Data General

Learning to Use Your RDOS/DOS System

069-000022-01

Learning to Use Your RDOS/DOS System

069-000022-01

For the latest enhancements, cautions, documentation changes, and other information on this product, please see the Release Notice (085-series) supplied with the software.

Preface

RDOS is an acronym for Data General's Real-time Disk Operating System; DOS stands for Disk Operating System. In an hour or two, you can develop a working sense of either system by using it. This book leads you through the steps required to:

- Talk to the system through the Command Line Interpreter (CLI);
- Write programs with a text editor program;
- Produce and run a FORTRAN IV program;
- Program in Extended BASIC; and
- Write, produce debug, and execute an assembly language program.

We don't attempt to describe all features of your operating system, the CLI, other utility programs, or the compilers you'll be using. These are all described completely in the manuals listed below.

If your operating system is new to you, this book will give you a practical basis for using it. If you want to *generate* a system (which someone must do before you can really use this manual), see *How to Load and Generate Your RDOS System* for RDOS, or the appropriate chapter of *The DOS Reference Manual* for DOS. After you have generated a system, return to this manual.

If you plan to program in an advanced language other than FORTRAN IV or BASIC, you'll be using a different compiler, but the material on the CLI and assembly language will be useful nonetheless.

Reader, Please Note:

We use these conventions for command formats in this manual:

COMMAND required *[optional]* ...

Where	Means
COMMAND	You must enter the command (or its accepted abbreviation) as shown.
required	You must enter some argument (such as a filename). Sometimes, we use: $\left\{\begin{matrix}\text{required}_1\\ \text{required}_2\end{matrix}\right\}$ which means you must enter *one* of the arguments. Don't enter the braces; they only set off the choice.
[optional]	You have the option of entering this argument. Don't enter the brackets; they only set off what's optional.
...	You may repeat the preceding entry or entries. The explanation will tell you exactly what you may repeat.

Contents

Chapter 6 - Instant FORTRAN IV Programming

Chapter 7 - Extended BASIC Programming

Chapter 8 - Assembly - Language Programming: The Assemblers

Illustrations

Chapter 1
Terms and Concepts

What are RDOS and DOS?

The Real-time Disk Operating System (RDOS) is a general-purpose software package that can support real-time control, batch, or program development. RDOS runs on NOVA® and ECLIPSE® computers; it can use many different kinds of disks, and supports up to 512K bytes of memory.

The Disk Operating System (DOS) is a compatible subset of RDOS, and supports up to 64K bytes of memory. DOS runs on diskettes or hard disks, on NOVA and microNOVA™ computers.

Both RDOS and DOS permit multitasking. This means that different program tasks can run concurrently, and that each task can respond individually to its own environment. Multitasking can make a program more efficient by permitting it to do useful processing while waiting for a slow peripheral device to complete an operation. However, multitasking is outside the scope of this book. You can find more information on multitasking in Chapter 5 of your RDOS or DOS Reference Manual.

How Do I Develop Programs?

Depending on your programming language interests, you'll use one or more system programs or utilities (two terms we use interchangeably). You'll always need the CLI, whose operating procedures we describe in Chapters 2 and 3, and whose common commands we survey in Chapter 4.

Unless you're a BASIC programmer, you'll be using a text editor utility to write your programs. Chapter 5 explains Superedit - one of our editors.

If you are a FORTRAN IV programmer, this is the cycle you will follow from creating through executing a program:

1) Create a FORTRAN source file using Superedit.
2) Compile the source file; compilation produces a binary file.
3) Load the binary file with the required FORTRAN libraries; the result is an executable program.
4) Execute the program.

Chapter 6 leads you through the steps to produce and run a sample FORTRAN program.

If you are a BASIC programmer, you need no system utilities except the CLI. Chapter 7 gives a capsule sketch of BASIC programming.

If you are an assembly language programmer, your procedure is much the same as the FORTRAN programmer's:

1) Create an assembly language source file using Superedit.
2) Assemble the source file; the assembly produces a binary file. Chapter 8 describes the assemblers.
3) Load the binary file. This produces an executable program.
4) Execute the program.

Chapter 9 leads you through the procedures to create and execute an assembly language program.

The remainder of this chapter describes two fundamental system concepts: memory management and files.

Chapter 2
At the Console - RDOS

This chapter describes a sample session with RDOS and the CLI, and leads you through many of the things you do on the keyboard to create and organize files. When you've finished the session, you'll have a practical working knowledge of RDOS basics. (For a session with DOS, see Chapter 3.)

If you inadvertently depart from a step we describe, your later experiences may differ from the text description. This is ok; mistakes are a primary vehicle for learning, and the CLI will usually prevent disasters. If you get really lost, go back to the beginning of the section you are in and give the files and directories different names; for example, FILEA1.MC instead of FILEA.MC.

Later on, you can find more detail on the features and ramifications of your commands in the *RDOS/DOS Command Line Interpreter User's Manual* or the *RDOS Reference Manual.* If you generated your own RDOS system, you already have some experience with RDOS.

Starting Up (Bootstrapping)

Turn your system console ON, and make sure it is ON LINE. On some DASHER™ displays, the LINE switch is in back of the console. If this console has both upper- and lowercase letters, set it in uppercase mode with the ALPHA LOCK key because the program that brings up the system doesn't accept lowercase letters. Later you can change back to upper- and lowercase mode.

Press or turn the computer's POWER switch to ON and flip the disk power switch (not the LOAD/READY or START switch) to ON. If your system is on a removable disk and the diskette is not in its drive, insert it in drive 0 and flip the LOAD/READY switch to READY (or press START). On any disk, wait for the READY light.

Now, turn to the system console. If it shows an exclamation point (!) prompt, then you have a virtual or *programmed* console. If it shows nothing, then your computer has hardware data switches.

For a machine with a programmed console, find nn in Table 2-1. Type **1000nnL** (for example, 100033L) on the *system* console next to the ! prompt. Skip the next paragraph.

Table 2-1. Disk Device Codes

Disk Type Model No.	**Device Code (octal) nn =**	**Set These Switches Up (Others Down):***
	Fixed-head	
Model 6001-08	20	0, 11
Model 6063/64	26	0, 11, 13, 14
	Moving-head	
Model 6060/61	27	0, 11, 13, 14, 15
All others	33	0, 11, 12, 14, 15

* For a disk on the second controller, also set switch 10 up

For a machine with hardware data switches, turn to the computer front panel and make sure the data switches are set properly for your type of disk, as shown in Table 2-1. The data switches are toggle-type switches, numbered 0 through 15. If the switches aren't set properly, fix them. (If your computer lacks automatic program load, see Chapter 2 of *How to Load and Generate Your RDOS System* for the manual load procedure.) Now, lift the RESET switch, then the PROGRAM LOAD switch.

For either type of computer, the system console will ask:

FILENAME?

It's asking for the name of your RDOS system. If the person who generated this system gave it any name other than SYS, you must type that name; but let's assume it was named SYS. To indicate SYS, type **SYS** and press the RETURN key ()), or simply press).

Voila. You now have an empty disk file named FILEA. FILEA was an *argument* to your command; it told the CLI what to name the new file. Some CLI commands require arguments, others don't.

You can verify FILEA's existence with the LIST command:

```
LIST FILEA)
FILEA.  0 D
R
```

and remove FILEA with the DELETE command:

```
DELETE/V FILEA)
DELETED FILEA
R
```

The /V is a *switch,* which modifies the basic meaning of a command; here, it told the CLI to verify the deletion. Now, create a different version of FILEA:

```
CRAND FILEA.MC)
R
```

Now there's an empty FILEA.MC on the disk. Normally, you'd use a text editor to put something in it, but you haven't reached Chapter 5 -- *Creating and Editing Text* -- yet. You can, however, insert text by transferring it directly from the console into FILEA.MC:

```
XFER/A/B $TTI FILEA.MC
MESSAGE HELLO)
CTRL-Z      (Hold down CTRL key and press Z)
R
```

The CTRL and Z keys won't echo as characters on the console. On a display terminal, the R prompt may leap to the top of the screen when you type CTRL-Z. If so, type CTRL-L to clear the screen and proceed with a clear screen.

You've just transferred the CLI command MESSAGE and the text string HELLO into FILEA.MC. The XFER command transfers the contents of one file (the console input file, $TTI) to another file (disk file FILEA.MC). XFER requires two arguments; in this case, they were $TTI and FILEA.MC. The /A switch specifies ASCII transfer; /B tells XFER to append to the existing file. If you omitted /B, XFER would try to create FILEA.MC, which would produce an error message because FILEA.MC already exists.

Try to execute FILEA.MC:

```
FILEA)
HELLO
R
```

Your FILEA.MC is a CLI macro. The .MC extension tells the CLI to execute all commands within it. You can omit the .MC extension to *execute* a file, but you must include it for all other commands that involve the file. Check FILEA.MC's statistics with LIST:

```
LIST/E FILEA.MC)
FILEA.MC 14 D 04/02/79 13:20 04/02/79 [000444]0
R
```

the /E switch tells the CLI to list every statistic about the file. These include byte-length (14), organization type (D means random), date and time created or last modified, date last opened, starting disk block address in octal, and use count. Obviously, the central four categories will differ for your own FILEA.MC.

To check the file's contents, type:

```
TYPE FILEA.MC)
MESSAGE HELLO
R
```

Now, you can add a little sophistication to FILEA.MC:

```
XFER/A/B $TTI FILEA.MC)
MESSAGE HOW MANY BLOCKS ARE LEFT)
MESSAGE ON THIS DISK? ;DISK)
MESSAGE WHAT'S THE CURRENT DIRECTORY)
GDIR)
CTRL-Z
R
```

One problem with inserting text this way is that you can't edit. If you make a mistake and don't correct it before you terminate the line with a), you must delete the file and rebuild it from the beginning. Having made no mistakes, check the improved macro:

```
FILEA)
HELLO
HOW MANY BLOCKS ARE LEFT
ON THIS DISK?
LEFT:9008 USED:768
WHAT'S THE CURRENT DIRECTORY?
Dxx
R
```

FILEA.MC is much larger now, as you can see:

```
LIST FILEA.MC)
FILEA.MC 118 D
R
```

FILEA.MC now contains four MESSAGE commands, a DISK command, and a GDIR command. Each would work separately, but you've combined them. (Your own DISK figures may differ from those here).

The MOVE command copies the files into the new directory; the /V switch instructs the CLI to verify their names as they arrive. Now, the files are safely in MACRODIR; you can make MACRODIR the current directory and then list the files in it:

```
DIR MACRODIR)
R
LIST)
FILEA.MC 118 D
FILEB.MC 14
R
```

The DIR command makes MACRODIR the current directory. DIR also *initializes* a directory, if it hasn't been initialized. Initialization opens a directory for access to its files. The MOVE command - an exception to the rule - doesn't require initialization, but other commands do. Starting up RDOS automatically initializes the master directory, but you must specifically initialize other directories to use them. DIR does this for you.

Now you can check the current directory with another useful command:

```
GDIR)
MACRODIR
R
```

For neatness, let's delete the original files in master directory Dxx. First, get back to the master directory:

```
DIR %MDIR%)
R
```

%MDIR% is a CLI variable that contains the master directory name. You can use it in command lines just as you'd use Dxx.

Now to delete the original files:

```
DELETE/V FIELA.MC FILEB.MC)
FILE DOES NOT EXIST: FIELA.MC
DELETED FILEB.MC
R
```

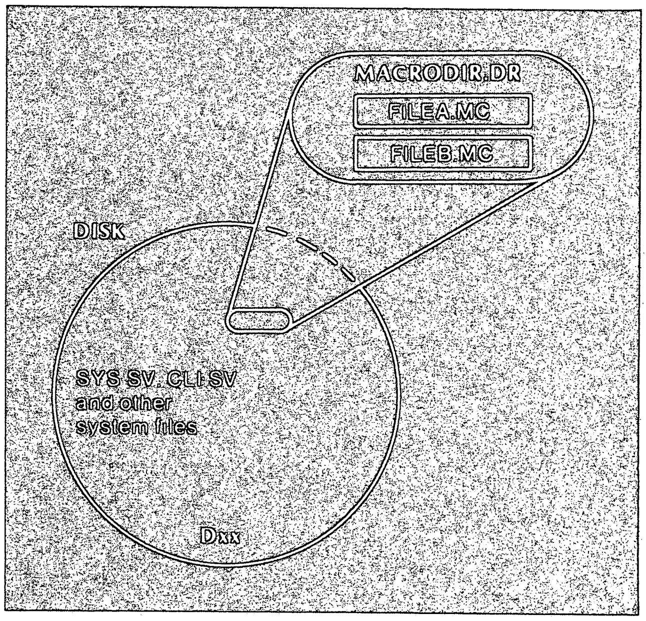
Typos are no-noes.

```
DELETE/V FILEA)
FILE DOES NOT EXIST: FILEA
R
```

(sigh)

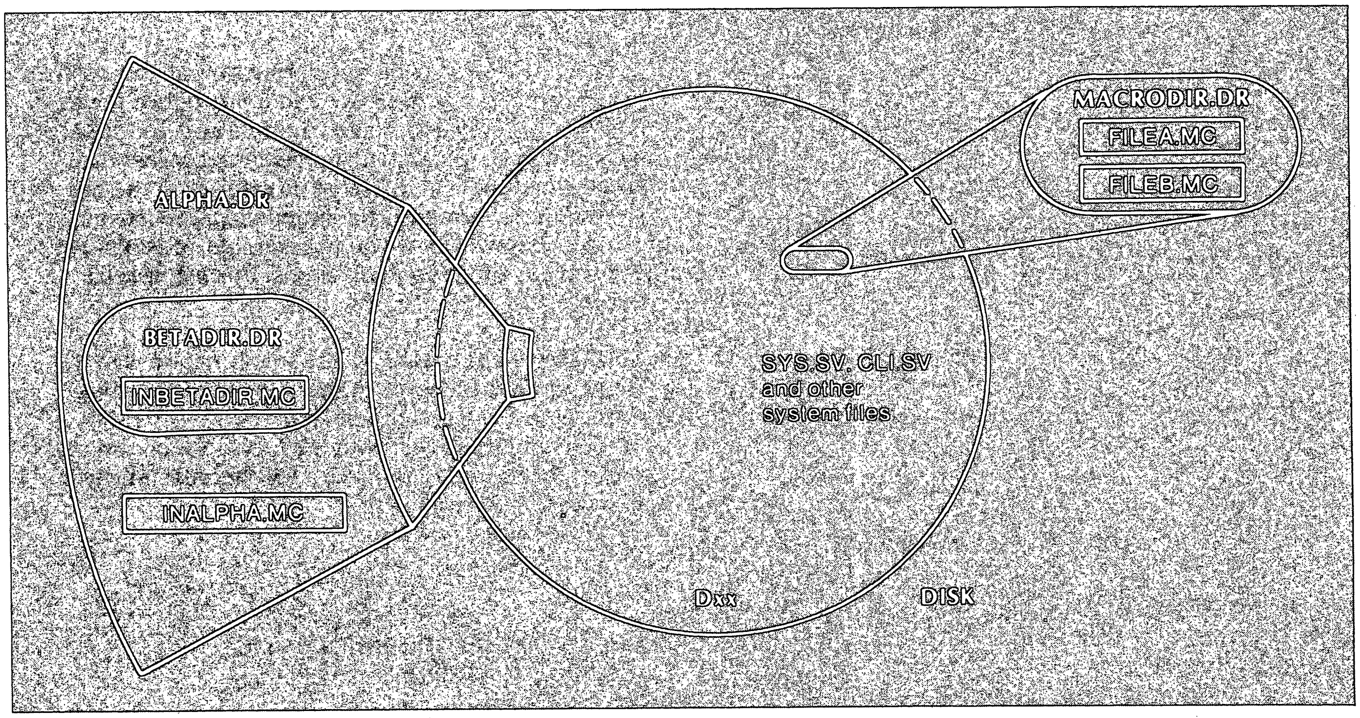
```
DELETE/V FILEA.MC)
DELETED FILEA.MC
R
```

At this point, your disk looks like Figure 2-2; the current directory is Dxx.



SD-00730

Figure 2-2. Disk with Subdirectory



SD-00731

Figure 2-3. Disk with Secondary Partition and Subdirectories

The master directory, Dxx, is the *primary partition;* it has one secondary partition, ALPHA, and one subdirectory, MACRODIR, ALPHA, in turn, has one subdirectory, BETADIR.

Your directory structure is growing. Take a breather, and offer thanks for the GDIR and DIR commands. If the hierarchy seems too complex, you can always delete the new directories later.

