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SC34-0943-0

Event Driven Executive Language Programming Guide

Version 6.0

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Summary of Changes for Version 6.0

This document contains the following changes.

3151 Display Terminal

- Chapter 8,"Reading Data from and Writing to Screens," has been updated to include the 3151 display everywhere a reference to the 3161 appears.
- Appendix B, "Interrupt Processing" has been updated to include the 3151 display everywhere a reference to the 3161 appears.
- Appendix C, "Static Screens and Device Considerations" has been updated to include the 3151 display everywhere a reference to the 3161 appears.

$INSTAL Utility Enhancements

- Chapter 1, "Getting Started" has been updated to include the new option for $INSTAL (Option 12) on the Session Manager Option Menu screen.
- Chapter 4, "Compiling a Program" has been updated to include the new option for $INSTAL (Option 12) on the Session Manager Option Menu screen.

System Partition Statements

- References to the SYSTEM statement have been replaced by the appropriate system partition statements: SYSPARTS, SYSPARMS, SYSCOMM, or SYSEND.

Miscellaneous Changes

- Numerous editorial and usability changes have been made throughout the book.

Contents

About This Book

This book contains an introduction to the Event Driven Language. It does not contain a description of all Event Driven Language instructions. For a description of all Event Driven Language instructions, refer to the *Language Reference*.

Audience

Chapters 1 through 8 of this book are intended for the application programmer who is coding in the Event Driven Language for the first time. Readers should be familiar with basic data processing terminology and concepts, such as input, output, and data sets.

Chapters 9 through 20 are intended for application programmers who need information about such advanced topics as multitasking, data management from a program, communicating with other programs, writing reentrant programs, and writing graphics or sensor I/O programs.

How This Book is Organized

This book contains twenty chapters and three appendixes:

- Chapter 1, "Getting Started" describes the steps necessary to develop and run a simple Event Driven Language (EDL) program.
- Chapter 2, "Writing a Source Program" tells how to use EDL instructions to do such things as read data, write data, convert data, and manipulate data.
- Chapter 3, "Entering a Source Program" tells how to use the full-screen editor to enter and modify a source program.
- Chapter 4, "Compiling a Program" shows how to use the Event Driven Language compiler to translate a source program to object code.
- Chapter 5, "Preparing an Object Module for Execution" shows how to use the linkage editor to prepare an object program for execution.
- Chapter 6, "Executing a Program" describes how to run a program that has been compiled and link-edited.
- Chapter 7, "Finding and Fixing Errors" describes a tool you can use to diagnose program logic errors and exception conditions.
- Chapter 8, "Reading Data from and Writing to Screens" on page 8-1 shows how to read and write data from display terminals. The chapter defines roll screens and static screens and describes how to write programs that interact with the operator.
- Chapter 9, "Designing Programs" defines what a program and a task are and describes multitasking, subroutines, program overlays, segment overlays, and unmapped storage.

- Chapter 10, "Performing Data Management from a Program" describes various ways to do data management from a program. The chapter describes how to allocate, delete, rename, and open a data set. In addition, the chapter shows how to set the logical end of file, add records to a tape data set, and find the device type from a program.
- Chapter 11, "Reading and Writing to Tape" tells how to read to and write from a magnetic tape data set.
- Chapter 12, "Communicating with Another Program (Cross-Partition Services)" shows how programs can interact with each other, either within the same partition or between partitions.
- Chapter 13, "Communicating with Other Programs (Virtual Terminals)" shows how one program can load another program and how the programs can interact with each other.
- Chapter 14, "Designing and Coding Sensor I/O Programs" describes digital and analog input/output and shows how to read and write to sensor I/O devices.
- Chapter 15, "Designing and Coding Graphic Programs" shows how to code the instructions that produce graphic messages and draw curves on a display terminal.
- Chapter 16, "Controlling Spooling from a Program" describes how a program can control printed output.
- Chapter 17, "Creating, Storing, and Retrieving Program Messages" shows how to save storage or coding time by creating messages than can be used by more than one program.
- Chapter 18, "Queue Processing" shows how to create queues, store data in queues, and retrieve data from queues.
- Chapter 19, "Writing Reentrant Code" shows how to design and write EDL programs that are reentrant.
- Chapter 20, "Accessing $SYSCOM through a Program" provides sample EDL programs that access the system common data area ($SYSCOM).
- Appendix A, "Tape Labels" shows the layout of tape labels.
- Appendix B, "Interrupt Processing" on page B-1 describes the interrupts that occur when a program interacts with a terminal.
- Appendix C, "Static Screens and Device Considerations" provides reference information on defining logical screens, $IMAGE subroutines, and the $UNPACK and $PACK subroutines.

Aids in Using This Book

This book contains the following aids to using the information it presents:

- A table of contents that lists the major headings in the book.
- In example screens where you must answer a system request, the sample responses appear highlighted in red.
- An index of the topics covered in this book.

Using the Enter and Attention Keys

This book uses the term "enter key" to mean the key that indicates that you have completed input to a screen and want the system to process the data you keyed in. It uses the term "attention key" to mean the key that indicates that you want to direct keyboard input to the operating system supervisor. If your keyboard does not have these keys, use the corresponding keys on your keyboard.

A Guide to the Library

Refer to the *Library Guide and Common Index* for information on the design and structure of the Event Driven Executive library, for a bibliography of related publications, for a glossary of terms and abbreviations, and for an index to the entire library.

Contacting IBM about Problems

You can inform IBM of any inaccuracies or problems you find when using this book by completing and mailing the **Reader's Comment Form** provided in the back of this book.

If you have a problem with the IBM Series/1 Event Driven Executive, refer to the *IBM Series/1 Software Service Guide*, GC34-0099.

Chapter 1. Getting Started

This chapter is intended for people who have never coded an Event Driven Language (EDL) program. It describes the steps necessary to develop and run a simple program on the Series/1. If you are familiar with EDL and the EDX operating system, skip this chapter and go to Chapter 2.

Specifically, this chapter shows you how to design, code, enter, compile, link edit, and execute an EDL program. Using a simple example program, we will show you all these steps. You may want to enter and run this program on your Series/1 to gain hands-on experience.

All of the major steps in the development and execution of an EDL program are covered in greater detail later in this book. The following chart describes these steps and shows you where the material is covered:

Write the source program *(Chapter 2)*	Write a source program that does such things as read data, manipulate data, and write data.
Enter the source program *(Chapter 3)*	Enter the source program by using the session manager to build a data set.
Compile the source program *(Chapter 4)*	Compile your source program.
Link edit the program *(Chapter 5)*	Produce an executable load module.
Run the program *(Chapter 6)*	Cause your program to run or "execute."
Find and fix errors *(Chapter 7)*.	Use the $DEBUG utility or a task error exit routine to help you locate and correct any problems in your program.

Designing a Program

The first step in the development of any program is the design of the program. You must be able to describe what you want the program to accomplish.

Typically, a program reads some data, processes the data, and writes the results. The sample program we have chosen does all of these things. The program requests that an operator enter a number at the terminal. That number is added to a storage area ten times, and the results are displayed on the terminal screen.

Here are some questions you should ask when you plan a program. We have shown how we answered those questions in our sample program.

Questions	In Our Program
Where is the data coming from and what form will it take?	The data is a number that the operator enters at the terminal.
What do you want to do with the data and in what order do you want to process the data?	The number that is entered from the terminal will be added 10 times to a storage area that you define.
Where do you print or record the results?	The results are displayed on the terminal screen.

In the next section, we will show you how to implement this design in an EDL program.

Coding the Program

On the next few pages, we will show you how the design of this program was implemented. We will build the program step by step. We will not describe *every* possible operand of the instructions we use. (The *Language Reference* fully describes the operands for every EDL instruction.)

The instructions and statements that make up a program are called the *source program.* They have the following general format:

label	*operation*	*operands*

where these terms have the following meanings:

label The name you assign an instruction or statement. You can use this name in your program to refer to that specific instruction or statement. In most cases, the label is optional. Labels must begin in column 1; must begin with a letter or one of the special characters $, #, or @; and must be 1 to 8 characters long.

operation The name of the instruction or statement you are coding. The operation can begin in column 2 and cannot extend beyond column 71.

operands The data that is required to do an operation, or information on how the system is to perform the operation.

To continue a line of code on the next line, place any nonblank character in column 72 and continue the next line in column 16.

Starting the Program

Any EDL program begins with the PROGRAM statement.

A PROGRAM statement defines the address or label of the first instruction to be executed. The PROGRAM statement also defines the name of the primary task of the program. (EDL programs may consist of multiple tasks. In our sample program, the primary task is the only task of the program.)

Our program statement looks like this:

```
ADD10    PROGRAM    STPGM
```

ADD10 is the *task name* of the primary (and only) task.

STPGM is the label of the first instruction to be executed.

Defining Your Data

The program needs two data areas: one to hold the input and one to hold the results of the process. Use the DATA statement to reserve storage for data.

```
ADD10    PROGRAM    STPGM
           •
           •
           •
COUNT    DATA       F'0'
SUM      DATA       F'0'
```

These DATA statements indicate that the reserved areas are type F (for fullword) and that the initial value of the areas is 0. In the Series/1, a "fullword" contains two bytes (16 bits).

Since DATA statements do not cause any action to occur, place them either before the first instruction or after the last instruction.

Retrieving Data

The next step is to get input data into the program. In this program, we use a GETVALUE instruction to get the data.

```
ADD10    PROGRAM    STPGM
STPGM    GETVALUE   COUNT,'ENTER NUMBER: '
           •
           •
           •
COUNT    DATA       F'0'
SUM      DATA       F'0'
```

When the GETVALUE instruction executes, the message "ENTER NUMBER: " appears on the terminal screen. When someone enters a number and presses the ENTER key, the system stores the number in the data area called COUNT.

Processing the Data

This program is going to add the number that is entered from the terminal to the contents of storage area SUM. You need an ADD instruction to perform the addition. The number is going to be added to COUNT ten times. So the ADD instruction is placed inside a DO loop, which consists of a DO instruction and an ENDDO instruction. The DO instruction indicates how many times the instructions (in this case, an ADD instruction) are to be executed.

```
ADD10       PROGRAM   STPGM
STPGM       GETVALUE  COUNT,'ENTER NUMBER: '
LOOP        DO        10,TIMES
              ADD     SUM,COUNT
            ENDDO
             •
             •
             •
COUNT       DATA       F'0'
SUM         DATA       F'0'
```

Obtaining the Results

At this point, the program includes instructions to read the data and process the data. To print the results, you use two instructions: PRINTEXT and PRINTNUM.

```
ADD10       PROGRAM   STPGM
STPGM       GETVALUE  COUNT,'ENTER NUMBER: '
LOOP        DO        10,TIMES
              ADD     SUM,COUNT
            ENDDO
            PRINTEXT  '@RESULT='
            PRINTNUM  SUM
             •
             •
             •
COUNT       DATA      F'0'
SUM         DATA      F'0'
```

The PRINTEXT instruction will print "RESULT=" on the terminal screen. The "@" symbol will cause "RESULT=" to be printed on a new line on the terminal screen. The PRINTNUM instruction will print the results of the process, which are stored in the SUM data area.

Ending the Program

The program needs three more statements to be complete. The PROGSTOP statement stops the program execution and releases the storage allocated to the program. You code PROGSTOP after the last executable instruction in the program. The ENDPROG statement ends the program. The END statement signals the compiler that the program has no more source statements.

All EDL programs must end with the ENDPROG and END statements.

The completed program looks like this:

```
ADD10     PROGRAM   STPGM
STPGM     GETVALUE  COUNT,'ENTER NUMBER: '
LOOP      DO        10,TIMES
            ADD      SUM,COUNT
          ENDDO
          PRINTEXT  '@RESULT='
          PRINTNUM  SUM
          PROGSTOP
COUNT     DATA      F'0'
SUM       DATA      F'0'
          ENDPROG
          END
```

The next step is to enter your program into a data set. We will show you how to use the *session manager* to enter the source program. The session manager provides a series of menus to help you enter a source program. This section shows you how to enter our sample program. For more information on entering a source program, see Chapter 3, "Entering a Source Program."

Entering the Source Program into a Data Set

All the steps for entering the source program into a data set are listed below. If you want to actually enter the sample source program, follow the numbered steps.

To load the session manager on your terminal:

1. Press the attention key.
2. Type **$L $SMMAIN.**
3. Press the enter key.

When you press the enter key, the logon screen appears:

```
$SMMLOG: THIS TERMINAL IS LOGGED ON TO THE SESSION MANAGER------------
                                                              09:55:31
ENTER 1-4 CHAR USER ID ==>                                    10/24/82
(ENTER LOGOFF TO EXIT)

ALTERNATE SESSION MENU ==>
(OPTIONAL)
```

To begin a session:

1. Type a unique user identification (called a *user ID*). The user id can be 1 to 4 characters long. This chapter uses ABCD as the user ID.
2. Press the enter key.

```
$SMMLOG: THIS TERMINAL IS LOGGED ON TO THE SESSION MANAGER------------
                                                              09:55:31
ENTER 1-4 CHAR USER ID ==> ABCD                               10/24/82
(ENTER LOGOFF TO EXIT)

ALTERNATE SESSION MENU ==>
(OPTIONAL)
```

The Primary Option Menu appears on the screen. To enter a source program into a data set, select option 1 (TEXT EDITING).

1 Type **1** on the SELECT OPTION line.

2 Press the enter key.

```
$SMMPRIM: SESSION MANAGER PRIMARY OPTION MENU ----------------------------
ENTER/SELECT PARAMETERS:                                  PRESS PF3 TO EXIT

                                                          10:00:00
      SELECT OPTION ==> 1                    10/24/82
                                                          ABCD

           1 - TEXT EDITING
           2 - PROGRAM PREPARATION
           3 - DATA MANAGEMENT
           4 - TERMINAL UTILITIES
           5 - GRAPHICS UTILITIES
           6 - EXEC PROGRAM/UTILITY
           7 - EXEC $JOBUTIL PROC
           8 - COMMUNICATION UTILITIES
           9 - DIAGNOSTIC AIDS
          10 - BACKGROUND JOB CONTROL UTILITIES
```

The $FSEDIT PRIMARY OPTION MENU appears on the screen. Use option 2 (EDIT) to create a new data set.

1 Type **2** on the OPTION line.

2 Press the enter key.

```
$FSEDIT PRIMARY OPTION MENU  ---------------------------------STATUS = INIT
                                                        PRESS PF3 TO EXIT
OPTION ===> 2

DATASET NAME =========>          (CURRENTLY IN WORK FILE)
VOLUME NAME ==========>

HOST DATASET ========>

ENTER A VOLUME NAME AND PRESS ENTER FOR A DIRECTORY LIST.

1 ---- BROWSE
2 ---- EDIT
3 ---- READ (HOST/NATIVE)
4 ---- WRITE (HOST/NATIVE)
5 ---- SUBMIT
6 ---- PRINT
7 ---- MERGE
8 ---- END
9 ---- HELP
```

Your data set then appears. This is where you will type the source program.

```
EDIT --- $SMEABCD , EDX002     0( 1089)---------------------- COLUMNS 001 072
COMMAND INPUT ===>                                            SCROLL ==> HALF
***** ***** TOP OF DATA ********************************************************
.....
***** ***** BOTTOM OF DATA *****************************************************
```

To enter the source program:

1. Type the first line of code.
2. Press the enter key to cause a blank entry line to appear.
3. Type the next line of code.
4. Press the enter key.
5. Repeat steps 3 and 4 until you have entered the entire source program.
6. When you finish entering the source program, move the cursor to the COMMAND INPUT line and type **M** (for "menu").

```
EDIT --- $SMEABCD , EDX002     0( 1089)------------------------ COLUMNS 001 072
COMMAND INPUT ===> M                                           SCROLL ==> HALF
***** ***** TOP OF DATA ********************************************************
00010 ADD10       PROGRAM       STPGM
00020 STPGM       GETVALUE      COUNT,'ENTER NUMBER: '
00030 LOOP        DO            10,TIMES
00040               ADD         SUM,COUNT
00050             ENDDO
00060             PRINTEXT      '@RESULT='
00070             PRINTNUM      SUM
00080             PROGSTOP
00090 COUNT       DATA          F'0'
00100 SUM         DATA          F'0'
00110             ENDPROG
00120             END
***** ***** BOTTOM OF DATA *****************************************************
```

7. Press the enter key.

The $FSEDIT PRIMARY OPTION MENU appears again.

The next step is to write the data set to a volume. When you write the data set, you copy the data set from the temporary data set that $FSEDIT has been using. The data set name we have chosen is ADD10 and the volume name is EDX002. Select option 4 (WRITE) to write the data set to a volume.

1 Type **4** on the OPTION line.

2 Type **ADD10** on the DATASET NAME line.

3 Type **EDX002** on the VOLUME NAME line.

4 Press the enter key.

```
$FSEDIT PRIMARY OPTION MENU  ----------------------------STATUS = MODIFIED
                                                          PRESS PF3 TO EXIT
OPTION ===> 4

DATASET NAME =========> ADD10      (CURRENTLY IN WORK DATASET)
VOLUME NAME ==========> EDX002

HOST DATASET ========>

ENTER A VOLUME NAME AND PRESS ENTER FOR A DIRECTORY LIST.

1 ---- BROWSE
2 ---- EDIT
3 ---- READ (HOST/NATIVE)
4 ---- WRITE (HOST/NATIVE)
5 ---- SUBMIT
6 ---- PRINT
7 ---- MERGE
8 ---- END
9 ---- HELP
```

A prompt appears on the bottom of the screen. Type **Y** and press the enter key.

```
WRITE TO ADD10 ON EDX002 (Y/N)? Y
```

A message appears on the bottom of the screen. This message means that your source program is 12 lines long and has been written to volume EDX002.

```
12 LINES WRITTEN TO ADD10   ,EDX002
```

Now that you have entered and written the source program to a data set, return to the Session Manager Primary Option Menu.

1 Type **8** on the OPTION line.

2 Press the enter key.

```
$FSEDIT PRIMARY OPTION MENU  ----------------------------STATUS = SAVED
OPTION ===> 8

DATASET NAME ==========>          (CURRENTLY IN WORK FILE)
VOLUME NAME ==========>

HOST DATASET ========>

ENTER A VOLUME NAME AND PRESS ENTER FOR A DIRECTORY LIST.

1 ---- BROWSE
2 ---- EDIT
3 ---- READ (HOST/NATIVE)
4 ---- WRITE (HOST/NATIVE)
5 ---- SUBMIT
6 ---- PRINT
7 ---- MERGE
8 ---- END
9 ---- HELP
```

Compiling Your Source Program

Now that you have coded and entered the source program into a data set, the next step is to compile it into object code. *Object code* is code that the computer can read. To compile the source program, use $EDXASM, the EDX compiler. This section shows you how to compile the sample program. For more information on compiling a source program, see Chapter 4, "Compiling a Program."

Before you actually begin to compile, you must allocate a data set to hold the output (the object code). Start by selecting option 3 (DATA MANAGEMENT).

1 Type **3** on the SELECT OPTION line.

2 Press the enter key.

```
$SMMPRIM: SESSION MANAGER PRIMARY OPTION MENU ------------------------
ENTER/SELECT PARAMETERS:                              PRESS PF3 TO EXIT

                                                                10:42:07
     SELECT OPTION ==> 3                              10/24/82
                                                                ABCD

          1 - TEXT EDITING
          2 - PROGRAM PREPARATION
          3 - DATA MANAGEMENT
          4 - TERMINAL UTILITIES
          5 - GRAPHICS UTILITIES
          6 - EXEC PROGRAM/UTILITY
          7 - EXEC $JOBUTIL PROC
          8 - COMMUNICATION UTILITIES
          9 - DIAGNOSTIC AIDS
         10 - BACKGROUND JOB CONTROL UTILITIES
```

The Data Management Option Menu appears on the screen. To allocate your object code data set, select option 1 ($DISKUT1).

1 Type **1** on the SELECT OPTION line.

2 Press the enter key.

```
$SMM03  SESSION MANAGER DATA MANAGEMENT OPTION MENU----------------------
ENTER/SELECT PARAMETERS:                                PRESS PF3 TO RETURN

  SELECT OPTION ==> 1

   1 - $DISKUT1 (DISK(ETTE) ALLOCATE, LIST DIRECTORY)
   2 - $DISKUT2 (DISK(ETTE) DUMP/LIST DATASETS)
   3 - $COPYUT1 (DISK(ETTE) COPY DATASETS/VOLUMES)
   4 - $COMPRES (DISK(ETTE) COMPRESS A VOLUME)
   5 - $COPY    (DISK(ETTE) COPY DATASETS/VOLUMES)
   6 - $DASDI   (DISK(ETTE) SURFACE INITIALIZATION)
   7 - $INITDSK (DISK(ETTE) INITIALIZE/VERIFY)
   8 - $MOVEVOL (COPY DISK VOLUME TO MULTI-DISKETTES)
   9 - $IAMUT1  (INDEXED ACCESS METHOD UTILITY PROGRAM)
  10 - $TAPEUT1 (TAPE ALLOCATE, CHANGE, COPY)
  11 - $HXUT1   (H-EXCHANGE DATASET UTILITY)
  12 - $INSTAL  (INSTALL/UPDATE A SOFTWARE PACKAGE)

   WHEN ENTERING THESE UTILITIES, THE USER IS EXPECTED
   TO ENTER A COMMAND. IF A QUESTION MARK (?) IS ENTERED
   INSTEAD OF A COMMAND, THE USER WILL BE PRESENTED WITH
   A LIST OF AVAILABLE COMMANDS.
```

The $DISKUT1 utility prompts you for the command and for information about the data set you want to create. Use the AL (allocate) command. Call the data set that will hold the object code ADDOBJ. Allocate a 25-record data set and use the default data type.

1 Type **AL** on the COMMAND (?) line.

2 Press the enter key.

3 Type **ADDOBJ** on the MEMBER NAME line.

4 Press the enter key.

5 Type **25** next to the HOW MANY RECORDS? prompt.

6 Press the enter key.

7 Type **Y** next to the DEFAULT TYPE = DATA - OK (Y/N)? prompt.

8 Press the enter key.

```
LOADING $DISKUT1      nnP, hh:mm:ss, LP= xxxx, PART= yy

$DISKUT1 - DATA SET MANAGEMENT UTILITY I

USING VOLUME EDX002

COMMAND (?): AL
MEMBER NAME: ADDOBJ
HOW MANY RECORDS? 25
DEFAULT TYPE = DATA - OK (Y/N)? Y
ADDOBJ CREATED

COMMAND  (?): EN
```

A message appears telling you that the ADDOBJ data set has been created. Enter the EN (end) command to return to the Data Management Option Menu screen.

1 Type **EN** next to the COMMAND (?) prompt.

2 Press the enter key.

The next step is to return to the Session Manager Primary Option Menu to compile your program. To return to that menu, press the PF3 key.

From the Session Manager Primary Option Menu, select option 2 (PROGRAM PREPARATION) to prepare to compile your program.

1 Type **2** on the SELECT OPTION line.

2 Press the enter key.

```
$SMMPRIM: SESSION MANAGER PRIMARY OPTION MENU ----------------------------
ENTER/SELECT PARAMETERS:                                  PRESS PF3 TO EXIT

                                                          11:12:07
      SELECT OPTION ==> 2                        10/24/82
                                                          ABCD

          1 - TEXT EDITING
          2 - PROGRAM PREPARATION
          3 - DATA MANAGEMENT
          4 - TERMINAL UTILITIES
          5 - GRAPHICS UTILITIES
          6 - EXEC PROGRAM/UTILITY
          7 - EXEC $JOBUTIL PROC
          8 - COMMUNICATION UTILITIES
          9 - DIAGNOSTIC AIDS
         10 - BACKGROUND JOB CONTROL UTILITIES
```

The Program Preparation Option Menu appears on your screen. To compile the source program, select option 1 ($EDXASM COMPILER).

1 Type **1** on the SELECT OPTION line.

2 Press the enter key.

```
$SMM02  SESSION MANAGER PROGRAM PREPARATION OPTION MENU-------------------
ENTER/SELECT PARAMETERS:                                 PRESS PF3 TO RETURN

      SELECT OPTION ==> 1

          1 - $EDXASM COMPILER
          2 - $EDXASM/$EDXLINK
          3 - $S1ASM ASSEMBLER
          4 - $COBOL COMPILER
          5 - $FORT FORTRAN COMPILER
          6 - $PLI COMPILER/$EDXLINK
          7 - $EDXLINK LINKAGE EDITOR
          8 - $XPSLINK LINKAGE EDITOR FOR SUPERVISORS
          9 - $UPDATE
         10 - $UPDATEH (HOST)
         11 - $PREFIND
         12 - $PASCAL COMPILER/$EDXLINK
         13 - $EDXASM/$XPSLINK FOR SUPERVISORS
         14 - $MSGUT1 MESSAGE SOURCE PROCESSING UTILITY
```

The $EDXASM Parameter Input Menu appears on your screen. You must enter the name of your source program (data set ADD10 on volume EDX002) and your object output (data set ADDOBJ on volume EDX002).

1 Type **ADD10,EDX002** next to SOURCE INPUT (NAME,VOLUME).

2 Type **ADDOBJ,EDX002** next to OBJECT OUTPUT (NAME,VOLUME).

3 Press the enter key.

```
$SMM0201: SESSION MANAGER $EDXASM PARAMETER INPUT MENU----------------------
ENTER/SELECT PARAMETERS:                                  PRESS PF3 TO RETURN


  SOURCE INPUT   (NAME,VOLUME) ==> ADD10,EDX002

  OBJECT OUTPUT  (NAME,VOLUME) ==> ADDOBJ,EDX002

  OPTIONAL PARAMETERS ==>
  (SELECT FROM THE LIST BELOW)

 FOREGROUND OR BACKGROUND (F/B) ==>
 (DEFAULT IS FOREGROUND)

 ---------------------------------------------------
AVAILABLE PARAMETERS:     ABBREVIATION:        DESCRIPTION:
 NOLIST                    NO                   USED TO SUPPRESS LISTING
 LIST TERMINAL-NAME        LI TERMINAL-NAME     USE LIST * FOR THIS TERMINAL
 ERRORS TERMINAL-NAME      ER TERMINAL-NAME     USE ERRORS * FOR THIS TERMINAL
 CONTROL DATA SET,VOLUME   CO DATA SET,VOLUME   $EDXASM LANGUAGE CONTROL DATASET
 OVERLAY #                 OV #                 # IS NUMBER OF AREAS FROM 1 TO 6

DEFAULT PARAMETERS:
 LIST $SYSPRTR CONTROL $EDXL,ASMLIB OVERLAY 6
```

$EDXASM then compiles the source program into object code and puts the object code into data set ADDOBJ. This data set is used as input in the next step, "Creating a Load Module."

