOAT</td>
<td>Make real (x) 1</td>
<td>real</td>
<td>integer</td>
<td></td>
</tr>
<tr>
<td>IABS</td>
<td>Absolute (x) 1</td>
<td>integer</td>
<td>integer</td>
<td></td>
</tr>
<tr>
<td>101M</td>
<td>Positive difference 2</td>
<td>real</td>
<td>real</td>
<td></td>
</tr>
<tr>
<td>IFIX</td>
<td>Truncate (x) 1</td>
<td>integer</td>
<td>real</td>
<td></td>
</tr>
<tr>
<td>INP</td>
<td>Input from a port 1</td>
<td>either</td>
<td>either</td>
<td></td>
</tr>
<tr>
<td>ISIGN</td>
<td>Transfer of sign 2</td>
<td>integer</td>
<td>integer</td>
<td></td>
</tr>
<tr>
<td>MAX0</td>
<td>Maximum &lt;255</td>
<td>either</td>
<td>either</td>
<td></td>
</tr>
<tr>
<td>MAX1</td>
<td>Maximum &lt;255</td>
<td>either</td>
<td>either</td>
<td></td>
</tr>
<tr>
<td>MIN0</td>
<td>Minimum &lt;255</td>
<td>either</td>
<td>either</td>
<td></td>
</tr>
<tr>
<td>MIN1</td>
<td>Minimum &lt;255</td>
<td>either</td>
<td>either</td>
<td></td>
</tr>
<tr>
<td>MOD</td>
<td>Remainder (x/y) 2</td>
<td>integer</td>
<td>integer</td>
<td></td>
</tr>
<tr>
<td>PEEK</td>
<td>Examine mem loc. 1</td>
<td>either</td>
<td>either</td>
<td></td>
</tr>
<tr>
<td>RAND</td>
<td>Random Number (x) 1</td>
<td>real</td>
<td>real</td>
<td>0.0&lt; R&lt; 1.0</td>
</tr>
<tr>
<td>SIGN</td>
<td>Transfer of sign 2</td>
<td>real</td>
<td>real</td>
<td></td>
</tr>
<tr>
<td>SIN</td>
<td>Sine(x) 1</td>
<td>real</td>
<td>real</td>
<td></td>
</tr>
<tr>
<td>SORT</td>
<td>Square Root (x) 1</td>
<td>real</td>
<td>real</td>
<td></td>
</tr>
<tr>
<td>TAN</td>
<td>Tangent(x) 1</td>
<td>real</td>
<td>real</td>
<td></td>
</tr>
</tbody>
</table>

Most of the above functions are ANSI standard except for RAND. This function behaves as if it were returning an entry from a table.
of random numbers. The argument of RAND determines which entry of this table will be returned:

<table>
<thead>
<tr>
<th>Rand Arg.</th>
<th>Value returned for RAND</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>The next entry in the table</td>
</tr>
<tr>
<td>-1</td>
<td>The first entry in the table. Also, the pointer for the next entry (arg = 0) is reset to the second entry in the table.</td>
</tr>
<tr>
<td>n</td>
<td>Returns the table entry following n.</td>
</tr>
</tbody>
</table>

APPENDIX C - SUMMARY OF SYSTEM SUBROUTINES

CALL BIT (variable,disp,code)
Set, resets or flips bit 0+ disp of variable according to the code.

CALL CBTOF(loc1,disp1,loc2{},flag)
Converts a binary number to its floating point equivalent.

CALL CHAIN{'program name'{},error}
Loads another program and executes it.

CALL CIN(var)
Reads a single character from the system console.

CALL CLOSE(unit)
Close the file associated with unit.

CALL CTEST(status)
Determines if a character has been entered on the system console.

CALL DELAY(time)
Delays execution the specified time in 1/100ths of a second.

CALL DELETE{'filename'{},error}
Delete the specified filename from the disk.

CALL EXIT
Terminates program execution.

CALL MOVE(n,loc1,disp1,loc2,disp2)
Moves n bytes from loc1 to loc2.

CALL OPEN(unit,'filename'{},error)
Opens the specified filename and associates it with unit.

CALL LOAD{'filename'{},load-type,{},error}
This routine is used to load a file of type .HEX or .OBJ into memory depending on the value of load-type. It is usually used to load assembly language routines into memory. No check is made to see if the code that is loaded into memory would overwrite the program or CP/M.

CALL LOPEN(unit,'filename'{},error)
Opens the specified filename and associates it with unit. This file is also treated as a printer file with the first character of each output record controlling paper movement.

CALL POKE(LOCATION,LOCATION)
The POKE routine is used to change a memory location. Value will be stored in memory at location.

CALL OUT(port,value)
The value is converted to an 8 bit number and output to port.
CALL PUT(CHARACTER)
The PUT routine is used to output a character to the system console directly. It is commonly used to do such things as clear the screen or position the cursor.

CALL RENAME('old name','new name','{error})
Renames old name to be new name.

CALL RESET
The RESET routine allows for the changing of a disk at runtime and then being able to write on the changed disk. Without using this function, an attempt to write on a disk that has been changed will result in a BDOS read only error.