The system allows you to execute any file simply by typing the directory name, a colon, and the file name (of course, you could always DIR to the directory you wanted, then type the file name, but that requires an extra step).

```
GDIR)
BETADIR
R
INALPHA)
FILE DOES NOT EXIST: INALPHA.SV
R
```

(True, in directory BETADIR.) Try a directory specifier:

```
ALPHA:INALPHA)
I'M A FILE IN SECONDARY
PARTITION ALPHA.
R
```

Eureka. The directory specifier (:) also works with most other CLI commands:

```
LIST ALPHA:INALPHA.MC)
ALPHA:INALPHA.MC 57
R
TYPE ALPHA:INALPHA.MC)
MESSAGE I'M A FILE IN SECONDARY
MESSAGE PARTITION ALPHA.
R
```

Try it with FILEA.MC in MACRODIR:

```
MACRODIR:FILEA)
HELLO
HOW MANY BLOCKS ARE LEFT
MESSAGE ON THIS DISK?
LEFT:97 USED:31
WHAT'S THE CURRENT DIRECTORY?
BETADIR
R
```

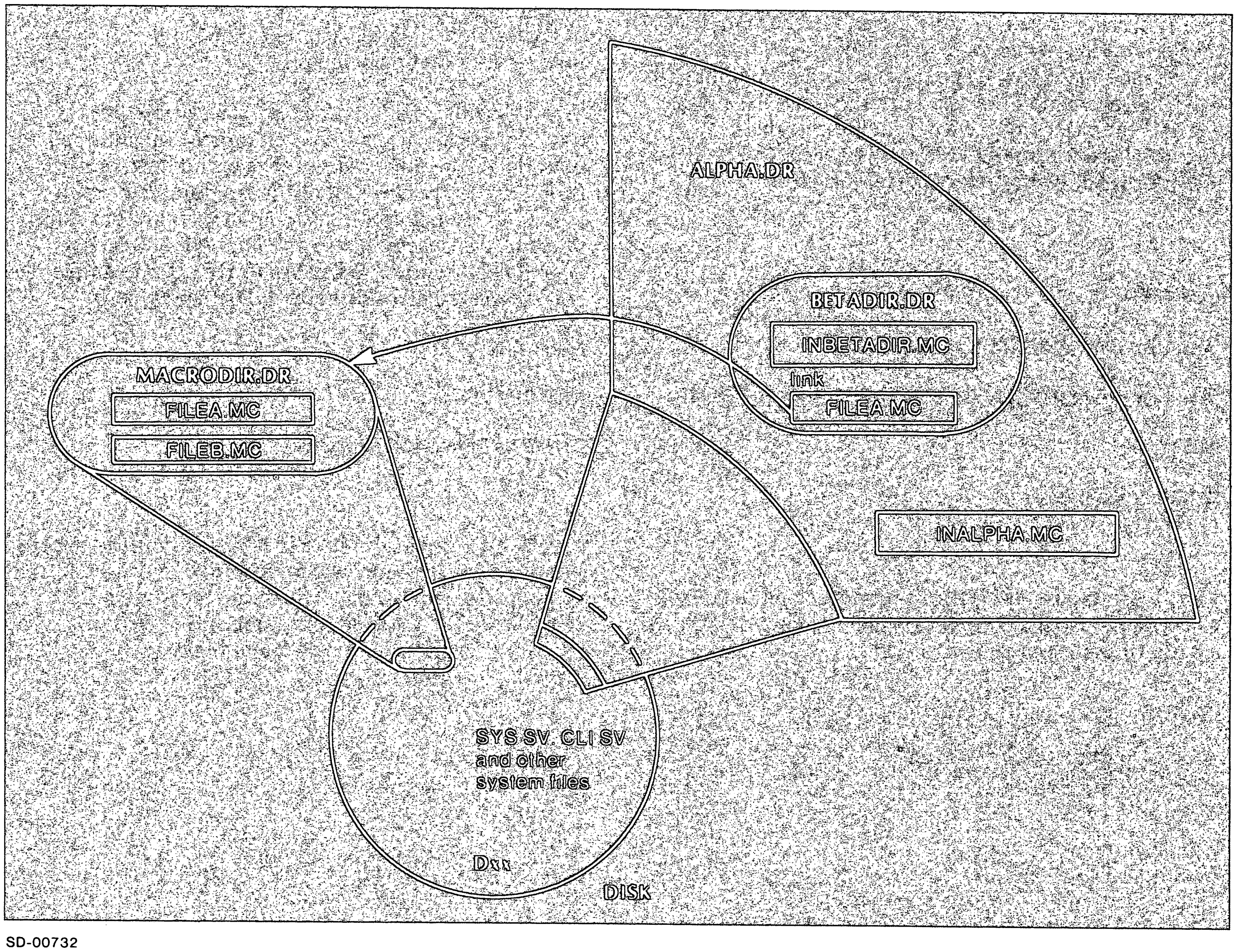
This example shows two things: that DISK always returns the space left in the current *partition* (here, ALPHA), and that GDIR always returns the current directory name (even though a file in another directory issues GDIR).

You can use any name you want for a link, but if you forget it, your link will be useless. In this example, the link name had to be FILEA.MC because FILEB.MC would search for that name only.

You'll use the same procedure to create all links. For example, the RDOS Macroassembler uses three files, which can require up to 250 disk blocks. You can link to the files from any directory, use the assembler, and consume only a few bytes per link.

You have now created files, a subdirectory, a secondary partition, another subdirectory, and a link entry, and used the commands LOG, CRAND, LIST, DELETE, XFER, TYPE, MESSAGE, DISK, GDIR, RENAME, CTRL-A (not really a command, but an interrupt), CDIR, MOVE, DIR, CPART, INIT, RELEASE, LINK, and UNLINK. You've also used switches and template characters, - and *, and CLI variable %MDIR%.

Your disk structure now looks like Figure 2-4.



SD-00732

Figure 2-4. Disk with Secondary Partition, Subdirectories and a Link Entry

Normally, whatever device you're dumping to, you'll want to dump selected files, not the entire disk. To dump files by date, use the /A switch, which instructs the CLI to dump only those files created or modified on or after a specific date. The counterpart of /A (after) is /B (before).

```
        ( MT0:0            )
DUMP/V <                    > 04-01-79/A)
        ( DP1:040279.DU    )
```

You DUMP any specific directory from within it:

```
DIR ALPHA)
R
         ( MT0:n            )
DUMP/V  <                    >  )
         ( DPn:040279.DU    )
```

By dumping a directory, you dump its contents; hence, dumping ALPHA also dumps BETADIR.

You can also use the template characters within *the current directory.* For example, to dump all save and overlay files from current directory Dxx, you would type:

```
DUMP/V destinationfile -.SV -.OL)
```

Later on, to return the DUMPed files to the current directory, you must use the LOAD command. The /R switch, described under LOAD in Chapter 4, conflicts with identical filenames that exist in the current directory. After readying the source device, you must INIT it, then do the LOAD:

```
DIR %MDIR%)
        ( MT0 )
INIT   <       >  )
        ( DP1 )
R
         ( MT0:0          )
LOAD/V  <                  > )
         ( DP1:040279.DU  )
```

You can also use local date switches and the template characters in the LOAD command.

At this point, we assume that you've DUMPed all the files you created during this session. If you want, you can now delete them and restore the disk to its original state with only the system files on master directory Dxx. This requires little effort:

```
DIR %MDIR%)
R
RELEASE ALPHA)
R
DELETE/V ALPHA.DR)
DELETED ALPHA.DR
R
RELEASE MACRODIR)
R
DELETE/V MACRODIR.DR)
DELETED MACRODIR.DR
R
```

The RELEASE command removes the directory or device that you introduced by INIT (or DIR) to the system. It also releases any subordinate directories. At this point, if you opened log file LOG.CM earlier, you might want to close it and print it. This will give you a hard-copy record of your dialog with the CLI. If you have a line printer, turn it on, place it ON LINE, and type:

```
ENDLOG)
R
DIR %MDIR%)
R
PRINT LOG.CM)
      .
      .
R
```

If you have no line printer, but have a printing console connected to the second keyboard/printer interface, type:

```
ENDLOG)
R
DIR %MDIR%)
R
XFER/A LOG.CM $TTO1)
      .
      .
      .
R
```

Chapter 3
At the Console - DOS

This chapter describes a sample session with DOS and the CLI, and leads you through many of the things you would do on the keyboard to create and organize files. When you've finished the session, you'll have a practical working knowledge of DOS basics. (For a session with RDOS, see Chapter 2.)

If you inadvertently depart from a step we describe, your later experiences may differ from the text description. This is ok; mistakes are a primary vehicle for learning and the CLI will usually prevent disasters. If you get really lost, go back to the beginning of the section you are in and give the files and directories different names; for example, FILEA1.MC instead of FILEA.MC.

Later on, you can find more detail on the features and ramifications of your commands in the *RDOS/DOS CLI User's Manual* or the *DOS Reference Manual.* If you generated your own DOS system, you already have some experience with DOS.

This session assumes that you'll be using a hard disk with diskette or dual-diskette drive and that the system disk(ette) will be in drive 0. You can, however, do almost everything in this chapter with a single diskette drive.

Within this chapter and book, the word *disk* means either hard disk or diskette; *diskette* means only diskette.

Program Load Steps (Bootstrapping)

Turn your system console ON, and make sure it is ON LINE. On some DASHER™ displays, the LINE switch is in back of the console. If this console has both upper- and lowercase letters, set it in uppercase mode with the ALPHA LOCK key because the program that brings up the system doesn't accept lowercase letters. Later you can change back to upper- and lowercase mode.

Turn or press the computer power switch to ON or RUN, whichever applies. Turn the disk or diskette drive ON. If your DOS system is on a removable hard-disk cartridge, make sure this cartridge is in its drive; press the LOAD/READY switch to READY. For any hard disk, wait for the READY lamp to light.

For diskette-based DOS, make sure the write-protect hole of the system diskette is taped. Then insert this diskette in diskette drive 0 and close the door. (If you don't know which drive is 0, try the left; then if program loading doesn't work, try the right. The one that works is drive 0.)

Look at the system console. If it shows an exclamation point (!) prompt, then you have a virtual or *programmed* console. If it shows nothing, then your computer has either a hand-held console, console debug, or CPU program load.

Computers with Programmed Consoles

For a microNOVA machine with a programmed console, find n in Table 3-1. Type nL (for example, 100026L) on the *system* console. Skip to *Bringing Up DOS.*

For a NOVA computer with a programmed console, type 100033L on the system console. Skip to *Bringing Up DOS.*

Table 3-1. microNOVA Device Codes

Disk type:	n =
Hard, sealed disk (hard disk without a LOAD/READY switch).	100026
Hard dual-platter disk subsystem (disk drive with a LOAD/READY or LOAD/RUN switch).	100027
Double-density diskette (these drives have a lamp in the center of the latch).	100026
Single-density diskette (these drives have three lamps above the diskette slot).	33

The Session

If your system console has a display screen instead of a printer, you should record console dialog in the disk log file so that you can print and review it later. If the system console has a printer, it provides reviewable copy as you type; you don't need a disk log file and can proceed to the section called *Master Directory Name.*

Log File

With a display terminal, type

```
LIST LOG.CM)
```

If there is an old LOG.CM log file on the disk, the screen will display

```
LOG.CM
```

and a number and letter, then the R prompt. Preserve the old log file by typing

```
RENAME LOG.CM LOGOLD.CM)
R
```

Next, whether or not there was an old log file, type

```
LOG/H)
```

to create a new log file, open it, and start recording console dialog in it. Later, to close the log file, you'll type ENDLOG).

Master Directory Name

Next you should discover your master directory name, so type:

```
MDIR)
```

The CLI returns the master directory name, which varies with the type of disk you have. Generally, it is either DE0, DP0, or DH0. We use *Dxx* to indicate the master directory name, so you should mentally substitute the name returned from MDIR) for *Dxx* in this session.

Creating Some Files

The next step, naturally, is to create a file. The CLI offers several file-creating commands, and we choose CRAND:

```
CRAND FILEA)
R
```

Voila. You now have an empty disk file named FILEA. FILEA was an *argument* to your command; it told the CLI what to name the new file. Some CLI commands require arguments, others don't.

You can verify FILEA's existence with the LIST command:

```
LIST FILEA)
FILEA.   0 D
R
```

and remove FILEA with the DELETE command:

```
DELETE/V FILEA)
DELETED FILEA
R
```

The /V is a *switch,* which modifies the basic meaning of a command; here, it told the CLI to verify the deletion. Now, create a different version of FILEA:

```
CRAND FILEA.MC)
R
```

Now there's an empty FILEA.MC on the disk. Normally, you'd use a text editor to put something in it, but you haven't reached Chapter 5 -- *Creating and Editing Text* -- yet. You can, however, insert text by transferring it directly from the console into FILEA.MC:

```
XFER/A/B $TTI FILEA.MC
MESSAGE HELLO)
CTRL-Z      (Hold down CTRL key and press Z)
R
```

The CLI looked for FILEB.MC, then for the save file, FILEB.SV; finding neither, it returned the error message. To fix it, give FILEB the .MC extension:

```
RENAME FILEB FILEB.MC)
R
FILEB)
MESSAGE HELLO
MESSAGE HOW MANY BLOCKS ARE LEFT
MESSAGE ON THIS DISK ?;DISK
      .
      .
      .
R
```

You planned to have your second file type your first file and succeeded. Now, you'd like to compare the files, so you type LIST/E without an argument, as in Figure 3-1.

Your command told the CLI to list all nonpermanent files in the master directory; who knows how long the listing would have continued if you hadn't hit the CTRL-A keys to interrupt the command and return the CLI prompt. (Your own listing will differ from that above). The letters following the byte count indicate the file type and organization.

There are some old friends shown in Figure 3-1: SYS.SV, CLI.SV (save files always end in .SV), and FILEA.MC. If you generated your own system, you'll recognize BOOT.SV. Unfortunately, FILEB.MC didn't show up. You could list the entire contents of directory DP0 to find FILEB.MC, but there's a better way: create a directory for the two macro files.

Creating Some Directories

Proceed to create a directory:

```
CDIR MACRODIR)
R
```

Now, to move the macros into the new directory.

```
MOVE/V MACRODIR FILEA.MC FILEB.MC)
FILEA.MC
FILEB.MC
R
```

The MOVE command copies the files into the new directory: the /V switch instructs the CLI to verify their names as they arrive. Now, the files are safely in MACRODIR; you can make MACRODIR the current directory and then list the files in it:

```
DIR MACRODIR)
R
LIST)
FILEA.MC  118
FILEB.MC  14
R
```

The DIR command makes MACRODIR the current directory. DIR also *initializes* a directory, if it hasn't been initialized. Initialization opens a directory for access to its files. The MOVE command - an exception to the rule - doesn't require initialization, but other commands do. Starting up DOS automatically initializes the master directory, but you must specifically initialize other directories to use them. DIR does this for you.

```
LIST/E)
SYS.SV      36864  SD    03/26/79  13:36  03/26/79  [002707]   0
DSKED.SV    18432  SD    03/29/78  16:18  03/29/78  [001670]   0
RLDR.SV      4608  SD    13/23/78  13:16  03/23/78  [015741]   0
CLI.OL      43008  C     10/05/78  10:14  03/30/79  [000366]   1
BOOT.SV      6656  SD    10/05/78  23:03  10/05/78  [000522]   0
FILEA.MC      118  D     04/02/79  13:24  04/02/79  [000444]   0
CLI.SV      10752  SD    10/05/78  10:14  10/05/78  [003467]   0
CTRL-A
INT
R
```

Figure 3-1. Master Directory Listing

Templates work only with certain commands, in certain contexts. Don't be afraid to experiment with them (except DELETE); at worst, you'll get an error message.

At this point, you can explore disk directories further. Your disk has the master directory (Dxx) and one other directory (MACRODIR). Because you've just started using your system, you don't have enough different kinds of files to require another directory; but eventually you will want others. So, make sure Dxx, is the current directory, and create another directory.

```
DIR %MDIR%)
R
CDIR ALPHA)
R
LIST□-.DR)
MACRODIR.DR  512DY
ALPHA.DR     512DY
R
```

Now, you can proceed with your file hierarchy by giving the new directory a little file:

```
DIR ALPHA)
R
XFER/A $TTI INALPHA.MC)
MESSAGE I'M A FILE IN DIRECTORY ALPHA.)
CTRL-Z
R
DIR %MDIR%)
R
```

Your disk structure looks like Figure 3-3. The current directory is ALPHA.