The information listed under DEFAULT PARAMETERS means that the compiler will print a listing of the program on the system printer, $SYSPRTR.

As the compilation runs, the following appears on your screen.

```
LOADING $JOBUTIL    nnP, hh:mm:ss, LP= xxxx, PART= yy
REMARK
ASSEMBLE ADD10,EDX002 TO ADDOBJ,EDX002
*** JOB - $EDXASM - STARTED AT 11:21:56 00/00/00 ***

JOB      $EDXASM  ($SMP0201)  USERID=ABCD
LOADING $EDXASM       nnP, hh:mm:ss, LP= xxxx, PART= yy

ASSEMBLY STARTED   1 OVERLAY  AREA  ACTIVE
COMPLETION CODE =          -1

$EDXASM  ENDED AT 11:22:55

$JOBUTIL ENDED AT 11:22:56

PRESS ENTER KEY TO RETURN
```

If the screen fills up before displaying PRESS ENTER KEY TO RETURN, press the enter key.

A completion code of −1 means that your program compiled successfully. Any completion code other than −1 means the program did not compile successfully.

Checking Your Compiler Listing

The compiler prints a listing that consists of statistics, source code statements and object code, undefined or external symbols, and a completion code.

If you do not receive a completion code of −1, check your listing for errors, fix them in your source data set, and compile the program again. For information on fixing compiler errors, see "Checking Your Compiler Listing and Correcting Errors."

If you receive a completion code of −1:

1. Press the enter key to return to the $EDXASM Parameter Input Menu.
2. Press the PF3 key to return to the Program Preparation Option Menu.

Creating a Load Module

The last step is creating a load module. A *load module* is a program that is ready to run or "execute" on the system. In this example, we use the linkage editor, $EDXLINK, to create the load module. $EDXLINK LINKAGE EDITOR is option 7 on the Program Preparation Option Menu.

1 Type **7** on the SELECT OPTION line.

2 Press the enter key.

```
$SMM02  SESSION MANAGER PROGRAM PREPARATION OPTION MENU----------------------
ENTER/SELECT PARAMETERS:                                  PRESS PF3 TO RETURN

      SELECT OPTION ==> 7

            1 - $EDXASM COMPILER
            2 - $EDXASM/$EDXLINK
            3 - $S1ASM ASSEMBLER
            4 - $COBOL COMPILER
            5 - $FORT FORTRAN COMPILER
            6 - $PLI COMPILER/$EDXLINK
            7 - $EDXLINK LINKAGE EDITOR
            8 - $XPSLINK LINKAGE EDITOR FOR SUPERVISORS
            9 - $UPDATE
           10 - $UPDATEH (HOST)
           11 - $PREFIND
           12 - $PASCAL COMPILER/$EDXLINK
           13 - $EDXASM/$XPSLINK FOR SUPERVISORS
           14 - $MSGUT1 MESSAGE SOURCE PROCESSING UTILITY
```

The $EDXLINK Parameter Input Menu appears on your screen. Enter an asterisk (*) next to EXECUTION PARM to indicate that you want the system to prompt you for linkage editor statements.

1 Type an asterisk on the EXECUTION PARM line.

2 Press the enter key.

```
$SMM0207: SESSION MANAGER $EDXLINK PARAMETER INPUT MENU----------------------
ENTER/SELECT PARAMETERS:                                  PRESS PF3 TO RETURN



  EXECUTION PARM ==> *

  ENTER A CONTROL DATA SET NAME,VOLUME OR
  AN ASTERISK (*) FOR INTERACTIVE MODE.

  OUTPUT DEVICE (DEFAULTS TO $SYSPRTR) ==>

  FOREGROUND OR BACKGROUND (F/B) ==>
  (DEFAULT IS FOREGROUND)
```

$EDXLINK displays the following screen:

```
LOADING $JOBUTIL    nnP, hh:mm:ss, LP= xxxx, PART= yy
REMARK
$EDXLINK *
*** JOB - $EDXLINK - STARTED AT 11:27:16 11/13/82 ***

JOB      $EDXLINK ($SMP0207) USERID=ABCD
LOADING $EDXLINK      nnP, hh:mm:ss, LP= xxxx, PART= yy

$EDXLINK - EDX LINKAGE EDITOR


$EDXLINK INTERACTIVE MODE
  DEFAULT VOLUME = EDX002

STMT (?):
```

Next, enter an INCLUDE statement to indicate which object module to use. (Remember, the object module is ADDOBJ.) Then, enter a LINK statement to indicate the name of the output data set. When you enter the name of this data set (in this case, ADDPGM), the system allocates the data set.

1 Type **INCLUDE ADDOBJ,EDX002** next to STMT (?).

2 Press the enter key.

```
LOADING $JOBUTIL    nnP, hh:mm:ss, LP= xxxx, PART= yy
REMARK
$EDXLINK *
*** JOB - $EDXLINK - STARTED AT 11:27:16 11/13/82 ***

JOB      $EDXLINK ($SMP0207) USERID=ABCD
LOADING $EDXLINK      nnP, hh:mm:ss, LP= xxxx, PART= yy

$EDXLINK - EDX LINKAGE EDITOR


$EDXLINK INTERACTIVE MODE
  DEFAULT VOLUME = EDX002

STMT (?):INCLUDE ADDOBJ,EDX002
```

1 Type **LINK ADDPGM,EDX002** next to STMT (?).

2 Press the enter key.

```
LOADING $JOBUTIL    nnP, hh:mm:ss, LP= xxxx, PART= yy
REMARK
$EDXLINK *
*** JOB - $EDXLINK - STARTED AT 11:27:16 11/13/82 ***

JOB      $EDXLINK ($SMP0207) USERID=ABCD
LOADING $EDXLINK      nnP, hh:mm:ss, LP= xxxx, PART= yy

$EDXLINK - EDX LINKAGE EDITOR


$EDXLINK INTERACTIVE MODE
  DEFAULT VOLUME = EDX002

STMT (?):LINK ADDPGM,EDX002
```

A completion code of −1 means that the link edit completed successfully. If you do not receive a completion code of −1, check your listing for errors, fix them, and link edit the program again. After the system indicates that the link edit is successful, return to the Primary Option Menu to execute your program by doing the following.

1 Type **EN** next to STMT (?).

2 Press the enter key.

3 Press the PF3 key to return to the Program Preparation Option Menu.

4 Press the PF3 key again.

Running Your Program

To run (or execute) your program, select option 6 (EXEC PROGRAM/UTILITY).

1 Type **6** on the SELECT OPTION line.

2 Press the enter key.

```
$SMMPRIM: SESSION MANAGER PRIMARY OPTION MENU ----------------------------
ENTER/SELECT PARAMETERS:                                  PRESS PF3 TO EXIT

                                                          11:42:07
     SELECT OPTION ==> 6                          10/24/82
                                                          ABCD

          1 - TEXT EDITING
          2 - PROGRAM PREPARATION
          3 - DATA MANAGEMENT
          4 - TERMINAL UTILITIES
          5 - GRAPHICS UTILITIES
          6 - EXEC PROGRAM/UTILITY
          7 - EXEC $JOBUTIL PROC
          8 - COMMUNICATION UTILITIES
          9 - DIAGNOSTIC AIDS
         10 - BACKGROUND JOB CONTROL UTILITIES
```

The Execute Program/Utility menu appears. You must enter the program name (ADDPGM) and volume (EDX002). Then, type asterisks (*) next to the data sets not used.

1. Type **ADDPGM,EDX002** next to PROGRAM/UTILITY (NAME,VOLUME).
2. Type an asterisk in the DATA SET 1, DATA SET 2, and DATA SET 3 fields.
3. Press the enter key.

```
$SMM06  SESSION MANAGER EXECUTE PROGRAM/UTILITY--------------------------
ENTER/SELECT PARAMETERS:                                  PRESS PF3 TO RETURN

 PROGRAM/UTILITY (NAME,VOLUME) ==> ADDPGM,EDX002
 DYNAMIC STORAGE (OPTIONAL)    ==>

 PARAMETERS ===>

 DATA SET 1 (NAME,VOLUME / * = DS1 NOT USED) ===> *
 DATA SET 2 (NAME,VOLUME / * = DS2 NOT USED) ===> *
 DATA SET 3 (NAME,VOLUME / * = DS3 NOT USED) ===> *

 FOREGROUND OR BACKGROUND (F/B) ==>
 (DEFAULT IS FOREGROUND)

 NOTE: IF A DATA SET (DS1, DS2 OR DS3) IS NOT USED,
       AN ASTERISK (*) MUST BE ENTERED IN THE DATA SET FIELD.
```

The following text appears on the terminal:

```
LOADING $JOBUTIL    nnP, hh:mm:ss, LP= xxxx, PART= yy
REMARK
EXECUTE  PROGRAM/UTILITY: ADDPGM
*** JOB - ADDPGM - STARTED AT 11:48:22 11/14/82 ***

JOB      ADDPGM ($SMP06) USERID=ABCD
LOADING ADDPGM      nnP, hh:mm:ss, LP= xxxx, PART= yy
ENTER NUMBER:
```

The program displays ENTER NUMBER on the screen and waits for you to enter a number. (Remember that "ENTER NUMBER" was coded on the GETVALUE instruction.)

1 Type **5** next to ENTER NUMBER.

2 Press the enter key.

```
LOADING ADDPGM        nnP, hh:mm:ss, LP= xxxx, PART= yy
ENTER NUMBER: 5
     RESULT=     50
ADDPGM   ENDED AT 11:48:57

$JOBUTIL ENDED AT 11:48:58

PRESS ENTER KEY TO RETURN
```

The program displays the results of the processing. The program:

1 Stored the number you entered (5) in an area called COUNT.

2 Added the value of COUNT to the value of SUM, which was initialized to 0.

3 Added the two values 10 times.

4 Displayed the result (RESULT= 50) on the terminal screen.

The PRINTEXT instruction displayed RESULT=. The PRINTNUM instruction displayed the value of SUM (50).

Chapter 2. Writing a Source Program

This chapter tells how to use the EDL instructions to handle the basic functions of the language: reading and writing data, data conversions, and data manipulation (such as moving, adding, and subtracting).

This chapter discusses the following topics:

- Beginning the program
- Reserving storage
- Reading data into a data area
- Moving data
- Converting data
- Manipulating data
- Writing data from a data area
- Controlling program logic
- Ending the program.

All the instructions are discussed in detail in the *Language Reference*. This chapter discusses only a subset of the the instructions and lists them by function.

Beginning the Program

The first statement in every EDL program must be a PROGRAM statement. The PROGRAM statement defines several things about the program to the Event Driven Executive, only two of which are discussed in this section.

Defining the Primary Task

Two important functions of the PROGRAM statement are to define the "primary task" and provide the label of the first "executable instruction."

The *primary task* is the first task the system starts when you load the program.

An *executable* instruction causes some action to take place. For example, instructions that read, write, move, or perform arithmetic operations are executable instructions.

The following example shows a program with task name TASK1. Its first executable instruction is at location START1.

```
TASK1       PROGRAM     START1
```

Identifying Data Sets to be Used in Your Program

Another important function of the PROGRAM statement is to identify the data sets that a program will use.

The DS= keyword operand of the PROGRAM statement allows you to identify up to nine data sets that the program can use. A *keyword operand* usually contains an equal (=) sign. The "keyword" to the left of the equal sign identifies what information you are supplying. The keyword operand must appear, of course, exactly as the system expects it. For example, if you code the DS= operand as SD=, the system would not recognize it. You can code keyword operands in any order.

When you specify data set names in the PROGRAM statement, the system opens the data sets when you load the program. When the program executes, all data sets must already exist. One way to allocate data sets is with the $DISKUT1 utility. If a program uses one data set *and* the data set resides on the IPL volume, the PROGRAM statement might look like this:

```
UPDATE  PROGRAM  START1,DS=TRANS
```

This program uses data set TRANS on the IPL volume.

If a program uses more than one data set and the data sets all reside on the IPL volume, the DS= operand would contain one set of parentheses as follows:

```
UPDATE  PROGRAM  START1,DS=(TRANS,MASTIN,MASTOUT)
```

The program uses data sets TRANS, MASTIN, and MASTOUT on the IPL volume.

If the data resides on a volume other than the IPL volume, two sets of parentheses are required. For example:

```
TASK1   PROGRAM  START1,DS=((DATA1,MYVOL),MASTER)
```

The program uses data set DATA1 on volume MYVOL and data set MASTER on the IPL volume.

Reserving Storage

This section shows how to reserve storage for arithmetic values or character strings.

EDL allows you to define arithmetic values in two ways: as "integer" data or as "floating-point" data. *Integer* data consists of positive and negative numbers with no decimal points. *Floating-point* data consists of positive and negative numbers that can have decimal points.

For example, you can define the number 7 as either a floating-point number or an integer. To define the number 7.5, however, you must define it as a floating-point number.

Reserving Storage for Integers

To reserve storage for an integer, you can use either the DATA or DC statement. The following DATA statement, for example, defines a storage area for a 2-byte signed integer.

```
SUM      DATA  F'0'
```

SUM is the name or label of the storage area. This type of storage area is often called a variable. The F defines a fullword (two bytes) and '0' assigns an initial value of zero to the area.

To set up more than one 1-word area in one statement, you can use the duplication factor. The statement:

```
FITABLE  DATA  15F'0'
```

reserves fifteen 1-word areas and assigns a zero to each.

You can use the areas called SUM and FITABLE in data manipulation instructions such as ADD and SUBTRACT.

Assigning an Initial Value

To assign an initial value, enclose the value in apostrophes as follows:

```
FIM      DATA  F'5280'
```

The storage area called FIM will contain the decimal value 5280 throughout the execution of your program, unless you change it.

You can also assign a hexadecimal value to a storage area. For example:

```
XFIM     DATA  X'14A0'
```

XFIM contains the hexadecimal value '14A0' (decimal 5280).

Defining a Halfword or Doubleword Data Area

You can also define a halfword (1-byte) or doubleword (4-byte) data area. The following statements reserve storage for halfword integers:

```
MSIX     DATA  H'-6'
SHVAR    DATA  H'0'
```

MSIX contains the value −6.

To reserve a doubleword of storage, define a data area as follows:

```
QTRMIL   DATA  D'250000'
LNGVAR   DATA  D'0'
```

QTRMIL occupies a doubleword of storage and contains an initial value 250 000 (decimal).

Defining Floating-Point Values

To define floating-point values, you can use either the DATA or DC statement. How large the number is determines how you define the storage. If the number falls between 10^{-76} and 10^{76} and contains fewer than seven significant digits, you can define a single-precision floating-point data area. Each single-precision floating-point number requires 4 bytes of storage.

The following DATA statement defines a storage area for a single-precision floating-point number.

```
NETPAY   DATA  E'000.00'
```

NETPAY is the name of the storage area. The E defines a floating-point data area and assigns it an initial value of zero.

To set up more than one floating-point data area, you can use the duplication factor. The statement

```
NPTAB    DATA  12E'000.00'
```

reserves storage for twelve 4-byte floating-point data areas and assigns an initial value of zero to each.

Assigning an Initial Value

To assign an initial value to a floating point data area, enclose the value in apostrophes as follows:

```
PI    DATA  E'3.14159'
```

PI contains the decimal value 3.14159.

You can also assign an initial value to a floating-point data area in exponent (E) notation as follows:

```
PI    DATA  E'.314159E1'
PI2   DATA  E'314.159E-2'
```

Defining an Extended-Precision Data Area

If a floating-point number requires more than 6 and fewer than 15 significant digits, you must use extended-precision floating point. Each extended-precision floating-point number requires 8 bytes of storage.

The following DATA statements define storage areas for extended-precision floating-point numbers:

```
MSMNT    DATA  L'0.000'
MYCELLS  DATA  L'15063842E12'
```

Defining Character Strings

To define character strings, you can use either the DATA or DC statement. The following DATA statement defines a storage area for a 6-byte character string:

```
NAME   DATA  C'TILTON'
```

NAME is the name or label of the storage area. The length of the storage area is the number of characters inside the apostrophes.

If you want an area containing blanks, you can use the duplication factor:

```
BLNKS  DATA  10C' '
```

BLNKS contains ten blanks.

To set up an area that contains a character string followed by blanks, define the storage area as follows:

```
DOLCON  DATA  CL4'$$'
```

DOLCON contains two dollar signs ($$) followed by two blanks.

Assigning a Value to a Symbol

The EQU statement assigns a value to a symbol. You can use the symbol (the label on the EQU statement) as an operand in other instructions wherever symbols are allowed. You must define a label before you use that label as an operand in the EQU statement.

For example, you cannot code:

```
ABLE   EQU  BAKER
```

unless you have defined BAKER previously.

The following example assigns the word value X'0002' to A.

```
A      EQU   2
```

If you refer to the equated value by its label, the system assumes you are referring to a storage location. For example, if you use A in the following instruction:

```
       MOVE   B,A
```

the system moves the word at address 0002 to B.

If, however, you want to use the equated value as the *number* 2, you must precede the label with a plus sign (+) as follows:

```
      MOVE   B,+A
```

This instruction moves 2 to B.

The next example assigns the word value of A to B.

```
B      EQU   A
```

The following example shows how you can use the equated symbols in a program. An explanation of the numbered items follows the example.

```
1          MOVE  C,A
2          MOVE  C,+A
3          MOVE  C,+B
4          MOVE  C,+A,(1,BYTE)
           •
           •
           •
5  A       EQU   2
6  B       EQU   A
   C       DATA  F
```

1. Move the contents of address 0002 to C.
2. Move X'0002' to C.
3. Move X'0002' to C.
4. Move the leftmost byte of the word value X'0002' (in this case, X'00') to C.
5. Define A with a word value of X'0002'.
6. Assign B the value of A (X'0002').

Defining an Input/Output Area

To define an area to read into or to write from, you must know where the data is coming from or where it is going.

If you are reading or writing data from tape, disk, or diskette, you can define an input/output area with a BUFFER statement, a DATA statement, or a DC statement.

If you are reading or writing data from a terminal, you can define an input/output area with a TEXT statement, a DATA statement, or a DC statement.

If you use either a DATA statement or a DC statement, however, you must precede the storage area with a word (2 bytes) containing the length and count. (Refer to the *Language Reference* for information on how the system constructs a storage area defined by a TEXT statement.)

Defining a BUFFER Statement

A BUFFER statement defines a data storage area. When you read or write records to disk, diskette, or tape, you can use the BUFFER statement to define the buffer. To define a 256-byte buffer, use the BUFFER statement as follows:

```
RDAREA  BUFFER  256,BYTES
```

RDAREA is the name of the buffer.

A buffer contains an index, the length of the storage area, and the data storage area. The index and the length occupy one word (2 bytes) each. Therefore, a 256-byte buffer actually occupies 260 bytes of storage. For more information on the structure of a buffer, refer to the *Language Reference*.

Defining a TEXT Statement

Use the TEXT statement to define a message or storage area. Use the TEXT statement in conjunction with the PRINTEXT or READTEXT instructions. The PRINTEXT instruction prints the message or storage area on a terminal. The READTEXT instruction reads a character string from a terminal into the storage area defined by the TEXT statement.

When you code a TEXT statement, the system creates an area that contains the length (the size of the storage area), the count (the actual number of characters in the storage area), and the message or storage area. The length and count occupy one byte each. Therefore, a 24-character message, for example, requires 26 bytes of storage. The maximum length of a TEXT statement is 254 bytes.

The following example creates the message ENTER YOUR NAME:

```
LABEL2   PRINTEXT MSG1
           •
           •
           •
MSG1     TEXT     'ENTER YOUR NAME:'
```

The PRINTEXT instruction that references MSG1, the name of the TEXT statement, causes the message to appear on the terminal.

To define a storage area for data that you will read from a terminal, code the following:

```
ADDRESS  TEXT      LENGTH=30
```

A READTEXT instruction can read data from a terminal into the storage area by referencing ADDRESS, the name of the TEXT statement. If the response entered from the terminal is greater than 30 characters, the system truncates the response after reading 30 bytes.

Reading Data into a Data Area

When you read data into a data area, the instruction you use depends on the kind of data and where it is coming from.

If the data resides on disk, diskette, or tape, use the READ instruction. If the data is coming from a terminal, use either the READTEXT or GETVALUE instruction. If the data is alphanumeric, use READTEXT. If the data consists of one floating-point number or one or more integers, use GETVALUE.

Reading Data from Disk or Diskette

You can read disk or diskette data sets either sequentially or directly. You always read a multiple of 256 bytes. An "EDX record" contains 256 bytes.

The READ instruction reads a record from one of the data sets you specify in the PROGRAM statement. The following READ instruction reads a record sequentially from the third data set defined on the PROGRAM statement.

```
          READ  DS3,DISKBUFF,1,0,ERROR=RDERROR,END=NOTFOUND
                  •
                  •
                  •
DISKBUFF  BUFFER  256,BYTES
```

The system reads one record (indicated by 1 in the third operand) sequentially (indicated by 0 in the fourth operand) into DISKBUFF. If no more records exist on the data set, the program branches to NOTFOUND. If an I/O error occurs, the program branches to RDERROR. Otherwise, the system places the data in the 256-byte buffer DISKBUFF.

To read a data set directly, code the fourth operand with an integer greater than zero as follows:

```
          READ  DS2,BUFR,1,52,ERROR=RDERR,END=ALLOVER
                •
                •
                •
BUFR      BUFFER  512,BYTES
```

The system reads the 52nd record (indicated by 52 in the fourth operand) into BUFR. If the data set does not contain 52 records, the program branches to ALLOVER. If an I/O error occurs, the program branches to RDERR. Otherwise, the system places one record (indicated by 1 in the third operand) into the 512-byte buffer BUFR.

Reading Data from Tape

You can read tape data sets sequentially only. A tape READ retrieves a record from 18 to 32767 bytes long.

The following READ instruction reads a record from a tape.

```
          READ    DS1,BUFF,1,327,END=END1,ERROR=ERR,WAIT=YES
                  •
                  •
                  •
BUFF      BUFFER  327,BYTES
```

The system reads one record (indicated by 1 in the third operand). The size of the record is 327 bytes (indicated by 327 in the fourth operand). If no more records exist on the data set, control transfers to END1. If an error occurs, control transfers to ERR. The system waits for the operation to complete before continuing (WAIT=YES). The buffer BUFF is 327 bytes long.

The following READ instruction reads 2 records into buffer BUFF2.

```
          READ     DS1,BUFF2,2,327,END=END1,ERROR=ERR,WAIT=YES
                   •
                   •
                   •
BUFF2     BUFFER   654,BYTES
```

The system reads two records (indicated by 2 in the third operand). The size of each record is 327 bytes (indicated by 327 in the fourth operand). If no more records exists on the data set, control transfers to END1. If an error occurs, control transfers to ERR. The system waits for the operation to complete before continuing (WAIT=YES). The buffer BUFF2 is 654 bytes long.

Reading from a Terminal

To read data that an operator enters on a terminal, you can use either the READTEXT or GETVALUE instruction. The READTEXT instruction allows you to read alphanumeric data (alphabetic characters, numbers, and special characters). With the GETVALUE instruction, you can read numbers (both integer and floating-point) only.

Reading Alphanumeric Data

To read an alphanumeric data item into a storage area, use the READTEXT instruction as follows:

```
          READTEXT COUNTY,'ENTER YOUR COUNTY: ',SKIP=1,MODE=LINE
            •
            •
            •
COUNTY    TEXT     LENGTH=20
```

The instruction displays the prompt **ENTER YOUR COUNTY:** and the system waits for a response. When the operator enters a name and presses the enter key, the system stores the text string in an area called COUNTY.

The operand SKIP = 1 causes the system to skip one line before displaying the prompt. The operand MODE = LINE allows blanks in the response.

For more information on reading alphanumeric data from terminals, see Chapter 8, "Reading Data from and Writing to Screens."

Reading Numeric Data

The GETVALUE instruction allows you to read either a single floating-point value or more than one integer from a terminal. The following instruction reads a floating-point number:

```
          GETVALUE  BASAL,'ENTER YOUR BASE SALARY: ',              C
                TYPE=F,FORMAT=(6,2,F)
            •
            •
            •
BASAL     DATA  E'0.00'
```

The instruction prompts the operator, waits for a response, reads the response, and stores the number in BASAL. You must have defined BASAL as a floating-point variable. The operand TYPE = F means that the number will be a single-precision floating-point number.

The operand FORMAT = (6,2,F) says that the number will occupy six positions on the screen (including the decimal point), that the number will contain two digits to the right of the decimal point, and that the number will be an "F-type" number such as 325.78.

To read more than one integer, code a third operand on the instruction as follows:

```
          GETVALUE HEIGHTS,'ENTER FIVE HEIGHTS (IN INCHES): ',5
```

The instruction assumes that you have defined HEIGHTS as follows:

```
HEIGHTS   DATA  5F'0'
```

Moving Data

You can move data from one place in storage to another with the MOVE instruction. Unless you specify otherwise, the system moves one word (two bytes). For example, the instruction

```
          MOVE  OLDDATA,NEWDATA
           •
           •
           •
OLDDATA   DATA  F'0'
NEWDATA   DATA  F'0'
```

moves the word at NEWDATA to OLDDATA. Note that whatever OLDDATA contained before the instruction was executed has been overlaid by the data in NEWDATA.

To move more than one word, you must code a third operand. For example, the following instruction moves 12 words from NEWNAME to OLDNAME:

```
          MOVE  OLDNAME,NEWNAME,12
           •
           •
           •
OLDNAME   DATA  F'0'
NEWNAME   DATA  F'0'
```

To move bytes, code the third operand as follows:

```
          MOVE  OLDADDR,NEWADDR,(15,BYTE)
           •
           •
           •
OLDADDR   TEXT  LENGTH=15
NEWADDR   TEXT  LENGTH=15
```

This instruction moves the 15 bytes at NEWADDR to OLDADDR. To move doublewords, code the third operand as follows:

```
          MOVE  OLDDESC,NEWDESC,(10,DWORD)
           •
           •
           •
OLDDESC   DATA  10D'0'
NEWDESC   DATA  10D'0'
```

This instruction moves the 10 doublewords at NEWDESC to OLDDESC. To move floating-point values, you must specify FLOAT (for single-precision) or DFLOAT (for extended-precision).

```
          MOVE  TEMPS,MSMNTS,(4,FLOAT)
           •
           •
           •
TEMPS     DATA  4E'0.0'
MSMNTS    DATA  4E'0.0'
```

The instruction moves the four single-precision floating-point values at MSMNTS to TEMPS.