CALL SEEK(unit,position)
Positions the file associated with unit to the byte position specified by position.

CALL SETIO (new 110)
Allows changing the way that console 110 is performed during program execution.

APPENDIX D - RUNTIME ERRORS

During execution of a program, there are numerous conditions that can occur which cause program termination. When one of these conditions is encountered, a RUNTIME ERROR message will be generated to the system console file. The message has the format:

Runtime error: XXXXXXXX, called from loc. YYYYH
pgm was executing line LLLL in routine NNNN
where: XXXXXXXX is the ERROR, YYYY is the memory location of the CALL to the runtime package in which the error occurred.
The second line of the error message will be generated as a traceback of CALL statements that have been executed. The LLLL
is the FORTRAN generated line number (shown on the listing of the source from the compiler) of the statement which caused the
error, and NNNN if the name of the routine in which that line
number corresponds. The line number will be output as ???? if the
X option was not specified on the $OPTIONS statement for a
given routine. If multiple 'PGM WAS' lines are printed, the first
one specifies the line in which the error actually occurred.

SUMMARY OF RUNTIME ERRORS

ARG CNT
ARGUMENT COUNT ERROR: a subprogram call had too many
or too few arguments. In other words, the number or arguments
in the CALL or function reference is not the same as the
number of parameters specified for this SUBROUTINE or FUNCTION.

ASN GOTO
ASSIGNED GO TO ERROR: the value of the variable specified in
an ASSIGNED GO TO does not match that of one of the statement labels listed.

CALL POP
CALL STACK POP ERROR: this error should never occur (This
means that a RETURN has been executed that does not have a
corresponding CALL or FUNCTION reference. Usually caused
by user assembly language programs).

CALL PSH
CALL STACK PUSH ERROR: this error is caused by a recursive
subprogram CALLS of depth greater than 36. Only in very
special cases should a subprogram CALL itself or one of those
that has CALLED it.
CON

CHAIN FILE ERROR: the filename specified in a call to the
CHAIN or LOAD routine was not found on the disk.

COM GOTO

COMPUTED GO TO INDEX OUT OF RANGE: the variable
specified in a computed GOTO is either zero or greater than the
number of statement labels that were specified.

CON BIN

BINARY 110 TO CONSOLE: binary 110 is not supported to the
system console.

CONTRL/C

CONTROL/C error: CONTROL/C was hit and the CONTROL/C
was not trapped.

CONV.

16 BIT CONVERSION ERROR: in converting a number from
integer to internal 16 bit binary, an overflow has occurred. This
can occur on all statements associated with 110 (unit number),
subscript evaluation and anywhere that a number has to be
converted from floating to 16 BIT binary. Also, subscripts
outside of the DIMENSIONED space for an array can cause this
error.

DIV ZERO

DIVIDE BY ZERO: an attempt has been made to divide by zero.

DSK FULL

DISK FULL: either the disk is full or the directory is full.

FILE OPR

FILE OPERATION ERROR: an error has occurred while trying to
do some file operation, such as renaming when the new file
already exists.

FORMAT

FORMAT ERROR: an unrecognized or invalid FORMAT
specification has been encountered in a FORMATTED READ or
WRITE. The most likely error is an unrecognized format
specification or blanks in a variable format.

ILL CHAR

ILLEGAL CHARACTER: an illegal character has been
encountered during a READ.

ILL UNIT

ILLEGAL UNIT NUMBER <2 or >7): the unit number in a READ,
WRITE, OPEN, LOPEN, REWIND, CLOSE, SEEK is either less
than 2 or greater than 7.

INPT ERR

INPUT ERROR: during a READ, an invalid character has been
encountered for the number being processed. This will be
generated for such things as: two decimal points in a number,
an E in an F type field, decimal point in an I type field, etc.

INT RANG

INTEGER OVERFLOW: a result greater than 8 digits has been
generated in an expression.

110 ERR

110 ERROR: an error occurred during a READ or WRITE
operation and the ERROR label was not specified in the
statement. It will also be generated during a READ if END OF
FILE is encountered and an EOF label was not specified.

110 LIST

INVALID 110 LIST: this error indicates an error in the I/Olist
specification of a formatted WRITE or READ. This error will not
normally occur.

LINE LEN

LINE LENGTH ERROR: an attempt has been made to READ or
WRITE a record whose length exceeds 250 characters. This
count also includes a carriage return at the end of the line.

LOG NEG

LOG OF NEGATIVE NUMBER: argument of the log either
(ALOG or ALOG10) function is negative.

OVERFLOW

FLOATING POINT OVERFLOW: the result of a floating point
operation has resulted in a number whose value is too large to
be stored.

SEEK ERR

SEEK ERROR: an error has occurred while positioning a file to
the specified position and no error variable was specified in the
CALL.

SQRT NEG

SQRT OF NEGATIVE NUMBER: argument of the square root
function is negative.

UNIT CLO

UNIT CLOSED: the unit number passed to the CLOSE routine
specifies a unit number that has not been OPENed.