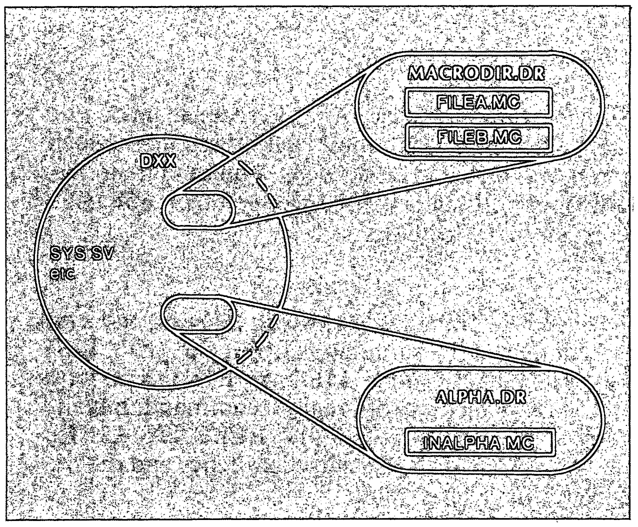


Figure 3-3. Disk with Two Directories

The system allows you to access or execute any file simply by typing the directory name, a colon, and the file name (of course, you could always DIR to the directory you wanted, then type the file name, but that requires an extra step).

```
GDIR)
Dxx
R
INALPHA)
FILE DOES NOT EXIST: INALPHA.SV
R
```

(True, in directory Dxx.) Try a directory specifier:

```
ALPHA:INALPHA)
I'M A FILE IN DIRECTORY ALPHA.
R
```

Eureka. The directory specifier (:) also works with most other CLI commands:

```
LIST ALPHA:INALPHA.MC)
INALPHA.MC  39
R
TYPE ALPHA:INALPHA.MC)
MESSAGE I'M A FILE IN DIRECTORY ALPHA.
R
```

Try it with FILEA.MC in MACRODIR:

```
MACRODIR:FILEA)
HELLO
HOW MANY BLOCKS ARE LEFT
MESSAGE ON THIS DISK?
LEFT:2022 USED:434
WHAT'S THE CURRENT DIRECTORY?
Dxx
R
```

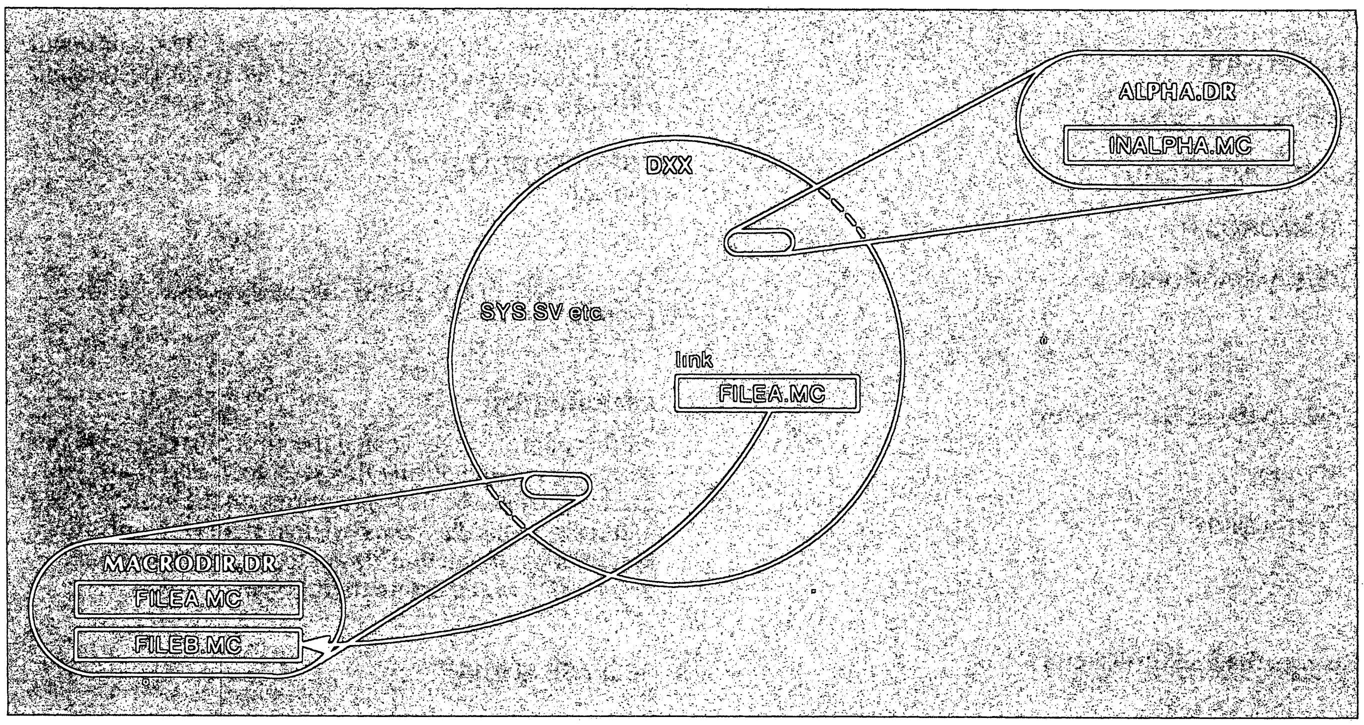
This example shows that GDIR always returns the current directory name (even though a file in another directory issues GDIR).

There are some restrictions on directory specifiers; for example, they don't work with template characters:

```
LIST MACRODIR:-.MC)
R
```

Now that you've tried directory specifiers, you can use them to clarify the idea of initialization. The rules say that a directory must be initialized before we can access its files. Let's release MACRODIR (remove its initialization), and see.

```
RELEASE MACRODIR)
R
MACRODIR:FILEA)
NO SUCH DIRECTORY: MACRODIR:FILEA
R
```



SD-00740

Figure 3-4. Disk with Directories and a Link Entry

Concluding the Session

Before terminating the session, you might want to back up your disk material on a diskette. Take a fresh diskette, tape the write-protect hole, and insert it in the appropriate diskette drive. This drive is DE1 if "Dxx" is DE0; otherwise it is DP1. If this copy diskette hasn't been initialized with DOSINIT, read the appropriate Chapter (7 or 8) of *How to Generate Your DOS System, Backing Up Your Files.*

The dump procedure itself depends whether the master directory Dxx is (1) a double-density diskette or hard disk or (2) a single-density diskette.

File Backup on a Double-density Diskette or Hard-disk System

On this kind of system, you'll create facsimile backup directories on your backup diskette and MOVE the files into them. To do ALPHA, type the following commands:

```
INIT DE1 )     (for NOVA systems, substitute DP1 for
R               DE1 in this section)
CDIR DE1:ALPHABU)
R
INIT DE1:ALPHABU)
R
DIR ALPHA)
R
MOVE/V ALPHABU)
    .
(names of files copied to directory ALPHABU)
    .
R
```

Shutting Down

At this point, if you opened log file LOG.CM earlier, you might want to close it and print it. This will give you a hard-copy record of your dialog with the CLI. If you have a printing console connected to the second teletypewriter interface, type:

```
ENDLOG)
R
XFER/A LOG.CM $TTO1)
      .
      .
R
```

If you have a line printer, place it ON LINE and type:

```
ENDLOG)
R
PRINT LOG.CM)
      .
      .
R
```

You don't need a directory specifier to access LOG.CM (although a specifier would do no harm) because you started the log file in the current directory. For more on LOG and any other commands you've used, see the command in the *CLI User's Manual.* The log file is quite large by now (check it with LIST LOG.CM); you might want to delete it.

Now you can RELEASE the system. The RELEASE command removes a directory or device that INIT or DIR introduced to the system. In so doing, it updates the directory on disk. You can RELEASE any directory from any directory -- including itself. To shut down the system, RELEASE the master directory:

```
RELEASE %MDIR%)    (or Dxx)
```

The CLI and DOS will shut down; their final message will be:

MASTER DEVICE RELEASED

You can now remove all diskettes from their drives and turn off the disk drives, computer, console and line printer (if any). Don't forget to write a label for the backup diskette (e.g., DOS SYSTEM BACKUP and the date) and apply the label. Never write on a diskette label after applying it -- unless you use a felt-tipped pen. After labeling, insert each diskette in its outer envelope and store it safely.

Congratulations. You've just completed a session with DOS. This isn't a toddler's lesson; it includes most of the concepts and commands you'll use in your day-to-day interaction with DOS, and it provides a sound background for the intricacies of other CLI commands, DOS itself, and the next chapters.

You can find details on certain CLI commands in Chapter 4; these are covered more deeply in the *CLI User's Manual.* You may feel ready to proceed to Chapter 5, which describes using the Superedit text-editing utility.

End of Chapter

Chapter 4
Common CLI Commands

The CLI is a powerful system utility that provides many commands, plus a macro facility so you can create still more. As you saw in the last chapter, you can do a lot of work using just a small subset of CLI commands.

In this chapter, we will describe CLI commands in greater detail. Most of these commands have features that are not described here. For a complete description of every command, see the *RDOS/DOS CLI User's Manual.*

From the sample session, you have some sense of *switches.* We divide switches into two categories. Those that affect entire commands are called *global* switches; those that affect one argument in the command are called *local* switches. For example, say you want to copy all files with the extension .SR to directory XDIR *except* files whose names begin with MYPROG, and you want console verification. You would type

```
MOVE/V□XDIR□-.SR□MYPROG-/N)
```

/V is the global switch which instructs the CLI to verify files moved. /N is a local switch which directs the CLI not to move files beginning with MYPROG.

Wherever you can use the template characters (- and *) in a command, we have noted this.

If the CLI command you want to type is too long to fit on a single line, simply type an uparrow (SHIFT-6 or SHIFT-N) immediately before you type). (Note that ↑ works only in CLI commands. It does not function this way in other programs.) You can now continue the command on the next line. Naturally, you omit the ↑ before the last) in the command line. For example,

```
CRAND□↑)
XFILE)
R
```

You can also stack CLI commands on one line by typing a semicolon between them; e.g.,

```
CRAND MYFILE;LIST MYFILE)
MYFILE  0  D
R
```

CDIR

Create a subdirectory (RDOS) or directory (DOS)

Format:

```
CDIR (sub)directoryname
```

The new (sub)directory will receive the .DR extension.

Switches:

None

Examples:

```
DIR DP1)
R
CDIR BETH)
```

DIR makes DP1 the current directory; CDIR creates (sub)directory BETH.DR on DP1. CDIR DP1:BETH is an equivalent command.

CPART

Create a secondary partition (RDOS)

Format:

```
CPART partname blockcount
```

Create the secondary partition named partname with the length specified in blockcount. A disk block is 512 bytes or 256 words. The new partition will be a contiguous disk file and will receive the extension .DR.

You cannot create a partition with less than 48 disk blocks. Also, if blockcount is not a multiple of 16, RDOS truncates it to the nearest lower multiple.

Switches:

None

Examples:

```
DIR DP4F)
R
CPART ALEPH 128)
R
```

The DIR command makes primary partition DP4F the current directory; CPART creates secondary partition ALEPH on DP4F. An equivalent command would be CPART DP4F:ALEPH 128). ALEPH is 128 disk blocks long and is logically distinct from primary partition DP4F.

Local Switches:

mm-dd-yy/A	Delete only files created this date or after. Arguments mm (month) and dd (day) can be one or two digits.
mm-dd-yy/B	Delete only files created before this date.
name/N	Do not delete any files that match this name.

Template Characters:

Permitted only when filename argument is in the current directory.

Examples:

```
DELETE/V LIMIT.-)
```

This command deletes all files which have the name LIMIT and any extension (including none); e.g., LIMIT.SR, LIMIT.RB, LIMIT.SV, and LIMIT. This also verifies their names on the console.

```
DELETE/V□A**B)
```

This command deletes all files with four-character filenames that begin with A, end with B, and have no extensions. It also verifies files deleted.

```
DELETE/V□A-B)
```

This command deletes all files whose names begin with A, end with B, and have no extensions.

```
DELETE/C□-.LS)
```

A.LS:) *	Delete file A.LS
COM.LS:) *	Delete COM.LS
MAP.LS:	Don't delete MAP.LS

Confirm before deleting. The system asks for a confirmation of each deletion. When you confirm a deletion with a carriage return, the system echoes an asterisk (*). Any other character echoes a carriage return.

DIR

Change the current directory

Format:

DIR directory *[:subordinate directory]*

At bootstrap time, the master directory becomes the current directory. The DIR command specifies another device or directory as the current device or directory. If necessary, this command will also initialize the device or directory.

Switches:

None

Examples:

```
DIR ACCTSDUE)
```

This command makes directory ACCTSDUE, on the current partition or disk, the current directory.

```
DIR DP1:DEF)
```

This command makes directory DEF, on DP1, the current directory.

Template Characters:

Permitted only when *filename* argument is in the current directory.

Examples:

```
DUMP/A/L MT0:0 2-20-79/A)
```

This dumps all permanent and nonpermanent disk files created on or after February 20, 1979 onto file 0 (the first file) of magnetic tape unit number 0. It also sends a listing to the line printer. You can then save this tape file as a backup for the disk.

```
DUMP/A/L DP4:SOURCE -.SR 7-14-77/A)
```

This tells the system to dump all files with the .SR extension created on or after July 14, 1977 to file SOURCE on DP4, and to send a listing of filenames to the printer.

```
DUMP/V□MT0:0 -.-□-.RB/N□TEMP.DR
```

Dump all nonpermanent files in the current directory (except .RB files) and directory TEMP and all its files, to file 0 of the tape MT0.

ENDLOG

Close the LOG file

Format:

ENDLOG *[password]*

Close the log file which you opened by a previous LOG command. You must close this file before you can TYPE, PRINT or DELETE it. If the previous LOG command included a *password* argument, you must use the password with the ENDLOG command.

This command, ENDLOG *password,* appears in the log file.

Switches:

None

Examples:

```
ENDLOG GSTONE)
```

The password GSTONE is used since it was specified when the log file was last opened.

Note that you must type the full name of the log file to PRINT or DELETE it; this name is LOG.CM.

LINK

Create a link to a file in another directory

Format:

```
LINK { resfilename/2                                           }
     { linkentryname [directory specifier:] resfilename }
```

resfilename is the file you're linking to. If your link entry will have the same name as the resolution file (resfilename), and resfilename is in the current directory's parent directory, you can create your link with the first command format (the local /2 switch specifies the same filename). Linkentryname will always be created in the current directory unless you specify another directory.

If the resolution file is not in the current directory's parent, or if your link name will differ from the resolution file's, use the second command format. The resolution file resfilename may exist in any initialized directory.

Global Switches:

None

Local Switches:

linkentryname/2

Create linkentryname to a resolution file of the same name in linkentryname's parent partition. The parent partition is the disk or secondary partition that contains the current directory.

Examples:

```
MDIR)
DE0
R
DIR MYDIR)
R
LINK EDIT.SV/2)
```

The master directory is DE0, and it contains (sub)directory MYDIR. DE0 is MYDIR's parent directory, so the LINK EDIT.SV/2 links to EDIT.SV (the Text Editor) in directory DE0. Typing LINK EDIT.SV/2 is easier than typing LINK EDIT.SV DE0:EDIT.SV, which would have the same effect.

```
DIR DP1)
LINK NSPEED.SV DP0:NSPEED.SV)
LINK SPEED.ER DP0:SPEED.ER)
```

This command creates two link entries named NSPEED.SV and SPEED.ER in DP1 to the editor files on DP0. This permits anyone in directory DP1 to use the NOVA (NSPEED) Supereditor.

```
LINK ASM.SV DZ0:ASM.SV)
```

This command creates a link entry named ASM.SV in the current directory to the extended assembler in directory DZ0.

```
DIR FORT4)
LINK FORT.SV DP0:FORT.SV)
LINK FIV.SV DP0:FIV.SV)
LINK ASM.SV DP0:ASM.SV)
```

These commands create link entries to the FORTRAN IV compiler files and to the extended assembler (which the compiler needs) in directory FORT4.

Examples:

```
LIST/E/A)
```

This command lists every type of information on all files and link entries in the current directory. A typical line of information would look like this:

FLI.SV 8160 SD 03/23/79 13:56 03/23/79 [000164]0

In this example, FLI.SV is the filename; it consists of 8,160 bytes, is a randomly organized save file, was created (or modified) at 1:56 p.m. on the 23rd day of March 1979, was last opened on that same date, has a starting logical block address of 164_8, and has a file use count of zero.

Typical lines describing link entries would look like this:

ASM.SV DP0:ASM.SV

The link entry name is ASM.SV; the link was created to resolution file ASM.SV on DP0.

EDIT.SV @ :EDIT.SV

In this example, the link entry name is EDIT.SV and the resolution file was defined to have the same name and to reside on the parent partition or diskette.

```
LIST/K/S□-.SV□5-2-79/A)
```

List all nonpermanent save files (.SV extension) created after May 1, 1979 and sort the list alphabetically. This will not list links and output will go to the console.

```
LIST/A□-TEXT-.SR□-TEXT1-.-/N)
```

List all files whose names include the letters TEXT, with the extension .SR, except those filenames which include TEXT1.

LOAD

Load dumped files

Format:

LOAD *inputfilename [filename...]*

Load a previously-dumped file from *inputfilename* into the current directory. If you omit filenames and switches, all nonpermanent files in the input file are loaded. With global switches, you can select filenames for LOADing, or you can choose simply to list on the console or printer the filenames in the input file.

The LOAD command can load only those files that were previously DUMPed. Files you want to load must bear different names from files in the current directory (unless you specify the /N, /O or /R switches).