Converting Data

EDL allows you to do two types of conversion, from binary to an EBCDIC character string and from an EBCDIC character string to binary. The CONVTB instruction converts from binary to an EBCDIC character string, while the CONVTD instruction converts from an EBCDIC character string to binary.

Converting to an EBCDIC Character String

If a number has been stored as a binary number, you must convert it to an EBCDIC character string if, for example, you want to display the number with the PRINTEXT instruction.

A binary number is any variable you have defined as single-precision integer, double-precision integer, single-precision floating point, extended-precision floating point, or hexadecimal.

You must convert any of the following data items before you can display them:

```
NUM1     DATA  F'0'
NUM2     DATA  D'0'
PI       DATA  E'0.0'
FINMEAS  DATA  L'0.0'
XTRAS    DATA  X'0'
```

To convert a single-precision integer to an EBCDIC character string, code the CONVTB instruction as follows:

```
         CONVTB  TEXT1,NUM1,PREC=S,FORMAT=(5,0,I)
          •
          •
          •
TEXT1    TEXT    LENGTH=5
NUM1     DATA    F'0'
```

The instruction converts the single-precision integer (indicated by PREC=S) in NUM1 and stores the result in TEXT1. The FORMAT operand says that you want the converted output to be 5 digits long, contain 0 digits to the right of the decimal point, and be an integer (I).

To convert a double-precision integer, code the CONVTB instruction as follows:

```
         CONVTB  TEXT2,NUM2,PREC=D,FORMAT=(8,0,I)
          •
          •
          •
TEXT2    TEXT    LENGTH=8
NUM2     DATA    D'0'
```

The instruction converts the double-precision integer (indicated by PREC=D) in NUM2 and stores the result of the conversion in TEXT2. The FORMAT operand says that you want the converted output to be 8 digits long, contain 0 digits to the right of the decimal point, and be an integer (I).

To convert a single-precision floating-point variable:

```
          CONVTB  TEXT3,PI,PREC=F,FORMAT=(15,4,F)
           •
           •
           •
TEXT3     TEXT    LENGTH=16
PI        DATA    E'0.0000'
```

The instruction converts the single-precision floating-point variable (indicated by PREC=F) in PI and stores the result of the conversion in TEXT3. The FORMAT operand says that you want the converted output to be 15 digits long, contain 4 digits to the right of the decimal point, and be a floating-point value (F).

To convert an extended-precision floating-point variable:

```
          CONVTB  TEXT4,OP,PREC=L,FORMAT=(17,3,E)
           •
           •
           •
TEXT4     TEXT    LENGTH=24
OP        DATA    L
```

The instruction converts the extended-precision floating-point variable (indicated by PREC=L) in OP and puts the result of the conversion in TEXT4. The FORMAT operand says that you want the converted output to be 17 digits long, contain 3 digits to the right of the decimal point, and be expressed in exponent notation (E).

Converting to Binary

If you read a number with the READTEXT instruction, you must convert it to binary before you can add, subtract, multiply, or divide.

The CONVTD instruction converts a character string to a binary number. You can convert a character string that contains a number to a single-precision integer, a double-precision integer, single-precision floating point, or extended-precision floating point.

To convert a single-precision integer to binary:

```
          CONVTD  BINUM1,NUM1,PREC=S,FORMAT=(5,0,I)
           •
           •
           •
BINUM1    DATA    F'0'
NUM1      TEXT    LENGTH=5
```

The instruction converts the EBCDIC character string in NUM1 and stores the result in BINUM1, a single-precision integer variable (indicated by PREC=S).

The FORMAT operand says that the data to be converted is 5 digits long, contains 0 digits to the right of the decimal point, and is an integer (I).

To convert a a number that is greater than 32767, you must convert it to a double-precision integer as follows:

```
          CONVTD  BINUM2,NUM2,PREC=D,FORMAT=(9,0,I)
           •
           •
           •
BINUM2    DATA    D'0'
NUM2      TEXT    LENGTH=9
```

The instruction converts the EBCDIC character string in NUM2 and puts the result in BINUM2, a double-precision integer variable (indicated by PREC=D).

The FORMAT operand says that the data to be converted is 9 digits long, contains 0 digits to the right of the decimal point, and is an integer(I).

To convert to a single-precision floating point number, code the instruction as follows:

```
          CONVTD  AVTEMP,TEMP,PREC=F,FORMAT=(8,2,F)
           •
           •
           •
AVTEMP    DATA    E'0.0'
TEMP      TEXT    LENGTH=9
```

The instruction converts the EBCDIC character string in TEMP and stores the result in AVTEMP, a single-precision floating-point variable (indicated by PREC=F).

The FORMAT operand says that the data to be converted is 8 digits long, contains 2 digits to the right of the decimal point, and is a floating-point number (F).

To convert to an extended-precision floating point number, code the instruction as follows:

```
          CONVTD  AVCOST,COST,PREC=L,FORMAT=(15,3,E)
           •
           •
           •
AVCOST    DATA    L'0.00'
COST      TEXT    LENGTH=20
```

The instruction converts the EBCDIC character string in COST and stores the result in AVCOST, an extended-precision floating-point variable (indicated by PREC=L).

The FORMAT operand says that the data to be converted is 15 digits long, contains 3 digits to the right of the decimal point, and is expressed in exponent notation (E).

Converting from Floating Point to Integer

If you want to manipulate data, both operands in the operation must be either floating point or integer.

To convert a single-precision floating-point number to integer, code the FPCONV instruction as follows:

```
         FPCONV  INTNUM,FPNUM,PREC=SF
          •
          •
          •
INTNUM   DATA    F'0'
FPNUM    DATA    E'0.0'
```

The instruction converts the single-precision floating-point number in FPNUM and stores the result in INTNUM, a single-precision integer variable. The PREC operand indicates that INTNUM is a single-precision integer (S) and that FPNUM is a single-precision floating-point number (F).

To convert an extended-precision floating-point number to double-precision integer, code the FPCONV instruction as follows:

```
         FPCONV  INTDBL,FPEXT,PREC=DL
          •
          •
          •
INTDBL   DATA    D'0'
FPEXT    DATA    L'0.0'
```

The instruction converts the extended-precision floating-point number in FPEXT and puts the result in INTDBL, a double-precision integer variable. The PREC operand indicates that INTDBL is a double-precision integer (D) and that FPEXT is an extended-precision floating-point number (L).

Note: When you convert from floating point to integer, remember that the system truncates all data to the right of the decimal point.

Converting from Integer to Floating Point

To convert a single-precision integer to floating-point, code the FPCONV instruction as follows:

```
         FPCONV  FPNUM,INTNUM,PREC=FS
          •
          •
          •
INTNUM   DATA    F'0'
FPNUM    DATA    E'0.0'
```

The instruction converts the single-precision integer INTNUM and stores the result in FPNUM, a single-precision floating-point variable. The first letter in the PREC operand (F) indicates that FPNUM is a single-precision floating-point variable. The second letter (S) indicates that INTNUM is a single-precision integer.

To convert a double-precision integer to floating-point:

```
         FPCONV  FPEXT,INTDBL,PREC=LD
          •
          •
          •
INTDBL   DATA    D'0'
FPEXT    DATA    L'0.0'
```

The instruction converts the double-precision integer INTDBL and stores the result in FPEXT, an extended-precision floating-point variable. The first letter in the PREC operand (L) indicates that FPEXT is an extended-precision floating-point variable. The second letter (D) indicates that INTDBL is a double-precision integer.

Checking for Conversion Errors

Each time you execute an instruction that converts data, the system expects the data to be numeric. If the conversion is successful, the value −1 appears in the first word of the task control block (TCB) of the program or task issuing the instruction. (The label of the TCB is the label of your program or task.) If you try to convert a character other than a number, a conversion error occurs and the value −1 is not stored as the return code.

If, for example, a program prompts an operator for a number and he or she enters a letter, the system places a return code in the task code word indicating a conversion error. Your program can check the return code for a conversion error and print an error message. Notice that you must test the return code before executing any other instruction because the system may overlay the task code word with the return code of the next instruction.

The following program shows how to check for a conversion error:

```
BEGIN    PROGRAM  START
          •
          •
          •
         CONVTD    BINUM1,NUM1,PREC=S,FORMAT=(5,0,I)
ERRTEST  MOVE      TASKRC,BEGIN
         IF        (TASKRC,NE,-1),GOTO,CHECK
         ENDIF
          •
          •
          •
CHECK    PRINTEXT  'CONVERSION ERROR',SKIP=1
         PRINTNUM  TASKRC
         GOTO      END
          •
          •
          •
END      PROGSTOP
TASKRC   DATA      F'0'
BINUM1   DATA      F'0'
NUM1     TEXT      LENGTH=5
         ENDPROG
         END
```

The instructions at label ERRTEST compare the return code of the CONVTD instruction with the successful return code (−1). If NUM1 contains a nonnumeric character, the system branches to CHECK.

Manipulating Data

The data manipulation instructions perform arithmetic operations on single- or double-precision integers and single- or extended-precision floating-point numbers. You can also manipulate two bit-strings with logical instructions such as inclusive-OR and exclusive-OR.

Manipulating Integer Data

The instructions that manipulate integers add, subtract, multiply, or divide two integers. If two numbers are floating-point numbers, you must use floating-point instructions.

If one number is a floating-point number and the other is an integer, use the FPCONV instruction to convert one of the numbers to match the form of the other.

The instructions have the following general form:

```
operation   operand1,operand2
```

The flow of data is from *operand2* to *operand1*.

The ADD instruction adds the data in *operand2* to the data in *operand1* and stores the results in *operand1*.

The SUBTRACT instruction subtracts the data in *operand1* from the data in *operand1* and stores the results in *operand1*.

The DIVIDE and MULTIPLY instructions multiply or divide the data in *operand1* by the data in *operand2* and store the results in *operand1*.

Adding Integers

The ADD instruction adds two integers. If A and B are integers, you can add A to B with the following instruction:

```
ADD  B,A
```

The result of the addition replaces B. The value in A remains unchanged.

To add two integers without altering the first operand, use the RESULT operand as follows:

```
ADD  OLDSUM,SCORE,RESULT=NEWSUM
```

The instruction adds SCORE to OLDSUM and stores the result in NEWSUM. The values in SCORE and OLDSUM remain unchanged.

Adding Double-Precision Integers:

Unless you specify otherwise, EDL assumes that the integers are single-precision (1-word) integers. To add two double-precision (2-word) integers, specify the PREC operand as follows:

```
ADD  TOTPOP,LOCPOP,PREC=DD
```

The operand PREC=DD says that both TOTPOP and LOCPOP are double-precision integers.

If only one of the operands is a double-precision integer, it must be the first operand. In addition, if you specify the RESULT operand, it must be a double-precision variable. For example:

```
ADD  TOWN2,TOWN1,RESULT=TOTPOP,PREC=D
```

The operand PREC=D says that TOWN2 and TOTPOP are double-precision integers. The absence of the second letter (D or S) on the PREC operand means that TOWN1 is a single-precision integer.

Adding Consecutive Integers:

To add more than one set of integers, you can specify the number of integers you want to add. For example:

```
ADD  NEWTOTS,OLDTOTS,10
```

The instruction adds the 1-word integer at OLDTOTS to NEWTOTS. Then the instruction adds the word in OLDTOTS+2 to the word at NEWTOTS+2. The instruction continues to add until it adds the word at OLDTOTS+18 to the word at NEWTOTS+18. This instruction, then, adds the 10 consecutive words at OLDTOTS to the 10 consecutive words at NEWTOTS. You can specify up to 32767 consecutive additions.

Subtracting Integers

The SUBTRACT instruction subtracts one integer from another. If QUERY and ANSWER are integers, you can subtract ANSWER from QUERY with the following instruction:

```
SUBTRACT   QUERY,ANSWER
```

The result of the subtraction replaces QUERY. The value in ANSWER remains unchanged.

To subtract two integers without altering the first operand, use the RESULT operand as follows:

```
SUBTRACT   SALES,COSTS,RESULT=PROFITS
```

The instruction subtracts COSTS from SALES and stores the result in PROFITS. The values in SALES and COSTS remain unchanged.

Subtracting Double-Precision Integers:

Unless you specify otherwise, EDL assumes that the integers are single-precision (1-word) integers. To subtract two double-precision (2-word) integers, specify the PREC operand as follows:

```
SUBTRACT    GROSS,DEDUCT,RESULT=NET,PREC=DD
```

The instruction subtracts DEDUCT from GROSS and stores the result in NET. The operand PREC=DD says that GROSS, DEDUCT, and NET are all double-precision integers.

If only one of the operands is a double-precision integer, it must be the first operand. In addition, if you specify the RESULT operand, it must be a double-precision variable. For example:

```
SUBTRACT    ATTEND,MALES,RESULT=FEMALES,PREC=D
```

The instruction subtracts MALES from ATTEND and stores the result in FEMALES. The operand PREC=D says that ATTEND and FEMALES are double-precision integers. The absence of the second letter (D or S) on the PREC operand means that MALES is a single-precision integer.

Subtracting Consecutive Integers:

To subtract more than one set of integers, you can specify the number of integers you want to subtract. For example:

```
SUBTRACT NEWTOTS,OLDTOTS,6
```

The instruction subtracts the 1-word integer at OLDTOTS from NEWTOTS. Then the instruction subtracts the word in OLDTOTS+2 from the word at NEWTOTS+2. The instruction continues to subtract until it subtracts the word at OLDTOTS+10 from the word at NEWTOTS+10. This instruction, then, subtracts the 6 consecutive words at OLDTOTS from the 6 consecutive words at NEWTOTS. You can specify up to 32767 consecutive subtractions.

Multiplying Integers

The MULTIPLY instruction multiplies one integer by another.

If M and N are single-precision integers, you can multiply M by N as follows:

```
MULTIPLY   M,N
```

The result of the multiplication replaces M.

You can also multiply an integer by a constant. The following instruction multiplies FEET by the constant 12:

```
MULTIPLY   FEET,12
```

The result of the multiplication replaces FEET.

To multiply two integers without altering the first operand, use the RESULT operand as follows:

```
MULTIPLY  BOXES,WEIGHT,RESULT=TOTWGT
```

The instruction multiplies BOXES by WEIGHT and stores the result in TOTWGT. The values in BOXES and WEIGHT do not change.

Multiplying Double-Precision Integers:

Unless you specify otherwise, EDL assumes that integers are single-precision (1-word) integers. To multiply two double-precision (2-word) integers, specify the PREC operand as follows:

```
MULTIPLY LENGTH,WIDTH,RESULT=TOTAREA,PREC=DD
```

The instruction multiplies LENGTH by WIDTH and stores the result in TOTAREA. The operand PREC=DD says that LENGTH, WIDTH, and TOTAREA are all double-precision integers.

If only one of the operands is a double-precision integer, it must be the first operand. In addition, if you specify the RESULT operand, it must be a double-precision variable. For example:

```
MULTIPLY ATTEND,GAMES,RESULT=TOTATT,PREC=D
```

The instruction multiplies ATTEND by GAMES and stores the result in TOTATT. The operand PREC=D says that ATTEND and TOTATT are double-precision integers. The absence of the second letter (D or S) on the PREC operand means that GAMES is a single-precision integer.

Multiplying Consecutive Integers:

To multiply more than one set of integers, you can specify the number of integers you want to multiply. For example:

```
MULTIPLY SALARIES,RATES,400
```

The instruction multiplies the 1-word integer at RATES by SALARIES and stores the result in SALARIES. Then the instruction multiplies the word at RATES+2 by the word at SALARIES+2. The instruction continues to multiply until it multiplies the word at RATES+798 by the word at SALARIES+798. This instruction, then, multiplies the 400 consecutive words at RATES by the 400 consecutive words at SALARIES. You can specify up to 32767 consecutive multiplications.

Dividing Integers

The DIVIDE instruction divides one integer by another. The system stores the remainder in the first word of the task control block (TCB).

If P and Q are single-precision integers, you can divide P by Q as follows:

```
DIVIDE   P,Q
```

The result of the division replaces P.

You can also divide an integer by a constant. The following instruction divides FEET by the constant 3:

```
DIVIDE   FEET,3
```

The result of the division replaces FEET.

To divide two integers without altering the first operand, use the RESULT operand as follows:

```
DIVIDE  TOTWGT,BOXES,RESULT=BOXWGT
```

The instruction divides TOTWGT by BOXES and stores the result in BOXWGT. The values in TOTWGT and BOXES do not change.

Dividing Double-Precision Integers:

Unless you specify otherwise, EDL assumes that integers are single-precision (1-word) integers. To divide double-precision (2-word) integers, specify the PREC operand as follows:

```
DIVIDE  TOTSAL,NOEMPS,RESULT=AVESAL,PREC=DD
```

The instruction divides TOTSAL by NOEMPS and stores the result in AVESAL. The operand PREC=DD says that TOTSAL, NOEMPS, and AVESAL are all double-precision integers.

If only one of the operands is a double-precision integer, it must be the first operand. In addition, if you specify the RESULT operand, it must be a double-precision variable. For example:

```
DIVIDE  TOTATT,GAMES,RESULT=AVEATT,PREC=D
```

The instruction divides TOTATT by GAMES and stores the result in AVEATT. The operand PREC=D says that TOTATT and AVEATT are double-precision integers. The absence of the second letter (D or S) on the PREC operand means that GAMES is a single-precision integer.

Dividing Consecutive Integers:

To divide more than one set of integers, you can specify the number of integers you want to divide. For example:

```
DIVIDE  SALARIES,RATES,100
```

The instruction divides the 1-word integer at SALARIES by RATES. Then the instruction divides the word in SALARIES+2 by the word at RATES+2. The instruction continues to divide until it divides the word at SALARIES+198 by the word at RATES+198. This instruction, then, divides the 100 consecutive words at SALARIES by the 100 consecutive words at RATES. You can specify up to 32767 consecutive divisions.

Accessing the Remainder:

One way to access the remainder is to use the TCBGET instruction as in the following example:

```
        DIVIDE  SALARIES,RATES
        TCBGET  REMAIN,$TCBCO
          •
          •
          •
REMAIN  DATA  F'0'
```

The instruction puts the first word of the task control block, containing the remainder, into REMAIN.

Manipulating Floating-Point Data

EDL allows you to add, subtract, multiply, and divide floating-point numbers. Floating-point numbers are positive and negative numbers that can have decimal points.

To use floating-point instructions, you must:

- Have the hardware floating-point feature installed on your system.
- Include floating-point support in the supervisor when it is generated.
- Specify FLOAT=YES on both the PROGRAM and TASK statements whenever you use floating-point instructions in any task within a program.
- Define the variables you are manipulating as floating-point variables.

Adding Floating-Point Data

The FADD instruction adds two floating-point numbers. If A and B are floating-point numbers, you can add A to B with the following instruction:

```
FADD   B,A
```

The result of the addition replaces B. The value in A remains unchanged.

To add two floating-point numbers without altering the first operand, use the RESULT operand as follows:

```
FADD   WAGES,OVTIME,RESULT=NETPAY
```

The instruction adds OVTIME to WAGES and stores the result in NETPAY. The values in WAGES and OVTIME remain unchanged.

Adding Extended-Precision Floating-Point Numbers:

Unless you specify otherwise, EDL assumes that the floating-point numbers are single-precision (2-word) floating-point numbers. To add two extended-precision (4-word) floating-point numbers, specify the PREC operand as follows:

```
FADD   TOTSAL,PRESAL,PREC=LL
```

The operand PREC=LL says that both TOTSAL and PRESAL are extended-precision floating-point numbers.

If only one of the operands is an extended-precision floating-point number, the PREC operand must reflect the precision. In the following example:

```
FADD   MSMNT1,MSMNT2,RESULT=MSMTS,PREC=LFL
```

the operand PREC=LFL says that MSMNT1 and MSMTS are extended-precision floating-point numbers and MSMNT2 is a single-precision floating-point number.

Subtracting Floating-Point Numbers

The FSUB instruction subtracts one floating-point number from another. If OCTEMP and NOVTEMP are floating-point numbers, you can subtract NOVTEMP from OCTEMP with the following instruction:

```
FSUB    OCTEMP,NOVTEMP
```

The result of the subtraction replaces OCTEMP. The value in NOVTEMP remains unchanged.

To subtract two floating-point numbers without altering the first operand, use the RESULT operand as follows:

```
FSUB    SAL,DEDUCS,RESULT=NET
```

The instruction subtracts DEDUCS from SAL and stores the result in NET. The values in SAL and DEDUCS remain unchanged.

Subtracting Extended-Precision Floating-Point Numbers:

Unless you specify otherwise, EDL assumes that the floating-point numbers are single-precision (2-word) floating-point numbers. To subtract two extended-precision (4-word) floating-point numbers, specify the PREC operand as follows:

```
FSUB    TOTSAL,TOTDUCS,RESULT=TOTNP,PREC=LLL
```

The instruction subtracts TOTDUCS from TOTSAL and stores the result in TOTNP. The operand PREC=LLL says that TOTSAL, TOTDUCS, and TOTNP are all extended-precision floating-point numbers.

If only one of the operands is an extended-precision floating-point number, the PREC operand should reflect the precision. In the following example:

```
FSUB    GROSS,TAXES,RESULT=NET,PREC=FLF
```

the instruction subtracts TAXES from GROSS and stores the result in NET. The operand PREC=FLF says that GROSS and NET are single-precision and that TAXES is an extended-precision floating-point number.

Multiplying Floating-Point Numbers

The FMULT instruction multiplies one floating-point number by another.

If M and N are single-precision floating-point numbers, you can multiply M by N as follows:

```
FMULT    M,N
```

The result of the multiplication replaces M.

You can also multiply a floating-point number by an integer constant. The following instruction multiplies FEET by the integer constant 12:

```
FMULT    FEET,12
```

The result of the multiplication replaces FEET.

To multiply two floating-point numbers without altering the first operand, use the RESULT operand as follows:

```
FMULT   LENGTH,WIDTH,RESULT=AREA
```

The instruction multiplies LENGTH by WIDTH and stores the result in AREA. The values in LENGTH and WIDTH do not change.

Multiplying Extended-Precision Floating-Point Numbers:

Unless you specify otherwise, EDL assumes that floating-point numbers are single-precision (2-word) floating-point numbers. To multiply two extended-precision (4-word) floating-point numbers, specify the PREC operand as follows:

```
FMULT   PI,DIAM,RESULT=CIRCUM,PREC=LLL
```

The instruction multiplies PI by DIAM and stores the result in CIRCUM. The operand PREC=LLL says that PI, DIAM, and CIRCUM are all extended-precision floating-point numbers.

If only one of the operands is a double-precision floating-point number, the PREC operand must reflect the precision. In the following example:

```
FMULT   BASEAREA,HEIGHT,RESULT=VOLUME,PREC=LFL
```

the instruction multiplies BASEAREA by HEIGHT and stores the result in VOLUME. The operand PREC=LFL says that BASEAREA and VOLUME are extended-precision floating-point numbers and that HEIGHT is a single-precision floating-point number.

Dividing Floating-Point Numbers

The FDIVD instruction divides one floating-point number by another. The system stores the remainder in the first word of the task control block (TCB).

If P and Q are single-precision floating-point numbers, you can divide P by Q as follows:

```
FDIVD   P,Q
```

The result of the division replaces P.

You can also divide a floating-point number by a constant. The following instruction divides FEET by the integer constant 3:

```
FDIVD   FEET,3
```

The result of the division replaces FEET.

To divide two floating-point numbers without altering the first operand, use the RESULT operand as follows:

```
FDIVD  TOTWGT,BOXES,RESULT=BOXWGT
```

The instruction divides TOTWGT by BOXES and stores the result in BOXWGT. The values in TOTWGT and BOXES do not change.

Dividing Extended-Precision Floating-Point Numbers:

Unless you specify otherwise, EDL assumes that floating-point numbers are single-precision (2-word) floating-point numbers. To divide two extended-precision (4-word) floating-point numbers, specify the PREC operand as follows:

```
FDIVD  CUBICFT,BASEAREA,RESULT=HEIGHT,PREC=LLL
```

The instruction divides CUBICFT by BASEAREA and stores the result in HEIGHT. The operand PREC=LLL says that CUBICFT, BASEAREA, and HEIGHT are all extended-precision floating-point numbers.

If only one of the operands is an extended-precision floating-point number, the PREC operand must reflect the precision. In the following example:

```
FDIVD  TOTSAL,NOEMPS,RESULT=AVESAL,PREC=LFL
```

the instruction divides TOTSAL by NOEMPS and stores the result in AVESAL. The operand PREC=LFL says that TOTSAL and AVESAL are extended-precision floating-point numbers and that NOEMPS is a single-precision floating-point number.

Manipulating Logical Data

The instructions that manipulate logical data make a bit-by-bit comparison of two bit strings. The result of the comparison depends on the instruction.

The Exclusive-OR Instruction

The exclusive-OR instruction (EOR) compares two bit strings and produces a third bit string, called the resulting field.

The instruction compares the two bit strings one bit at a time. If the bits are the same, the instruction sets a bit in the resulting field to 0. If the bits are not the same, the instruction sets a bit in the resulting field to 1.

If the bit strings are identical, the resulting field contains all 0s. If one or more bits differ, the resulting field contains a mixture of 0s and 1s.

The following example compares PHI to CHI and stores the result in PHI. CHI remains unchanged.

```
EOR   PHI,CHI
```

The following table shows PHI and CHI before and after the instruction executes.

Data Item	Hex	Binary
PHI (before)	049C	0000 0100 1001 1100
CHI (before)	56AB	0101 0110 1010 1011
PHI (after)	5237	0101 0010 0011 0111

Data Item	Hex	Binary
CHI (after)	56AB	0101 0110 1010 1011

To compare a variable to a constant, code *operand2* as follows:

```
EOR   MU,X'5280'
```

The following table shows MU before and after the instruction executes.

Data Item	Hex	Binary
MU (before)	F0F0	1111 0000 1111 0000
constant	5280	0101 0010 1000 0000
MU (after)	A270	1010 0010 0111 0000

To compare two bit strings without altering the first operand, use the RESULT operand as follows:

```
EOR   SIGMA,DELTA,RESULT=THETA
```

The instruction compares SIGMA and DELTA and stores the resulting field in THETA. SIGMA and DELTA do not change.