UNIT OUP

UNIT ALREADY OPEN: this is generated by the OPEN or
LOPEN routine when an attempt is made to open a file on an
already open FORTRAN logical unit. This error will also occur if
unit 0 or 1 is specified in the OPEN or LOPEN call.
APPENDIX E - COMPIL E TIME ERRORS

The following is a list of errors that may occur during the compilation of a FORTRAN program. If the G option is not selected, a two digit error number will be printed instead. This number can be found at the beginning of each line.

00 *FATAL* compiler error
01 Syntax error, 2 operators in a row
02 unexpected continuation (column 6 not blank or 0)
03 input buffer overflow (increase B= compiler option)
04 invalid character for FORTRAN statement
05 unmatched parenthesis
06 statement label> 99999
07 invalid character encountered in statement label
08 invalid HEX digit encountered in constant
09 expected constant or variable not found
0A 8 bit overflow in constant
0B unidentifiable statement
0C statement not implemented
0D quote missing
0E SUBROUTINE/FUNCTION/BLOCK DATA not first statement in routine
0F columns 1-5 of continuation statement are not blank
10 cannot initialize BLANK COMMON
11 RETURN is not valid in main program
12 syntax error on unit specification
13 missing comma after) in COMPUTED GO TO
14 missing variable in COMPUTED GO TO
15 invalid variable in ASSIGNED/COMPUTED GO TO
16 invalid LITERAL, no beginning quote
17 number of subscripts exceeds maximum of 7
18 invalid SUBROUTINE or FUNCTION name
19 subscript not POSITIVE INTEGER CONSTANT
1A FUNCTION requires at least one argument
1B syntax error
1C invalid argument in SUBROUTINE/FUNCTION call
1D first character of variable not alphabetic
1E ASSIGNED/COMPUTED GOTO variable not integer
1F label has already defined
20 specification of array must be integer
21 invalid variable name
22 invalid DIMENSION specification
23 dimension specification is invalid
24 variable has already appeared in type statement
25 invalid subroutine name in CALL
26 SUBPROGRAM argument cannot be initialized
27 improperly nested DO loops
28 unit not integer constant or variable
29 Array size exceeds 32K
2A invalid use of unary operator
2B variable DIMENSION not valid in MAIN program
2C variable dimensioned array must be argument
2D DO/END/LOGICAL IF cannot follow LOGICAL IF
2E undefined label
2F unreferenced label
30 FUNCTION or ARRAY missing left parenthesis
31 invalid argument of FUNCTION or ARRAY
32 DIMENSION specification must precede first executable statement
33 unexpected character in expression
34 unrecognized logical opcode
35 argument count for FUNCTION or ARRAY wrong
36 *COMPILER ERROR* popped off bottom of operand stack
37 expecting end of statement, not found
38 statement too complex: increase P and/or 0 table
39 invalid delimiter in ARITHMETIC IF
3A invalid statement number in IF
3B HEX constant> FFFF (HEX)
3C replacement not allowed within IF
3D multiple assignment statement not implemented
3E subscripted-subscripts not allowed
3F subscript stack overflow; increase P= or O= missing left ( in READ/WRITE
40 invalid unit specified
41 invalid FORMAT, END= or ERR= label
42 invalid element in I/O list
43 built-in function invalid in I/O list
44 cannot subscript a constant
45 variable not dimensioned
46 invalid subscript
47 missing comma
48 invalid subscript
49 index in IMPLIED DO must be a variable
4A invalid starting value for IMPLIED DO
4B invalid ending value of IMPLIED DO
4C invalid increment of IMPLIED DO
4D illegal use of built-in function
4E variable cannot be dimensioned in this context
4F invalid or multiple END= or ERR=
50 invalid constant
51 exponent overflow in constant
52 invalid exponent
53 character after invalid
54 integer overflow
55 integer underflow (too small)
missing = in DO
string constant not allowed
invalid variable in DATA list
DATA symbol not used in program, line
invalid constant in DATA list
error in DATA list specification
FUNCTION invalid in DATA list
no filename specified on COPY
runtime format not array name
DUMP label invalid or more than 10 characters
more than 1 IMPLICIT is not allowed
IMPLICIT not first statement in MAIN, 2nd statement in SUBPROGRAM
data type not REAL, INTEGER or LOGICAL
illegal IMPLICIT specification
improper character sequence in IMPLICIT
variable already DIMENSIONED
Q option must be specified for ERRSETIERRCLR
Hex constant of zero (0) invalid in I/O statement
Argument cannot also be in COMMON
Illegal COMMON block name
Variable already in COMMON
Array specification must precede COMMON
Executable statement invalid in BLOCK DATA
Hex constant of 27H (') invalid in FORMAT
Invalid number following STOP or PAUSE
invalid TRACE statement (operand not ON/OFF)
invalid 10STAT = variable
missing, in ENCODE/DECODE
invalid label in ASSIGNED GOTO
invalid variable in ASSIGNED GOTO
label not allowed on this statement
multiple RETURN not valid in FUNCTION
UNUSED
no matching IF-THEN for ELSE or ENDIF
invalid ELSE or ENDIF
missing ENDIF
initialization of non-COMMON variable
"DOUBLE PRECISION" not supported, treated as "REAL"
UNUSED
UNUSED
UNUSED
UNUSED
unused
no program to compile
missing $OPTIONS statement
missing = in $OPTIONS statement
invalid digit in number in $OPTIONS
"FATAL" value exceeds 255 in $OPTIONS
"FATAL" COMMON table overflow, increase C=
"FATAL" unknown option (letter before =)
"FATAL" missing END statement
LABEL TABLE overflow, increase L=
SYMBOL TABLE overflow, increase S=
ARRAY STACK overflow, increase A=
DO LOOP STACK overflow, increase 0=
stack overflow (compiler error)
stack overflow (compiler error)
internal tables exceed user memory
MEMORY ERROR
OPEN error on COPY file
too many routines to compile (>62)
no more room to store DATA statements
IF-THEN stack overflow, increase 1=
Nested "COPY" statements not permitted
Disk write error (disk probably full)
Cannot close file (disk probably full)
Input file not found
Invalid drive specifier
No filename found on COPY statement
File specified on COPY not found
APPENDIX F - ASSEMBLY LANGUAGE INTERFACE