Global Switches:

/A	Load all files, including permanent files.
/K	Do not load link entries.
/L	List loaded filenames on the line printer. (Overrides /V switch and listing by /N.)
/N	Do not load files; output the filenames to the console.
/O	Delete current file if it exists and replace with file being loaded that has the same name.
/R	Select most recent version. If a file in the current directory has the same name as a file in the inputfile, check both files' creation dates. If the version in the inputfile is newer, delete the version in the current directory and replace it with the newer one in the inputfile. If the version in the inputfile is not newer, take no action.
/V	Verify the load by listing filenames loaded on the console. Filenames in a directory are listed before the directory name.

MOVE

Copy files to any directory

Format:

MOVE destination-directoryname *[filename...]* ↑)
[oldfilename/S newfilename]...

This command will copy a given file or files in the current directory to another directory. *Filename* cannot be a directory. If you omit filenames and switches, all nonpermanent files in the current directory are moved.

Global Switches:

/A	Move all files, including permanent files.
/D	Delete original files after MOVE.
/K	Do not move links.
/L	List moved filenames on the line printer.
/R	Select most recent version. If a file in the destination-directory has the same name as a file to be MOVEd, check both files' creation dates. If the version to be MOVEd is newer, delete the version in the destination-directory and replace it with the newer version. If the version to be MOVEd is not newer, take no action.
/V	Verify MOVEd filenames on the console.

Local Switches:

mm-dd-yy/A	Move any file created or modified this date or after. Arguments mm (month) and dd (day) may be one or two digits. Date switches move *all* matching links unless you include the global /K switch.
mm-dd-yy/B	Move any file created or modified before this date.
name/N	Do not move files that match name.
oldname/S newname	Assign newname to the preceding file but retain its oldname in the current directory.

Template Characters:

Permitted.

Examples:

```
MOVE/D/K□MYDIR□-.SR)
```

This command moves all nonpermanent files in the current directory with .SR extension (except link entries) into destination-directory MYDIR, and deletes the original files after the transfer.

```
MOVE/A ACCTSDUE□-.-□3/1/79/B)
```

This command moves to directory ACCTSDUE all files created or modified before March 1, 1979.

```
DIR MYDIR)
MOVE/V %GDIR% FILEA/S FILEA1)
FILEA1
```

This command copies a file, under a different name, in the current directory. By doing this when you plan extensive changes to a file, you preserve a backup version. In this case, FILEA1 is a backup version of FILEA.

RENAME

Rename a file

Format:

RENAME oldname newname *[oldname newname]...*

Rename a file in the current directory. You can rename any nonpermanent file that is not open, but note that some system utilities (e.g., the assemblers or the FORTRAN compiler) will not work if you RENAME them. No save (program) file can execute without the .SV extension.

Switches:

None

Examples:

```
RENAME LOG.CM LOGOLD.CM)
R
```

Rename the current log file LOGOLD.CM. The log file must have been closed via ENDLOG before you can RENAME it.

```
RENAME FILEB FILEB.MC)
R
```

Give FILEB the .MC extension so that the CLI can execute it as a macro file.

TYPE

Type a file on the system console

Format:

TYPE filename *filename...*

Copy an ASCII file or files on the console. The source files may come from any device.

Switches:

None

Examples:

```
TYPE A.SR B.SR DP1:XX.SR)
    .
    .
    .
```

This command displays or types the following disk files on the program console: A.SR and B.SR in the current directory, and source file XX.SR on DP1.

The Next Steps

If you'll be working exclusively in BASIC, skip all the way to Chapter 7; you don't need the next two chapters.

To code in another high-level language, you'll use a text editor program (described in Chapter 5), a compiler, then another utility to make the compiled code executable. Chapter 6 covers the compiling and processing steps for a FORTRAN IV program; steps for other languages are similar. For the precise details, of course, see the language reference manual for your compiler.

If you're an assembly language programmer, you'll follow the same procedure as the FORTRAN programmer, except that you'll use an assembler instead of a compiler. You'll need Superedit (Chapter 5), then the assembly language information in Chapters 8 and 9.

End of Chapter

Chapter 5
Creating and Editing Text

You received two different editor utilities with your system: the text editor (EDIT) and the Supereditor. Superedit, the topic of this chapter, is the more advanced editor and is much handier than the XFER/A command you used in the last chapter. Within *this* chapter, we explain enough Supereditor features to let you use it. A complete description of the editor is outside the scope of this book; you can find a complete description in the *Superedit Text Editor User's Manual (RDOS/DOS)*.

It's sound practice, especially for a new user, to save a backup copy of each text file under a different name.

Superedit Features

The editor is a utility program which you evoke by a CLI command, but its commands bear no relation to the CLI's. Superedit lets you create and modify files containing upper- and lowercase ASCII text. During editing you can change, delete, search for, or insert single text characters, lines of text, or large portions of whole files. The editor is *string-oriented*. This means that its commands work with character sequences, which need not be complete lines. A line of text is a string of characters terminated by a carriage return. You can change or search for character combinations without knowing where they are.

Superedit maintains a *character pointer* (CP), which indicates the current editing position in the file. It also provides a command to show you where the CP is; but for the most part, you simply keep a mental note of the pointer's position. You change the CP's position by executing edit commands. 2L, for example, moves the CP down to the start of the second line beyond its current position.

executing edit commands. 2L, for example, moves the CP down to the start of the second line beyond its current position.

You can enter two kinds of input when you edit: editor commands and text you want in your file. When you are inserting new text, your Superedit command, which may include many lines, will include text you want inserted.

When it is ready to execute a command, Superedit types an exclamation point (!) prompt character. After you see this prompt, you can type in one or more editing commands. You can enter two or more commands on one line by typing an ESC character between each command; you terminate the entire command line by typing ESC twice. When you type ESC, Superedit echoes a dollar sign on your screen; obviously, ESC ESC appears as two consecutive dollar signs. Superedit executes the commands in a multiple command entry sequentially, from left to right. If you enter an incorrect command anywhere in a multiple command line, Superedit informs you of the error, then ignores the remainder of the command line; that is, it processes only those commands to the left of the invalid command.

Note: Although Superedit accepts both upper- and lowercase characters, the FORTRAN compiler and assemblers do not, except in text or comment strings. Thus, for all text you intend to compile or assemble, you must enter letters in uppercase, except for comment or text strings.

If you want to delete the entire current line, simply type CTRL-X. This is equivalent to typing DEL or RUBOUT back to the beginning of the line. CTRL-X deletes the last line only.

Finally, if you want to cancel a command that Superedit is executing (after you've type ESC ESC), type CTRL-A. With the commands we've described here, however, you will usually not be quick enough to stop the whole command from being executed.

A Note of Caution

Superedit is a powerful editor -- practically a text-processing language -- but its power and speed can sometimes make life difficult for a novice user. Until you learn it well, you should update your file often, saving a backup version with the US and H commands (US$H$$) to minimize lost effort. If text seems to have vanished from the edit buffer after a command, type USH to update the file and save the original version, then examine both the current and original versions with either Superedit or the CLI TYPE command and work with the one you want. The US and H commands are detailed later in this chapter.

Insert New Text (I)

When you evoke Superedit, it reads some or all of your file into its buffer (if the file already exists), or simply starts with a clear buffer. In either case, its CP (character pointer) always points to the first position in the buffer. Since you have just created a file, there is nothing to edit and you can start by inserting lines of source code.

```
!tabREAL INT, ITD, LB)
5tabTYPE "ENTER AMOUNT, RATER, YEARS")
tabTYPE "AND, 0 FOR SUMMARY OR 1 FOR")
$$
```

tab represents pressing the CTRL and I keys to produce a tab.

After each insertion, the CP points after the last inserted character. This lets you repeat insert commands in the same order that you would type words or lines of text on a typewriter. In the text above, we could have typed the text between quotes in lowercase, however, the compiler requires the REAL statement in uppercase.)

Generally, you should not insert more than ten lines of text in one I command. It's sound practice to end each Insert with $$ after typing several lines, then continue inserting with a new I command.

Jump CP to the Beginning of the Buffer (J)

At any time in the editing process you can move the CP to the start of the buffer; simply key in the J command. You can also use the L command to move the CP from one line to another, but J gets you to the start of the buffer immediately.

Examine Some Lines in Your File (T)

It's pretty good practice to review each addition or change after you make it, so after every change you should type the T command. There are three variations of this command, and none of them moves the CP:

0,nT	Type the buffer from the beginning to character n. To type the entire buffer, simply insert a number sign before T; i.e., # T.
nT	Starting at the current CP, type the next or previous n lines of the buffer. n is positive (forward) unless you precede it with a minus sign.
-mTnT	Type text from m lines backward to n lines forward, to show the text surrounding the CP.
T	Type the current line and show where the CP is. Superedit uses the 3-character combination (↑) to show where the CP is.

The command

```
2T$$
```

types the current line and the next line, while

```
-2T$$
```

types the two previous lines. In the example above, the string J$3T$$ displays the three lines typed.

Set the CP at the Start of a New Line (L)

Often you may want to set the CP several lines forward or backward from its current position. You use the L command to do this, and it has two variations:

L	Set the CP to the beginning of the current line.
nL	Set the CP to the start of a different line. If n is positive, the CP moves n lines forward from the current line. If you precede it with a minus sign, the CP moves n lines backward.

L moves the CP to the start of the current line, 2L moves the CP to the start of the second line down from the current line.

Again, you can use the T command to check the CP position:

```
!J$T$$
(↑) REAL INT, ITD, LB
!L$T$2L$T$$
(↑) REAL INT, ITD, LB
(↑) TYPE "AND, 0 FOR SUMMARY OR 1 FOR"
!
```

The first command line starts at the beginning of the buffer and types the first line. The second command line moves the CP to the beginning of the line, types the line, then moves the CP two lines forward and types that line.

Move the CP (M)

The M command, format nM, moves the CP backwards or forwards by n number of characters. To move the CP to the left, make n negative; e.g., -2M. To move it to the right, use a positive number; e.g., 2M. Generally, you'll use M to move the CP within a line, but you need not do so. For example, if you move the CP past a carriage return character, it will move into another line of text.

If the current line (displayed by T$$) is:

```
(↑) REAL INT, ITD, LB
```

And you type the command 2M$T$$

```
!2M$T$$
RE (↑) AL INT, ITD, LB
!
```

Then, type -2M$T$$ to restore the CP to its original position:

```
!-2M$T$$
(↑) REAL INT, ITD, LB
!
```

Delete Lines (K)

Sometimes you may want to delete an entire line. (Often it's easier to delete a bad line and insert a new one than to try to correct the original.) To delete one or more lines, use the K command. This command takes an argument n indicating how many lines to delete:

```
3K$$
```

This command kills (deletes) three lines from the current CP position (the first line is everything to the right of the CP on the current line). We suggest that you use only positive values of n to keep your editing simple. (A negative n when the CP is in the middle of a line will delete not only the previous line but also the left portion of the current line).

For example, assume you want to delete the second line, which begins with 5. First, use the S, L, and T commands to check the surrounding lines:

```
!J$S5$-1L$3T$$
REAL INT, ITD, LB
5 TYPE "ENTER AMOUNT, RATE, YEARS"
TYPE "AND, 0 FOR SUMMARY OR 1 FOR"
!
```

Then get to the target line with S, and verify the line with T. Get to the beginning of the line with L, delete the line with K, and verify the deletion with T.

```
!S5$T$$
5 (↑)  TYPE "ENTER AMOUNT, RATE, YEARS"
!L$1K$-1L$2T$$
REAL INT, ITD, LB
TYPE "AND, 0 FOR SUMMARY AND 1 FOR"
!
```

To restore the line, set CP position *after* the carriage return character in line one, and use the I command:

```
!J$SLB)
$$
!I5tabTYPE "ENTER AMOUNT,RATE,YEARS")
$$
```

Table 5-1. Superedit Command Examples

Command	Examples	Result	Command	Examples	Result
#T	#T$$	Type the entire buffer on the console.	M	ZMT-ZM$T$$	Move the CP two characters right, type line, then move the CP two characters left, type line.
	3T$$	Type three lines from CP including the current line.			
	T$$	Type the current line and show where the character pointer is.	S	SOUNT,$$	Set the CP after the comma following OUNT as shown in this example string: ...ENTER AMOUNT,...
	SOUNT, $T$$	Given this string. ...ENTER AMOUNT, RATE AS... this command shows the pointer located immediately after the comma after AMOUNT: ...ENTER AMOUNT,(↑) RATE AS...	C	SOUNT,$$ CTER$TE$$	Set the CP after OUNT, then change TER to TE Applied to this string, ...ENTER AMOUNT, RATER AS... it produces this result: ...ENTER AMOUNT, RATE AS...
J	J$5T	Go to the start of the buffer and type the first 5 lines.	I	L$ I HELLO$$	Insert the string HELLO before the current line.
L	L$I)) $$	Insert two blank lines before the current line.	K	L$1K$$	Delete the entire current line.
	3L$$	Set the CP to the start of the 3rd line down from the current line.	UE US	UEH$$ USH$$	Apply editing changes to the file, close it, and return to the CLI.

End of Chapter

Chapter 6
Instant FORTRAN IV Programming

This chapter assumes that you have the optional FORTRAN IV compiler utility programs, and that you have loaded them, along with the FORTRAN libraries, into your master directory, as described in an appendix of the *FORTRAN IV User's Manual.* The FORTRAN IV compiler consists of two files: FORT.SV and FIV.SV. (If your machine has only 16K of memory, do not use the FIV.SV file; instead use FIVNS8.SV, DUMP or COPY FIV.SV to save it, then delete the original and RENAME FIVNS8.SV to FIV.SV.) The compiler also expects that the Extended Assembler, ASM.SV, is in this directory.

Program Steps

These are the steps you follow to write a FORTRAN IV program.

1) Create or edit a FORTRAN IV source file with Superedit.

2) Compile and assemble the source file with the CLI command

   ```
   FORT filename)
   ```

   This produces a relocatable binary file.

3) If there are any compile-time errors, go to 1; if not, go to 4.

4) Make the relocatable binary file into an executable save file with RLDR:

   RLDR filename *[subroutine names...]* FORT0.LB↑)
   FORT1.LB FORT2.LB FORT3.LB SMPYD.LB)

5) Run the save file with the CLI command

   ```
   filename)
   ```

6) If the program is correct, go to 9; if not, go to 7.

7) Diagnose your program using runtime error messages or erroneous output.

8) Go to 1.

9) You're done!

This chapter guides you through all the steps you need to write and execute such a program.

Writing the FORTRAN Source Program

The FORTRAN example in this chapter is a simple program to calculate home mortgage payments; it produces a schedule of monthly principal and interest. The program uses only ordinary arithmetic operations, calls no subroutines, and (excluding comments) is only about half a page long. The program uses two formulas. You need not understand how these formulas work to understand the illustration. We have chosen FORTRAN IV for this program (instead of FORTRAN 5) because FORTRAN IV runs under both RDOS and DOS.

```
        REAL INT, ITD, LB                 ; Else these would be integers.
5       TYPE "ENTER AMOUNT, RATE, YEARS"
        TYPE "AND, 0 FOR SUMMARY OR 1 FOR"
        TYPE "FULL SCHEDULE.  SEPARATE EACH"
        TYPE "ENTRY WITH A COMMA."
        TYPE "TERMINATE INPUT WITH RETURN."
        ACCEPT  AMOUNT,RATE,IYEARS,IFULL        ; Get figures from console.

C  Change yearly rate RATE to monthly rate R.
        R = RATE/12
C  Change years IYEARS to months N.
        N = IYEARS*12

C  Calculate monthly payment PAY, write header and PAY.
        PAY = AMOUNT*R*(1+R)**N/((1+R)**N-1)
        WRITE (10,110) AMOUNT,RATE,IYEARS
110     FORMAT (1H0,"AMOUNT     = $",F9.2,/," INTEREST RATE =",F7.4,/,
     X  " LOAN LIFE IS",I4," YEARS",/)    ; Char. in pos. 6 continues line.
        WRITE (10,120) PAY
120     FORMAT (1H0,"MONTHLY PAYMENT = $",F10.2,/)

C   Summary or full schedule?
        IF (IFULL .LE. 0) GO TO 40

C   Full schedule -- set up variables.
        LB = AMOUNT      ; Initial Loan Balance equals original amount.
        NN = N           ; Save original number of months in NN.
        ITD = 0          ; Interest To Date is initially 0.

C   Write header, then calculate and write figures month by month.
        WRITE (10,130)
130     FORMAT (1H0," NUM",7X,"INTEREST",5X,"PRIN. PAY        PRIN."
     X  "BAL",6X,"INTEREST PAID TO DATE",/)

        DO 30 I=1,NN    ; DO until you reach NN months --
C       Calculate amount of principal in payment, PN.
        PN = LB*R/((R+1)**N-1)
C       Decrement month.
        N = N-1
C       Calculate amount of interest in payment, INT.
        INT = PAY-PN
C       Update loan balance.
        LB = LB-PN
C       Update interest paid to date.
        ITD = ITD+INT
C       Write figures for this month.
        WRITE (10,140) I, INT, PN, LB, ITD
140     FORMAT (1H0,I3,7X,"$",F9.2,"     $",F9.2,"     $",F9.2, 8X,"$", F0.2)
30      CONTINUE

40      ACCEPT " TYPE 1 TO REPEAT, 0 TO STOP. ', ISTOP
        IF (ISTOP .GT. 0) GO TO 5
        END
```

Figure 6-2. MORTGAGE.FR Program With Errors

Creating the Save File

The RLDR command line for MORTGAGE is:

```
RLDR MORTGAGE FORT0.LB FORT1.LB↑)
 FORT2.LB FORT3.LB SMPYD.LB)
```

The -.LB names following MORTGAGE are the names of libraries that you must always use when loading a FORTRAN IV program. Typing the four library names is a nuisance; eventually you may want to merge the libraries under a single name (e.g., FORT.LB) with the Library File Editor (LFE) utility.