Unless you specify otherwise, EDL assumes that the bit strings you specify are one-word (2-byte) variables. To compare a single byte or more than two bytes, specify the number of consecutive units (bytes, words, or doublewords) that you want to compare. For example:

```
        EOR   MASK1,MASK2,(3,BYTE),RESULT=MASK3
         •
         •
         •
MASK1   DATA  X'12A4E6'
MASK2   DATA  X'0101'
MASK3   DATA  X'000000'
```

The instruction compares three bytes at MASK1 with the first byte at MASK2 and stores the result in MASK3. After the instruction executes in this example, MASK3 contains X'13A5E7'.

The Inclusive-OR Instruction

The inclusive-OR instruction (IOR) compares two bit strings and produces a third bit string, called the resulting field.

The instruction compares the two bit strings one bit at a time. If either or both bits are 1, the instruction sets a bit in the resulting field to 1. If neither bit is 1, the instruction sets a bit in the resulting field to 0.

The following example compares ETA to RHO and stores the result in ETA. RHO is unchanged.

```
IOR   ETA,RHO
```

The following table shows ETA and RHO before and after the instruction executes.

Data Item	Hex	Binary
ETA (before)	049C	0000 0100 1001 1100
RHO (before)	56AB	0101 0110 1010 1011
ETA (after)	56BF	0101 0110 1011 1111
RHO (after)	56AB	0101 0110 1010 1011

To compare a variable to a constant, code *operand2* as follows:

```
IOR   XI,X'5280'
```

The following table shows XI before and after the instruction executes.

Data Item	Hex	Binary
XI (before)	F0F0	1111 0000 1111 0000
constant	5280	0101 0010 1000 0000
XI (after)	F2F0	1111 0010 1111 0000

To compare two bit strings without altering the first operand, use the RESULT operand as follows:

```
IOR   OPER1,OPER2,RESULT=TEST1
```

The instruction compares OPER1 and OPER2 and stores the resulting field in TEST1. OPER1 and OPER2 do not change.

Unless you specify otherwise, EDL assumes that the bit strings you specify are one-word (2-byte) variables. To compare a single byte or more than two bytes, specify the number of consecutive units (bytes, words, or doublewords) that you want to compare. For example:

```
IOR   MASK1,MASK2,(4,DWORD),RESULT=MASK3
```

The instruction compares the first doubleword at MASK2 with the four doublewords at MASK1 and stores the resulting field in MASK3.

The AND Instruction

The AND instruction (AND) compares two bit strings and produces a third bit string, called the resulting field.

The instruction compares the two bit strings one bit at a time. If both bits are 1, the instruction sets a bit in the resulting field to 1. If either or both bits are 0, the instruction sets a bit in the resulting field to 0.

The following example compares BETA to THETA and stores the result in BETA.

```
AND   BETA,THETA
```

The following table shows BETA both before and after the instruction executes.

Data Item	Hex	Binary
BETA (before)	049C	0000 0100 1001 1100
THETA	56AB	0101 0110 1010 1011
BETA (after)	0488	0000 0100 1000 1000

To compare a variable to a constant, code *operand2* as follows:

```
AND   LAMBDA,X'5280'
```

The following table shows LAMBDA both before and after the instruction executes.

Data Item	Hex	Binary
LAMBDA (before)	F0F0	1111 0000 1111 0000
constant	5280	0101 0010 1000 0000
LAMBDA (after)	5080	0101 0000 1000 0000

To compare two bit strings without altering the first operand, use the RESULT operand as follows:

```
AND   OPER1,OPER2,RESULT=TEST1
```

The instruction compares OPER1 and OPER2 and stores the resulting field in TEST1. OPER1 and OPER2 do not change.

Unless you specify otherwise, EDL assumes that the bit strings you specify are one-word (2-byte) variables. To compare a single byte or more than two bytes, specify the number of consecutive units (bytes, words, or doublewords) that you want to compare. For example:

```
AND   OPER1,OPER2,(2,WORD),RESULT=TEST1
```

The instruction compares the first word at OPER2 with the two words at OPER1 and stores the resulting field in TEST1.

Writing Data from a Data Area

When you write data from a data area, the instruction you use depends on the kind of data and where you write it.

To write data to disk, diskette, or tape, use the WRITE instruction. To write data to a terminal, use either the PRINTEXT or PRINTNUM instruction. If the data is alphanumeric, use PRINTEXT. If the data consists of either one floating-point number or one or more integers, use PRINTNUM.

Writing Data to Disk or Diskette

You can write disk or diskette data sets either sequentially or directly. You always write 256 bytes, an "EDX record."

The following WRITE instruction writes a record sequentially:

```
          WRITE  DS3,DISKBUFF,1,0,ERROR=WRITERR
           •
           •
           •
DISKBUFF BUFFER 256,BYTES
```

The instruction writes a record to the third data set defined on the PROGRAM statement (DS3). The system writes one record (indicated by 1 in the third operand) sequentially (indicated by 0 in the fourth operand) into DISKBUFF. If an I/O error occurs, the program branches to WRITERR. Otherwise, the system writes the 256-byte buffer DISKBUFF to the data set.

The following WRITE instruction writes a record directly:

```
          WRITE  DS5,BUFR,1,RECNO,ERROR=BADWRIT
           •
           •
           •
BUFR     BUFFER 256,BYTES
RECNO    DATA   F
```

The instruction writes a record to the fifth data set defined on the PROGRAM statement (DS5). The system writes one record (indicated by 1 in the third operand) directly (indicated by the presence of the label RECNO in the fourth operand) into BUFR. The contents of RECNO indicate which record the system will write. For example, if RECNO contains 150, the system writes the 150th record.

If an I/O error occurs, the program branches to BADWRIT. Otherwise, the system writes BUFR to the data set.

Writing Data to Tape

You can write tape data sets sequentially only. A tape WRITE writes a record from 18 to 32767 bytes long.

The following WRITE instruction writes a record to a tape:

```
          WRITE   DS1,BUFF,1,328,ERROR=ERR,WAIT=YES
           •
           •
           •
BUFF      BUFFER  328,BYTES
```

The system writes one record (indicated by 1 in the third operand). The size of the record is 328 bytes (indicated by 328 in the fourth operand). If an error occurs, control transfers to ERR. The system waits for the write operation to complete before continuing execution (WAIT = YES).

The following WRITE instruction writes two records from buffer BUFF2:

```
          WRITE    DS1,BUFF2,2,328,ERROR=ERR,WAIT=YES
           •
           •
           •
BUFF2     BUFFER   656,BYTES
```

The system writes two records (indicated by 2 in the third operand). The size of each record is 328 bytes (indicated by 328 in the fourth operand). If an error occurs, control transfers to ERR. The system waits for the operation to complete before continuing (WAIT = YES).

Writing to a Terminal

Two of the instructions that write data to a terminal are the PRINTEXT and PRINTNUM instructions. The PRINTEXT instruction allows you to write alphanumeric data (alphabetic characters, numbers, and special characters). With the PRINTNUM instruction, you can write numbers (both integer and floating-point) only.

Writing Alphanumeric Data

To write alphanumeric data to a terminal, use the PRINTEXT instruction as follows:

```
          PRINTEXT DESC,SKIP=3
           •
           •
           •
DESC      TEXT     'NOW IS THE TIME FOR ALL GOOD MEN'
```

The instruction writes (or *displays*) the 25 alphanumeric characters in DESC. The operand SKIP = 3 causes the system to skip three lines before displaying DESC.

For information on writing alphanumeric data to screens, see Chapter 8, "Reading Data from and Writing to Screens."

Writing Numeric Data

The PRINTNUM instruction allows you to write either a single floating-point value or more than one integer to a terminal. The following instruction writes a floating-point number:

```
PRINTNUM  BASAL,TYPE=F,FORMAT=(6,2,F)
```

The instruction writes the number contained in the variable BASAL. The operand TYPE=F means that BASAL is a single-precision floating-point number. The operand FORMAT=(6,2,F) tells the system to display the number in 6 positions on the screen (including the decimal point), to display 2 digits to the right of the decimal point, and to display it as an "F-type" number such as 436.32.

To write more than one integer, code a second operand on the instruction as follows:

```
PRINTNUM WEIGHTS,7
```

The instruction displays the 7 one-word values starting at location WEIGHTS. The instruction assumes that you have defined WEIGHTS as follows:

```
WEIGHTS  DATA  7F'0'
```

Controlling Program Logic

This section discusses the EDL instructions used to control the logic or execution of instructions. The following instructions are the primary means of controlling program logic:

- DO—initializes a loop
- ENDDO—ends a loop
- IF—tests a condition
- ELSE—specifies the action for a false condition
- ENDIF—ends an IF-ELSE structure
- GOTO—branches to another location.

Relational Operators

The IF and DO statements involve the use of the following relational operators:

- EQ—equal
- NE—not equal
- GT—greater than
- LT—less than
- GE—greater than or equal
- LE—less than or equal.

The IF Instruction

The IF instruction allows you to compare two areas of storage. You can compare data in two ways: *arithmetically* or *logically*.

When you compare data arithmetically, the system interprets each number as a positive or negative value. The system, for example, interprets X'0FFF' as 4095. It interprets X'FFFD', however, as −3. Although X'FFFD' seems to be a larger hexadecimal number than X'0FFF', the system recognizes X'FFFD' as a negative number and X'0FFF' as a positive number. X'FFFD' is a negative number to the system because the leftmost bit is "on."

When you compare data logically, the system compares the data byte-by-byte. The system interprets X'FFFF' as 2 bytes with all bits "on."

Comparing Data Arithmetically

The form of the arithmetic comparison is:

```
IF (data1,operator,data2,width)
```

If *data1* has the relationship indicated by *operator* to *data2*, the next sequential instruction executes. *Width* indicates the length of the data to be compared and must be BYTE, WORD (the default), DWORD, FLOAT, or DFLOAT.

The true portion of the IF-ELSE-ENDIF structure is usually an arithmetic comparison. For example:

```
IF   (A,EQ,B,WORD)
  PRINTNUM  A
ELSE
  PRINTNUM  B
ENDIF
```

ELSE is an optional part of the structure. The instructions following it are called the false part of the structure. Therefore, in the preceding example, the instruction following the ELSE instruction executes if A is not equal to B. If ELSE is not coded and the condition is false, control passes to the instruction following the ENDIF.

You can test more than two conditions in a single IF statement.

```
IF   (ALPHA,LT,BETA),AND,(GAMMA,NE,DELTA)
```

If ALPHA is less than BETA *and* GAMMA is not equal to DELTA, the next sequential instruction executes.

You can also execute the next sequential instruction if either test produces a true condition.

```
IF   (PI,GE,PSI),OR,(CHI,NE,OMEGA)
```

If PI is greater than or equal to PSI *or* CHI is not equal to OMEGA, the next sequential instruction executes.

To compare a variable to a constant, code the constant as *data2* as follows:

```
IF   (FEET,EQ,5280)
```

If FEET equals 5280 (decimal), the next sequential instruction executes.

Comparing Data Logically

The form of the logical comparison is:

```
IF (data1,operator,data2,width)
```

If *data1* has the relationship indicated by *operator* to *data2*, the next sequential instruction executes. *Width* indicates the number of bytes to be compared and must be an integer.

For example:

```
IF   (A,GE,B,4)
  PRINTNUM  A
  PRINTEXT  SKIP=1
ELSE
  PRINTNUM  B
  PRINTEXT  SKIP=1
ENDIF
```

If the 4 bytes in A are greater than or equal to the 4 bytes in B, the "true" portion of the structure executes. If the 4 bytes in A are *not* greater than or equal to the 4 bytes in B, the "false" portion of the structure executes.

The instructions between the IF instruction and the ELSE statement constitute the "true" portion of the IF-ELSE-ENDIF structure. The instructions following the ELSE statement constitute the "false" part of the structure. ELSE is an optional part of the structure.

If the ELSE instruction is not coded and the condition is false, control passes to the instruction following the ENDIF.

The Program Loop

The DO instruction allows you to execute the same code repetitively. The DO instruction starts a DO loop and the ENDDO instruction ends the loop. The loop consists of the instructions between the DO and ENDDO. The following sections show the different forms of the DO loop.

The Simple DO

The loop executes a specified number of times.

```
DO  100,TIMES
  GETVALUE  PSI,PROMPT3
  ADD       COUNT,PSI
ENDDO
```

The GETVALUE and ADD instructions execute 100 times.

The DO UNTIL

The loop executes until the condition occurs. The loop always executes at least once and is known as a "trailing" decision loop.

```
DO   UNTIL,(CDED,GT,1000,FLOAT)
  GETVALUE  OMICRON,OMPRMPT
  FSUB      CDED,OMICRON
ENDDO
```

The GETVALUE and FSUB instructions execute until CDED is greater than 1000.

The DO WHILE

The loop executes as long as the condition exists and is know as a "leading" decision loop.

```
DO   WHILE,(B,NE,C)
  GETVALUE B,'ENTER B'
  GETVALUE C,'ENTER C'
ENDDO
```

The GETVALUE instructions execute as long as B does not equal C.

The Nested DO Loop

A DO loop can contain other DO loops. For example:

```
DO   UNTIL,(ALPHA,LT,BETA,DFLOAT),OR,(#1,EQ,1000)
  GETVALUE ALPHA,'ENTER ALPHA',TYPE=L,FORMAT=(12,3,E)
  GETVALUE BETA,'ENTER BETA',TYPE=L,FORMAT=(12,3,E)
  MOVE     #1,BETA,(1,DFLOAT)
  DO  10,TIMES
    FADD  GAMMA,ALPHA,PREC=LLL
  ENDDO
ENDDO
```

The FADD statement contained in the inner DO executes 10 times for each execution of the outer DO.

The Nested IF Instruction

A DO loop can also contain IF statements. For example:

```
READTEXT  CHAR,'ENTER A CHARACTER'
GETVALUE  A,'ENTER A'
GETVALUE  B,'ENTER B'
DO  WHILE,(A,GT,B)
  IF  (CHAR,EQ,C'A',BYTE)
    DO  40,TIMES
     •
     •
     •
    ENDDO
  ELSE
     •
     •
     •
  ENDIF
  GETVALUE  A,'ENTER A'
  GETVALUE  B,'ENTER B'
ENDDO
```

The outer DO loop executes as long as A is greater than B. The inner DO loop executes 40 times if CHAR equals the letter A.

Branching to Another Location

The GOTO instruction allows you to transfer control to another location within a program. For example, the following instruction transfers control to the instruction at label LOC1:

```
GOTO  LOC1
```

To branch to an address defined by a label, enclose the label in parentheses as follows:

```
GOTO  (CALC)
```

This instruction branches to the address contained in CALC. You must define CALC as an address variable as in the following DATA statement:

```
CALC    DATA  A(RTN01)
```

To branch to a location that is based on the contents of a variable, code the GOTO statement like this:

```
GOTO  (ERR,L1,L2),I
```

The instruction branches to L1 if I equals 1, to L2 if I equals 2, and to ERR for any other value of I.

Referring to a Storage (Program) Location

You can use the EQU statement to refer to the next available storage location in a program. You can use it to generate labels in your program. For example:

```
CALLA   EQU    *
        MOVE   C,+A,(1,BYTE)
         •
         •
         •
        GOTO   CALLA
```

Ending the Program

Ending a program requires three statements: PROGSTOP, ENDPROG, and END.

The PROGSTOP statement ends the program and releases any storage that it used. It also signals the end of the executable instructions.

The ENDPROG statement follows the statements that define storage areas and precedes the END statement.

The END statement follows the ENDPROG statement. It tells the compiler that the program contains no more statements.

The following example shows the position of the three statements and the general structure of a program.

```
PRINT    PROGRAM  START
START    EQU      *
          •
          •
          •
         PROGSTOP
FIELD1   DATA     F'0'
          •
          •
          •
         ENDPROG
         END
```

Chapter 3. Entering a Source Program

After you code a source program, you must enter it into a data set. The data set can be on either disk, diskette, or tape.

This chapter shows how to use the text editor called the $FSEDIT utility. The chapter describes the commands you need to enter a new source program or change an existing source program. For a complete list of $FSEDIT commands, refer to the *Operator Commands and Utilities Reference.*

Loading the Editor

You can load the editor in one of two ways. You can load it directly using the $L command. Or, you can load it using the session manager.

This chapter discusses how to load the editor with the session manager. For information on how to load $FSEDIT with the $L command, refer to the *Operator Commands and Utilities Reference.*

As you learned in Chapter 1 of this book, you load the session manager by pressing the attention key, typing **$L $SMMAIN**, and pressing the enter key.

At this point, enter a one- to four-character ID and press the enter key.

The Session Manager Primary Option Menu appears. From this menu, select option 1 (TEXT EDITING).

```
$SMMPRIM: SESSION MANAGER PRIMARY OPTION MENU ----------------------------
ENTER/SELECT PARAMETERS:                                  PRESS PF3 TO EXIT

                                                              06:09:00
     SELECT OPTION ==> 1                        09/23/84
                                                              ABCD

          1 - TEXT EDITING
          2 - PROGRAM PREPARATION
          3 - DATA MANAGEMENT
          4 - TERMINAL UTILITIES
          5 - GRAPHICS UTILITIES
          6 - EXEC PROGRAM/UTILITY
          7 - EXEC $JOBUTIL PROC
          8 - COMMUNICATION UTILITIES
          9 - DIAGNOSTIC AIDS
         10 - BACKGROUND JOB CONTROL UTILITIES
```

The session manager displays the $FSEDIT Primary Option Menu.

Creating a New Data Set

The session manager allocates data sets automatically when you log on. One of these data sets, a work data set used by $FSEDIT, is named $SMExxxx, where xxxx is the ID you entered when you logged on to the session manager. For example, if you entered ABCD when you logged on, the work data set is $SMEABCD.

Use option 2 (EDIT) to type your source program into the work data set.

```
$FSEDIT PRIMARY OPTION MENU  ------------------------------STATUS = INIT
                                                    PRESS PF3 TO EXIT
OPTION ===> 2

DATASET NAME =========>          (CURRENTLY IN WORK FILE)
VOLUME NAME ==========>

HOST DATASET ========>

ENTER A VOLUME NAME AND PRESS ENTER FOR A DIRECTORY LIST.

1 ---- BROWSE
2 ---- EDIT
3 ---- READ (HOST/NATIVE)
4 ---- WRITE (HOST/NATIVE)
5 ---- SUBMIT
6 ---- PRINT
7 ---- MERGE
8 ---- END
9 ---- HELP
```

An empty data set appears on your screen. The name of the data set and the volume on which it resides are shown at the top of the screen.

```
EDIT --- $SMEABCD, EDX003     0(1089)------------------------ COLUMNS 001 072
COMMAND INPUT ===>                                          SCROLL ==> HALF
***** ***** TOP OF DATA ********************************************************
..... _
***** **** BOTTOM OF DATA *****************************************************
```

The cursor is located at the first input line. After you finish typing text on this line, press the enter key.

The following example shows how the screen looks after you enter the first line of a source program. (We have used the source program described in Chapter 1 of this book.) The editor automatically numbers each line and presents a new blank line.

```
EDIT --- $SMEABCD, EDX003     0(1089)------------------------ COLUMNS 001 072
COMMAND INPUT ===>                                            SCROLL ==> HALF
***** ***** TOP OF DATA ********************************************************
00010 ADD10        PROGRAM   STPGM
..... _
***** **** BOTTOM OF DATA ******************************************************
```

Continue to type each line of your source program. When you finish, press the enter key on a blank line.

```
EDIT --- $SMEABCD , EDX003    12( 1089)----------------------- COLUMNS 001 072
COMMAND INPUT ===>                                            SCROLL ==> HALF
***** ***** TOP OF DATA ********************************************************
+00010 ADD10        PROGRAM        STPGM
+00020 STPGM        GETVALUE       COUNT,'ENTER NUMBER: '
+00030 LOOP         DO             10,TIMES
+00040                ADD          SUM,COUNT
+00050              ENDDO
+00060              PRINTEXT       '@RESULT='
+00070              PRINTNUM       SUM
+00080              PROGSTOP
+00090 COUNT        DATA           F'0'
+00100 SUM          DATA           F'0'
+00110              ENDPROG
+00120              END
***** ***** BOTTOM OF DATA ******************************************************
```

Saving Your Data Set

The next step is to save your data set. Return to the $FSEDIT Primary Option Menu by typing **M** (for "menu") on the COMMAND INPUT line.

Select option 4 (WRITE) to save the data set. Type the name next on the DATASET NAME line. (In this example, we named the data set ADD10.) Type the volume on the VOLUME NAME line. (In this example, the volume is EDX002.) Then press the enter key.

```
$FSEDIT PRIMARY OPTION MENU  ----------------------------STATUS = MODIFIED
                                                          PRESS PF3 TO EXIT
OPTION ===> 4

DATASET NAME =========> ADD10      (CURRENTLY IN WORK FILE)
VOLUME NAME ==========> EDX002

HOST DATASET ========>

ENTER A VOLUME NAME AND PRESS ENTER FOR A DIRECTORY LIST.

1 ---- BROWSE
2 ---- EDIT
3 ---- READ (HOST/NATIVE)
4 ---- WRITE (HOST/NATIVE)
5 ---- SUBMIT
6 ---- PRINT
7 ---- MERGE
8 ---- END
9 ---- HELP
```

Next, the system prompts you as follows:

```
WRITE TO ADD10 ON EDX002 (Y/N)?
```

Type **Y** and press the enter key.

Then you see a message on your screen indicating that the data set has been written to the volume. In the example shown above, the following message would appear:

```
12 LINES WRITTEN TO ADD10,EDX002
```

This message means that the source program is 12 records long and has been written to volume EDX002.

Modifying an Existing Data Set

You have seen how to enter a source program into a new data set. You can also modify an existing data set.

You must first read the data set you want to modify into the work data set. Select option 3 (READ) from the $FSEDIT Primary Options Menu. On the menu, you specify which data set you want to read.

Next, you select option 2 (EDIT) to modify the data set.

The data set appears on your screen.

```
EDIT --- ADD10    , EDX002    12( 1089)---------------------- COLUMNS 001 072
COMMAND INPUT ===>                                            SCROLL ==> HALF
***** ***** TOP OF DATA ********************************************************
00010 ADD10        PROGRAM        STPGM
00020 STPGM        GETVALUE       COUNT,'ENTER NUMBER: '
00030 LOOP         DO             10,TIMES
00040                ADD          SUM,COUNT
00050              ENDDO
00060              PRINTEXT       '@RESULT='
00070              PRINTNUM       SUM
00080              PROGSTOP
00090 COUNT        DATA           F'0'
00100 SUM          DATA           F'0'
00110              ENDPROG
00120              END
***** ***** BOTTOM OF DATA ******************************************************
```

Changing a Line

To change a line, move the cursor to the line and type in the correction. For example, suppose you wanted to change 10 to 15 in the DO instruction. Move the cursor to the 0 and type a 5.

Or, suppose you wanted to delete the = character in the PRINTEXT instruction. Move the cursor to the = character and press the delete key.

Inserting a Line

You can insert a new line into your data set. You insert a line by typing an **I** in the line number *after which* you want to insert.

For example, suppose you want to insert another instruction before PROGSTOP. Type the **I** as follows:

```
EDIT --- ADD10    , EDX002    12( 1089)---------------------- COLUMNS 001 072
COMMAND INPUT ===> _                                        SCROLL ==> HALF
***** ***** TOP OF DATA ********************************************************
00010 ADD10        PROGRAM       STPGM
00020 STPGM        GETVALUE      COUNT,'ENTER NUMBER: '
00030 LOOP         DO            10,TIMES
00040                ADD         SUM,COUNT
00050              ENDDO
00060              PRINTEXT      '@RESULT='
I0070              PRINTNUM      SUM
00080              PROGSTOP
00090 COUNT        DATA          F'0'
00100 SUM          DATA          F'0'
00110              ENDPROG
00120              END
***** ***** BOTTOM OF DATA ******************************************************
```

After you press the enter key, your data set looks like this:

```
EDIT --- ADD10    , EDX002    12( 1089)---------------------- COLUMNS 001 072
COMMAND INPUT ===>                                          SCROLL ==> HALF
***** ***** TOP OF DATA ********************************************************
00010 ADD10        PROGRAM       STPGM
00020 STPGM        GETVALUE      COUNT,'ENTER NUMBER: '
00030 LOOP         DO            10,TIMES
00040                ADD         SUM,COUNT
00050              ENDDO
00060              PRINTEXT      '@RESULT='
00070              PRINTNUM      SUM
.....              _
00080              PROGSTOP
00090 COUNT        DATA          F'0'
00100 SUM          DATA          F'0'
00110              ENDPROG
00120              END
***** ***** BOTTOM OF DATA ******************************************************
```

You could now enter your new line of text at the position of the cursor. After you press enter, the editor assigns a line number to your new line of text. A new blank input line also appears. You can continue to insert lines or you can press the enter key again to indicate that you have finished inserting.

Deleting a Line

You can delete a line or series of lines from your data set.

To delete a single line, enter a **D** in the line number you want deleted and press the enter key.

```
EDIT --- ADD10    , EDX002    13( 1089)---------------------- COLUMNS 001 072
COMMAND INPUT ===>                                           SCROLL ==> HALF
***** ***** TOP OF DATA ********************************************************
00010 ADD10        PROGRAM        STPGM
00020 STPGM        GETVALUE       COUNT,'ENTER NUMBER: '
00030 LOOP         DO             10,TIMES
00040                ADD          SUM,COUNT
00050              ENDDO
00060              PRINTEXT       '@RESULT='
00070              PRINTNUM       SUM
D0080 *********Delete this line**********************
00090              PROGSTOP
00100 COUNT        DATA           F'0'
00110 SUM          DATA           F'0'
00120              ENDPROG
00130              END
***** ***** BOTTOM OF DATA ******************************************************
```

After you press the enter key, the editor deletes the line.

```
EDIT --- ADD10    , EDX002    12( 1089)---------------------- COLUMNS 001 072
COMMAND INPUT ===>                                           SCROLL ==> HALF
***** ***** TOP OF DATA ********************************************************
00010 ADD10        PROGRAM        STPGM
00020 STPGM        GETVALUE       COUNT,'ENTER NUMBER: '
00030 LOOP         DO             10,TIMES
00040                ADD          SUM,COUNT
00050              ENDDO
00060              PRINTEXT       '@RESULT='
00070              PRINTNUM       SUM
00090              PROGSTOP
00100 COUNT        DATA           F'0'
00110 SUM          DATA           F'0'
00120              ENDPROG
00130              END
***** ***** BOTTOM OF DATA ******************************************************
```

You can also delete more than one line.