ASSEMBLY statements can be directly inserted into a FORTRAN program by preceding the statement with an asterisk (*). The line that contains that asterisk will be directly output to the assembly file without further processing (the asterisk is deleted first). Because of the nature of the FORTRAN compiler (it actually reads one statement ahead of where it is processing), it is ALWAYS a good idea to put a CONTINUE statement immediately preceding the first assembly statement in each separated group of assembly statements. The CONTINUE will cause the assembly statements to be inserted at the expected place. FORTRAN maintains nothing in the registers between statements, but does use the 8080 stack for saving RETURN addresses for user called FUNCTIONS and SUBROUTINES.

Example

CONTINUE
  * MVI A,'A'
  * STA STRING

APPENDIX G - GENERAL COMMENTS

1. In the description of the individual routines, anywhere that a character string is specified, a variable or array name can be used. The variable or array can be set to the desired character string.

2. A variable can be set to a character string using an assignment statement such as:

   A = 'STRING'

No more than six characters will be retained for any variable and if less than six, will be zero filled in the low order bytes of the variable.

3. If a variable or array name is used to reference a CPIM file (such as in the OPEN routine) the filename itself within the variable or array) is terminated after:
   • the first 13 characters,
   • a NULL is encountered.

4. Hexadecimal constants can be used anywhere that a constant or variable is permitted. A hexadecimal constant is specified by preceding it by a dollar sign ($). Examples are:

   A = $E060
   A = -$C00

Hexadecimal constants are limited to a maximum value of FFFF. An error is generated if a hexadecimal constant exceeds this limit. Internally, a hexadecimal constant is treated as any other INTEGER constant would be.

5. A hexadecimal constant that is preceded by # instead of a $ will be stored internally in binary format in the first two bytes of the variable. Numbers of this form should not be used in any expression as they are not stored in the normal floating point format. The number is stored in standard 8080 format (HIGH byte followed by LOW byte).
6. A backslash (\) can be used in a literal to specify an 8 bit binary constant to be inserted at that point. The constant is enclosed in backslashes and is assumed to be a hexadecimal constant. The backslash can be changed using the CONFIG program supplied.

Example

A = 'THIS \32\ IS AN EXAMPLE'
CALL OUTIT (3,1,'\7F\ \FF\ \2,32)

10 FORMAT ('IT IS ALLOWED \1\ HERE \FF\ ALSO')

NOTE: The backslash is the default character and can be changed using the CONFIG program.

7. Eight FORTRAN files may be open at anyone time (file numbers 0-7). Remember that files 0 and 1 are permanently open.

APPENDIX H - COMPARISON OF NEVADA FORTRAN AND ANSI FORTRAN

NEVADA FORTRAN includes the following extensions to version X3.9-1966 of ANSI Standard FORTRAN:

1. Free-format input and output.
2. IMPLICIT statement for setting default variable types.
3. Options end-of-file and error branches in READ and WRITE statements.
4. COPY statement to insert source files into a FORTRAN program.
5. Direct inline assembly language.
6. Access to file system for such functions as creating, deleting, and renaming files.
7. Random access on a byte level to files.
8. Access to absolute memory locations.
9. Program controlled time delay.
10. A pseudo random number generator function.
11. Program control of runtime error trapping.
12. Ability to chain a series of programs.
13. Ability to load object code into memory.
14. CALL function to execute previously loaded code.
15. Program tracing.
16. IF-THEN-ELSE statement.
17. Enabling and disabling console abort of program.
18. ENCODE and DECODE memory to memory I/O.
19. Multiple returns from subroutines.