Later, for more on the LFE command, see the appropriate appendix of the *FORTRAN IV User's Manual.* Note that if your computer has hardware multiply-divide, you might want to select the hardware-multiply-divide library (instead of SMPYD.LB) for later programs, or for your single merged library file. For now, if you want, you can create a CLI macro to do the load; or you can simply type in the filenames.

As RLDR processes MORTGAGE, you see the following series of messages on the console:

```
MORTGAGE.SV LOADED BY RLDR
REV xx.xx AT time date

.MAIN
I
FREAD
   .
   .
   .
NMAX  012177
ZMAX  000210
CSZE  000000
 EST  000000
 SST  000000
```

Following the initial line, which tells you the name of the save file and when it was created, RLDR describes all the modules that it extracted from the FORTRAN libraries and the system library to build the program. .MAIN is always the title of the main FORTRAN program; you can ignore the other modules. The next group of entries describes the memory addresses at which MORTGAGE will execute. NMAX is the highest address of normal-relocatable code plus one.

CSZE is the unlabeled common area size; here, there is none. EST and SST are the end and start of the symbol table, and, again, there is none. In most FORTRAN applications, you won't care about the information produced by RLDR; but if you plan to run dual programs or have limited memory, the NMAX and ZMAX figures may concern you. You can find more detail on this in your system reference manual or the *Extended Relocatable Loaders User's Manual.*

Executing the FORTRAN Program

You now proceed to the next step, executing MORTGAGE.SV. To execute this or any other program, simply type the program name and follow it with a).

```
MORTGAGE)
ENTER AMOUNT, RATE, YEARS
AND, 0 FOR SUMMARY OR 1 FOR
FULL SCHEDULE. SEPARATE EACH
ENTRY WITH A COMMA.
TERMINATE INPUT WITH RETURN.
```

You then respond with a request for the summary information (monthly payment only) given a mortgage of $20,000 at 9% for 25 years:

```
20000,.09,25,0)
```

MORTGAGE then types:

```
AMOUNT = $20000.00
INTEREST RATE = 0.0900
LOAN LIFE IS 25 YEARS

MONTHLY PAYMENT = $167.84
```

on the console, and then says:

```
TYPE 1 TO REPEAT, 0 TO STOP
```

To continue, type:

```
1)
```

Since you responded with 1, the same instructions appear on the console. This time, enter the same arguments but ask for a full schedule:

```
20000,.09,25,1)

AMOUNT = $20000.00
INTEREST RATE = 0.0900
LOAN LIFE IS 25 YEARS

MONTHLY PAYMENT = $167.84
NUM. INTEREST PRIN. PAY...
FATAL RUNTIME ERROR 15 AT LOC. xxxxxx
CALLED FROM LOC. yyyyyy
R
```

and find the CLI running on the console. The FORTRAN IV manual describes *Runtime Error 15* as a "field" error, which might have occurred in an F or E entry in a FORMAT statement. Checking the Fs in our program, we find a typo in statement 140: *F0.2* should be *F9.2.* Fix this with the Superedit command

```
J$CF0.2$F9.2$T$$
```

Chapter 7
Extended BASIC Programming

This chapter leads you through a sample session in Extended BASIC. It assumes that you have some experience with the BASIC language, and that you have loaded the BASIC System Generation program (BSG) from tape or diskette, and generated a BASIC system. Chapter 2, the *Extended BASIC System Manager's Guide* covers BSG. This chapter also assumes that you are the only person on the system using BASIC. On a multiuser BASIC system, log on according to your system manager. Skip step 1 below and all the CLI material in this chapter.

Aside from the *Extended BASIC System Manager's Guide,* we offer two other books on Extended BASIC: *basic BASIC,* for beginners, and the *Extended BASIC User's Manual,* which covers the features and commands of our BASIC. Here are the steps you follow to create a BASIC program:

1) Invoke the BASIC interpreter and get into BASIC by typing the CLI command:

```
BASIC)
```

2) Write a series of BASIC program statements. BASIC has its own editor and an interactive compiler that rejects bad syntax as you type each statement.

3) Run the program with the BASIC command:

```
RUN)
```

4) If the program runs correctly, you're done! Save the program on disk with the LIST command. Type BYE) to get back to the CLI.

5) If your program contains runtime errors, fix it using erroneous output or BASIC runtime error messages. Go to 3.

Writing BASIC Programs

You write a BASIC program as a series of statements, which you must begin with a number between 1 and 9999. Each statement includes a command to BASIC, which then executes the statements sequentially, by number; thus, your program can do useful work.

At various points, you can examine the statements in your program with the LIST command, or tell BASIC to execute the statements with the RUN command. BASIC's error messages will help you correct errors; you can correct offending statements by typing their line numbers, then the new text. When you're satisfied with a program, save it on disk with the command LIST "filename"); later, you can read it back into memory with the command ENTER "filename"). To print it on the line printer, type LIST "$LPT"). To start work on another program, type NEW), then proceed. To sign off BASIC and return to the CLI, type BYE).

You can execute a BASIC program only from BASIC; you can't do it from the CLI. The BASIC interpreter accepts both upper- and lowercase characters, and translates lowercase letters to uppercase. You can make lowercase text part of your program (in PRINT and comment statements) by editing your BASIC program file with Superedit, after the program runs.

Strings and Arrays

BASIC strings and arrays allow you to store and access alphanumeric strings and numbers by subscript. You can declare a string or array, assign it a fixed number of elements with a DIM statement, and then access elements by the string or array name, followed by the element subscript number in parentheses or brackets. String names begin with a letter and end with a dollar sign (e.g., A$, A1$); array names don't include the dollar sign (e.g., A,A1). For example, type:

```
*NEW)
*10 DIM N$(30))
*20 INPUT "WHAT'S YOUR NAME?",N$)
```

Run it:

```
*RUN)
WHAT'S YOUR NAME?
```

Type a name:

```
WHAT'S YOUR NAME? MELINA)
*
```

Line 20 uses a *string literal,* which you simply enclose in quotes, and BASIC accepts it literally; line 10 dimensions *string variable,* N$. Your response assigned values MELINA to the first six elements of N$, which look like this in memory:

```
M      E      L      I      N      A      null .... null
N$(1) N$(2) N$(3) N$(4) N$(5) N$(6) N$(7) N$(30)
```

Elements $N(7) through $N(30) contain nulls (ASCII 000).

You can reference substrings using the form *stringname(element1, elementn).* For example, append a statement to your program and run it:

```
*30 PRINT N$(1,3))
*RUN)
WHAT'S YOUR NAME? MELINA)
MEL
*
```

The subscripts specified elements 1 through 3; hence, MEL.

Now, we can try a more sophisticated version of the program, which dimensions two strings, compares them, and acts on the comparison. Note that whenever you change mode in a PRINT statement, from string literal or string variable or numeric variable, you must insert a semicolon (or comma). This rule accounts for the complex punctuation in lines 30 and 80. Type NEW), then type in this program. If you make a mistake, retype the bad line from the beginning.

```
10 DIM N$(30) O$(30))
20 INPUT "WHAT'S YOUR NAME?□",N$)
30 PRINT "IS IT REALLY□";N$;"?□TYPE IT AGAIN.")
40 INPUT O$)
50 IF O$< >N$ THEN GOTO 80)
60 PRINT N$;"□MUST REALLY BE YOUR NAME.")
70 STOP)
80 PRINT"IS IT□";N$;"□OR□";O$;"?"
```

Now, try running the program. If you want to save it on disk, type LIST "name"), where name is any legal RDOS or DOS filename. Chapter 8 of *basic BASIC* describes strings further.

BASIC arrays resemble strings, but each element in an array must be a number, whereas each element in a string must be an alphanumeric character. For example,

```
10 DIM A(20))
20 A(1) = 9.5)
30 A(2) = 46)
40 A(20) = A(1)+A(2))
50 PRINT A(1),A(2),A(20))
```

These statements dimension array A and assign values to three of its elements; the other elements contain nulls. Chapter 7 of *basic BASIC* explains elementary arrays.

BASIC Program

The BASIC program flowcharted in Figure 7-1 and shown in Figure 7-2 is a variation of the FORTRAN program in Chapter 6. It computes mortgage payments, taxes, and deductions in a general way; and writes its computations to the console. You can enter the program using Superedit from the BASIC directory (link to the Superedit files first), or you can use the BASIC interpreter. If you use the BASIC interpreter, it will check the syntax of each line as you type it in. If you use Superedit and make a syntax mistake, the BASIC interpreter will reject the bad line when you ENTER the program.

If you use the BASIC interpreter, you can examine the lines you've typed by typing LIST. To list a portion of the lines, type LIST number comma number, where each number is a line number, e.g., LIST 10,100).

Periodically as you type the program in, and when you're done, type LIST "MORTGAGE.BA", to write the program to disk; you can also get a hardcopy listing by typing LIST), or LIST "$LPT") if you have a line printer.

If you want the program to write to the line printer, insert the statement OPEN FILE (0,2), "$LPT" before the first PRINT statement. Then change the PRINT or PRINT USING statements to PRINT FILE (0), or PRINT FILE (0), USING statements wherever you want the program to write to the printer. Insert the statement CLOSE right before the STOP statement (line 300).

You should examine Figures 7-1 and 7-2 before proceeding to the next section.

```
0010 REM    PROGRAM MORTGAGE.BA, COMPUTES MORTGAGE PAYMENTS, HAS TAX SUBROUTINE.
0020 PRINT "<12> I CALCULATE MORTGAGE PAYMENTS, INTEREST, AND TAXES."
0030 PRINT "TYPE AMOUNT OF PRINCIPAL, INTEREST RATE IN WHOLE NUMBERS,"
0040 PRINT "MORTGAGE LIFE IN YEARS, AND ANNUAL PROPERTY TAX BILL FOR HOUSE."
0050 PRINT "SEPARATE ENTRIES WITH A COMMA; FOR EXAMPLE  40000,10.5,25,2000."
0060 PRINT
0070 PRINT "  AMOUNT? RATE? YEARS? TAXES?"
0080 INPUT " ?    ",A,R1,Y,T
0090 REM   GET MONTHLY RATE R (R1/12), MAKE INTO FRACTION AS R1 WAS WHOLE NUMBER.
0100 LET R=R1/1200
0110 REM   GET NUMBER OF MONTHS M FOR LOAN.
0120 LET M=12*Y
0130 REM   COMPUTE MONTHLY PAYMENT.
0140 LET P=A*R*(1+R)↑M/((1+R)↑M-1)
0150 REM    DEFINE FORMAT F$ THAT ROUNDS NUMBERS TO NEAREST WHOLE CENT.
0160 LET F$="-------.##"
0180 REM    PRINT TOTALS AND GIVE OPTION FOR TAX SUBROUTINE.
0190 PRINT "MONTHLY PAYMENT:        TAXES:            HIDEOUS TOTAL:"
0200 PRINT USING F$,P,"  ",T," ",P+T
0210 PRINT
0220 PRINT "WANT TO COMPUTE THE TRUE COST AFTER U.S.TAX DEDUCTIONS ON THE"
0230 PRINT "INTEREST AND TAXES?  YOU MUST ITEMIZE TO QUALIFY."
0240 INPUT "ANSWER Y (YES) OR N (NO).       ",Q$
0250 REM  $ SPECIFIES STRING INPUT (E.G."Y") INSTEAD OF NUMERIC.
0260 IF Q$="Y" THEN GOSUB 1000
0270 PRINT
0280 INPUT "TYPE Y (YES) TO RUN PROGRAM AGAIN, ANYTHING ELSE TO STOP. ",Q$
0290 IF Q$="Y" THEN GOTO 0060
0300 STOP
1000 REM   TAX DEDUCTION COMPUTATION SUBROUTINE.
1010 INPUT "WHAT IS YOUR TAX BRACKET, IN WHOLE NUMBERS?    ",B1
1020 LET B=B1/100
1030 PRINT
1040 PRINT "SHOULD I LIST PAYMENTS FOR THE FIRST TWO YEARS? I HAVE"
1050 INPUT "TO FIGURE THE INTEREST ANYWAY. ANSWER Y (YES) OR N (NO).  ",Q$
1060 REM SET UP VARIABLES A1 (PRINCIPAL PD PER MONTH) AND I1 (FOR TOTAL INTEREST)."
1070 LET A1=A
1080 LET I1=0
1090 IF Q$<>"Y" THEN GOTO 1110
1100 PRINT "       MONTH     PRIN.      INT.     INT. TOTAL"
1110 REM   FOR-NEXT LOOP COMPUTES (OPTIONALLY LISTS) FIGURES BY MONTH AND TOTALS.
1120 FOR J=1 TO 24
1130   LET P1=A1*R/((R+1)↑M-1)
1140   LET I1=I1+(P-P1)
1150   LET A1=A1-P1
1160   IF Q$<>"Y" THEN GOTO 1180
1170   PRINT USING F$,J,P1,P-P1,I1
1180 NEXT J
1190 PRINT
1200 REM GET DEDUCTIONS D FOR 1 YEAR, T(AXES) + I1/2 (HALF OF 2 YRS. INTEREST)
1210 LET D=T+I1/2
1220 PRINT "ANNUAL MORTGAGE-RELATED DEDUCTIONS ARE:"
1230 PRINT USING F$,D
1240 PRINT "BUT I MUST SUBTRACT THE $3200 STANDARD (0 BRACKET) DEDUCTION"
1250 PRINT "BUILT INTO THE TAX TABLES. THE TRUE MONTHLY COST IS:"
1260 LET D1=D-3200
1270 REM GET REAL MO. COST. (TOTAL MO. PAY =  P+T12) - ((BRKT * ADJ. DEDS)/12)
1280 LET C=(P+T/12)-(B*D1/12)
1290 PRINT USING F$,C
1300 PRINT "                 ****SUMMARY****"
1310 PRINT "      LIFE:   AMOUNT:      RATE:  CASH PAY:    BRKT:    TRUE COST:"
1320 PRINT USING F$,Y,A,R1,P+T/12,B1,C
1330 RETURN
```

Figure 7-2. MORTGAGE Program With Errors

Unfortunately, there is a problem in this schedule--the amount of interest paid each month increases while it should decrease. This must be wrong, and being wrong, it voids the entire deduction figure. Looking over the FOR-NEXT loop that computes the monthly interest, note that we forgot to decrement the month indicator, N, for each circuit through the FOR-NEXT loop. You can fix this easily. First, stop the program:

```
)
STOP AT 300
*
```

Having incremented line numbers by 10, you can easily insert a new statement:

```
1155 LET M=M-1 )
```

Now RUN) it again, giving the same figures (40000, 10.5, 25, 20, and 2000) and tax bracket (25), to compare the results. The monthly schedule now says:

```
MONTH      PRIN.     INT.      INT. TOTAL
1.00       27.67     350.00    350.00
2.00       27.92     349.76    699.76
3.00       28.16     349.51    1049.27
4.00       28.41     349.27    1398.54

MORTGAGE-RELATED DEDUCTIONS ARE:
6164.34
BUT I MUST SUBTRACT...
...TRUE MONTHLY COST IS:
482.58



                  ****SUMMARY****
LIFE:AMOUNT:RATE:CASH          PAY:BRKT:TRUE
COST:
25.00 40000.00  10.50  544.34       25.00  482.58
TYPE Y (YES) TO RUN PROGRAM AGAIN,.....
```

Eureka! The interest is now declining, and the program works correctly. (The difference may not seem significant here, but if the FOR-NEXT loop covered 60 months instead of 24; i.e., J = 1 TO 60; it would be immense.)

You've fixed the program, so you can write it to disk under its original name; this overwrites the old, erroneous version:

```
LIST "MORTGAGE.BA")
*
```

You can also print it (LIST "$LPT") if you have a line printer, or type it (LIST). To leave BASIC and return to the CLI, type:

```
BYE)
  .
  .
R
```

All programs you write via the BASIC interpreter reside in the BASIC directory; the interpreter automatically goes to this directory when you invoke it.

Itemized Deductions and Tax Bracket

For simplicity, this sample BASIC program assumes you are married and, when you acquire this mortgage, you will start itemizing deductions instead of taking the standard deduction. When you itemize, the IRS allows you to deduct only the itemized amount over the standard deduction ($3200 if married filing jointly, $2200 if single). The standard deduction is already figured into the tax tables. This is why line 420 of the program subtracts the standard deduction from the mortgage-related deductions. If you are, in fact, moving to itemized deductions, you can deduct much more than mortgage-related expenses (e.g., medical expenses, casualty losses), but the program doesn't deal with these. It figures the TRUE COST amount as if you were deducting *only* the mortgage-related amounts.