For example, suppose you want to delete lines 80 through 120 in the following program. Type **DD** in line 80 and another **DD** in line 120.

```
EDIT --- ADD10    , EDX002    17( 1089)---------------------- COLUMNS 001 072
COMMAND INPUT ===>                                            SCROLL ==> HALF
***** ***** TOP OF DATA ********************************************************
00010 ADD10        PROGRAM        STPGM
00020 STPGM        GETVALUE       COUNT,'ENTER NUMBER: '
00030 LOOP         DO             10,TIMES
00040                ADD          SUM,COUNT
00050              ENDDO
00060              PRINTEXT       '@RESULT='
00070              PRINTNUM       SUM
DD080 **********Delete these lines*********************
00090 ******                                  ******
00100 ******                                  ******
00110 ******                                  ******
DD120 **********Delete these lines*********************
00130              PROGSTOP
00140 COUNT        DATA           F'0'
00150 SUM          DATA           F'0'
00160              ENDPROG
00170              END
***** ***** BOTTOM OF DATA ******************************************************
```

After you press the enter key, your program looks like this:

```
EDIT --- ADD10    , EDX002    12( 1089)---------------------- COLUMNS 001 072
COMMAND INPUT ===>                                            SCROLL ==> HALF
***** ***** TOP OF DATA ********************************************************
00010 ADD10        PROGRAM        STPGM
00020 STPGM        GETVALUE       COUNT,'ENTER NUMBER: '
00030 LOOP         DO             10,TIMES
00040                ADD          SUM,COUNT
00050              ENDDO
00060              PRINTEXT       '@RESULT='
00070              PRINTNUM       SUM
00130              PROGSTOP
00140 COUNT        DATA           F'0'
00150 SUM          DATA           F'0'
00160              ENDPROG
00170              END
***** ***** BOTTOM OF DATA ******************************************************
```

The editor deletes the lines.

Moving Lines

You can move a line or series of lines from one part of your data set to another. For example, suppose you want to move lines 110 through 130. First type **MM** in both 110 and 130. If you want to move these lines after line 10, place an **A** (for "after") on line 10 and press the enter key.

```
EDIT --- ADD10    , EDX002    15( 1089)---------------------- COLUMNS 001 072
COMMAND INPUT ===>                                           SCROLL ==> HALF
***** ***** TOP OF DATA ********************************************************
A0010 ADD10        PROGRAM        STPGM
00020 STPGM        GETVALUE       COUNT,'ENTER NUMBER: '
00030 LOOP         DO             10,TIMES
00040                ADD          SUM,COUNT
00050              ENDDO
00060              PRINTEXT       '@RESULT='
00070              PRINTNUM       SUM
00080              PROGSTOP
00090 COUNT        DATA           F'0'
00100 SUM          DATA           F'0'
MM110 *********Move these lines**********************
00120 *****                                      *****
MM130 *********Move these lines**********************
00140              ENDPROG
00150              END
***** ***** BOTTOM OF DATA ******************************************************
```

When you press the enter key, the editor moves the lines to the position *after* line 10.

```
EDIT --- ADD10    , EDX002    15( 1089)---------------------- COLUMNS 001 072
COMMAND INPUT ===>                                           SCROLL ==> HALF
***** ***** TOP OF DATA ********************************************************
 00010 ADD10        PROGRAM        STPGM
+00020 *********Move these lines**********************
+00030 *****                                      *****
+00040 *********Move these lines**********************
 00050 STPGM        GETVALUE       COUNT,'ENTER NUMBER: '
 00060 LOOP         DO             10,TIMES
 00070                ADD          SUM,COUNT
 00080              ENDDO
 00090              PRINTEXT       '@RESULT='
 00100              PRINTNUM       SUM
 00110              PROGSTOP
 00120 COUNT        DATA           F'0'
 00130 SUM          DATA           F'0'
 00140              ENDPROG
 00150              END
***** ***** BOTTOM OF DATA ******************************************************
```

After you make changes to your data set, return to the $FSEDIT Primary Options Menu. Return to that menu by typing **M** (for "menu") on the COMMAND INPUT line. To save the changes, select option 4 and press the enter key.

You have seen how you can change lines in your programs. You have also seen how to insert and delete lines and move a series of lines. The session manager was used to load $FSEDIT and to allocate the necessary data sets. The next chapter explains how to compile your programs using $EDXASM, the EDX compiler.

Chapter 4. Compiling a Program

After you design, code, and enter your source program into a data set, you have to compile the source program into an object module. This chapter shows you how to compile your source program using the Event Driven Language Compiler, $EDXASM.

The chapter also shows a step-by-step example of compiling a source program that contains some syntax errors. The chapter then shows how to correct the errors so that the compilation is successful.

You can load $EDXASM in one of three ways. You can load $EDXASM directly using the $L command. You can use the $JOBUTIL utility to load $EDXASM. Or, you can run your compilation under control of the session manager.

This chapter describes how to compile a program using the session manager.

For information on using the $L command or the $JOBUTIL utility, refer to the *Operator Commands and Utilities Reference.*

Allocating Data Sets

When you use $EDXASM under control of the session manager, you must provide two data sets. The first data set is the actual source program to be compiled. You must have entered the source program on a disk, diskette, or tape data set. Chapter 3, "Entering a Source Program" describes how to use the $FSEDIT utility to enter your source programs.

The output of the compiler is a data set that contains an object module. You can allocate this data set by selecting option 3 (DATA MANAGEMENT) from the Session Manager Primary Option Menu.

```
$SMMPRIM: SESSION MANAGER PRIMARY OPTION MENU ----------------------------
ENTER/SELECT PARAMETERS:                                  PRESS PF3 TO EXIT

                                                  19:42:07
     SELECT OPTION ==> 3                          10/24/82
                                                  ABCD

          1 - TEXT EDITING
          2 - PROGRAM PREPARATION
          3 - DATA MANAGEMENT
          4 - TERMINAL UTILITIES
          5 - GRAPHICS UTILITIES
          6 - EXEC PROGRAM/UTILITY
          7 - EXEC $JOBUTIL PROC
          8 - COMMUNICATION UTILITIES
          9 - DIAGNOSTIC AIDS
         10 - BACKGROUND JOB CONTROL UTILITIES
```

Note: This example assumes that you logged on to the Session Manager with an ID of ABCD.

The Data Management Option Menu appears on the screen. To allocate your object code data set, select option 1 ($DISKUT1).

```
$SMM03  SESSION MANAGER DATA MANAGEMENT OPTION MENU----------------------
ENTER/SELECT PARAMETERS:                                PRESS PF3 TO RETURN

  SELECT OPTION ==> 1

   1 - $DISKUT1 (DISK(ETTE) ALLOCATE, LIST DIRECTORY)
   2 - $DISKUT2 (DISK(ETTE) DUMP/LIST DATASETS)
   3 - $COPYUT1 (DISK(ETTE) COPY DATASETS/VOLUMES)
   4 - $COMPRES (DISK(ETTE) COMPRESS A VOLUME)
   5 - $COPY    (DISK(ETTE) COPY DATASETS/VOLUMES)
   6 - $DASDI   (DISK(ETTE) SURFACE INITIALIZATION)
   7 - $INITDSK (DISK(ETTE) INITIALIZE/VERIFY)
   8 - $MOVEVOL (COPY DISK VOLUME TO MULTI-DISKETTES)
   9 - $IAMUT1  (INDEXED ACCESS METHOD UTILITY PROGRAM)
  10 - $TAPEUT1 (TAPE ALLOCATE, CHANGE, COPY)
  11 - $HXUT1   (H-EXCHANGE DATASET UTILITY)
  12 - $INSTAL  (INSTALL/UPDATE A SOFTWARE PACKAGE)

   WHEN ENTERING THESE UTILITIES, THE USER IS EXPECTED
   TO ENTER A COMMAND. IF A QUESTION MARK (?) IS ENTERED
   INSTEAD OF A COMMAND, THE USER WILL BE PRESENTED WITH
   A LIST OF AVAILABLE COMMANDS.
```

The session manager loads the $DISKUT1 utility and prompts for the command you want to use.

```
LOADING $DISKUT1     nnP, hh:mm:ss, LP= xxxx, PART= yy

$DISKUT1 - DATA SET MANAGEMENT UTILITY I

USING VOLUME EDX002

COMMAND (?): _
```

Notice the USING VOLUME EDX002 message. Unless you change volumes, $DISKUT1 allocates your data set on EDX002.

When you do *not* want to use the default volume, change the default volume to MYVOL, using the following CV command:

```
USING VOLUME EDX002

COMMAND (?): CV MYVOL
```

The system responds with:

```
USING VOLUME MYVOL

COMMAND (?): _
```

Use the **AL** command to allocate your data set.

```
COMMAND (?): AL
MEMBER NAME:
```

The system then prompts you for the name of the data set. In this example, the data set name is OBJECT.

```
MEMBER NAME: OBJECT
HOW MANY RECORDS? _
```

Next, the system prompts for the number of records you want to allocate. A 25- to 50-record data set should be large enough for most programs. This example defines a 25-record data set.

```
HOW MANY RECORDS? 25
DEFAULT TYPE = DATA - OK(Y/N)? _
```

Finally, the system prompts for the type of information to be contained in the data set. The default is DATA. Because this data set will contain data, enter a **Y**.

```
DEFAULT TYPE = DATA - OK(Y/N)? Y
```

The system responds with:

```
OBJECT CREATED

COMMAND (?):
```

Once the data set has been created, enter an **EN** (for "end") to return to the Data Management Option Menu screen.

```
COMMAND (?): EN

$DISKUT1 ENDED 08:30:24
```

Return to the Session Manager Primary Option Menu to begin the compilation by pressing the PF3 key.

Running the Compilation

Once you have allocated the data set to hold the output, you are ready to begin compiling the source program. The following is a listing of the source program to be compiled:

```
            PROGRAM     STPGM
STPGM       GETVALUE    COUNT,'ENTER NUMBER: '
LOOP        DO          10,TIMES
              ADD       SUM,COUNT
            ENDDO
            PRINTEXT    'RESULT='
            PRINTNUM    SUM
            PROGSTOP
COUNT       DATA        F'0'
SUM         DATA        F'0'
            ENDPROG
            END
```

This program is similar to the examples we used in Chapter 1 and Chapter 3 of this book. However, we have included two errors in this source program.

From the Session Manager Primary Option Menu, select option 2 (PROGRAM PREPARATION) to begin the compile step.

```
$SMMPRIM: SESSION MANAGER PRIMARY OPTION MENU ----------------------------
ENTER/SELECT PARAMETERS:                                  PRESS PF3 TO EXIT

                                                          19:48:07
      SELECT OPTION ==> 2                                 10/24/82
                                                          ABCD

          1 - TEXT EDITING
          2 - PROGRAM PREPARATION
          3 - DATA MANAGEMENT
          4 - TERMINAL UTILITIES
          5 - GRAPHICS UTILITIES
          6 - EXEC PROGRAM/UTILITY
          7 - EXEC $JOBUTIL PROC
          8 - COMMUNICATION UTILITIES
          9 - DIAGNOSTIC AIDS
         10 - BACKGROUND JOB CONTROL UTILITIES
```

The Program Preparation Option Menu appears on your screen. To compile the program, select option 1 ($EDXASM COMPILER).

```
$SMM02  SESSION MANAGER PROGRAM PREPARATION OPTION MENU--------------------
ENTER/SELECT PARAMETERS:                                 PRESS PF3 TO RETURN

      SELECT OPTION ==> 1

          1 - $EDXASM COMPILER
          2 - $EDXASM/$EDXLINK
          3 - $S1ASM ASSEMBLER
          4 - $COBOL COMPILER
          5 - $FORT FORTRAN COMPILER
          6 - $PLI COMPILER/$EDXLINK
          7 - $EDXLINK LINKAGE EDITOR
          8 - $XPSLINK LINKAGE EDITOR FOR SUPERVISORS
          9 - $UPDATE
         10 - $UPDATEH (HOST)
         11 - $PREFIND
         12 - $PASCAL COMPILER/$EDXLINK
         13 - $EDXASM/$XPSLINK FOR SUPERVISORS
         14 - $MSGUT1 MESSAGE SOURCE PROCESSING UTILITY
```

The $EDXASM Parameter Input Menu appears on your screen. Enter the name of your source input (in this example, ADD10 on volume EDX002). Also enter the name of your object output (in this example, data set OBJECT on volume MYVOL).

You could enter something on the OPTIONAL PARAMETERS line if you want to change one of the parameters listed on the DEFAULT PARAMETERS line. In this example, we are using the defaults.

```
$SMM0201: SESSION MANAGER $EDXASM PARAMETER INPUT MENU--------------------
ENTER/SELECT PARAMETERS:                                PRESS PF3 TO RETURN


  SOURCE INPUT   (NAME,VOLUME) ==> ADD10,EDX002

  OBJECT OUTPUT  (NAME,VOLUME) ==> OBJECT,MYVOL

  OPTIONAL PARAMETERS ==>
  (SELECT FROM THE LIST BELOW)

 FOREGROUND OR BACKGROUND (F/B) ==>
 (DEFAULT IS FOREGROUND)

 ---------------------------------------------------
AVAILABLE PARAMETERS:     ABBREVIATION:         DESCRIPTION:
 NOLIST                    NO                    USED TO SUPPRESS LISTING
 LIST TERMINAL-NAME        LI TERMINAL-NAME      USE LIST * FOR THIS TERMINAL
 ERRORS TERMINAL-NAME      ER TERMINAL-NAME      USE ERRORS * FOR THIS TERMINAL
 CONTROL DATA SET,VOLUME   CO DATA SET,VOLUME    $EDXASM LANGUAGE CONTROL DATASET
 OVERLAY #                 OV #                  # IS NUMBER OF AREAS FROM 1 TO 6

DEFAULT PARAMETERS:
 LIST $SYSPRTR CONTROL $EDXL,ASMLIB OVERLAY 6
```

Checking Your Compiler Listing and Correcting Errors

The output of the compiler prints on your printer. The listing consists of statistics, source code statements and object code, undefined or external symbols, and a completion code.

The following is an example of the output listing generated by the compile example being run.

```
EDX ASSEMBLER STATISTICS

 SOURCE INPUT  - ADD10,EDX002
 WORK DATA SET - WORK1,MYVOL
 OBJECT MODULE - OBJECT,MYVOL
 DATE: 10/24/82 AT 19:56:18
 ASSEMBLY TIME:     4 SECONDS
 STATEMENTS PROCESSED -  12

    4  STATEMENTS FLAGGED
                                                                      PAGE   1
LOC    +0    +2    +4    +6    +8    SOURCE STATEMENT   ADD10    ,EDX002  (5719

                                       PROGRAM      STPGM
   08 *** TASK NAME NOT SPECIFIED                                  $EDXL   12
0000   802C 0000 000A 0001 0E0E   STPGM    GETVALUE     COUNT,'ENTER NUMBER: '
000A   C5D5 E3C5 D940 D5E4 D4C2
0014   C5D5 7A40
   08 *** ONE OR MORE UNDEFINED LABELS WERE REFERENCED             $EDXL    3
0018   809C 0024 000A             LOOP     DO           10,TIMES
001E   0032 0040 0000                      ADD          SUM,COUNT
   08 *** ONE OR MORE UNDEFINED LABELS WERE REFERENCED             $EDXL    3
0024   009D 0000 0001                      ENDDO
002A   8026 0808 D9C5 E2E4 D3E3            PRINTEXT      'RESULT='
0034   7E40                                PRINTNUM      SUM
003C   0022 FFFF                           PROGSTOP
                                  COUNT    DATA          F'0'
   08 *** INVALID OR UNDEFINED OPERATION CODE                      $EDXL   11
0040   0000                        SUM      DATA          F'0'
0042                                       ENDPROG
0042                                       END


                      EXTERNAL/UNDEFINED SYMBOLS

                         COUNT        UNDEFINED

COMPLETION CODE =     8
```

This example shows that the compile did not run successfully. The completion code expected is a -1. The completion code received is an 8.

The listing shows the compilation errors. They are:

- 08 *** TASK NAME NOT SPECIFIED
- 08 *** ONE OR MORE UNDEFINED LABELS WERE REFERENCED
- 08 *** INVALID OR UNDEFINED OPERATION CODE

To fix these errors, you must understand what caused them. Look the errors up in *Messages and Codes*.

The first message, 08 *** TASK NAME NOT SPECIFIED, is a result of not having a task name coded on the PROGRAM statement.

The second message, 08 *** ONE OR MORE UNDEFINED LABELS WERE REFERENCED, means that one of the labels referenced in the instruction has not been defined to the program. If you check the listing for undefined symbols, you will see that COUNT is undefined.

The third message, 08 *** INVALID OR UNDEFINED OPERATION CODE, means that something is wrong with the COUNT definition statement. If you check the statement, you will see that the label, COUNT, starts in column two. The label must start in column one.

After isolating the errors, you must go back to the source data set and correct them. Use $FSEDIT as explained in "Modifying an Existing Data Set" on page 3-5 to make the corrections. After you make the corrections, the source data set looks as follows:

```
PROG1       PROGRAM       STPGM
STPGM       GETVALUE      COUNT,'ENTER NUMBER: '
LOOP        DO            10,TIMES
              ADD         SUM,COUNT
            ENDDO
            PRINTEXT      '@RESULT='
            PRINTNUM      SUM
            PROGSTOP
COUNT       DATA          F'0'
SUM         DATA          F'0'
            ENDPROG
            END
```

Rerunning the Compilation

To rerun the compilation, return to the Session Manager Primary Option Menu and select option 2 (PROGRAM PREPARATION).

```
$SMMPRIM: SESSION MANAGER PRIMARY OPTION MENU ----------------------------
ENTER/SELECT PARAMETERS:                                  PRESS PF3 TO EXIT

                                        20:02:07
      SELECT OPTION ==> 2                10/24/82
                                        ABCD

          1 - TEXT EDITING
          2 - PROGRAM PREPARATION
          3 - DATA MANAGEMENT
          4 - TERMINAL UTILITIES
          5 - GRAPHICS UTILITIES
          6 - EXEC PROGRAM/UTILITY
          7 - EXEC $JOBUTIL PROC
          8 - COMMUNICATION UTILITIES
          9 - DIAGNOSTIC AIDS
         10 - BACKGROUND JOB CONTROL UTILITIES
```

The Program Preparation Option Menu appears on your screen. Select option 1 ($EDXASM COMPILER).

```
$SMM02  SESSION MANAGER PROGRAM PREPARATION OPTION MENU-------------------
ENTER/SELECT PARAMETERS:                                 PRESS PF3 TO RETURN

      SELECT OPTION ==> 1

          1 - $EDXASM COMPILER
          2 - $EDXASM/$EDXLINK
          3 - $S1ASM ASSEMBLER
          4 - $COBOL COMPILER
          5 - $FORT FORTRAN COMPILER
          6 - $PLI COMPILER/$EDXLINK
          7 - $EDXLINK LINKAGE EDITOR
          8 - $XPSLINK LINKAGE EDITOR FOR SUPERVISORS
          9 - $UPDATE
         10 - $UPDATEH (HOST)
         11 - $PREFIND
         12 - $PASCAL COMPILER/$EDXLINK
         13 - $EDXASM/$XPSLINK FOR SUPERVISORS
         14 - $MSGUT1 MESSAGE SOURCE PROCESSING UTILITY
```

The $EDXASM Parameter Input Menu appears on your screen. Again, enter the name of your source input (in this example, ADD10). Also enter the name of your object output (in this example, data set OBJECT on volume MYVOL).

```
$SMM0201: SESSION MANAGER $EDXASM PARAMETER INPUT MENU--------------------
ENTER/SELECT PARAMETERS:                                  PRESS PF3 TO RETURN


  SOURCE INPUT   (NAME,VOLUME) ==> ADD10,EDX002

  OBJECT OUTPUT  (NAME,VOLUME) ==> OBJECT,MYVOL

  OPTIONAL PARAMETERS ==>
  (SELECT FROM THE LIST BELOW)

 FOREGROUND OR BACKGROUND (F/B) ==>
 (DEFAULT IS FOREGROUND)

 ------------------------------------------------------
AVAILABLE PARAMETERS:     ABBREVIATION:        DESCRIPTION:
 NOLIST                    NO                   USED TO SUPPRESS LISTING
 LIST TERMINAL-NAME        LI TERMINAL-NAME     USE LIST * FOR THIS TERMINAL
 ERRORS TERMINAL-NAME      ER TERMINAL-NAME     USE ERRORS * FOR THIS TERMINAL
 CONTROL DATA SET,VOLUME   CO DATA SET,VOLUME   $EDXASM LANGUAGE CONTROL DATASET
 OVERLAY #                 OV #                 # IS NUMBER OF AREAS FROM 1 TO 6

DEFAULT PARAMETERS:
 LIST $SYSPRTR CONTROL $EDXL,ASMLIB OVERLAY 6
```

The following is an example of the output listing generated by the compiler.

```
EDX ASSEMBLER STATISTICS

 SOURCE INPUT  - ADD10,EDX002
 WORK DATA SET - $SM1ABCD,EDX002
 OBJECT MODULE - OBJECT,MYVOL
 DATE: 10/24/82 AT 20:06:18
 ASSEMBLY TIME:     4 SECONDS
 STATEMENTS PROCESSED -  12

   NO  STATEMENTS FLAGGED

LOC    +0    +2    +4    +6    +8    SOURCE STATEMENT   ADD10  ,EDX002   (5719

0000   0008 D7D9 D6D7 D9C1 D440   PROG1    PROGRAM      STPGM
            .
0034   802C 0074 003E 0001 0E0E   STPGM    GETVALUE     COUNT,'ENTER NUMBER: '
003E   C5D5 E3C5 D940 D5E4 D4C2
0048   C5D9 7A40
004C   809C 0058 000A             LOOP     DO           10,TIMES
0052   0032 0076 0074                      ADD          SUM,COUNT
0058   009D 0000 0001                      ENDDO
005E   8026 0808 D9C5 E2E4 D3E3            PRINTEXT       'RESULT='
0068   7E40
006A   0028 0076 0001                      PRINTNUM       SUM
0070   0022 FFFF                           PROGSTOP
0074   0000                        COUNT    DATA           F'0'
0076   0000                        SUM      DATA           F'0'
0078   0000 0000 0000 0234 0000            ENDPROG
            .
00FA   0000 0000 0000 0000 0000
010E   0000
0110                                           END

                      EXTERNAL/UNDEFINED SYMBOLS

                         SVC       WXTRN
                         SUPEXIT   WXTRN
                         SETBUSY   WXTRN

COMPLETION CODE =    -1
```

The −1 completion code tells you that the compile was successful. The next step is to link edit the object module into program data that can be executed. See the next chapter, Chapter 5, "Preparing an Object Module for Execution," for details.

Chapter 5. Preparing an Object Module for Execution

So far in this book, you have learned how to code and enter a source program into a data set. You have also learned how to compile the source program.

The next step is to prepare your object modules for execution. In this chapter, we will show you how to use the linkage editor $EDXLINK to prepare your object modules to run on an EDX system. $EDXLINK links together any separately assembled object modules that make up your program. $EDXLINK also produces a load module that is ready for execution.

In this chapter, we will show you how to prepare a single object module for execution. We will also show you an example of link editing more than one object module.

You can load $EDXLINK in one of three ways. You can load $EDXLINK directly using the $L command. You can use the $JOBUTIL utility to load $EDXLINK, or use $EDXLINK under control of the session manager.

This chapter describes how to use $EDXLINK under control of the session manager. For information on using the $L command or the $JOBUTIL utility, refer to the *Operator Commands and Utilities Reference*.

Link Editing a Single Object Module

This section shows how to link edit a single object module.

$EDXLINK LINKAGE EDITOR is option 7 of the Session Manager Program Preparation Option menu.

```
$SMM02  SESSION MANAGER PROGRAM PREPARATION OPTION MENU--------------------
ENTER/SELECT PARAMETERS:                                PRESS PF3 TO RETURN

      SELECT OPTION ==> 7

            1 - $EDXASM COMPILER
            2 - $EDXASM/$EDXLINK
            3 - $S1ASM ASSEMBLER
            4 - $COBOL COMPILER
            5 - $FORT FORTRAN COMPILER
            6 - $PLI COMPILER/$EDXLINK
            7 - $EDXLINK LINKAGE EDITOR
            8 - $XPSLINK LINKAGE EDITOR FOR SUPERVISORS
            9 - $UPDATE
           10 - $UPDATEH (HOST)
           11 - $PREFIND
           12 - $PASCAL COMPILER/$EDXLINK
           13 - $EDXASM/$XPSLINK FOR SUPERVISORS
           14 - $MSGUT1 MESSAGE SOURCE PROCESSING UTILITY
```

When you select option 7 and press the enter key, the $EDXLINK Parameter Input Menu appears on your screen.

```
$SMM0207: SESSION MANAGER $EDXLINK PARAMETER INPUT MENU-------------------
ENTER/SELECT PARAMETERS:                                PRESS PF3 TO RETURN



  EXECUTION PARM ==> *

  ENTER A CONTROL DATA SET NAME,VOLUME OR
  AN ASTERISK (*) FOR INTERACTIVE MODE.

  OUTPUT DEVICE (DEFAULTS TO $SYSPRTR) ==>

  FOREGROUND OR BACKGROUND (F/B) ==>
  (DEFAULT IS FOREGROUND)
```

You can run $EDXLINK in interactive mode. If you choose interactive mode, the system prompts you for information about the object module you want to link edit. To choose interactive mode, enter an asterisk (*) on the EXECUTION PARM line.

$EDXLINK then displays the following screen:

```
LOADING $JOBUTIL    nnP, hh:mm:ss, LP= xxxx, PART= yy
REMARK
$EDXLINK *
*** JOB - $EDXLINK - STARTED AT 18:28:42 03/15/83 ***

JOB      $EDXLINK ($SMP0207) USERID=ABCD
LOADING $EDXLINK      nnP, hh:mm:ss, LP= xxxx, PART= yy

$EDXLINK - EDX LINKAGE EDITOR


$EDXLINK INTERACTIVE MODE
  DEFAULT VOLUME = EDX002

STMT (?):
```

$EDXLINK prompts you for a control statement. Control statements are the instructions $EDXLINK uses to convert the object modules into load modules.

When using interactive mode, you enter the control statements one at a time. (As you will see later in this chapter, you can write the control statements to a link control data set for execution in noninteractive mode.)