NEVADA FORTRAN does not include the following features of ANSI standard FORTRAN:

1. Double precision, double precision functions. (Double precision is treated as single precision).
2. Complex numbers, complex statements and functions.
3. EQUIVALENCE statement.
4. Extended DATA statement of the form:
   DATA A,B,C11,2/31
5. The P format specifications.
7. The following are reserved names and cannot be used for functions, subroutines, or COMMON block names:
   A, B,C,D, E, H, L, M,SP, PSW
8. EXTERNAL statement.
9. Subscripted subscripts.
10. Certain of the numerical library functions such as the hyperbolic functions and others.
## APPENDIX 1 - 8080 Operation Code

### MOVE

<table>
<thead>
<tr>
<th>Acc</th>
<th>LOAD IMMEDIATE*</th>
<th>RETURN IMMEDIATE*</th>
<th>STACK OPS</th>
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<tbody>
<tr>
<td>06</td>
<td>MVI B, C6 ADI</td>
<td>07 LXI B C6</td>
<td>C5 PUSH B</td>
</tr>
<tr>
<td>0E</td>
<td>MVI C, CE ACI</td>
<td>11 LXI D, C6</td>
<td>D5 PUSH D</td>
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<tr>
<td>16</td>
<td>MVI D, D6 SUI</td>
<td>21 LXI H, D16</td>
<td>E5 PUSH H</td>
</tr>
<tr>
<td>1E</td>
<td>MVI E, DE SBI</td>
<td>31 LXI SP, D8</td>
<td>F5 PUSH PSW</td>
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<td>2E</td>
<td>MVI L, EE XRI</td>
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<td>C1 POP B</td>
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<td>33</td>
<td>INX SP 3B DCX SP</td>
<td>32 STA ADR 3B DCX</td>
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</table>

**D8 constant, or logical/arithmetic expression that evaluates to an 8 bit data quantity.**

*all flags (C.Z.S.P) affected*

**D16 = constant, or logical/arithmetic expression that evaluates to a 16 bit data quantity.**

† = only CARRY affected

** = all flags except CARRY affected;

(=exception: INX and DCX affect no Flags)
D8 = constant, or logical/arithmetic expression that evaluates to an 8 bit data quantity.

D16 = constant, or logical/arithmetic expression that evaluates to a 16 bit data quantity.

Adr = 16 bit address
### APPENDIX J - TABLE OF ASCII CODES (Zero Parity)

#### (Continued)

<table>
<thead>
<tr>
<th>Upper</th>
<th>Octal</th>
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<th>Hex</th>
<th>Character</th>
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### APPENDIX J - TABLE OF ASCII CODES (Zero Parity) (Continued)

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<th>Decimal</th>
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### APPENDIX K - SAMPLE ASSEMBLER LISTING

<table>
<thead>
<tr>
<th>ADDRESS</th>
<th>ASSEMBLED CODE</th>
<th>ERROR FLAG</th>
<th>LABEL</th>
<th>OPERATION</th>
<th>OPERAND</th>
<th>COMMENT</th>
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<tr>
<td>0100 E5</td>
<td>0011 TSRCH</td>
<td>PUSH</td>
<td>H</td>
<td>SAVE</td>
<td>STRING ADDRESS</td>
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<tr>
<td>0101 41</td>
<td>0012 MOV B,C</td>
<td>INITIALIZE</td>
<td>CHARACTER</td>
<td>COUNT</td>
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<tr>
<td>0102 1A</td>
<td>0013 TS1</td>
<td>LDAX</td>
<td>D</td>
<td>COMPARE CHARACTERS</td>
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<td>0103 BE</td>
<td>0014 CMP</td>
<td>M</td>
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<td>0104 C211 01</td>
<td>0015 JNZ TS3</td>
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<td>0107 23</td>
<td>0016 INX H</td>
<td>CHARACTER MATCH, GO ON</td>
<td>TO NEXT</td>
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<td>0108 13</td>
<td>0017 INX D</td>
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<td>0109 05</td>
<td>0018 DCR B</td>
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<td>010A C2 02 01</td>
<td>0019 JNZ TS1</td>
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<tr>
<td>010D F601 020</td>
<td>ORI I MATCHING ENTRY FOUND</td>
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<td>010F E1</td>
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<td>0110 C9</td>
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<td>0111 B7</td>
<td>0023 TS3</td>
<td>ORA A</td>
<td>TEST FOR END OF TABLE</td>
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<td>0112 CA OF 01</td>
<td>0024 JZ TS2</td>
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<td>0115 13</td>
<td>0025 TS4</td>
<td>INX D</td>
<td>SKIP TO NEXT ENTRY</td>
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<td>011B 13</td>
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<td>011C E1</td>
<td>0030 POP H</td>
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<td>0110 C3 00 01</td>
<td>0031 JMP TSRCH</td>
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<tr>
<td>0332 *</td>
<td>0033 EXAMPLE OF TSRCH USE:</td>
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<tr>
<td>0334 *</td>
<td>0035 ASSUME HL POINTS TO A FOUR-CHARACTER STRING</td>
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<tr>
<td>0120 11 3501 0036</td>
<td>LXI DCTABL DE POINTS TO COMMAND TABLE</td>
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<td>0123 OE 04 0037</td>
<td>MVI C4 TABLE ENTRIES ARE FOUR CHARACTERS LONG</td>
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<td>0125 CD 00 01</td>
<td>0038 CALL TSRCH</td>
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<td>0128 CA 00 00 U 0039</td>
<td>JZ ERROR COMMAND NOT IN TABLE</td>
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<td>012B EB</td>
<td>0040 XCHG</td>
<td>SET UP STACK FOR RETURN TO MAIN ROUTINE</td>
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### APPENDIX L - SAMPLE PROGRAM OF LOADER SOURCE CODE