Thus, if the mortgage moves you from the standard deduction to itemized deductions, your real cost per month will be less than the TRUE COST figure. If this is true for you, you can modify the program to compute the TRUE figure more accurately. The critical figure is the "3200" in line 1260. Your program statements should get all mortgage-unrelated deductions (medical, contributions, casualty losses, etc.) and put them in a variable, let's say Q. Then it should *add* Q to D in line 1260; e.g., LET D1 = D+Q-3200.

In any case, if you are single, change the 3200 in line 1260 to 2200; e.g., LET D1 = D-2200.

Chapter 8
Assembly - Language Programming: The Assemblers

This primer can't possibly teach you all you must know to program in assembly language, but this chapter will introduce some of the basics. We assume that you have some familiarity with the mechanism of assembly language and with the instruction set for your computer. But even if you do not, you will profit by reading this chapter, for it will familiarize you with fundamental concepts before you study them in greater detail. Also, you'll need some of the basics described in this chapter to fully understand the next chapter where we write, assemble, execute, and debug our own assembly language program.

Before it can do useful work, a program must be translated into machine-level instructions. System software does this: programs like the FORTRAN compiler, the Relocatable Loader, and the BASIC interpreter, translate your program commands into machine code: binary numbers that physically direct the computer. Assembly language is no exception; it also employs symbolic commands which translate into machine code. The software that does the translation is called an assembler.

The Assemblers

You can choose between two assemblers: the Macroassembler (MAC) and the Extended Assembler (ASM). MAC is more powerful and more flexible, while ASM is faster. Each assembler has a manual of its own, which you can read for more detail. For the concepts we'll study in this chapter, and the program we'll write in the next, there is no practical difference between the two. We have chosen to emphasize the Macroassembler (MAC); but if you want to use ASM, go ahead. The term *assembler* in this chapter and the next applies to either MAC or ASM.

To produce a program, you start by coding a source file in assembly language and emerge with a save file. The sequence looks like this:

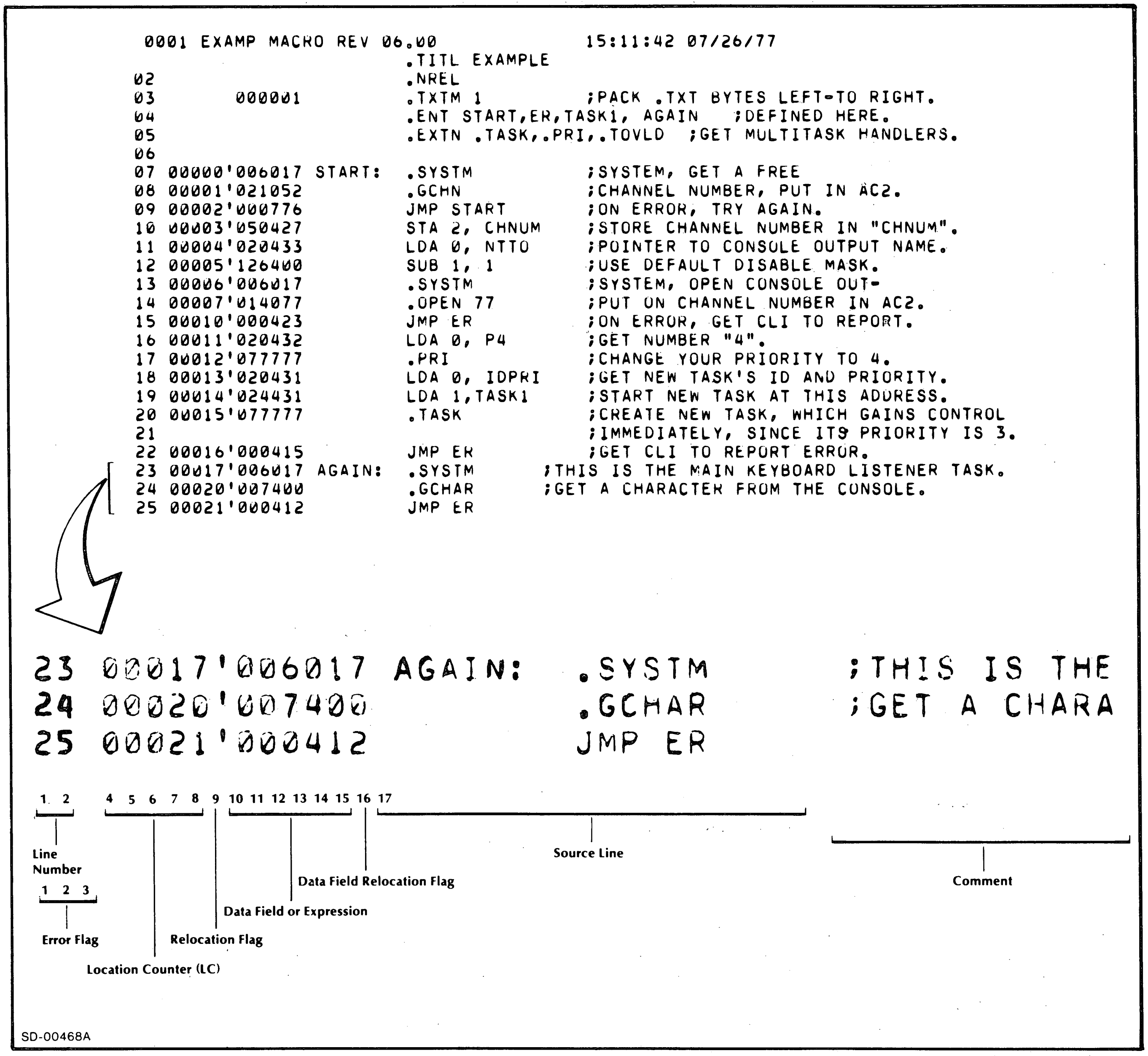
```
SOURCEPROGRAM
  ↓
  MAC or ASM
  ↓
SOURCEPROGRAM.RB
  ↓
  RLDR
  ↓
SOURCEPROGRAM.SV
```

A source program (also called a module) employs symbolic instruction codes (such as LDA 0,2 for "load the contents of location 2 into accumulator 0") and operating system calls (such as .RDL for "read a line"). Your modules will also use assembler pseudo-instructions (pseudo-ops), which direct the assembly process but do not result in any final program instructions themselves.

Each is a two-pass assembler (i.e., it examines the modules twice), and at the end of the second pass, it produces one or more of the following:

- an assembly listing of the module(s)
- an error code listing
- a binary module

The assembly listing shows your original source module(s) and additional information such as the octal codes of your instructions and data, the absolute or relative locations of these items in the executable program, and other miscellaneous information.



```
        0001 EXAMP MACRO REV 06.00                 15:11:42 07/26/77
                                        .TITL EXAMPLE
        02                              .NREL
        03       000001                 .TXTM 1          ;PACK .TXT BYTES LEFT-TO RIGHT.
        04                              .ENT START,ER,TASK1, AGAIN   ;DEFINED HERE.
        05                              .EXTN .TASK,.PRI,.TOVLD  ;GET MULTITASK HANDLERS.
        06
        07 00000'006017 START:          .SYSTM           ;SYSTEM, GET A FREE
        08 00001'021052                 .GCHN            ;CHANNEL NUMBER, PUT IN AC2.
        09 00002'000776                 JMP START        ;ON ERROR, TRY AGAIN.
        10 00003'050427                 STA 2, CHNUM     ;STORE CHANNEL NUMBER IN "CHNUM".
        11 00004'020433                 LDA 0, NTTO      ;POINTER TO CONSOLE OUTPUT NAME.
        12 00005'126400                 SUB 1, 1         ;USE DEFAULT DISABLE MASK.
        13 00006'006017                 .SYSTM           ;SYSTEM, OPEN CONSOLE OUT-
        14 00007'014077                 .OPEN 77         ;PUT ON CHANNEL NUMBER IN AC2.
        15 00010'000423                 JMP ER           ;ON ERROR, GET CLI TO REPORT.
        16 00011'020432                 LDA 0, P4        ;GET NUMBER "4".
        17 00012'077777                 .PRI             ;CHANGE YOUR PRIORITY TO 4.
        18 00013'020431                 LDA 0, IDPRI     ;GET NEW TASK'S ID AND PRIORITY.
        19 00014'024431                 LDA 1,TASK1      ;START NEW TASK AT THIS ADDRESS.
        20 00015'077777                 .TASK            ;CREATE NEW TASK, WHICH GAINS CONTROL
        21                                               ;IMMEDIATELY, SINCE ITS PRIORITY IS 3.
        22 00016'000415                 JMP ER           ;GET CLI TO REPORT ERROR.
        23 00017'006017 AGAIN:          .SYSTM      ;THIS IS THE MAIN KEYBOARD LISTENER TASK.
        24 00020'007400                 .GCHAR      ;GET A CHARACTER FROM THE CONSOLE.
        25 00021'000412                 JMP ER

23 00017'006017 AGAIN:     .SYSTM          ;THIS IS THE
24 00020'007400            .GCHAR          ;GET A CHARA
25 00021'000412            JMP ER
```

Figure 8-1. Program Listing

Argument Operators

From time to time, you may want to perform some operations on symbols. Typical operations include forming a byte pointer from a symbol name, and creating indexes in a table. For example, if START is the name of the beginning of a text string, 2 times START would be a byte pointer to the beginning of this string (the next chapter reviews byte pointer and byte string concepts). Similarly, if TABLE is the name of the beginning of a table with one-word entries, then TABLE+1 would name the second entry in the table, TABLE+2 the third entry in the table, etc.

You may apply the following operators to symbols, integers, and the current location counter:

	Operator	Meaning
Arithmetic	+	Addition (2+3) or unary plus (+3)
	-	Subtraction, (5-2) or unary minus (-7)
	*	Multiplication
	/	Division

Thus you could write JMP .+5 to jump 5 words from the current location. If your program reserves a series of addresses whose first word is address TABLE, indexes off TABLE wold be TABLE+1, TABLE+2, etc.

Numbers

All numbers that you use in your programs are octal unless you specify otherwise. Indicate decimal values by placing a decimal point after the number. Thus 10 equals octal 10 (decimal 8), while 10. equals decimal 10.

Instruction Types:

Most Data General machine instructions assemble into one 16-bit storage word. There are three types of instruction:

- *Memory Reference Instructions (MRIs).* MRIs concern memory locations or their contents. They permit one of four different kinds of indexing into these locations. The address they reference must fit in 8 bits, because their address field is 8 bits long. Examples of MRIs are LDA 0, TEMP (load accumulator 0 with the contents of address identified with label TEMP) JMP ER (Jump to the instruction identified by label ER), and JSR PRINT (Jump to subroutine PRINT, save return address in AC3). Some basic MRI instructions and their *simplest* formats are shown in Table 8-1.

- *Arithmetic-Logical Instructions* (ALCs). ALCs can add and subtract values, shift bits, swap bytes, use the overflow (Carry), and redirect program execution. They can also AND values to mask portions of words. All ALC instructions require a source accumulator and a destination accumulator to receive the result of the arithmetic-logical operation. Examples of ALC instructions are MOV 0, 1 (copy the contents of AC0 to AC1) and SUB #0, 1, SZR (Subtract the contents of AC0 from AC1, don't load AC1 with the result, skip the next instruction if the result is 0). Some common ALC instructions are shown in Table 8-2.

- *Input-Output (I/O) Instructions.* I/O instructions govern the operation of all system devices. Generally, operating system calls will manage I/O devices, and you'll need these instructions only to write your own interrupt handlers, which are outside the scope of this book.

Table 8-1. Common MRI Instructions

Instruction and Format	Explanation	Example
JMP addr	Jump to address addr, which can be a symbolic or numeric address or expression. This definition of addr applies to all instructions.	JMP ER JMP LOOP+6 JMP 300
JSR addr	Jump to addr, save return address (current addr +1) in AC3. You can return from a JSR with a JMP 03 instruction (if the code to write you jumped didn't overwrite AC3).	JSR SUBR1
LDA ac addr	Load accumulator (ac) with contents of addr.	LDA O, MYFIL
STA ac addr	Store the contents of ac in addr.	STA 3 LOOPO
DSZ addr	Decrement the contents of addr by 1, skip the next instruction if contents equal O.	DSZ COUNT

In a source program line containing a memory reference instruction (such as LDA, load an accumulator; or JSR, jump to a subroutine, save return address), or before an expression, you may use the commercial at sign (@). An @ anywhere in a memory reference instruction argument sets bit 5 in that instruction, the indirect addressing bit. For example:

```
024060 LDA 1,60
026060 LDA 1,@60
```

The first instruction loads accumulator 1 (AC1) with the contents of memory location 60; the second loads AC1 with the word whose *address* is in location 60. Likewise, using @ in a data word sets bit 0 (the indirect bit for a data word) of that word to one:

```
000025 25
100025 @25
```

Like @, a number sign (#) may appear anywhere in an arithmetic/logical instruction. A # sets bit 12 of the instruction to 1; this is the no-load bit, and you use it with one of the arithmetic/logical instruction symbols when you want to test for equality, zero or other values without changing the value in the accumulator.

```
133102 ADDL 1,2,SZC
133112 ADDL# 1,2,SZC
```

The first instruction adds the contents of AC1 to AC2, places the result in AC2, and skips the next instruction if the carry bit equals 0; the second instruction does the same thing, but does not load AC2 with the result. in the first instruction, AC2 is loaded with the result; in the second, it is unchanged.

The following examples show you how you can use special instruction symbols and special characters to modify the ADD instruction.

Instruction	**Meaning**
ADD 1,2	Add the contents of accumulator AC1 to AC2.
ADDL 1,2	Add the contents of AC1 and AC2, shift the result one bit to the left, placing the carry in bit 15, and leave the result in AC2 and carry.
ADDL 1,2,SZC	Add the contents of AC1 and AC2, shift the result one bit to the left, leave the result in AC2 and carry, and skip if this operation yields a zero carry.
ADDL# 1,2,SZC	Add the contents of AC1 and AC2, shift the result one bit to the left, and skip if this operation yields a zero carry. Do not alter the original contents of AC2.

Note that whenever you use the no-load (#) symbol you must specify one of the skip symbols (SZR, etc.) and specify a shift operation (L for shift left, R for shift right, etc.). The shift operation can be a dummy (e.g., SUB C,0,0,SZR when you don't care about the carry bit) but it must be present for no-load to work.

Pseudo-ops

A *pseudo-op* instruction directs the operation of the assembler. It is called a "pseudo instruction" because your program never executes it. The pseudo-ops that you need to start assembly language programming are:

Pseudo-op	**Function**
.BLK	Reserve a series of 16-bit words.
.END symbol	Terminate a module and name a starting address
.ENT	Declare an entry point or symbol to be available for other modules' use.
.EXTD	Declare a symbol (unsigned 8-bit or signed 7-bit quantity) or page-zero (ZREL) entry point to be external; that is, found in some other module. .ZREL references are useful because they will fit into the 8-bit field of an MRI instruction.
.EXTN	Declare an entry point or 16-bit symbol to be external; that is, found in some other module.
.NREL	Assemble the following code and data for execution in normal-relocatable (NREL) memory.
.TITL	Assign a title to a module.
.TXT	Create an ASCII text string.
.TXTM	Specify text string byte packing (e.g., left to right).
.ZREL	Assemble the following code and data for execution in page zero (ZREL).

.BLK

Allocate a Block of Storage

Format:

.BLK expression

Description:

This pseudo-op allocates a block of memory storage. Expression is the number of words you want reserved; the current location counter is incremented by expression.

Examples:

```
TABLE:.BLK 10.
```

This example reserves a block of ten memory words; the first word in the series has the symbolic name TABLE, the second TABLE + 1, and so on.

.END

Indicate the End of a Module

Format:

.END *[expression]*

Description:

This pseudo-op terminates each assembly language module. If the program you are building has several modules, one of these modules must supply an *expression* argument to .END indicating the address to receive control when the program is executed. ASM requires a .END for each module; MAC does not.

Examples:

```
START: SUB 0,0
       .
       .
       .
       .END START
```

In this example, the .END pseudo-op terminates the module and defines START as the address that will receive control when you run the program.

.EXTD

Declare an External Displacement

Format:

.EXTD symbol *[symbol...]*

Description:

This pseudo-op declares that one or more symbols referenced by this module are defined (.ENTered) in other modules. The value of the symbol must be an 8-bit quantity; e.g., a ZREL address. Generally, you will use .EXTD when the symbol is defined in another module's ZREL space.

Here, the ERR routine in module MAIN is available to module MOD1 through a pointer in MAIN's ZREL space. This allows the assembler to resolve ERR's address for the JSR instruction (which it could not otherwise do because JSR's address field is only eight bits). All of a program's ZREL space (locations 50-377$_8$) is accessible to the eight bits of an MRI instruction.