To link edit a single object module, use the INCLUDE and LINK statements. (You will learn about some of the other control statements later in this chapter.)

The INCLUDE statement indicates which object module to use. (Remember that the object module is the output from $EDXASM, the compiler.) In this example, the object module is OBJECT. This is the only module name you enter next to the INCLUDE statement.

```
LOADING $JOBUTIL    nnP, hh:mm:ss, LP= xxxx, PART= yy
REMARK
$EDXLINK *
*** JOB - $EDXLINK - STARTED AT 10:27:16 00/00/00 ***

JOB      $EDXLINK ($SMP0207) USERID=ABCD
LOADING $EDXLINK      nnP, hh:mm:ss, LP= xxxx, PART= yy

$EDXLINK - EDX LINKAGE EDITOR


$EDXLINK INTERACTIVE MODE
  DEFAULT VOLUME = EDX002

STMT (?): INCLUDE OBJECT,MYVOL
```

Use the LINK statement to name the data set that is the output of $EDXLINK. When you enter the name of this data set, $EDXLINK allocates it. In the following example, the data set is named ADDPGM. It will reside on volume EDX002. The word REPLACE means to replace the program if it already exists on volume EDX002. The END statement signals $EDXLINK that the program contains no further source statements.

```
LOADING $JOBUTIL    nnP, hh:mm:ss, LP= xxxx, PART= yy
REMARK
$EDXLINK *
*** JOB - $EDXLINK - STARTED AT 10:27:16 00/00/00 ***

JOB      $EDXLINK ($SMP0207) USERID=ABCD
LOADING $EDXLINK      nnP, hh:mm:ss, LP= xxxx, PART= yy

$EDXLINK - EDX LINKAGE EDITOR


$EDXLINK INTERACTIVE MODE
  DEFAULT VOLUME = EDX002

STMT (?): INCLUDE OBJECT,EDX002

STMT (?): LINK ADDPGM,EDX002 REPLACE END
```

The system produces a data set (ADDPGM) that can now be executed on the system. In this example, we link edited only one object module (OBJECT). The next section shows how to link edit more than one object module.

If the system indicates (by returning a −1 completion code) that the link edit was successful, return to the Primary Option Menu to execute your program. For information on how to execute your program see Chapter 6, "Executing a Program."

Link Editing More Than One Object Module

This section shows how to specify that a load module consists of more than one object module. If you divide a large program into modules, those modules can be compiled separately. If you need to make a change to one of the modules, you need to recompile only that module. When you are ready to run the program, you can link edit the individual modules.

You might also have a function that is common to many of your programs. By making this function a separate module, you could include it wherever needed in your programs.

This section shows how to use both interactive and noninteractive mode to link edit the modules. All examples show $EDXLINK being used under control of the session manager.

As you learned earlier in this chapter, $EDXLINK LINKAGE EDITOR is option 7 of the Session Manager Program Preparation Option menu.

```
$SMM02  SESSION MANAGER PROGRAM PREPARATION OPTION MENU-------------------
ENTER/SELECT PARAMETERS:                              PRESS PF3 TO RETURN

     SELECT OPTION ==> 7

          1 - $EDXASM COMPILER
          2 - $EDXASM/$EDXLINK
          3 - $S1ASM ASSEMBLER
          4 - $COBOL COMPILER
          5 - $FORT FORTRAN COMPILER
          6 - $PLI COMPILER/$EDXLINK
          7 - $EDXLINK LINKAGE EDITOR
          8 - $XPSLINK LINKAGE EDITOR FOR SUPERVISORS
          9 - $UPDATE
         10 - $UPDATEH (HOST)
         11 - $PREFIND
         12 - $PASCAL COMPILER/$EDXLINK
         13 - $EDXASM/$XPSLINK FOR SUPERVISORS
         14 - $MSGUT1 MESSAGE SOURCE PROCESSING UTILITY
```

When you select option 7, the $EDXLINK Parameter Input Menu appears on your screen.

```
$SMM0207: SESSION MANAGER $EDXLINK PARAMETER INPUT MENU--------------------
ENTER/SELECT PARAMETERS:                                  PRESS PF3 TO RETURN



  EXECUTION PARM ==> *

  ENTER A CONTROL DATA SET NAME,VOLUME OR
  AN ASTERISK (*) FOR INTERACTIVE MODE.

  OUTPUT DEVICE (DEFAULTS TO $SYSPRTR) ==>

  FOREGROUND OR BACKGROUND (F/B) ==>
  (DEFAULT IS FOREGROUND)
```

Including Individual Object Modules

With the INCLUDE statement, you indicate which object modules to use. If the modules reside on the same volume, you can list them on one INCLUDE statement. In the example shown below, the first INCLUDE statement includes four object modules from volume EDX003. The second INCLUDE statement includes two object modules from volume MYVOL.

```
LOADING $JOBUTIL    nnP, hh:mm:ss, LP= xxxx, PART= yy
REMARK
$EDXLINK *
*** JOB - $EDXLINK - STARTED AT 07:27:16 00/00/00 ***

JOB      $EDXLINK ($SMP0207) USERID=ABCD
LOADING $EDXLINK      nnP, hh:mm:ss, LP= xxxx, PART= yy

$EDXLINK - EDX LINKAGE EDITOR


$EDXLINK INTERACTIVE MODE
  DEFAULT VOLUME = EDX002

STMT (?): INCLUDE OBJ12,OBJ13,OBJ14,OBJ15,EDX003

STMT (?): INCLUDE SQRT,STDEV,MYVOL
```

After you enter the first INCLUDE statement, $EDXLINK prompts you for another statement. Enter the second INCLUDE statement.

The LINK statement tells the linkage editor what to call the load module and where to put it. In this example, the output object data set will be named PGM1. It will reside on volume EDX003. The word REPLACE means to replace the program if it already exists on volume EDX003. The END statement signals $EDXLINK that the program contains no further source statements.

```
STMT (?): INCLUDE OBJ12,OBJ13,OBJ14,OBJ15,EDX003

STMT (?): INCLUDE SQRT,STDEV,MYVOL

STMT (?): LINK PGM1,EDX003 REPLACE END

$EDXLINK EXECUTION STARTED
PGM1    ,EDX003 STORED
PROGRAM DATA SET SIZE =      7 RECORDS
COMPLETION CODE =  -1

$EDXLINK ENDED AT 09:33:35

$JOBUTIL ENDED AT 09:33:55

PRESS ENTER KEY TO RETURN
```

Once you enter these statements, $EDXLINK produces a load module (PGM1) that is ready for execution. PGM1 consists of six object modules: OBJ12, OBJ13, OBJ14, OBJ15, SQRT, and STDEV.

Including Overlay Segments

Your program may include overlay segments. (Overlay segments are described in detail in "Reusing Storage using Overlays" on page 9-9.) You use the OVERLAY statement to identify these segments to $EDXLINK.

For example, suppose you had a program made up of a resident segment and two overlays. Assume the name of the resident segment is TESTROOT and the overlays are named TESTSUB1 and TESTSUB2. Your control statements would look like this:

```
$EDXLINK INTERACTIVE MODE
  DEFAULT VOLUME = EDX002

STMT (?): INCLUDE TESTROOT,EDX003

STMT (?): OVERLAY

STMT (?): INCLUDE TESTSUB1,EDX003

STMT (?): OVERLAY

STMT (?): INCLUDE TESTSUB2,EDX003

STMT (?): LINK TEST,EDX003 REPLACE END

$EDXLINK EXECUTION STARTED
TEST    ,EDX003 STORED
PROGRAM DATA SET SIZE =   26
COMPLETION CODE =   -1

$EDXLINK ENDED AT 04:05:35
```

The first INCLUDE statement identifies the resident (or root) portion of the program. The INCLUDE statement following the first OVERLAY statement identifies the first overlay segment. The INCLUDE statement following the second OVERLAY statement identifies the *second* overlay segment.

The LINK statement identifies the object output data set.

Using the Autocall Feature

You can use the AUTOCALL control statement to load the autocall feature. You can include up to three autocall data set names on the AUTOCALL statement. Autocall data sets contain a list of object module names and volumes, along with their entry points. Use the autocall option to include modules not explicitly included with the INCLUDE statement.

You need to use autocall data sets if, for example, you are link editing a program that uses $IMAGE subroutines. Some instructions, such as GETEDIT and PUTEDIT, also require that you link edit with the autocall option.

The following is an example of an autocall data set.

```
PGM1,EDX003  ENTER
PGM2,EDX40   START
PGM3,MYVOL   CALC
**END
```

PGM1, PGM2, and PGM3 are object modules on EDX003, EDX40, and MYVOL. ENTER, START, and CALC are the entry points for the modules. The module names must begin in column one and end with an **END statement.

Enter the AUTOCALL statement just before the LINK statement. This example specifies two autocall data sets: the system-supplied autocall data set ($AUTO on volume ASMLIB) and data set MYAUTO on volume MYVOL.

If you specify more than one AUTOCALL statement, the linkage editor uses the last one.

Suppose you wanted to add an AUTOCALL statement to the previous example. You would enter it like this:

```
$EDXLINK INTERACTIVE MODE
  DEFAULT VOLUME = EDX002

STMT (?): INCLUDE TESTROOT,EDX003

STMT (?): OVERLAY

STMT (?): INCLUDE TESTSUB1,EDX003

STMT (?): OVERLAY

STMT (?): INCLUDE TESTSUB2,EDX003

STMT (?): AUTOCALL $AUTO,ASMLIB MYAUTO,MYVOL

STMT (?): LINK TEST,EDX003 REPLACE END
```

The system would respond as follows:

```
$EDXLINK EXECUTION STARTED
TEST    ,EDX003 STORED
PROGRAM DATA SET SIZE =   26
COMPLETION CODE =   -1

$EDXLINK ENDED AT 04:05:35
```

The linkage editor also prints, on the system printer, the names of the object modules it included. For example:

```
INCLUDE $IMOPEN ,ASMLIB FROM $AUTO  ,ASMLIB VIA AUTOCALL
INCLUDE $IMGEN  ,ASMLIB FROM $AUTO  ,ASMLIB VIA AUTOCALL
INCLUDE $GPLIST ,ASMLIB FROM $AUTO  ,ASMLIB VIA AUTOCALL
INCLUDE $GEER   ,ASMLIB FROM $AUTO  ,ASMLIB VIA AUTOCALL
INCLUDE $GEAC   ,ASMLIB FROM $AUTO  ,ASMLIB VIA AUTOCALL
INCLUDE $IMDTYPE,ASMLIB FROM $AUTO  ,ASMLIB VIA AUTOCALL
INCLUDE $$RETURN,ASMLIB FROM $AUTO  ,ASMLIB VIA AUTOCALL
INCLUDE $UNPACK ,ASMLIB FROM $AUTO  ,ASMLIB VIA AUTOCALL
```

Using Noninteractive Mode

Using noninteractive mode means that you do not have to enter control statements each time you link edit a program.

When you use noninteractive mode, you must enter the name of a primary control data set on the $EDXLINK Parameter Input Menu. The primary control data set contains the control statements to be used by $EDXLINK.

You can create the primary control data set using $FSEDIT. Then enter control statements into the data set.

The following is an example of a primary control data set. Control statements must begin in column 1. This data set includes comment statements. A comment statement begins with an asterisk (*).

```
* PLOT PROGRAM INCLUDES
*
INCLUDE PLOTXY,MYVOL
INCLUDE PLOTXX,MYVOL
INCLUDE PLOTYY,MYVOL
INCLUDE PLOTYX,MYVOL
*
* PERFORM AUTOCALL PROCESSING USING:
*
AUTOCALL MYAUTO,MYVOL $AUTO,ASMLIB
*
* PERFORM THE LINK
*
LINK PLOT,MYVOL REPLACE END
```

After entering these statements into the data set, specify the name of this data set next to "EXECUTION PARM" on the $EDXLINK Parameter Input Menu. In this example, the data set is LINK1 on volume EDX003.

```
$SMM0207: SESSION MANAGER $EDXLINK PARAMETER INPUT MENU-------------------
ENTER/SELECT PARAMETERS:                              PRESS PF3 TO RETURN



  EXECUTION PARM ==> LINK1,EDX003

  ENTER A CONTROL DATA SET NAME,VOLUME OR
  AN ASTERISK (*) FOR INTERACTIVE MODE.

  OUTPUT DEVICE (DEFAULTS TO $SYSPRTR) ==>

  FOREGROUND OR BACKGROUND (F/B) ==>
  (DEFAULT IS FOREGROUND)
```

The primary control data set can also refer to a secondary control data set. The secondary control data set contains additional control statements. These control statements can be common control statements that are used frequently for many different link edits. You use the COPY control statement to refer to these secondary data sets. For example:

```
INCLUDE  ASMOBJ,EDX003
COPY  CTRL,EDX40
LINK  PGM3,EDX40 REPLACE END
```

The linkage editor includes object module ASMOBJ on volume EDX003, copies additional control statements from data set CTRL on volume EDX40, gives the load module the name PGM3, and puts it on volume EDX40.

For more information on specifying primary and secondary control statement data sets, refer to the *Operator Commands and Utilities Reference*.

Prefinding Data Sets and Overlays

You can locate data sets and overlay programs before you load a program by using the $PREFIND utility. You can improve program performance by using $PREFIND.

You should use $PREFIND if:

- The program uses a large number of data sets.
- The program loads several overlay programs.
- You load the program frequently.

For information on how to use the $PREFIND utility, refer to the *Operator Commands and Utilities Reference*.

Chapter 6. Executing a Program

After you have compiled and link edited a program, you are ready to run (or *execute*) it.

This chapter shows how to execute a program. You can execute a program in any of the following ways:

- You can load the program with the $L operator command.
- You can use the $JOBUTIL utility.
- You can use the session manager.
- You can submit the program from another program.
- You can use the $SUBMIT utility.

This chapter describes how to use the session manager to execute a program and how to submit a program from another program. For information on how to use the $L operator command or the $JOBUTIL utility or the $SUBMIT utility, refer to the *Operator Commands and Utilities Reference.*

Executing a Program with the Session Manager

To execute your program, select option 6 (EXEC PROGRAM/UTILITY) on the Primary Option Menu.

```
$SMMPRIM: SESSION MANAGER PRIMARY OPTION MENU ----------------------------
ENTER/SELECT PARAMETERS:                                  PRESS PF3 TO EXIT

                                                                  11:42:07
     SELECT OPTION ==> 6                                10/24/82
                                                                  ABCD

          1 - TEXT EDITING
          2 - PROGRAM PREPARATION
          3 - DATA MANAGEMENT
          4 - TERMINAL UTILITIES
          5 - GRAPHICS UTILITIES
          6 - EXEC PROGRAM/UTILITY
          7 - EXEC $JOBUTIL PROC
          8 - COMMUNICATION UTILITIES
          9 - DIAGNOSTIC AIDS
         10 - BACKGROUND JOB CONTROL UTILITIES
```

The Execute Program/Utility menu appears. Enter the program name (ADDPGM) and volume (EDX002) next to PROGRAM/UTILITY (NAME,VOLUME). Then type an asterisk in the DATA SET 1, DATA SET 2, and DATA SET 3 fields and press the enter key.

```
$SMM06  SESSION MANAGER EXECUTE PROGRAM/UTILITY--------------------------
ENTER/SELECT PARAMETERS:                                PRESS PF3 TO RETURN

 PROGRAM/UTILITY (NAME,VOLUME) ==> ADDPGM,EDX002
 DYNAMIC STORAGE (OPTIONAL)    ==>

 PARAMETERS ===>

 DATA SET 1 (NAME,VOLUME / * = DS1 NOT USED) ===> *
 DATA SET 2 (NAME,VOLUME / * = DS2 NOT USED) ===> *
 DATA SET 3 (NAME,VOLUME / * = DS3 NOT USED) ===> *

 FOREGROUND OR BACKGROUND (F/B) ==>
 (DEFAULT IS FOREGROUND)

 NOTE: IF A DATA SET (DS1, DS2 OR DS3) IS NOT USED,
       AN ASTERISK (*) MUST BE ENTERED IN THE DATA SET FIELD.
```

Putting asterisks in the DATA SET fields means either of two things. Either the program does not use any data sets or the program specifies the data sets with the DS operand. For example, the PROGRAM for program ADDPGM might look like this:

```
BEGIN  PROGRAM  ST
```

or this:

```
BEGIN  PROGRAM  ST,DS=((MASTER,EDX003),(UPDATES,MYVOL),(NEWMAST,EDX40))
```

If you want the program to execute in the background, enter **B** next to FOREGROUND OR BACKGROUND (F/B). Otherwise, the system executes the program in the foreground.

After you press the enter key, the following screen appears on the terminal:

```
LOADING $JOBUTIL    nnP, hh:mm:ss, LP= xxxx, PART= y
REMARK
EXECUTE  PROGRAM/UTILITY: ADDPGM
*** JOB - ADDPGM - STARTED AT 11:48:22 00/00/00 ***

JOB      ADDPGM ($SMP06) USERID=ABCD
LOADING ADDPGM      nnP, hh:mm:ss, LP= xxxx, PART= y
ENTER NUMBER:
```

Specifying Data Sets

You can specify data sets in any of these ways:

1. In the DS= operand of a PROGRAM instruction
2. In the DS= operand of a LOAD instruction
3. With the $L operator command
4. During execution of some system utility programs
5. On the Execute Program/Utility menu
6. With the DS command of the $JOBUTIL utility.

You identify a data set by specifying:

1. The data set name (dsname)
2. An optional volume label (volume) which specifies the volume on which the data set resides.

The format for a data set specification is:

```
dsname,volume
```

Volume is optional. If you omit volume, the system assumes that the data set resides on the volume from which you performed an IPL. Definitions of dsname and volume are:

dsname An alphanumeric character string of eight characters. When you specify fewer than eight characters, the system adds blanks to the right to complete the string.

volume An alphanumeric character string of six characters. To locate the volume, the appropriate TAPE or DISK statement must be in the system I/O definition. You must initialize the disk or diskette with the $INITDSK utility and tapes with the $TAPEUT1 utility. When you specify fewer than six characters, the system adds blanks to the right to complete the string.

To specify up to three data sets on the Execute Program/Utility menu, enter the data set name and volume as in the following example:

```
$SMM06  SESSION MANAGER EXECUTE PROGRAM/UTILITY--------------------------
ENTER/SELECT PARAMETERS:                                PRESS PF3 TO RETURN

 PROGRAM/UTILITY (NAME,VOLUME) ==> ADDPGM,EDX002
 DYNAMIC STORAGE (OPTIONAL)    ==>

 PARAMETERS ===>

 DATA SET 1 (NAME,VOLUME / * = DS1 NOT USED) ===> MASTER,EDX003
 DATA SET 2 (NAME,VOLUME / * = DS2 NOT USED) ===> UPDATES,MYVOL
 DATA SET 3 (NAME,VOLUME / * = DS3 NOT USED) ===> NEWMAST,EDX40

 FOREGROUND OR BACKGROUND (F/B) ==>
 (DEFAULT IS FOREGROUND)

 NOTE: IF A DATA SET (DS1, DS2 OR DS3) IS NOT USED,
       AN ASTERISK (*) MUST BE ENTERED IN THE DATA SET
       FIELD.
```

The PROGRAM statement for program ADDPGM might look like this:

```
BEGIN  PROGRAM  ST,DS=(??,??,??)
```

If a program requires fewer than three data sets, enter an asterisk (*) next to the data set(s) not used.

Submitting a Program from Another Program

A program can submit one or more programs to the EDX job processor. The *job queue processor* executes the programs independently of the program that submitted them.

The following example shows how one program can submit programs CALC on volume EDX003 and UPDATE on volume MYVOL. The explanation for each numbered step appears on the next page.

```
   BEGIN   PROGRAM  START
   START   EQU      *
           •
           •
           •
1          LOAD     $SUBMITP,SUBPARM1,LOGMSG=NO,EVENT=SUBEND
2          WAIT     SUBEND
3          IF       (SUBEND,NE,-1)
            PRINTEXT  'ERROR LOADING CALC',SKIP=1
           ENDIF
           •
           •
           •
4          LOAD     $SUBMITP,SUBPARM2,LOGMSG=NO,EVENT=SUBEND
           WAIT     SUBEND
           IF       (SUBEND,NE,-1)
             PRINTEXT  'ERROR LOADING UPDATE',SKIP=1
           ENDIF
           •
           •
           •
           PROGSTOP
   SUBEND  ECB
   SUBPARM1 EQU     *
5          DATA     C'SJ'
6          DATA     X'0002'
7          DATA     CL8'JOB01'
8          DATA     CL6'EDX40'
9          DATA     A(JOBNO)
   SUBPARM2 EQU     *
           DATA     C'SJ'
           DATA     X'0002'
           DATA     CL8'JOB02'
           DATA     CL6'EDX40'
           DATA     A(JOBNO)
10 JOBNO   DATA     F'0'
            ENDPROG
            END
```

1 Submit a job to the job queue. Point to a parameter list called SUBPARM1, and identify the event to be posted when the job has been submitted (EVENT=SUBEND).

2 Wait for the job to be submitted to the job queue.

3 Test for successful completion (−1) of the submit.

4 Submit a job to the job queue. Point to a parameter list called SUBPARM2, and identify the event to be posted when the job has been submitted (EVENT=SUBEND).

5 Specify that the job is to be submitted (SJ).

6 Specify the priority of the job (0002).

7 Identify the name of the data set that contains the job stream processor commands (JOB01).

8 Specify the volume that contains JOB01 (EDX40).

9 Specify the address of the field in which the system will put the job number (JOBNO).

10 Reserve storage for the system to put the job number.

The data set called JOB01 contains job stream processor commands. It might look like the following:

```
JOB  JOB01
PROGRAM  CALC,EDX003
EXEC
EOJ
```

The PROGRAM command refers to a program called CALC on volume EDX003.

The data set called JOB02 contains job stream processor commands. It might look like the following:

```
JOB  JOB02
PROGRAM  UPDATE,MYVOL
EXEC
EOJ
```

The PROGRAM command refers to a program called UPDATE on volume MYVOL.

Chapter 7. Finding and Fixing Errors

Up to this point, you have written, compiled, and link edited your program. However, the program may not run as you expect it to. Steps may be out of sequence or the program may come up with the wrong answers. In other words, you have problems with your program's logic.

The program also may not run to a successful conclusion. An exception condition may occur that interrupts the execution of a program.

The $DEBUG utility assists you in determining logic errors. The task error exit routine is one of the tools you can use to diagnose exception conditions.

Determining Logic Errors in a Program

This section tells you how to locate and fix logic errors in your program by using the $DEBUG utility. $DEBUG can work from terminals; you do not have to use the console. $DEBUG has commands that allow you to:

- Stop execution at one or more specific places in a program. The places where you choose to stop a program are called breakpoints.
- Set up a trace routine. A trace routine allows you to step through program instructions one at a time. You must specify one or more parts of the program you wish to trace (called a trace range). Each time the program executes an instruction within any of the specified trace ranges, the terminal displays a message identifying the task name and the instruction address just executed. You can stop program execution after each instruction executes within a trace range.
- List additional registers and storage location contents while the program is stopped at a breakpoint or at an instruction within a trace range.
- Change the contents of storage locations, registers, data, or instructions.
- Restart program execution. You can restart execution at the breakpoint or trace range address where it is currently stopped or you may specify another instruction address.

Creating and Running the Program

This section shows an EDL program that has a logic error in it. It shows briefly how to enter, compile, link edit, and run (execute) the program.

Perform the following steps using the session manager. Give the program the name ADD10. If you have any problems, see Chapter 3, "Entering a Source Program."

1 Enter the following program on your terminal exactly as shown.

```
ADD10    PROGRAM    STPGM
STPGM    GETVALUE   COUNT,'ENTER NUMBER: '
LOOP     DO         10,TIMES
           ADD      COUNT,SUM
         ENDDO
         PRINTEXT   'RESULT='
         PRINTNUM   SUM
         PROGSTOP
COUNT    DATA       F'0'
SUM      DATA       F'0'
         ENDPROG
         END
```

This program is supposed to take a number entered on a terminal and add it to itself 10 times. For example, if you enter the number 10, you should get the response: RESULT = 100. However, because of a program logic error, you will not get the expected answer when you run the program.

2 Now compile the program. If you have any problems, see Chapter 4, "Compiling a Program." Save the compiler listing. You will need it when you run $DEBUG.

3 Next, link edit your program. If you have any problems, see Chapter 5, "Preparing an Object Module for Execution."

4 Run the program. If you have any problems, see Chapter 6, "Executing a Program."

When the prompt ENTER NUMBER appears, enter the number 10.

```
ENTER NUMBER: 10
RESULT=      0
```

Because this program has a logic error, the answer returned is 0. The expected result was 100.

Debugging and Fixing the Program

This section describes how to use $DEBUG to find and correct a logic error.

Loading $DEBUG

To start debugging the program, do the following:

1. End the session manager. You cannot run $DEBUG while the session manager is active. One way to load $DEBUG is with the $L operator command.

2. Enter the following:

```
> $L $DEBUG
```

   The following message appears, telling you that $DEBUG is being loaded.

```
LOADING $DEBUG      nnP, hh:mm:ss, LP= xxxx, PART= y
```

3. Then $DEBUG asks for the name of the program to be debugged. Respond as follows:

```
PROGRAM (NAME,VOLUME): ADD10,EDX002
```

4. The utility then prompts for a partition number and a terminal name:

```
PARTITION (DEFAULT IS CURRENT PARTITION):
TERMINAL NAME (DEFAULT IS CURRENT TERMINAL):
```

   If you press enter after each of the prompts, the system uses the current partition and terminal.

$DEBUG then displays the following information:

```
LOADING ADD10       nnP, hh:mm:ss, LP= xxxx, PART= y

REQUEST "HELP" TO GET LIST OF DEBUG COMMANDS
ADD10    STOPPED AT   0034
```

These messages tell you:

- The load point (LP = BD00) of the program
- The partition where $DEBUG loaded the program (PART = 1)
- That $DEBUG set a breakpoint and stopped the program at address 0034, which is the first executable instruction.

Note that you can also enter HELP to see a list of the available $DEBUG commands.