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<td>TS4</td>
<td>0115</td>
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0002 * RUNA file-name [.ZCL]  
0003 * An .OBJ file consists of one or more segments that  
0004 * have the format:  
0005 * #BYTES DESCRIPTION  
0006 * 2 Number of code and data bytes in  
0007 * segment  
0008 * 2 Load address of code and data  
0009 * belonging to the segment.  
0010 * Variable Code and/or data.  
0011 * The run time package will load each segment at the  
0012 * specified address until a starting address is  
0013 * encountered. A starting address is represented as  
0014 * load address with a zero byte count.  
0015 * 121
0047  OCR C
0048  JZ NOOPTIONS
0049  MOV A,M
0050  CPI"
0051  JZ NOOPTIONS
0052  CPI 'Z'
0053  JZ ZEROFILE
0054  CPI 'C'
0055  JZ COMFILE
0056  CPI 'L'
0057  JZ NOEXEC
0058  * ERROR ILLEGAL OPTION
0059  LXI H,MESGA
0060  CALL DISPLAY
0061  JMP 0 + RELOC
0062  * GET SIZE OF INSTRUCTION
0063  GETSZ LXI H,TBL-1
0064  AGAIN MOV A,C
0065  INX H
0066  MOV B,M
0067  ANA B
0068  JZ BYTE1
0069  INX H
0070  MOV B,M
0071  XRA B
0072  INX H
0073  JNZ AGAIN
0074  MOV A,M
0075  RET. EXIT
0076  BYTE1 MOV A,1
0077  RET. EXIT
0078  * REL EQU$ RELOCATION
0079  PUSH H
0080  PUSHP SW
0081  MOV E,M
0082  MOV E,M
0083  INX H
0084  MOV A,M
0085  MOV A,M
0086  MOV A,M
0087  ORA A WE DON'T RELOCATE BELOW 100+ RELOC
0088  JZ NOREL
0089  MOV D,A
0090  PUSH H
0091  LHLD BASE
0092  DAD 0 ADDRESS IS NOW ADJUSTED
0093  XCHG
0094  POP H
0095  MOV M,D  PUT IT BACK
0096  DCX H
0097  MOV M,E
0098  NOREL EQU $
0099  POP PSW
0100  POP 0
0101  POP H
0102  RET
0103  *
0104  VER2X EQU$
0105  MVI C,19H ;GET CPM 2.X DEFAULT DRIVE
0106  CALL BOOS
0107  JMP SETDF
0108  *
0109  MESA ASC 'ILLEGAL OPTION'
0110  DB ODH,OAH
0111  ASC 'RUN D:FILE.ZCL<CR>'
0112  DB ODH,OAH,O
0113  *
0114  INX H
0115  TBL DB -1,1110101B,1
0116  DB -1,1100110B,3
0117  DB -1,1100001B,3
0118  DB -1,1100011B,3
0119  DB -1,1100011B,1
0120  DB -1,1100011B,1
0121  DB -1,1100011B,1
0122  DB -1,1100011B,1
0123  DB -1,1100011B,1
0124  DB -1,1100011B,1
0125  DB -1,1100011B,1
0126  DB -1,1100011B,1
0127  DB 0 END OF TABLE
0128  *
0129  BASE OW 0 BASE ADJ TO ADD TO ADDRESS TO BE
0130  RELOCATED
0131  *
0132  START OW 0 STARTING ADDR OF RELOCATED CODE
0133  *
0134  ZEROFILL EQU
0135  *
0136  STA ZX
0137  STA CX
0138  JMP NEXT
0139  *
0140  NOEXEC EQU$
0141  STA LX
0142  JMP NEXT
0143  *  
0144  OSET EQU $  
0145  LXID,OBUF  
0146  MVI C,26 :SET DMA  
0147  CALL BOOS  
0148  LOA ODRIVE  
0149  MVI D,O  
0150  MOV E,A  
0151  MVI C,14 :SET DRIVE  
0152  CALL BOOS  
0153  LXI D,OFCB  
0154  RET  
0155  *  
0156  NOOPTIONS EQU $  
0157  LXI H,080H + 3 + RELOC  
0158  MOV A,M  
0159  CPI ':' ; WAS DRIVE REQUESTED?  
0160  JNZ DEFDREV ; DEFAULT IS SET  
0161  DCX H  
0162  MOV A,M  
0163  CPI 'A'  
0164  JC DEFDREV  
0165  SUI 'A'  
0166  STA ODRIVE  
0167  DEFDREV EQU $  
0168  CALL SETFCB  
0169  MVI M,'O'  
0170  INX H  
0171  MVI M,'B'  
0172  INX H  
0173  MVI M,'J'  
0174  CALL OSET  
0175  LXI C,15 ; OPEN  
0176  CALL BOOS  
0177  CPI-1  
0178  JZ OERR ; OPEN ERROR  
0179  XRA A  
0180  STA OCR  
0181  *  
0182  *  
0183  *  
0184  LXI B,LAST-LOADFILE SIZE OF CODE TO BE RELOCATED  
0185  MOV A,L  
0186  SUB C  
0187  MOV L,A  
0188  MOV A,H  
0189  SBB B  
0190  MOV H,A  
0191  : H&L= STARTING ADDRESS  
0192  SHLD START  
0193  PUSH H  
0194  LXI D,LOADFILE  
0195  MOV A,L  
0196  SUB E  
0197  MOV L,A  
0198  MOVA,H  
0199  SBB 0  
0200  MOVE H,A  
0201  SHLD BASE  
0202  POP H  
0203  LXI B,CONSTANTS-LOADFILE SIZE OF INSTRUCTION MOVE  
0204  XCHG  
0205  NXTI EQU $  
0206  PUSH H  
0207  PUSH 0  
0208  PUSH B  
0209  MOV C,M GET OPCODE  
0210  CALL GETSZ GET SIZE OF INSTRUCTION  
0211  POP B  
0212  POP 0  
0213  POP H  
0214  CPI3  
0215  JC SKPREL  
0216  CALL REL RELOCATE ADDR IN THIS 3 BYTE INST  
0217  SKPREL EQU $  
0218  PUSH B  
0219  PUSH PSW  
0220  MOV C,A SIZE  
0221  NXTM EQU $  