Example:

```
        .TITL  MAIN ; Main program.
        .ENT   .ERR   ; Error handler is here.
        .EXTN FOO     ; FOO code is in other module.
        .TXTM 1

        .ZREL
.ERR:   ERR           ; ERR defined in MAIN's ZREL.

        .NREL
START:  LDA 0 ... ; MAIN's NREL
         .        ; code is here.
         .
ERR:     .        ; Error handler.
         .
        .END START

        .TITL MOD1    ; Module MOD1.
        .ENT FOO
        .EXTD .ERR    ; .ERR defined in
                      ; another module's ZREL.
        .TXTM 1
        .NREL
FOO:    LDA ...       ; MOD1's code is
         .            ; here.
        JSR @ .ERR    ; Use .EXTD error
                      ; handler.
         .
        .END
```

.TITL

Entitle a Binary Module

Format:

```
.TITL symbol
```

Description:

This pseudo-op gives an RB module a title, which is printed at the top of every listing page. The title need not be different from other symbols in the module. The title has no inherent relationship to the module's filename, although you might want to use the same names for clarity.

Examples:

```
.TITL EXAMPLE

.NREL
    .
    .
    .
.END
```

This example assigns the title EXAMPLE to this module and prints EXAMPLE at the top of each listing page. (The assembler, which considers all symbols to be unique within the first five characters only, will discard the "LE" of "EXAMPLE"; the listings will start with "EXAMP".)

.TXTM

Specify .TXT Byte Packing

.TXT

Create a Text String

Formats:

```
.TXTM number
.TXT u string u
```

Description:

Normally, the assembler packs bytes right to left - which is the wrong order for ASCII text strings and other required items. To correct this, insert a .TXTM 1 statement before the .TXT appears in your program.

The .TXT pseudo-op creates an ASCII string, which can contain any ASCII characters. You must delimit the text with a character that is unique (u); that is, not found in the string. You can put nonprinting characters in the string by enclosing them within angle brackets.

Examples:

```
.TXTM 1
    .
    .
    .
.TXT "ABCDE"
```

This example creates the ASCII string consisting of three words. The first contains the letters AB, the second contains the letters CD, and the last word contains an E in the left byte and a terminating null in the right byte.

```
.TXT "AB<011>CDE"
```

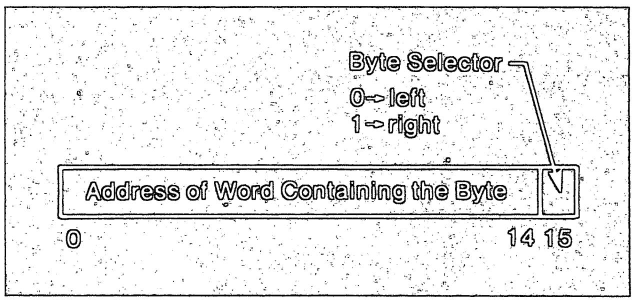
This example creates the ASCII string consisting of AB and CDE, separated by a horizontal tab (ASCII code 011).

Chapter 9
Programming RDOS or DOS Assembly Language System Calls

This chapter first introduces some operating system calls, with examples, and then shows the examples coded into a viable program. We'll then write an assembly language program, assemble it, correct assembly errors, process it with RLDR, and execute it. We will finish this chapter by showing you how to debug the program.

Operating System Conventions

Most Data General computer words are 16 bits long, and bit positions are numbered left to right, 0 to 15 inclusive. A byte is 8 bits long. A byte string consists of a sequence of bytes, packed right to left in series of one or more words. A byte pointer consists of a single word with two fields (see Figure 9-1). To pack bytes left to right, as required for system calls, insert a .TXTM 1 statement at the beginning of the program.



SD-00526

Figure 9-1. Byte Pointer Structure

The left field (bit positions 0 through 14) contains the address of the word that holds the selected byte. When right field (bit 15) equals 1, the pointer selects the right half, or byte; when this bit equals 0, the pointer selects the left byte. You can produce a byte pointer by multiplying the address at which it begins by 2; this shifts all bits left and zero (which specifies the left byte) in bit 15.

Here is a byte pointer example:

```
.TXTM 1
   .
   .
   .
BPTR:          .+1*2
               .TXT "$TTI"
```

.+1 is the address of the next location - the start of text string $TTI. The label BPTR contains the start address of the text string. The multiplier *2 zeros bit 15, thereby specifying the first byte, $.

System Call Format

Code each system call in the form:

```
.SYSTM
call-name
error return
normal return
```

You must precede the call with the mnemonic .SYSTM, and reserve a word after the call for the error return, which receives control on either an error condition, or an unusual condition such as an end-of-file. You must always reserve an error return word, even if you envision no possible exception condition, or even if no condition is currently defined. If no error or exception condition exists, control goes to the normal return.

Whenever control goes to the error return, the system places a numeric error code in AC2. These error codes are defined in the user parameter file. PARU.SR and they are explained in Appendix A of your system reference manual.

Upon either an error return or a normal return, AC3 contains the current contents of location 16_8, the user stack pointer. You can use this location as you want. Unless the text indicates otherwise, all other accumulators will remain unchanged.

.OPEN

Open a File for Reading or Writing

.APPEND

Open a File for Appending

.OPEN associates a file with an I/O channel and opens it for any kind of I/O. .APPEND associates a file with an I/O channel and opens it for writing only. If the file is an output device like a line printer, .OPEN and .APPEND are practically identical. For a disk file, if you open via .OPEN, lines are written to the beginning of the file. If you open via .APPEND, reads aren't allowed and lines are appended to the file.

While the file is open, your program references it by the channel number assigned in the open call. It keeps the channel number until the program issues .RTN or .CLOSEs it. We do not describe .CLOSE in this book because the .RTN or .ERTN calls automatically close all channels.

You can allocate a number of channels (and tasks) to a program in the RLDR command line. If you omit channel and task data entirely, the program receives one task and eight channels; this will suffice for the program in this chapter.

Format

```
.SYSTM
.OPEN n    ; n is the I/O channel number
  or
.APPEND n
error return
normal return
```

Required input:

AC0 - byte pointer to the file or device to be opened.

AC1 - if the file is a device, AC1 acts as a characteristic disable mask. You'll probably want to keep the default characteristics by setting AC1 to 0 (via a SUB # 1,1 instruction).

Return:

AC2 - error code.

Example (within a program):

This program just created the file "OUTPUT".

```
          LDA 0, NTTI       ;BYTE POINTER TO
                            CONSOLE
                            ;INPUT FILENAME.
          SUB 1,1           ;USE DEFAULT MASK FOR
                            OPEN.
          .SYSTM            ;0 IS THE I/O CHANNEL
                            NUMBER-
          .OPEN 0           ;WHILE THE $TTI IS
                            ;OPEN ON 0,
                            ;YOU'LL ADDRESS IT
                            ;AS 0.
          JMP ER            ;ER WAS DEFINED
                            EARLIER.

          LDA 0, OUTPUT
          SUB 1,1           ;DEFAULT MASK.
          .SYSTM
          .APPEND 1         ;OPEN "OUTPUT"
                            ;FOR APPENDING ON
                            ;CHANNEL 1.
          JMP ER

NTTI:     .+1*2
          .TXT "$TTI"       ;FILENAME $TTI.

OUTPUT:   .+1*2
          .TXT "OUTPUT"
```

.RTN or .ERTN

Return to the Program Above

RDOS and DOS offer five levels of program operation; the CLI normally operates on level 0, and any program you execute from the CLI executes on level 1.

By ending your program with .RTN (or .ERTN), you'll return control to the CLI when the program has executed. If you omitted .RTN (or .ERTN), you'd need to hit an interrupt like CTRL-A to return the CLI, but this lacks finesse.

Call .RTN simply returns control to the CLI, while .ERTN passes the contents of AC2 to the CLI. On a system call error, the system places an identifying error number in AC2. So, if a program issues .ERTN when a call error occurs, the system will pass the error code to the CLI; the CLI will interpret the number returned in AC2 and type an explanatory message on the console. Thus .ERTN is generally useful as an error handler, as shown in the .CRAND example.

Format:

```
.SYSTM
.RTN (or .ERTN)
error return
```

Required input:

None.

Example (to terminate our little program):

```
      .
      .
.SYSTM
.RTN
JMP ER
```

Common Errors

The following errors are the most common ones that can occur on the system calls we have shown. If one of them occurs, the system places the appropriate octal error number in AC2, then goes to the error return. You can have an error processing routine examine this number and act on what it finds. The "mnemonic" shown next to the error number means the same thing as the number; it is defined in the system parameter file, PARU.SR, and you can use it instead of the number if you insert PARU/S (PARU/Scan) in the assembler command before the program filename; e.g., ASM PARU/S filename ⟩.

AC2	**Mnemonic**	**Error on call was:**
0	ERFNO	Illegal channel number.
1	ERFNM	Illegal filename.
6	EREOF	End of file.
11	ERCRE	File already exists.
12	ERDLE	File does not exist.
15	ERFOP	File not open.

Example Program

The example program, called WRITE, is a short assembly language program that goes through the standard I/O cycle and uses three files: a disk file named W, the console output file (reserved filename $TTO) and console input file (reserved filename $TTI).

If disk file W doesn't exist, WRITE creates it; then WRITE opens all three files and prompts you with a question mark. It accepts a line typed on the console, and, after you press ⟩ to end the line, writes the line to disk file W and echoes the line on the console. It then prompts you again. WRITE opens W for appending via call .APPEND, which means that all lines you type will accumulate in file W. When you type a special terminating line (&⟩), WRITE returns to the CLI. Figure 9-2 is the flowchart for program WRITE. The slashed numbers are page/line abbreviations; e.g., 1/12 means page 1, line 12.

Writing and Assembling WRITE.SR

The following pages show WRITE and analyze it line by line. They show listing lines as page/line; e.g., 1/6 means page 1, line 6. You might want to examine WRITE in Figure 9-3 before reading the next paragraph.

If you want to try WRITE, you'll need a number of utility files, so begin in the master directory. Use Superedit to create a file named WRITE.SR and type in all the instructions shown in the program listing in Figure 9-3. This is an assembler listing so *don't* type in any of the numbers or punctuation in columns 1-16. It might help you to pencil a straight line down the beginning of the instruction field (e.g., from the space before .ER: down to the space before .ERDL on the first page of the listing) and use this as a guide.

If you have an upper- and lowercase console, you can code in either. The most legible way is to put source code in CAPITALS and comments and text strings in upper- and lowercase. The assemblers don't care what case you use, but legibility is important.

When you've finished typing in WRITE, close the file (UE$H$$).

Assembling WRITE

You can choose between the ASM and MAC asemblers for WRITE. We have used MAC for the listing shown, but either one will work.

To use ASM, type:

```
ASM/X PARU/S WRITE $LPT/L)
```

or, if you don't have a line printer, type:

```
ASM/X PARU/S WRITE $TTO/L)
```

If your printing terminal is connected to the second teletypewriter interface, type $TTO1/L instead of $TTO/L. From either ASM command, you should get a listing like the one in Figure 9-3, but without the MACRO header. Although the paging will differ a little, the critical locations are the same.

If, as we did, you want to use the MAC assembler, you may need to build the permanent symbol file for it. Generally, this is needed only once; MAC then uses it for all future assemblies. Try typing:

```
MAC PARU/S WRITE)
```

If you get U or F errors on instructions like LDA or .SYSTM, then you must build a new MAC.PS. This is easy to do.

If you have a NOVA 4 computer, type:

```
MAC/S NBID OSID NSID N4ID PARU)
```

For a NOVA 3, type:

```
MAC/S NBID OSID NSID PARU)
```

For a microNOVA, type:

```
MAC/S MBID OSID NSID PARU)
```

For other NOVA computers, type:

```
MAC/S NBID OSID PARU)
```

For ECLIPSE machines, type:

```
MAC/S NBID OSID NEID PARU)
```

The proper command creates MAC.PS for your machine; you need not create MAC.PS again for this book. Other source (-.SR) files you may eventually need for the Macroassembler are described on the Release Notice supplied with your system.

Having checked (or built) MAC.PS, type:

```
MAC WRITE $LPT/L)
```

or, lacking a line printer, type:

```
MAC WRITE $TTO/L)
```

for a console listing. If your printing terminal is connected to the second teletypewriter interface, type $TTO1/L instead of $TTO/L. From either MAC command, you should get a listing like the one in Figure 9-3, plus the cross-reference.

```
 0002 WRITE
01              ;Normal return to CLI.
02
03 00051'006017 TOCLI:  .SYSTM          ; System,
04 00052'004400         .RTN            ; return to CLI.
05 00053'002000-        JMP  @ .ER      ;   Error (can't happen).
06
07              ; Filenames, prompt, buffer, etc.
08
09 00054'000132"NW:     .+1*2           ; Point to filename W.
10 00055'053400         .TXT "W"        ;
11
 FU00056'000000 NTTO    .+1*2           ; Point to filename $TTO.
13 00057'022124         .TXT "$TT0"    ;
14        052060
15        000000
16 00062'000146"NTTI:   .+1*2           ; Point to filename $TTI.
17 00063'022124         .TXT  "$TTI"    ;
18        052111
19        000000
20
21 00066'000156"PROMT:   .+1*2          ; Point to prompt
22 00067'037415         .TXT "?<15>"    ;  "?" and CR (↙).
23        000000
24
25 00071'000164"SPACP:  SPACE*2         ; Point (addr*2) to 1st byte in line buffer.
26
27 00072'000103 SPACE:  .BLK 132./2+1   ; 133. bytes for read/write line buffer-
28                                      ; let the assembler compute it.
29
30              ;Error return to CLI.
31
32 00175'006017 ERROR:  .SYSTM          ; System,
33 00176'006400         .ERTN           ; return to CLI and have CLI report.
34 00177'002000-        JMP  @ .ER      ;   Error (can't happen).
35
 UU                     .END START

**00008 TOTAL ERRORS, 00000 PASS 1 ERRORS
```

Figure 9-3. WRITE.SR Program with Errors (continued)

The program .ENTers its starting address, START, not because other modules will use it, but because we want to identify START symbolically to the debugger. Later this will help us debug the program. The .ENT line is flagged with a GU error.

The .ZREL pointer on line 1/6 points to error handler ERROR at the end of page 2. Through this pointer, any location in 32K words can get to ERROR. Without the pointer, ERROR would be nearly out of range of the JMP in line 1/20. All system calls except the first, .APPEND, make use of this .ER pointer for their error returns.

The .NREL in line 8 specifies normal relocation, which applies to the rest of the program.

The first group of code, in lines 1/12-1/24, opens disk file W for appending and opens the console output and input files for normal I/O (line 16 has a U error). If .APPEND cannot open file, it takes the error return on 1/15; this jumps to the routine on lines 1/52-1/60. This routine creates file W if it doesn't exist, then jumps back to the beginning of the program.

The next block of code starts with LOOP and extends from line 1/28 to line 1/48. This code reads a line typed on the console, and checks to see if the first two characters are & and). It does this by loading the first two words (two bytes or two characters) from line 2/25 and comparing this to a match word (1/47) set up to contain &). If they match, the program returns to the CLI via sequence TOCLI, 2/3. If they don't match, the program writes the entire line to disk file W, echoes it on the console, and returns to LOOP.

The CLI's *explanation* of the error *(FILE DOES NOT EXIST)* is accurate, though. One of WRITE'S system calls took the error return because it could not find a file. This particular call must be one of the first three calls because WRITE didn't type the prompt on the console. It couldn't have been the .APPEND call, because .APPEND will jump to a file-creating routine if its file doesn't exist. Therefore it must be one of the console-opening .OPEN calls. The calls themselves look ok, as do the byte pointers (one of whose labels you fixed) on lines 2/12 and 2/16. The console device names on lines 2/13 and 2/17 also seem ok -- but no! Line 2/13 has the console output name as $TT0. The correct name is $TTO. This explains the error: WRITE tried to open file $TT0, which didn't exist.

Using Superedit, change $TT0 to $TTO in WRITE.SR. Then assemble the program again as shown earlier and run it through RLDR again. The assembler will delete the old, defective RB binary file and replace it with the new one; RLDR will do the same with the save file.

Run the new WRITE.SV again:

```
WRITE)
$TTI
```

At least it didn't bomb. "$TTI" may not be the correct prompt, but it's an improvement over "FILE DOES NOT EXIST". Type)

```
)
?
```

The *question mark* is the right prompt. Type something:

```
SOMETHING)
SOMETHING
?
```

WRITE repeated the line on the console -- so far so good -- but we don't know whether it wrote to the disk file yet. The prompt problem seems to have fixed itself.

```
SOMETHING ELSE)
SOMETHING ELSE
?
```

To check the disk file, you'll need to get back to the CLI. Try the terminating sequence (&)):

```
&)
R
```

The terminator works and you're back to the CLI. Now what about the disk file, W?

```
TYPE W)
SOMETHING
SOMETHING ELSE
R
```

The disk file mechanism seems fine, too. Aside from the initial prompt problem, WRITE seems to be in pretty good shape. Check by running it again:

```
WRITE)
$TTI )

?
SIGH)
SIGH
?
```

Clearly the problem isn't going to go away. Stop WRITE and check file W from the CLI:

```
&)
R
TYPE W)
SOMETHING
SOMETHING ELSE

SIGH
R
```

Everything works except the inital prompt, which is $TTI when it should be ?. The next step is a very common one in assembly language programming: debugging.