$DEBUG Commands

Both $DEBUG and the program have been loaded into partition 1. The program has stopped and $DEBUG is waiting for a command. To see a list of the $DEBUG commands:

1. Press the attention key.
2. Enter **HELP**.

The list of $DEBUG commands appears on the screen.

```
> HELP
THE FOLLOWING COMMANDS ARE AVAILABLE:

HELP     - LIST DEBUG COMMANDS
WHERE    - DISPLAY TASK STATUS
LIST     - DISPLAY STORAGE OR REGISTERS
PATCH    - MODIFY STORAGE OR REGISTERS
QUALIFY  - MODIFY BASE ADDR
AT       - ESTABLISH BREAKPOINTS
OFF      - REMOVE BREAKPOINTS
GO       - START TASK PROCESSING
POST     - POST EVENT OR PROCESS INTERRUPT
PRINT    - DIRECT LISTING TO PRINTER
BP       - LIST BREAK POINTS
GOTO     - CHANGE EXECUTION SEQUENCE
CLOSE    - CLOSE SPOOL JOB CREATED BY $DEBUG
END      - TERMINATE DEBUG FACILITY
```

Use the $DEBUG commands to:

- List $DEBUG commands (HELP).
- Display the current status of each task (WHERE).
- Display storage or register contents (LIST).
- Change storage or register contents (PATCH).
- Change the base address (QUALIFY).
- Set breakpoints and trace ranges (AT).
- Remove breakpoints and trace ranges (OFF).
- Restart a stopped task (GO).
- Start a task waiting for an event or process interrupt (POST).
- Direct output to another terminal (PRINT).
- List breakpoints and trace ranges (BP).
- Restart a stopped task at a different instruction (GOTO).
- Close a spool job that was created by $DEBUG (CLOSE).
- End $DEBUG (END).

You can enter any of the commands by pressing the attention key and entering the command name. $DEBUG then prompts for the command parameters. For example, if you want to set a breakpoint, enter the AT command. $DEBUG then prompts for the parameters as shown below.

```
> AT
OPTION(*/ADDR/TASK/ALL): ADDR
BREAKPOINT ADDRESS: 4C
LIST/NOLIST: LIST
OPTION(*/ADDR/R0...R7/#1/#2/IAR/TCODE/UNMAP): #1
LENGTH: 1
MODE(X/F/D/A/C): X
STOP/NOSTOP: STOP
      1 BREAKPOINT(S) SET
```

This command sets a breakpoint at address 4C. It requests that $DEBUG print the contents of register 1 (one word) in hexadecimal. STOP tells $DEBUG to stop at address 4C.

For detailed syntax descriptions, refer to each individual command in the *Operator Commands and Utilities Reference.*

You can also enter a command and its parameters without going through the prompts. For example:

```
> AT ADDR 4C L #1 1 X S
```

gives you the same results.

Finding the Errors

Now that you have loaded $DEBUG, specified your program name, and reviewed the $DEBUG commands, you are ready to start finding the logic errors in your program. You should have a listing of the program before you start. Then follow these steps:

1 Use the **AT** command to set a breakpoint to stop the program after the GETVALUE executes (address 004C). Respond to the prompts as follows:

```
> AT
OPTION(*/ADDR/TASK/ALL): ADDR
BREAKPOINT ADDR: 004C
LIST/NOLIST: NOLIST
STOP/NOSTOP: STOP
     1 BREAKPOINT(S) SET
```

The breakpoint to stop after the GETVALUE instruction executes is now set.

2 Enter a **GO** command and, when prompted, enter the number 10.

```
> GO
     1 BREAKPOINT(S) ACTIVATED
ENTER NUMBER: 10
ADD10    STOPPED AT   004C
```

Program execution has stopped at the instruction labeled LOOP. The GETVALUE instruction has executed.

To check to see if the program read the data correctly, use the LIST command to display data field COUNT at address 0074.

3 Enter a **LIST** command and respond as follows:

```
> LIST
OPTION(*/ADDR/R0...R7/#1/#2/IAR/TCODE/UNMAP): ADDR
ADDRESS: 0074
LENGTH: 1
MODE(X/F/D/A/C): D
  0074 D' 0010'
```

The LIST command shows that 0074 contains 10, the correct input. This indicates proper logic to this point.

The next set of instructions is the DO loop. Set another breakpoint to stop the program after execution of the DO loop at address 005E.

4 Enter an **AT** command and respond as follows:

```
> AT
OPTION(*/ADDR/TASK/ALL): ADDR
BREAKPOINT ADDR: 005E
LIST/NOLIST: NOLIST
STOP/NOSTOP: STOP
     1 BREAKPOINT(S) SET
```

The breakpoint to stop after the DO loop instructions executes is now set.

5 Enter a **GO** command and the following occurs:

```
> GO
     1 BREAKPOINT(S) ACTIVATED
ADD10    STOPPED AT   005E
```

At this point, the data field SUM at address 0076 should contain the number 100.

To check to see if the data field SUM contains the proper number, use the LIST command to display data field SUM at address 0076.

6 Enter a **LIST** command and respond as follows:

```
> LIST
OPTION(*/ADDR/R0...R7/#1/#2/IAR/TCODE/UNMAP): ADDR
ADDRESS: 0076
LENGTH: 1
MODE(X/F/D/A/C): D
  0076 D' 0000'
```

The LIST command shows that this field contains zero. This means that the DO loop or the ADD instruction in the DO loop is incorrect. If you examine these instructions, you will see that the DO loop is correct. However, The ADD instruction has a logic error. In order to receive the proper answer, the COUNT field should be added to the SUM field. The operands are backwards. The DO loop executes the ADD instruction 10 times but is adding SUM to COUNT, causing the SUM field to remain 0.

Fixing the Problem

To verify that this is the problem without having to recompile and link edit the program, you can use the PATCH command of $DEBUG for a temporary fix. This fix is good only for one execution of the program. PATCH only fixes the copy of the program loaded by $DEBUG. It does not fix the program on your volume. Once you have verified that the fix is correct, you can then change the program on your volume.

To verify that the problem is the ADD instruction, do the following:

1 Find address 0052 on your compiler listing. This line contains the ADD instruction. The entire line looks like this:

```
0052   0032 0074 0076                    ADD          COUNT,SUM
```

The address of the instruction is 0052. The operation code (0032) does not change. The next two words, 0074 and 0076, are the addresses of data fields COUNT and SUM.

To fix the logic error, change the instruction to look as follows:

```
0052    0032 0076 0074
```

2 Enter a **PATCH** command and respond to the prompts as follows:

```
> PATCH
OPTION( */ADDR/R0...R7/#1/#2/IAR/TCODE/UNMAP): ADDR
ADDRESS: 0054
LENGTH: 2
MODE(X/F/D/A/C): A
NOW IS
 0054 A'  0074 0076'
DATA:  0076 0074
NEW DATA
 0054 A'  0076 0074'
YES/NO/CONTINUE: YES
```

The program is now patched. When it executes, it will add COUNT to SUM to arrive at the expected result. You can test the change by reexecuting the program.

To reexecute the program, you have to know two things: the address where the program is currently stopped (005E) and the address of the first executable instruction (0034). Then you can use the GOTO command to restart the program at the first executable instruction.

3 Enter a **GOTO** command as shown:

```
> GOTO 005E 0034
 1 BREAKPOINT(S) ACTIVATED
ADD10    STOPPED AT 0034
```

4 The program is now at the beginning. To test it, set all the breakpoints off so that the program will run to completion.

Enter the following:

```
> OFF ALL
```

5 Now enter a **GO** command and respond to the prompts as follows:

```
> GO
ENTER NUMBER: 10
RESULTS=     100
ADD10   ENDED AT 00:27:56
```

This time you received the expected result of 100. You have verified that the logic error was the ADD instruction.

Ending $DEBUG

Now that you have found and fixed the logic error in your program, use the **END** command to terminate $DEBUG. Enter the following:

```
> END
```

When $DEBUG ends, your program remains in storage with all of its tasks active and operating if it has not already ended. In our example, however, the program has ended.

To make the fix permanent, change your source program (see Chapter 3, "Entering a Source Program"), recompile it (see Chapter 4, "Compiling a Program"), and link edit your object code module (see Chapter 5, "Preparing an Object Module for Execution").

Displaying Unmapped Storage

If you write a program that uses unmapped storage, you may want to display portions of unmapped storage. Displaying unmapped storage may be necessary to determine whether or not a program is processing correctly.

This section shows how to display a portion of unmapped storage. The program example used in this section is shown in "Sample Program" on page 7-12.

The program moves mortality rates to the unmapped storage areas. To find out if the rates are being moved properly, you can display an unmapped storage area as follows:

1 Load $DEBUG and specify your program name:

```
> $L $DEBUG
```

The following message appears, telling you that the system is loading $DEBUG.

```
LOADING $DEBUG     nnP, hh:mm:ss, LP= xxxx, PART= y
```

2 When $DEBUG asks for the name of the program to be debugged, respond as follows:

```
PROGRAM NAME: INSURE,EDX40
```

3 The utility then prompts for a partition number and a terminal name:

```
PARTITION (DEFAULT IS CURRENT PARTITION):
TERMINAL NAME (DEFAULT IS CURRENT TERMINAL):
```

If you press enter after each of the prompts, the system uses the current partition and terminal.

4 Use the **AT** command to set a breakpoint to stop the program after the ENDIF statement that follows the two MOVE instructions that move the rates to the unmapped storage area (address 152). Respond to the prompts as follows:

```
> AT
OPTION(*/ADDR/TASK/ALL): ADDR
BREAKPOINT ADDR: 0152
LIST/NOLIST: NOLIST
STOP/NOSTOP: STOP
     1 BREAKPOINT(S) SET
```

5 Enter a **GO** command.

```
> GO
     1 BREAKPOINT(S) ACTIVATED
INSURE    STOPPED AT   0152
```

Program execution has stopped at the ENDIF statement. One of the MOVE instructions has executed.

6 To see if the program moved data correctly, first find the number of the unmapped storage area. CNTRYC (address 02AE) contains the number of the unmapped storage area obtained with the SWAP instruction.

```
> LIST
OPTION(*/ADDR/R0...R7/#1/#2/IAR/TCODE/UNMAP): ADDR
ADDRESS: 02AE
LENGTH: 1
MODE(X/F/D/A/C): X
  02AE X' 0003'
```

The SWAP instruction obtained unmapped storage area number 3.

Then display storage in unmapped storage area number 3, using the LIST command as follows:

```
> LIST
OPTION(*/ADDR/R0...R7/#1/#2/IAR/TCODE/UNMAP): UNMAP
STORBLK ADDRESS (0 TO CANCEL LIST): 04B4
SWAP#: 3
DISPLACEMENT: 0
LENGTH: 20
MODE(X/F/D/A/C): C
  0000 C'00010002000300030004'
```

This LIST command shows the contents of the unmapped storage area. It contains five sets of four-digit numbers that could be mortality rates. Check the input data to determine if the program moved them properly.

Sample Program

```
LOC    +0   +2   +4   +6   +8    SOURCE STATEMENT  ADD10    ,EDX002
0000   0008 D7D9 D6C7 D9C1 D440  INSURE   PROGRAM  ST,DS=((ACTTAB,EDX40),(ACTOUT,EDX40))
         •
         •
         •
                                          COPY     STOREQU
00B8                              ST      EQU      *
00B8   00B9 04B4 0000 0000 0101           GETSTG   HOLD,TYPE=ALL
00C2   805C 02A8 0001                     MOVE     USANO,1
00C8   035C 0000 04C0                     MOVE     #1,HOLD+$STORMAP
00CE   809C 00EC 000A                     DO       10
00D4   00B9 04B4 02A8 01E4 0300             SWAP     HOLD,USANO,ERROR=SWAPERR
00DE   8158 0000 4000 0320                  MOVE     (+MENTBL,#1),C' ',(800,BYTE)
00E6   8032 02A8 0001                       ADD      USANO,1
00EC   009D 0000 0001                     ENDDO
00F2   8020 04FA 0001 0000 220E  READ     READ     DS1,MORTAL,1,END=STOP
00FC   0032 0156
0100   00B1 02AE 04FA 0002 0080           CONVTD   CNTRYC,CNTRY,PREC=S,FORMAT=(2,0,I)
010A   035C 0000 04C0                     MOVE     #1,HOLD+$STORMAP
0110   00B9 04B4 02AE 01E4 0300           SWAP     HOLD,CNTRYC,ERROR=SWAPERR
011A   00B1 02AC 04FC 0002 0080           CONVTD   AGEC,AGE,PREC=S,FORMAT=(2,0,I)
0124   035C 0002 02AC                     MOVE     #2,AGEC
012A   8338 0002 0004                     MULT     #2,4
0130   0F32 0000 0002                     ADD      #1,#2
0136   00A3 0502 02A6 014A               IF       (SEX,EQ,ONE,BYTE)
013E   015B 0000 04FE 0004                  MOVE     (+MENTBL,#1),RATE,(4,BYTES)
0146   00A0 0152                         ELSE
014A   015B 0190 04FE 0004                  MOVE     (+WMNTBL,#1),RATE,(4,BYTES)
0152                                      ENDIF
0152   00A0 00F2                         GOTO     READ
0156                              STOP    EQU      *
0156   805C 02A8 0001                     MOVE     USANO,1
015C   035C 0000 04C0                     MOVE     #1,HOLD+$STORMAP
0162   809C 01A8 000A                     DO       10
0168   00B9 04B4 02A8 01E4 0300           SWAP     HOLD,USANO,ERROR=SWAPERR
0172   045B 02B4 0000 0190                MOVE     OUTAREA,(+MENTBL,#1),(400,BYTES)
017A   8020 02B4 0002 0000 3110           WRITE    DS2,OUTAREA,2,0,END=EOFILE,ERROR=WRERR
0184   0072 01B2 0274
018A   045B 02B4 0190 0190                MOVE     OUTAREA,(+WMNTBL,#1),(400,BYTES)
0192   8020 02B4 0002 0000 3110           WRITE    DS2,OUTAREA,2,0,END=EOFILE,ERROR=WRERR
019C   0074 01B2 0274
01A2   8032 02A8 0001                     ADD      USANO,1
01A8   009D 0000 0001                   ENDDO
01AE   00A0 02A2                        GOTO     END
01B2                             EOFILE  EQU      *
01B2   8026 2A2A 7C5C 5C40 C1C3          PRINTEXT '@** ACTUARIAL FILE HAS EXCEEDED ...
         •
         •
         •
```

```
01E0   00A0 02A2                          GOTO     END
01E4                              SWAPERR EQU      *
01E4   005C 02AA 05FA                     MOVE     TASKRC,INSURE
01EA   80A2 02AA 021A                     IF       (TASKRC,EQ,1)
01F2   8026 2423 7C5C 5C40 C9D5             PRINTEXT '@** INVALID UNMAPPED STORAGE ...
         •
         •
         •
021A                                      ENDIF
021A   802A 02AA 0002 0244                IF       (TASKRC,EQ,2)
0222   8026 1E1D 7C5C 5C40 E2E6             PRINTEXT '@** SWAP AREA NOT INITIALIZED'
         •
         •
         •
0244                                      ENDIF
0244   80A2 02AA 0064 0270                IF       (TASKRC,EQ,100)
024C   8026 201F 7C5C 5C40 D5D6             PRINTEXT '@** NO UNMAPPED STORAGE SUPPORT'
         •
         •
         •
0270                                      ENDIF
0270   00A0 02A2                          GOTO     END
0274                              WRERR   EQU      *
0274   8026 2626 7C5C 5C40 C4C9           PRINTEXT '@** DISK WRITE ERROR ON ACTUARIAL ...
         •
         •
         •
029E   00A0 02A2                          GOTO     END
02A2                              END     EQU      *
02A2   0022 FFFF                          PROGSTOP
02A6   F1                         ONE     DATA     C'1'
02A7
02A8   0000                       USANO   DATA     F'0'
02AA   0000                       TASKRC  DATA     F'0'
02AC   0000                       AGEC    DATA     F'0'
02AE   0000                       CNTRYC  DATA     F'0'
02B0   0000 0200 0000 0000 0000   OUTAREA BUFFER   512,BYTES
02BA   0000 0000 0000 0000 0000
04AE   0000 0000 0000
04B4   0000 C1C1 0000 0000 0000   HOLD    STORBLK  TWOKBLK=1,MAX=10
         •
         •
         •
0000                              MENTBL  EQU      0
0000                              WMNTBL  EQU      MENTBL+300
04F6   0000 0100 0000 0000 0000   MORTAL  BUFFER   256,BYTES
0500   0000 0000 0000 0000 0000
04FA                              CNTRY   EQU      MORTAL
04FC                              AGE     EQU      MORTAL+2
04FE                              RATE    EQU      MORTAL+4
0502                              SEX     EQU      MORTAL+8
05FA   0000 0000 0000 0234 0000           ENDPROG
0692                                      END
```

Using Return Codes to Diagnose Problems

This section describes how to use the return codes to diagnose problems.

Many EDL instructions return a code to indicate whether or not they execute successfully. Each time EDX executes one of these instructions, it stores a code, called a *return code*, in the first two words, called *task code words*, of the task control block (TCB). You can access the TCB by referencing the task name.

In the following example, the instructions at label ERRTEST compare the return code of the READTEXT instruction with the successful return code (−1).

```
BEGIN   PROGRAM  START
         •
         •
         •
        READTEXT  NAME,'ENTER NAME: ',SKIP=4,MODE=LINE
ERRTEST MOVE      TASKRC,BEGIN
        IF        (TASKRC,NE,-1),GOTO,CHECK
        ENDIF
         •
         •
         •
CHECK   PRINTEXT  'ERROR IN READING NAME',SKIP=1
        PRINTNUM  TASKRC
        GOTO      END
         •
         •
         •
END     PROGSTOP
TASKRC  DATA      F'0'
        ENDPROG
        END
```

You must test the return code before executing any other instruction because the system may overlay the task code word with the return code of the next instruction.

Diagnosing Errors with ACCA Devices

To diagnose an error that occurs after you read or write to an ACCA device, you can use the following instructions to obtain the return code and three cycle steal status words.

```
TEST     PROGRAM  START,TERMERR=TERROR
           •
           •
           •
         COPY     CCBEQU
           •
           •
           •
1 TERROR TCBGET   RETCD,$TCBCO
2        TCBGET   #1,$TCBCCB
3        MOVE     CCS,($CCBSTW0,#1),3,FKEY=0
           •
           •
           •
RETCD    DATA     F'0'
CCS      DATA     3F'0'
           •
           •
           •
```

1 Obtain the return code from the first word of the TCB.

2 Obtain the address of the CCB (terminal control block).

3 Move the three cycle steal status words to CCS.

If the return code is not −1, the task code word contains the following information:

Bit	Description
0	Unused
1−8	ISB of last operation (I/O complete)
9	Unused
10	1 if error reported as attention interrupt
11	1 if a write or control operation (I/O complete)
12	Read operation (I/O complete)
13−15	Condition code +1 after I/O start or condition code after I/O complete

Refer to the appropriate hardware description manual for a description of the cycle steal status words and the interrupt status byte (ISB) condition codes.

Task Error Exit Routines

This section describes the facilities provided by the system when an exception occurs. These are the supervisor facility and the system-supplied task error exit routine.

When an exception occurs, the supervisor takes certain actions. What action it takes depends on whether or not you have coded a task error exit routine in your program. If your program does not have a task error exit routine, the supervisor simply writes a program check message on $SYSLOG and terminates the program. If your program has a task error exit routine, either the one supplied by the system or your own, the supervisor does the following:

1. Stores the hardware status at the time of the exception in a block of storage designated by the task.
2. Passes control to the task at its task error exit entry point.

At this point, the task error exit routine gains control. The next section discusses only the system-supplied routine. However, remember that, if necessary, you can substitute your own routine. (For information on writing your own task error exit routine, refer to the *Customization Guide*.)

Notes:

1. A task error exit routine is a part of the task it serves. The supervisor passes control to it at the task level; it is not a subroutine of the supervisor's error handler.
2. The registers (including the EDL software registers, #1 and #2) used by the error exit routine are those normally used by the task.
3. To resume executing the task following corrective action by task error exit, branch (if in Series/1 instruction mode) or GOTO (if in EDL mode) the appropriate location.
4. If the error exit is unable to recover from the exception, it should issue a PROGSTOP instruction.

The System-Supplied Task Error Exit Routine ($$EDXIT)

A task error exit routine named $$EDXIT is available on volume ASMLIB. This routine:

- Captures relevant data from the program header, task control block, and hardware status area when an exception occurs
- Formats and prints this data on $SYSLOG and $SYSPRTR
- Displays an error message on the loading terminal.

Using $$EDXIT

To use the supplied routine, you must:

- Code $$EDXIT as the value of the ERRXIT keyword parameter of each PROGRAM and TASK statement in your program. For example:

```
AB PROGRAM ....,ERRXIT=$$EDXIT
   •
   •
   •
CD TASK    ....,ERRXIT=$$EDXIT
```

- Declare the label $$EDXIT to be an EXTRN.

```
EXTRN  $$EDXIT
```

The task error exit routine is included in the autocall list $AUTO on volume ASMLIB. It is included automatically when you link edit any program that references $$EDXIT. A separate INCLUDE statement is not required for $$EDXIT in the LNKCTRL data set. All you need to do is code $AUTO,ASMLIB as the autocall data set on the AUTOCALL statement of $EDXLINK.

The following example shows what $$EDXIT prints on $SYSLOG and $SYSPRTR. It shows that a program check has occurred in an application program named PCHECK. The numbers to the left of both columns correspond to the explanations that follow the example. For additional information on interpreting program check messages refer to the *Problem Determination Guide*.

```
      ****************************************
      * WARNING!! AN EXCEPTION HAS OCCURRED!! *
      ****************************************

1  PROGRAM NAME              =  PCHECK      9  PSW =  8002
2  PROGRAM VOLUME            =  EDXWRK         IAR =  3124
3  PROGRAM LOAD POINT        =  0000           AKR =  0440
4  ADDRESS OF ACTIVE TCB     =  016C           LSR =  00D0
5  ADDRESS OF CCB            =  1802           R0 (WORK REGISTER)  = 0096
   NUMBER OF DATA SETS       =     1       10  R1 (EDL INSTR ADDR) = 00E7
   NUMBER OF OVERLAYS        =     0       11  R2 (EDL TCB ADDR)   = 016C
6  $TCBADS                   =  0004           R3 (EDL OP1 ADDR)   = 00E7
   ADDRESS OF FAILURE                          R4 (EDL OP2 ADDR)   = 00B2
7   (REL. TO PGM LOAD POINT =  00E7      12  R5 (EDL COMMAND)    = 0000
   DUMP OF FAIL ADDRESS                        R6 (WORK REGISTER)  = 0000
8   00E6: 0000 0028 0028 3635                  R7 (WORK REGISTER)  = 0000
   $TCBCO =       -1 DEC;  FFFF HEX           #1 =  0000
   $TCB02 =        0 DEC;  0000 HEX           #2 =  0000

   PSW ANALYSIS:

   SPECIFICATION CHECK
   TRANSLATOR ENABLED
```

Explanation:

1 The **PROGRAM NAME** field identifies the name of the active program.

2 The **PROGRAM VOLUME** field identifies the name of the volume where the program resides.

3 The **PROGRAM LOAD POINT** field contains the address at which the program was loaded for execution.

4 The **ADDRESS OF ACTIVE TCB** field contains the address of the active task control block (TCB) when the exception occurred.

5 The **ADDRESS OF CCB** field contains the address of the terminal control block for the terminal that loaded the program.

6 The **$TCBADS** field contains the address space where the program is loaded if not doing cross-partition move or the target address space if doing a cross-partition move.

7 The **ADDRESS OF FAILURE** field contains the address of the instruction that caused the program check.

8 The **DUMP OF FAIL ADDRESS** field shows the location and content of the instruction that was executing when the failure occurred.

9 The **PSW** field indicates the type of exception that occurred.

10 The **R1** field usually points to the EDL instruction address.

11 The **R1** field usually contains the EDL TCB address.

12 The **R5** field usually contains the operation code of the EDL instruction that was being executed.

The following message appears on the loading terminal when the program check occurs:

```
A MALFUNCTION HAS OCCURRED -- CALL SYSTEM PROGRAMMER
```

Notes:

1. If you are executing either a combination of EDL instructions and Series/1 instructions or all Series/1 instructions, the registers may not contain this information.
2. You can restart the program by writing your own error exit routine to reload it.

$$EDXIT provides you with information about the program, task, and hardware status when an exception occurs. You can extend the capabilities of $$EDXIT so that it will also evaluate the information and make an appropriate response. For more information on writing your own task error exit routine, refer to the *Customization Guide*.

Chapter 8. Reading Data from and Writing to Screens

The Event Driven Executive allows you to read from and write to a screen that appears on a terminal. A person at a terminal can supply data to a program and the program can display information on the terminal screen. EDX allows you to use two types of screens: roll screens and static screens.

This chapter describes:

- When to use roll screens
- When to use static screens
- Differences between static screens and roll screens
- Reading from and writing to roll screens
- Reading from and writing to static screens
- Designing device-independent static screens
- Reading from and writing to a 3101, 3151, 3161, 3163, or 3164 Display terminal.

Note: The procedures for a 3151, 3161, 3163, or 3164 terminal may differ from the procedures for a 3101 terminal. The notations to the examples explain the differences in the procedures. However, the procedures in this chapter that describe the 3101 terminal also apply to the 3151, 3161, 3163, and 3164 terminals running in 3101 emulation mode.

This chapter shows how to write a program to read five data items from a screen and write them back to the screen. The chapter shows how to use each kind of screen (roll and static).

You can generally code terminal programs using either roll or static screens. However, each screen offers distinct advantages for certain types of programs.

When to Use Roll Screens

A *roll screen* is similar to a typewriter. The system reads or writes data line-by-line, starting with line 0 at the top of the screen and ending with line 23 at the bottom of the screen. You can use roll screens to read or write a single data item.

A program that uses roll screens usually prompts the operator for data, waits for an operator response, and checks the validity of the input data. Roll screens are best suited for application programs in which:

- A simple question-and-answer dialogue occurs between program and operator.
- A single line is sufficient for each response.
- An incorrect response requires only a reprompt.
- You want to use a minimum of processor storage.

In addition, the terminal may support roll screens only.

Roll screen dialogue is relatively easy to code and requires little program preparation. You can code prompts in a tree structure where the choice of the next prompt depends on the reply to past prompts.

You can print more than one line of text to introduce a prompt. For example, you might want to offer the choice of several programs to be loaded, each of which may choose to continue the dialogue at the same terminal. You can also display more than one line of text in a program reply.

When to Use Static Screens

A *static screen* represents a page of information. The system reads or writes an entire screen at once. A static screen allows a terminal operator to modify an entire screen image before entering the data. You can use static screens to read or write several data items at one time.