0222  MOV A,M  
0223  STAX 0  
0224  INX H  
0225  INX 0  
0226  DCRC  
0227  JNZ NXTM  
0228  POP PSW  
0229  POP B  
0230  NXTD EQU $  
0231  DCX B  
0232  DCRA  
0233  JNZ NXTD  
0234  MOV A,C  
0235  ORA B  
0236  JNZ NXTI
0237  *  RELOCATE CONSTANTS
0238  LXI B,LAST-CONST ANTS  SIZE OF CONSTANTS
0239  NXTC EQU $  0240  MOV A,M
0241  STAX 0
0242  INX H
0243  INX 0
0244  DCX B
0245  MOV A,C
0246  ORA B
0247  JNZ NXTC
0248  LHLD START
0249  PCHL. CODE HAS BEEN RELOCATED NOW GO TO IT
0250  *  0251  ........................................................................
0252  *  RUNA A:FILE.OBJ<CR>
0253  *
0254  *  MOVE PARAMETERS AND CHECK  0255  *
0256  *
0257  LOADFILE EQU $  0258  LXI SP,STK  SET STACK AFTER RELOCATION
0259  LOA ZX  ZERO FILL MEMORY?
0260  ORA A
0261  JZ SKPCLR
0262  LXI D,LOADFILE-1
0263  MVI H,1  STARTING ADDR + RELOC
0264  MVI L,O
0265  CLEAR EQU $  0266  XRA A
0267  MOV M,A
0268  INX H
0269  MOV A,L
0270  SUB E
0271  MOV A,H
0272  SBB 0
0273  JC CLEAR
0274  SKPCLT EQU $  0275  CALL ORO  ;GET 1ST RECORD OF .OBJ FILE
0276  OLOAD EQU $  0277  CALL GETOP
0278  MAO MOV A,M  ;MOVE 4 BYTES FROM BUF TO WORK
0279  STAX 0
0280  INX H
0281  INX 0
0282  OCR C
0283  CZ ORO
0284  OCR B
0285  JNZ MAO
0286  ; H & L = BUFFER C = COUNT
0287  XCHG
0288  LHLD OWRK  ;SIZE OF NEXT READ
0289  MOV A,L
0290  ORA H
0291  JZ CLOSE
0292  SHLD OSIZE
0293  LHLD OWRK+ 2
0294  XCHG
0295  MAOA MOV A,M  ;MOVE FROM BUF TO OBJ ADDR
0296  STAX 0
0297  INX H
0298  INX 0
0299  OCR C
0300  CZ ORO
0301  PUSH H
0302  LHLD OSIZE
0303  DCX H
0304  SHLD OSIZE
0305  MOV A,L
0306  ORA H
0307  POP H
0308  JNZ MAOA
0309  CALL SAVOP
0310  JMP OLOAD
0311  *
0312  GETOP EQU $  ;GET O POINTERS
0313  LXID,OWRK
0314  LHLD OCBA  ;BUF AD DR
0315  MVI B,4  ;LENGTH OF WRK
0316  LOA OCBC  ;BUF CNT
0317  MOV C,A
0318  RET
0319  *
0320  ORO EQU $  0321  PUSH B
0322  PUSH 0  ;OPNT
0323  LXI D,OFCB
0324  MVI C,20  ;READ
0325  CALL BOOS
0326  POP 0
0327  POP B
0328  ORA A
0329  JNZ RERR
0330  LXI H,OBJ
0331  MVI ,BLKSIZ
0332  RET
SAVOP EQU $ 0333
SHLD OCBA ;BUFF ADDR 0334
MOV A,C 0335
STA OCBC ;BUF CNT 0336
LOA HIGH 0337
CMP 0 0338
RNC 0339
MOV A,D 0340
STA HIGH 0341
LOA HIGH 0342
CMP 0 0343
RNC 0344
MOV A,D 0345
STA HIGH 0346
RET 0347
CLOSE EQU $ 0348
LXI D,OFCB 0349
MVI C,16 ;CLOSE 0350
CALL BOOS 0351
LOA CX 0352
ORA A 0353
JNZ GENCOM 0354
LOA LX 0355
ORA A 0356
JNZ 0+ RELOC LOAD BUT DON'T EXECUTE 0357
LHLD OWRK+ 2 ;STARTING ADDRESS 0358
PCHL 0359
SETFCB EQU $ 0360
XRA A 0361
STA OFCB 0362
STA OCR 0363
ORA A 0364
JNZ GENCOM 0365
LXI H,OEX 0366
MVI C,4 0367
EXLUP EQU $ ;10-2-81 ZERO CPM EXT AREA 0368
MOV M,A 0369
INX H 0370
OCR C 0371
JNZ EXLUP 0372
LXI H,OBUF 0373
SHLD OCBA 0374
MVI A, BLKSIZ 0375
STA OCBC 0376
LXI H, 5CH + 9 + RELOC ;CPIM FILE TYPE 0377
RET 0378
CREATE EQU $ 0379
LXI D,OFCB 0380
MVI C,22 CREATE 0381
CALL BOOS 0382
CPI -1 0383
RNZ 0384
OERR EQU $ 0385
LXI H, MEGSO OPEN ERROR 0386
CALL DISPLAY 0387
JMP OXT1 0388
GENCOM EQU $ GENERATE .COM FILE 0389
CALL SETFCB 0390
MVI M,'C' 0391
INX H 0392
MVI M,'O' 0393
INX H 0394
MVI M,'M' .COM IN FCB 0395
OPEN 0396
LXI D,OFCB 0397
MVI C,15 OPEN .COM FILE 0398
CALL BOOS 0399
CPI -1 0400
CZ CREATE 0401
XRA A 0402
STA OCR 0403
WRITE 0404
LOA HIGH 0405
OCR A 0406
MOV H,A 0407
MVI L, OFFH 0408
SHLD SIZ OF THIS WRITE 0409
MVI E,O 0410
MVI C,15 OPEN .COM FILE 0411
MVI C,15 OPEN .COM FILE 0412
NXTW EQU $ ;10-2-81 ZERO CPM EXT AREA 0413
LDAX 0 0414
MOV M,A 0415
INX H 0416
INX 0 0417
OCR C Buff COUNT 0418
CZ WRITE 0419
PUSH H 0420
LH LD SIZ 0421
DCX H 0422
SHLD SIZ 0423
MOV A,L 0424
ORA H 0425
POP H 0426
JNZ NXTW 0427
CALL WRITE LAST BLOCK 0428
CLOSE
LXI D, OFCD
MVI C, 16
CALL BOOS
JMP 0+ RELOC
* WRITE EQU $
PUSH 0
LXI D, OFCB
MVI C, 21
WRITE
CALL BOOS
POP 0
ORA A
JNZ ERRW
LXI H, OBUF
MVI C, BLKSIZ
RET
*
* + + ********************************************
DISPLAY A MESSAGE TO THE CONSOLE
ENTRY H&L CONTAIN STARTING ADDRESS OF THE MESSAGE
THE MESSAGE TEXT IS TERMINATED BY 0 HEX
CALL DISPLAY