Examining and Changing Memory Locations

You can display the contents of any location by typing the symbolic or numberic address of the location followed by a slash. For example,

```
START/ 020454
```

displays the contents of START. START is a *debug address.* (Remember that we show user input in **boldface** type and system output in *italic* type.) To display successively higher locations, press the NEW LINE key, or if your terminal doesn't have a NEW LINE key, the LINE FEED key. We show this key as downarrow (↓) although the debugger doesn't echo it at all on the terminal. To display successively lower locations, type uparrows via the SHIFT-6 or SHIFT-N key. We show uparrows as (↑), as does the debugger. For example:

```
                ↓
START+1     006017↓
START+2     012400↑
START+1     006017
```

Octal numbers by themselves don't mean very much. You can tell the debugger to interpret them by typing one or more local display commands.

For example, address START contains an octal number:

```
START/ 020454
```

Semicolon (;) displays this number in instruction format:

```
;LDA START+54
```

Question mark (?) displays it in .SYSTM call format:

```
?.CCON 54
```

Apostrophe (') displays it in ASCII format:

```
'!,
```

and finally, ampersand (&) displays it in byte-pointer format:

```
& 010226 0
```

For any location, only one local display command gives a useful picture of the contents. If a locations holds an instruction, like JMP LDA, the appropriate command is ";", which displays in instruction format. The assembler listing can help in this process; for example, the listing in Figure 9-3 tells you that START contains an instruction, thus the semicolon is the appropriate display command.

If a location holds a system call, like .OPEN 1 or .RDL 2, the appropriate command is "?", which displays in .SYSTM call format. If a location holds ASCII characters, like $T or W, the appropriate command is "''", which gives ASCII format. For a byte pointer, like $T, the command is &, followed by a slash, which displays the contents of the location pointed to. Usually, you can tell which kind of display command is correct because other commands will give absurd results, like .CCON 54 and !, and 010226 0 above.

To change the contents of memory location, display the location with a / or ↓ or ↑ command, then type in the contents you want and press). The new contents can be an octal number or it can be an instruction like LDA 0, START+55. A word of caution about changing locations: the computer will execute the new contents without asking questions, so problems could occur if you make a mistake. Also, be wary of changing a location's contents accidentally. If, when a location is open, after / or ↓, or ↑, you inadvertently type something and press), the character(s) you typed may replace the old contents of the location. These new contents may cause problems when you run the program. If you suspect that you have accidentally modified a location, and haven't yet pressed), press the DEL or RUBOUT key. The debugger will reject the entire line and then will type ? or U; you can then proceed. If you *have* pressed) after accidentally changing something, type CTRL-A to get back to the CLI and type the debug command again; this will bring the original program (which remains unchanged on disk) back into memory.

Starting or Continuing to Run Your Program

To run your program for the first time, type $R; thereafter you can proceed with program execution by typing **P** or addr$R. For P, the debugger will proceed at the address contained in P, the program counter. Initially, P contains the value specified by the .END pseudo-op in the assembly language source program. If you are waiting at a breakpoint, P contains the address at which execution stopped, so all you have to do is type **$P** to continue where you left off.

Ending a Debugging Session

When you are done debugging and want to return to the CLI, simply type

$V (or CTRL-A)

The changes you have made to your program during the debugging session do not become part of the disk file when you leave the debugger. To make permanent changes to your program you must go through the cycle of editing your source program, assembling it, and processing it with RLDR.

After you have type $R once, you use $P to proceed with the program. You can use $R again only if you precede it with an address, like START. Type:

```
$P
6B START+1
0 001244  1  000000  2  000000  3  000000
```

Something got into AC0 -- looks like a byte pointer. You can check by displaying AC0's contents in byte-pointer format, then displaying the byte pointer location's contents in ACSII:

```
0$A   001244  &   0005220  )
```

AC0 contains 1244, which, in byte-pointer format, is 522. Now what does 522 contain in ASCII?

```
552/   053400  '   W<0>
```

It contains W for the disk filename -- as it should.

Return to START+2 and move forward to the next LDA instruction:

```
START+2/   012400   ?.APPE 0 ↓
START+3   000436 ; JMP START+41   ↓
START+4   020452  ;   LDA 0 START+56   ↓
START+5   126400  ;   SUB 1 1
```

This looks like a good place -- after the LDA instruction in START+4. Set another breakpoint and proceed:

```
)
START+5$B
$P
5B START+5
0 001250  1  00000  2  000000  3  000000
```

Another byte pointer in AC0; check it out:

```
0$A 001250 & 000524 0 524/ 022124' $T
```

AC0 contains a pointer to a text string beginning with $T. The LDA in START+4 worked and everything is ok thus far.

Now, get to LOOP and see if the byte pointer to the ? prompt gets loaded:

```
)
START+13/ 014002 ; DSZ +2 ?.OPEN 2 ↓
START+14   020452   ; LDA 0 START+66
```

Set another breakpoint after the LDA in START+14:

```
)
START+15$B
$P
4B START+15
0  001260  1  000000  2  000000  3  000000
```

AC0 contains 1260, which should be a bytepointer to the prompt (? <15 >). Check it out:

```
0SA 001260 & 000530 0 530/ 022124 ' $T
```

The "$T" doesn't look much like the prompt, but try the next location:

```
START+64 052111    ' TI
```

AC0 still has the byte pointer to $TTI, not to ? < 15 >, as it should. This explains why WRITE says $TTI instead of ?. It means that the LDA in location LOOP isn't happening. Why not? Continue the program:

```
)
$P $TTI
```

This is WRITE's .WRL at line 1/30. Type some text next to the $TTI prompt:

```
    FOO)
FOO
4B START+15
0 001270  1  000004  2  027070  3  000000
```

WRITE has jumped back to LOOP and is executing the LOOP breakpoint again. AC1 shows the byte count, including the CR (carriage return), from the .WRL on 1/44; the byte counts from .RDLs don't include CRs. AC2 shows the results of the SUB on line 1/38.

But AC0 differs from the first time you saw this breakpoint. It probably has the right byte pointer now. Check it:

```
0$A 001270 & 000534 0 534/ 037415' ? < 15 >   )
```

Yes. This is the right prompt. WRITE will display it when you proceed:

```
$P ?
```

? is the correct prompt. Try typing something else:

```
ZUT ALORS)
ZUT ALORS

4B START+15
0  001270  1  000012  2  032110  3  000000
```

The byte pointer in AC0 remains the same, which is consistent with your earlier experience: WRITE gave the correct prompt every time after the first pass. Clearly the loop is ok now.

```
0001 WRITE     MACRO REV 06.30          17:58:13 04/02/79
                         .TITL WRITE    ; Title is optional but sometimes useful.
                         .ENT  START    ; Global entry for debugging.
      000001             .TXTM 1        ; Pack text bytes left to right.

                         .ZREL          ; Pointer in page zero avoids assembler A error.
   00000-000176'.ER:     ERROR          ; .ER contains "ERROR" address in NREL space.

                         .NREL          ; Now for the code proper.

                ; Open the three files.

   00000'020455 START:   LDA 0, NW      ; Point to disk filename W.
   00001'006017          .SYSTM         ; System,
   00002'012400          .APPEND 0      ; open file W for append on channel 0.
   00003'000437          JMP  NOFIL     ;   Error on APPEND, go to NOFIL routine.
   00004'020453          LDA 0, NTTO    ; Point to console output filename.
   00005'126400          SUB 1, 1       ; To open a device, use default disable mask.
   00006'006017          .SYSTM         ; System,
   00007'014001          .OPEN 1        ; open console output on channel 1.
   00010'002000-         JMP @ .ER      ;   Error return via ZREL pointer to CLI.
   00011'020452          LDA 0, NTTI    ; Point to console input (keyboard) filename.
                                        ; Default mask:  AC1 still = 0.
   00012'006017          .SYSTM         ; System,
   00013'014002          .OPEN  2       ; open console keyboard on channel 2.
   00014'002000-         JMP @ .ER
                ; Begin the main program loop.

   00015'020452 LOOP:    LDA 0,PROMT    ; Point to prompt character.
   00016'006017          .SYSTM         ; System,
   00017'017001          .WRL 1         ; write prompt to channel 1 (console out).
   00020'002000-         JMP @ .ER      ;   Error - report via CLI.
   00021'020451          LDA 0, SPACP   ; Point to beginning of line buffer.
   00022'006017          .SYSTM         ; System,
   00023'015402          .RDL 2         ; read a line from channel 2 (console keyboard).
   00024'002000-         JMP @ .ER      ;   Error - report via CLI.
   00025'030446          LDA 2, SPACE   ; Get 1st word (2 bytes) of line buffer in AC2.
   00026'024412          LDA 1, TWORD   ; Put terminator word (&↵) in AC1.
   00027'132405          SUB 1, 2, SNR  ; Were 1st 2 bytes  &↵ ? (Skip if not.)
   00030'000422          JMP TOCLI      ;   Yes -- return to CLI.
   00031'006017          .SYSTM         ; No -- System,
   00032'017000          .WRL 0         ; write line to channel 0, file W.
   00033'002000-         JMP @ .ER      ;   Error -- report.
   00034'006017          .SYSTM         ; System,
   00035'017001          .WRL 1         ; echo the line on console out.
   00036'002000-         JMP @ .ER      ;   Error -- report.
   00037'000756          JMP LOOP       ; Now do it all again.
   00040'023015 TWORD:   .TXT "&<15>"   ; Terminator word, & in left byte, CR in right.
      000000


                ; Error processing routine, creates file W if it doesn't exist.  When
                ; system gets here, AC0 still has W pointer, AC2 has error number.

   00042'024407 NOFIL:   LDA 1, .ERDL   ; Get code ERDLE (file does not exist).
   00043'146404          SUB 2, 1, SZR  ; Skip next instruction if file already exists.
   00044'002000-         JMP  @ .ER     ;   Error other than ERDLE, exit.
   00045'006017          .SYSTM         ; System,
   00046'007000          .CRAND         ; create file W.
   00047'002000-         JMP @ .ER      ;   Error, exit and report.
   00050'000730          JMP START      ; Now go back and open the new file.
   00051'000012 .ERDL:   ERDLE          ; ERDLE = 12.
```

Figure 9-4. WRITE.SR Program without Errors

Figure 9-5 shows RLDR information (called a load map) from WRITE.

The RLDR load map, shown for WRITE in Figure 9-5, shows the module names and program size information. It also gives some module starting addresses, which makes a useful debugging tool, although you didn't use it during this debugging session. In Figure 9-5, WRITE is the .TITL of the module. TMIN is the single-task scheduler. If WRITE were a multitask program, you'd have specified the number of tasks with the local /K switch in the RLDR line, and the RLDR would have loaded the multitask scheduler, TCBMON.

NSAC3 tells the system to copy the contents of location 16_8, the USP or User Stack Pointer, into AC3 after each system or task call. Thus you can use USP, a handy ZREL location, to store the return address from a subroutine. No matter how the subroutine uses AC3, a system or task call will restore it to the value it had on entry. The program can then JMP 0,3 to return from the subroutine. The .ENT pseudo-op in Chapter 8 shows an example of USP usage.

```
WRITE.SV LOADED BY
 RLDR REV 07.10 AT 17:59:02 04/02/79

 WRITE
 TMIN
 NSAC3

    NMAX       000742
    ZMAX       000051
    CSZE       000000
     EST       000000
     SST       000000

    USTAD      000400
    START      000445
    TMIN       000647
    .SAC0      020016
    .SAC1      024016
    .SAC2      030016
    .SAC3      034016
```

Figure 9-5. RLDR Load Map from WRITE

NMAX, the first unused word of NREL memory above WRITE code, is 742_8. ZMAX, the first free word of ZREL memory, is 51_8 because the program uses location 50_8 for the ERROR pointer. CSZE is the FORTRAN COMMON area size; here there is no COMMON. EST is the (bottom) of the symbol table. SST is the start of this table. The symbol table helped you debug WRITE, but you didn't tell RLDR to load it (global /D) with this version of WRITE, hence, figures for it are zero.

USTAD is the starting address of WRITE's User Status Table. RLDR builds this table into each program and the system uses it to store runtime information on the program. START is WRITE's START address. TMIN, the task scheduler, starts at 647_8. The .SAC entries are LDA instructions, not locations. RLDR takes them from the module NSAC3, described above.

Running WRITE

WRITE should run properly now; you've spend enough time on it. Try it out:

```
WRITE)
?
```

You've fixed it; the intial prompt is correct.

```
WRITE RUNS RIGHT, Q.E.D.)
WRITE RUNS RIGHT, Q.E.D.

?

&)
R
```

TYPE W), and find that it contains all messages. WRITE is right, and all ventures into Superedit, the assembler, RLDR and the debugger have paid off. WRITE is a neat little program, and you can use it, or parts of it, to produce impromtu logfiles and do other things.

In the future, if you plan to do a lot of assembly language programming, you might want to create a directory (e.g., ASM.DR) for your assembly language programs, and link to the needed utilities from it. You'll need links to the following files: (N)SPEED.SV/SPEED.ER, ASM.SV/XREF.SV *or* MAC.SV/MACXR.SV/MAC.PS, RLDR.SV/RLDR.OL, and SYS.LB.

End of Chapter

Index

Within this index, the letter "f" means "and the following page"; "ff" means "and the following pages". For each topic, primary page references are listed first. All letters are lowercase, except CLI commands (e.g., BUILD), Superedit commands (e.g., C), FORTRAN, BASIC or assembly language symbols (e.g., FORMAT, LIST, JSR), pseudo-ops (e.g., .BLK), and system calls (e.g., .CRAND).

Data General

users group Installation Membership Form

Name ______ Position ______ Date ______

Company, Organization or School ______

Address ______ City ______ State ______ Zip ______

Telephone: Area Code ______ No. ______ Ext. ______

1. Account Category

- ☐ OEM
- ☐ End User
- ☐ System House
- ☐ Government

2. Hardware

	Qty. Installed	Qty. On Order
M/600		
C/350, C/330, C/300		
S/250, S/230, S/200		
S/130		
AP/130		
CS Series		
N3/D		
Other NOVA		
microNOVA		
Other (Specify) ______		
______		
______		

3. Software

- ☐ AOS ☐ RDOS
- ☐ DOS ☐ RTOS
- ☐ SOS ☐ Other

Specify ______

______

4. Languages

- ☐ Algol ☐ Assembler
- ☐ DG/L ☐ Interactive
- ☐ Cobol ☐ Fortran
- ☐ ECLIPSE Cobol ☐ RPG II
- ☐ Business BASIC ☐ PL/1
- ☐ BASIC ☐ Other

Specify ______

______

5. Mode of Operation

- ☐ Batch (Central)
- ☐ Batch (Via RJE)
- ☐ On-Line Interactive

6. Communications

- ☐ RSTCP ☐ CAM
- ☐ HASP ☐ 4025
- ☐ RJE80 ☐ Other
- ☐ SAM

Specify ______

______

7. Application Description

○ ______

______

______

______

______

______

8. Purchase

From whom was your machine(s) purchased?

- ☐ **Data General Corp.**
- ☐ Other

Specify ______

______

9. Users Group

Are you interested in joining a special interest or regional Data General Users Group?

○ ______

______

DG-05810

Data General

Data General Corporation, Westboro, Massachusetts 01581, (617) 366-8911

DataGeneral

Software Documentation Remarks Form

How Do You Like This Manual?

Title ______________________________ No. __________

We wrote the book for you, and naturally we had to make certain assumptions about who you are and how you would use it. Your comments will help us correct our assumptions and improve our manuals. Please take a few minutes to respond.

If you have any comments on the software itself, please contact your Data General representative. If you wish to order manuals, consult the Publications Catalog (012-330).

Who Are You?

☐ EDP Manager
☐ Senior System Analyst
☐ Analyst/Programmer
☐ Operator
☐ Other ______________

What programming language(s) do you use? ______________

How Do You Use This Manual?

(List in order: 1 = Primary use)

_____ Introduction to the product
_____ Reference
_____ Tutorial Text
_____ Operating Guide
_____ ______________

Do You Like The Manual?

Yes	Somewhat	No	
☐	☐	☐	Is the manual easy to read?
☐	☐	☐	Is it easy to understand?
☐	☐	☐	Is the topic order easy to follow?
☐	☐	☐	Is the technical information accurate?
☐	☐	☐	Can you easily find what you want?
☐	☐	☐	Do the illustrations help you?
☐	☐	☐	Does the manual tell you everything you need to know?

Comments?

(Please note page number and paragraph where applicable.)

From:

Name ______________ Title ______________ Company ______________

Address ______________ Date ______________

SD-00742