DISPLAY EQU $
MOV A, M
ORA A
RZ. EXIT TO CALLING ROUTINE **
MOV E, A
MVI C, 2
PUSH H
CALL BOOS ;PUT THE CHAR TO THE CONSOLE
POP H
INX H
JMP DISPLAY
*
ERRW EQU $
LXI H, MESGW WRITE ERROR
CALL DISPLAY
JMP OXT1
*
RERR EQU $
LXI H, MESGR READ ERROR
CALL DISPLAY
OXT1 EQU $
LXI H, OFCB + 1 ;FILE NAME
CALL DISPLAY

JMP 0+ RELOC RETURN TO CPIM

CONSTANTS EQU $
HIGH DB 0 HIGHEST PAGE USED FOR .COM
ZX DB 0 DEFAULT NO CLEAR ;Z= ZERO FILL BEFORE LOADING
CX DB 0 DEFAULT NO .COM ;C = .COM FILE
LX DB 0 DEFAULT EXECUTE ;L = LOAD BUT NO EXECUTION
ODrive DB 0
OWRK DB 0,0,0,0
OCBA OW OBUF ;CURRENT BUFFER ADDRESS
OCBC DB BLKSIZ ;CURRENT BUFFER COUNTER
OSIZE OW 0 ;SIZE OF NEXT OBJ BLOCK
OSIZE OW 0 SIZE OF COM FILE CODE
SIZ OW 0 SIZE OF COM FILE CODE
MESGO ASC 'OPEN ERROR'
MESGR ASC 'READ ERROR'
MESGW ASC WRITE ERROR'
DB 0
MESGR ASC 'READ ERROR'
DB 0
MESGW ASC WRITE ERROR'
DB 0
OS 30
STK DB'S'
LAST DB 0
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