Programming for static screens involves managing the entire screen as a series of protected and unprotected fields. A *protected field* is an area that contains an operator prompt or an input field name. It is protected from being accidentally changed by the operator. An *unprotected field* is an area that is to be filled in by the operator.

Static screens are best suited for programs in which:

- The dialogue involves a series of full screens.
- More than one line of response may be required.
- You need to determine cursor position or manipulate the cursor.
- You need to write protected fields.
- You need attribute characters such as blinking and nondisplay.
- The unprotected fields may be scattered across the screen and interspersed with the protected fields.
- Many related data fields are to be entered at one time.
- Medium to large amounts of data accompany each prompt, operator response, or program reply.

You can manage static screens most easily by using the $IMAGE utility to define your screens. $IMAGE places the screens on direct access storage. The program then can read them into processor storage. $IMAGE subroutines and terminal I/O statements allow you to read the screen into the application program, display it at the terminal, position the cursor, scatter read or write unprotected fields, and wait for a response.

Differences Between Static Screens and Roll Screens

Static screens differ from roll screens in the following ways:

- Forms-control operations that would cause a page-eject for roll screens simply wrap around to the top for static screens.
- On static screens, the system performs no automatic erasure.

- Input operations directed to static screens normally are executed immediately. This allows the program to read selected fields from the screen after the operator modifies the entire display. A program can issue the WAIT KEY instruction to wait for the operator to respond. The operator can signal the program with the program function (PF) keys.
- To allow convenient operator/program interaction, QUESTION, READTEXT, and GETVALUE instructions which include prompt messages are executed as if they were directed to a roll screen (automatic task suspension for input).
- On static screens, the "at sign" character @ is a data character. On roll screens, it indicates a new line.

Reading and Writing One Line at a Time

Reading and writing a single line from a terminal screen involves reading the data item from a roll screen and writing or *displaying* the data item on the screen.

To read and write to a roll screen:

1. Reserve storage for data.
2. Read a data item.
3. Write a data item.

Reserving Storage for the Data

To reserve storage for a data item that you will read, you must know its maximum length. To reserve storage for a text string of 30 characters, use the TEXT statement as follows:

```
NAME    TEXT    LENGTH=30
```

The name of the storage is NAME. The next section describes how to put a data item into NAME.

Reading a Data Item

To read a data item from a roll screen, you can use either the READTEXT or GETVALUE instruction. The READTEXT instruction allows you to read a text string. The GETVALUE instruction allows you to read one or more numbers.

To read a data item into a storage area, use the READTEXT instruction as follows:

```
READTEXT NAME,'NAME:',SKIP=1,MODE=LINE
```

The instruction displays the prompt **NAME:** and the system waits for a response. When the operator enters a name and presses the enter key, the system stores the text string in an area called NAME.

The operand SKIP=1 causes the system to skip one line before displaying the prompt. The operand MODE=LINE allows blanks in the response. Since most names contain at least one blank, you must code MODE=LINE to read the entire name.

Writing (Displaying) a Data Item

Writing (or *displaying*) a data item involves transferring the data item from storage to the terminal screen. You can use either the PRINTNUM or PRINTEXT instruction to transfer data to the terminal screen. The PRINTNUM instruction transfers one or more numbers. The PRINTEXT instruction transfers a text string.

To display the data item called NAME, use the PRINTEXT instruction as follows:

```
PRINTEXT NAME,SKIP=3
```

The operand SKIP=3 causes the system to skip three lines before displaying NAME.

Example

Prompt the operator for five data items: name, address, city, state, and zip code. Then display the five data items. Read from and write to the terminal that loaded the program.

```
1  TEST     PROGRAM  BEG
   BEG      EQU      *
2           READTEXT NAME,'       NAME:',SKIP=1,MODE=LINE
3           READTEXT ADDR,'    ADDRESS:',MODE=LINE
            READTEXT CITY,'       CITY:',MODE=LINE
            READTEXT ST,'      STATE:'
            READTEXT ZIP,'        ZIP:'
4           PRINTEXT NAME,SKIP=3
5           PRINTEXT ADDR,SKIP=1
            PRINTEXT CITY,SKIP=1
6           PRINTEXT ST,SPACES=1
            PRINTEXT ZIP,SPACES=2
            PROGSTOP
   NAME     TEXT     LENGTH=30
   ADDR     TEXT     LENGTH=30
   CITY     TEXT     LENGTH=30
   ST       TEXT     LENGTH=2
   ZIP      TEXT     LENGTH=5
            ENDPROG
            END
```

1 Begin the program and execute the instruction at label BEG.

2 Prompt the operator for the name and read the operator's response. Allow spaces in the name (MODE=LINE), skip one line (SKIP=1), and store the response in NAME.

3 Prompt the operator for the address and read the operator's response. Allow spaces in the name (MODE=LINE) and store the response in ADDRESS. Because the program writes to a roll screen, the prompt appears one line below the prompt for name.

4 Display the data item in NAME. Skip three lines before displaying (SKIP=3).

5 Display the data item in ADDR. Skip to the beginning of the next line before displaying (SKIP=1).

6 Display the data item in ST. Leave one blank space to the right before displaying (SPACES=1).

Executing the Example

If you entered, compiled, link edited, and loaded the example, the system would issue a prompt for each data item. After entering each data item, press the enter key. After you enter the last data item (zip code) and press enter, the system displays the data items.

After you enter all five data items, the screen might look like this:

```
     NAME:ROSE PETERSON
  ADDRESS:11 CYPRESS CREEK RD.
     CITY:SALINA
    STATE:KA
      ZIP:45367
```

When you press the enter key, the program displays the name and address as follows:

```
ROSE PETERSON
11 CYPRESS CREEK RD.
SALINA KA  45367
```

Note: Even though CITY is 30 characters long, the system displays only the actual length of the data.

Two Ways to Use Static Screens

Reading and writing an entire screen at once involves using *static screens*. The Event Driven Executive provides two methods to define static screens.

The first method requires that the format of the screen be defined within the program. Any change to the screen requires a change to the program.

In addition, programs that use this method are usually *not* device independent. In other words, a program that contains instructions that define a static screen may execute successfully on a 4978, 4979, or 4980 terminal and *not* execute on a 3101, 3151, 3161, 3163, or 3164 terminal.

The sections called "Coding the Screen within a Program" on page 8-6 and "Transferring an Entire Screen Image at Once" on page 8-10 describe the first method.

The second method for defining screens involves defining the screen with the $IMAGE utility and saving it in a data set. This method allows more than one program to use the same screen. In addition, a change to the screen does not necessarily require a change to each program that uses it.

Finally, you can write programs that are device independent; they execute successfully on 4978, 4979, 4980, 3101, 3151, 3161, 3163, or 3164 terminals. For information on designing static screens that you can use on these terminals, see "Designing Device-Independent Static Screens" on page 8-24.

The section called "Writing the Screen Image to a Data Set" on page 8-15 describes the second method.

For more information on coding static screens, see Appendix C, "Static Screens and Device Considerations."

Coding the Screen within a Program

This section describes reading data from and writing data to a static screen. Instructions in the program create the static screen.

For more information on static screens, see Appendix C, "Static Screens and Device Considerations."

This section describes one way to code a static screen within a program. For another way to define a screen within a program, see "Transferring an Entire Screen Image at Once" on page 8-10.

This section focuses on a sample program, describing the instructions in the same sequence that they appear in the program.

The sample program:

1 Defines the screen as static

2 Gets exclusive access to the terminal

3 Erases the screen

4 Reserves storage for data

5 Prompts the operator for a data item

6 Positions the cursor

7 Waits for a response

8 Reads a data item

9 Writes a data item.

Defining a Screen as Static

To define a screen as a static screen, use the IOCB statement as follows:

```
TERM  IOCB  SCREEN=STATIC
```

This statement defines the loading terminal as a static screen. The label TERM defines the name you will use in other instructions in the program.

For information on defining logical screens, see Appendix C, "Static Screens and Device Considerations."

Getting Exclusive Access to the Terminal

Before you can use a terminal as a static screen, you must get exclusive access to it. Use the ENQT instruction as follows:

```
ENQT  TERM
```

The operand TERM is the name you used to define the terminal in an IOCB instruction.

Erasing the Screen

Before you code instructions that prompt the operator for data, you should erase the screen. To erase the screen, use the ERASE instruction as follows:

```
ERASE    MODE=SCREEN,TYPE=ALL,LINE=0
```

The operand LINE=0 tells the system to begin erasing on line 0 (the first line) of the screen. The operand MODE=SCREEN causes the system to erase to the end of the screen. The operand TYPE=ALL allows the system to erase both protected and unprotected data.

Reserving Storage

To reserve storage for a data item that you read, you must know its maximum length. To reserve storage for a text string of 30 characters, use the TEXT statement as follows:

```
NAME    TEXT    LENGTH=30
```

The name of the storage is NAME. The READTEXT instruction transfers the data item containing the name into this area of storage.

Prompting the Operator for a Data Item

One way you can display information on a static screen is by issuing PRINTEXT instructions. For example, to prompt the operator for a name, use the PRINTEXT instruction as follows:

```
PRINTEXT 'NAME: ',LINE=1,PROTECT=YES
```

The instruction displays the prompt **NAME**. The operand LINE=1 causes the system to display the prompt on the second line of the screen. (The lines on a screen are numbered 0–23 and the columns are numbered 0–79.) The operand PROTECT=YES causes the prompt **NAME:** to be protected. A *protected* field cannot be changed by the operator.

Positioning the Cursor

If you use PRINTEXT instructions to prompt the operator for several data items, you would probably want to position the cursor after the first prompt. To position the cursor, you need two instructions: a PRINTEXT instruction and a TERMCTRL instruction:

```
PRINTEXT LINE=1,SPACES=13
TERMCTRL DISPLAY
```

The operands LINE=1 and SPACES=13 cause the system to position the cursor on the fourteenth space of line 1 (the second line). (The lines of a screen are numbered 0 through 23.)

Since the PRINTEXT instruction actually accumulates output in the system buffer, the TERMCTRL instruction is required to cause the cursor to be positioned.

Waiting for a Response

After you issue all the prompts, you must wait for the operator to respond. To wait for a response, use the WAIT instruction as follows:

```
WAIT    KEY
```

The operand KEY means that the program will wait until the operator presses either the enter key or one of the Program Function (PF) keys.

Reading a Data Item

Reading a data item involves issuing a READTEXT instruction for each data item you want to read. The READTEXT instruction might look like this:

```
READTEXT NAME,LINE=1,SPACES=13,MODE=LINE
```

The instruction reads the data item into the storage area called NAME. The operands LINE=1 and SPACES=13 cause the system to look for the data starting in the fourteenth position of the second line of the screen. The operand MODE=LINE allows the data to contain blanks.

Writing a Data Item

Writing a data item means transferring a data item from a storage area to the screen. A PRINTEXT instruction might look like this:

```
PRINTEXT NAME,LINE=11
```

The instruction writes the data item from the storage area called NAME. The operand LINE=11 causes the system to display the data starting in the first position of the twelfth line of the screen.

If you want to display another data item on the next line, you can use the SKIP operand as follows:

```
PRINTEXT ADDR,SKIP=1
```

The SKIP=1 causes the system to skip to the first position of the next line.

To leave spaces between one data item and another, use the SPACES operand as follows:

```
PRINTEXT CITY,SPACES=2
```

The SPACES=2 operand causes the system to leave two blanks between the previous data item and CITY.

Example

Prompt the operator for five data items: name, address, city, state, and zip code. Then display the five data items.

```
1  TEST      PROGRAM   BEG
2  TERM      IOCB      SCREEN=STATIC
3  BEG       ENQT      TERM
4            ERASE     MODE=SCREEN,TYPE=ALL,LINE=0
5            PRINTEXT  '        NAME:',LINE=1,PROTECT=YES
6            PRINTEXT  '     ADDRESS:',SKIP=1,PROTECT=YES
             PRINTEXT  '        CITY:',SKIP=1,PROTECT=YES
             PRINTEXT  '       STATE:',SKIP=1,PROTECT=YES
             PRINTEXT  '         ZIP:',SKIP=1,PROTECT=YES
7            PRINTEXT  LINE=1,SPACES=13
8            TERMCTRL  DISPLAY
9            WAIT      KEY
10           READTEXT  NAME,LINE=1,SPACES=13,MODE=LINE
11           READTEXT  ADDR,LINE=2,SPACES=13,MODE=LINE
             READTEXT  CITY,LINE=3,SPACES=13,MODE=LINE
             READTEXT  ST,LINE=4,SPACES=13
             READTEXT  ZIP,LINE=5,SPACES=13
12           PRINTEXT  NAME,LINE=11
13           PRINTEXT  ADDR,SKIP=1
             PRINTEXT  CITY,SKIP=1
14           PRINTEXT  ST,SPACES=1
             PRINTEXT  ZIP,SPACES=2
15           TERMCTRL  DISPLAY
16           DEQT
             PROGSTOP
   NAME      TEXT      LENGTH=30
   ADDR      TEXT      LENGTH=30
   CITY      TEXT      LENGTH=30
   ST        TEXT      LENGTH=2
   ZIP       TEXT      LENGTH=5
             ENDPROG
             END
```

1 Begin the program and execute the instruction at label BEG.

2 Define the screen as static.

3 Get exclusive use of the terminal.

4 Erase the screen. Erase the entire screen (MODE = SCREEN), including protected and unprotected fields (TYPE = ALL), and begin on the first line of the screen (LINE = 0).

5 Prompt the operator for name. Display the prompt on the second line of the screen (LINE = 1) and prevent the operator from overlaying the prompt (PROTECT = YES).

6 Prompt the operator for address. Display the prompt one line below the previous prompt (SKIP = 1) and prevent the operator from overlaying the prompt (PROTECT = YES).

7 Position the cursor on the fourteenth space (SPACES = 13) of the second line of the screen (LINE = 1).

8 Cause the cursor to be positioned (the previous PRINTEXT instruction accumulates output in the system buffer).

9 Wait for the operator to respond to the prompts. Resume execution when the operator presses either the enter key or one of the Program Function keys.

10 Read the first data item. Look for the data in the fourteenth space (SPACES=13) of the second line of the screen (LINE=1) and allow blanks in the data (MODE=LINE).

11 Read the second data item (address). Look for the data in the fourteenth space (SPACES=13) of the third line of the screen (LINE=2) and allow blanks in the data (MODE=LINE).

12 Display the data item NAME. Begin displaying the data on the first position of the twelfth line of the screen (LINE=11).

13 Display the data item ADDR. Begin displaying the data on the first position of the next line (SKIP=1). (In this example, ADDR would appear on the thirteenth line of the screen.)

14 Display the data item ST. Begin displaying the data after leaving one space (SPACES=1). (In this example, data item ST would appear one space to the right of data item CITY.)

15 Cause the data in ZIP to be displayed. (The data in ZIP remains in the system buffer until you issue this instruction or end the program with a PROGSTOP.)

16 Relinquish exclusive use of the terminal.

Transferring an Entire Screen Image at Once

This section describes a technique for transferring an entire screen to the display in one I/O operation.

This section shows how to:

1 Define protected and unprotected fields.

2 Define the screen.

3 Erase the screen.

4 Construct a screen image.

5 Read a series of data items.

6 Release the terminal.

Defining Protected and Unprotected Fields

The format of a 4978, 4979, or 4980 screen is defined as each character is written to the terminal. Fields are defined as follows:

- Each character or group of characters written with PROTECT=YES defines a protected field.
- Each character or group of characters written without PROTECT=YES defines an unprotected field.
- Null characters (X'00') can never be protected, so both protected and unprotected fields can be defined by writing data containing interspersed nulls with PROTECT=YES.

Once the fields of a screen have been defined, the 4978, 4979, or 4980 knows internally whether each of the 1920 positions on the screen is protected or unprotected; this is transparent to the user.

On the 4978, 4979, or 4980 there are two ways to write and read unprotected fields. The first is to read/write all the unprotected fields with one input/output operation. All the unprotected fields can be filled with data by one "scatter write" operation (PRINTEXT MODE=LINE). The unprotected fields can be read using one "gather read" operation (READTEXT MODE=LINE). The other way is to read or write individual fields by specifying screen coordinates (the LINE= and SPACES= parameters).

Defining the Screen

To define a screen as static, use the IOCB statement as follows:

```
SCREEN   IOCB      SCREEN=STATIC,BOTM=11,                C
      BUFFER=BUFF,RIGHTM=959
```

This statement defines the loading terminal as a static screen. The label SCREEN is the name you will use in other instructions in the program. The operand BOTM=11 defines the last usable line on the page as line eleven (the twelfth line). The operand RIGHTM=959 defines the last usable character position on the screen as the 959th position. The number 959 is the size of the buffer (BUFF is 960 bytes long) minus one.

Erasing the Screen

Before you code instructions that prompt the operator for data, you should erase the screen. Use the ERASE instruction as follows:

```
         ERASE     TYPE=ALL,LINE=0
```

The operand TYPE=ALL tells the system to erase both protected and unprotected data. The operand LINE=0 tells the system to begin erasing on line 0 (the first line) of the screen.

Constructing a Screen Image

To construct a screen image that minimizes screen flicker, you can concatenate a series of protected fields. The following instructions display an array of integers on the first six lines of the screen (lines 0 – 5).

```
1          DO     96,INDEX=1
2            PRINTEXT  'FIELD',PROTECT=YES
3            PUTEDIT   FORMAT1,VALS,((I)),PROTECT=YES
4            PRINTEXT  ' ',PROTECT=YES
5            PRINTEXT  NULLS,PROTECT=YES
           ENDDO
6            PRINTEXT  LINE=0
```

1 Begin a DO loop to construct the screen image. The screen image consists of 96 protected fields of the form FIELDxx, where xx is a sequential field number, each followed by one protected blank and two unprotected data positions.

2 Put the literal FIELD in the buffer.

3 Convert the sequence number to two EBCDIC characters and write it to the buffer.

4 Insert a protected separation character.

5 Define the data position with two null characters. Null characters generate unprotected fields. The operand PROTECT=YES is necessary to preserve concatenation. (You can concatenate a series of fields only if the fields are all protected (PROTECT=YES) or all unprotected (PROTECT=NO).)

6 Write the concatenated line to the screen. (Any line control character causes the system to display the concatenated fields.)

Reading a Series of Data Items

To read a series of data items, use the READTEXT instruction as follows:

```
READTEXT  VALS,MODE=LINE,LINE=6
```

The instruction does a "gather read," reading all the values beginning on line 6 (the seventh line) of the screen into VALS. The operand MODE=LINE indicates the gather read.

Releasing the Terminal

To release the terminal, use the DEQT instruction:

```
DEQT
```

The instruction releases the buffer designated in the IOCB statement and restores the configuration to that defined by the TERMINAL statement.

Example

Line-oriented input/output instructions provide a straightforward way to construct and read data from static screens. However, when individual data fields on the 4978, 4979, or 4980 are accessed frequently, excessive screen flicker can result. This problem can be eliminated by transferring an entire screen image to the display with one I/O operation. The following program shows this technique.

The program accesses the top six lines of a static screen and initially formats the screen with a sequence of protected fields. An array of integers is displayed on lines 0 – 5 of the screen and a pause is executed to allow the operator to enter a new set of values in corresponding positions of lines 6 – 11. The new values are then displayed on lines 0 – 5 of the screen.

In this program, terminal I/O operations are performed through concatenation of TEXT strings. If the application requires more complex formatting of the screen image, or if input of more than 254 bytes at a time is necessary, then direct access to the buffer is appropriate. See the PRINTEXT and READTEXT instructions in the *Language Reference* for details.

```
    DISPLAY  PROGRAM   BEGIN
1   SCREEN   IOCB      SCREEN=STATIC,BOTM=11,                          C
                 BUFFER=BUFF,RIGHTM=959
    I        DATA      F'0'
2   BUFF     BUFFER    960,BYTES
3            DATA      X'0202'
4   NULLS    DATA      X'0000'
5   NUMS     DATA      48F'0'
6   VALS     TEXT      LENGTH=254
7   BEGIN    ENQT      SCREEN
8            ERASE     TYPE=ALL,LINE=0
9            DO        96,INDEX=I
10            PRINTEXT  'FIELD',PROTECT=YES
11            PUTEDIT   FORMAT1,VALS,((I)),PROTECT=YES
12            PRINTEXT  ' ',PROTECT=YES
13            PRINTEXT  NULLS,PROTECT=YES
              ENDDO
14            PRINTEXT  LINE=0
15  WRITE     PUTEDIT   FORMAT1,VALS,((NUMS,48)),                      C
                 ACTION=STG
16            PRINTEXT  VALS,MODE=LINE,LINE=0
              PRINTEXT  LINE=6,SPACES=8
17            TERMCTRL  DISPLAY
18            WAIT      KEY
19            GOTO      (TRANSFER,QUIT),DISPLAY+2
20 TRANSFER   READTEXT  VALS,MODE=LINE,LINE=6
21            GETEDIT   FORMAT1,VALS,((NUMS,48)),                      C
                   ACTION=STG
22            ERASE     LINE=6,MODE=SCREEN,TYPE=DATA
23            GOTO      WRITE
24  QUIT      DEQT
              PROGSTOP
    FORMAT1   FORMAT (I2)
              ENDPROG
              END
```

1 Define the static screen with the terminal I/O buffer to be in the application program at BUFF, with a length of 960 bytes (half of the 4979 display screen).

2 Allocate storage for the buffer. Note that in this program the buffer is never accessed directly; the space is merely allocated here for use by the supervisor.

3 and 7 Define a TEXT message consisting of two null characters (EBCDIC code X'00').

4 and 5 Define the array of integers (initially zero) and the TEXT buffer that will be used for output of the data in EBCDIC form.

6 and 7 Acquire the terminal, erase all data and establish the screen position for the first I/O operation. Since several text strings will be concatenated to form the first output line, the screen position must be established in advance.

8 Begin a DO loop to construct the initial screen image. This will consist of 96 protected fields of the form FIELDxx, where xx is a sequential field number, each followed by one protected blank and two unprotected data positions. Note the conditions required for forming a concatenated line: the protect mode of the PRINTEXT instructions must not change (either all PROTECT=YES or all PROTECT=NO), and no intervening forms control operations can be executed. The TERMCTRL DISPLAY instruction prints the contents of the terminal buffer.

9 Write "FIELD" to the buffer.

10 Convert the sequence number to two EBCDIC characters and write it to the buffer.

11 Write a protected separation character.

12 Write the two null characters to define the data positions. Null characters always generate unprotected positions on the screen; however, PROTECT=YES is required here in order to maintain concatenation.

13 Write the concatenated line to the display. Any convenient line control operation or the DEQT instruction will accomplish this.

14 Convert the integer array to two-character EBCDIC values and store the resulting line in the TEXT buffer VALS.

15 Write the values into successive unprotected positions of the display beginning at LINE=0,SPACES=0. This "scatter write" operation is defined by MODE=LINE; without MODE=LINE the protected fields of the display would be overwritten.

16 Define the cursor to be at the first unprotected position.

17 Display the cursor at its defined position.

18 Wait for the operator to press an interrupt key.

19 Go to QUIT if PF1 was pressed. Go to TRANSFER if the ENTER key or any key other than PF1 was pressed.

20 Read the updated values entered by the operator in lines 6 – 11. MODE = LINE indicates a "scatter read."

21 Convert the EBCDIC representations to binary and store the binary values in the array NUMS.

22 Erase the unprotected (data) fields in lines 6 – 11 of the screen.

23 Repeat beginning at the label WRITE.

24 Release the terminal. The buffer designated in the IOCB will be released and the screen configuration restored to that defined by the TERMINAL statement.

Writing the Screen Image to a Data Set

This section shows how to create a screen image and use it in a program. The approach assumes that you want to write a program that can execute on different terminals.

For information on writing terminal-independent static screens, see "Designing Device-Independent Static Screens" on page 8-24. For more information on writing a screen image to a data set, see Appendix C, "Static Screens and Device Considerations."

Writing a screen to a data set and using it in a program requires that you do the following things:

1. Create the screen.
2. Define the screen as static.
3. Read the screen into a buffer.
4. Get exclusive access to the terminal.
5. Display the screen and position the cursor.
6. Reserve storage for data.
7. Wait for a response.
8. Read a data item.
9. Write a data item.
10. Link edit the program.

Creating a Screen

To create a screen image, use the $IMAGE utility as follows:

1. From the session manager, select option 4 (TERMINAL UTILITIES) from the primary option menu.

2. Then select option 4 ($IMAGE). This option loads the $IMAGE utility.

3. Define a null character when the COMMAND(?) prompt appears by entering:

```
COMMAND (?): NULL #
```

   You will use the null character to define unprotected fields. *Unprotected fields* are the fields in which the operator will enter data.

4. Define the screen dimensions as 24 by 80 (full screen) by entering:

```
COMMAND (?): DIMS 24 80
```

5. Enter the command EDIT. A blank screen appears.

6. Press the PF1 key to enter define protected fields mode. While in define protected fields mode, you can define the screen.

7. Enter the text for your screen image. Enter the fixed part of the screen exactly as you want it to appear on the screen. The fixed fields are called *protected fields.* Use the null character (#) to define the unprotected data fields.

   An example of how the screen might look follows:

```
   NAME: ############################  (line 1)
ADDRESS: ############################  (line 2)
   CITY: ############################  (line 3)
  STATE: ##                            (line 4)
    ZIP: #####                         (line 5)
```

8. Press the enter key after you complete the design of your screen image. The enter key takes you out of define mode.

9. Press the PF3 key to return to the $IMAGE command mode.

10 Save your new screen image in data set AP08CSCR on volume EDX002 by entering:

```
SAVE AP08CSCR,EDX002
```

11 In response to the message:

```
SHOULD THE 31XX INFORMATION BE SAVED (Y/N)?
```

reply **N** if you want to save only a 4978/4979/4980 screen image. Reply **Y** to this message if you are using the ATTR command of $IMAGE to define a 31xx screen image. Refer to the *Operator Commands and Utilities Reference* for details on the ATTR command of $IMAGE.

Note: A 31xx screen image is used for a 3101, 3151, 3161, 3163, or 3164 terminal in block mode.

12 After the system saves the screen, use the EN command to end the $IMAGE utility.

For more information on creating a screen image, refer to the *Language Reference.*

Defining the Screen as Static

To define a screen as static, use the IOCB statement as follows:

```
TERM  IOCB  SCREEN=STATIC,                    X
            BUFFER=IOBUF,                    X
            OVFLINE=YES,                     X
            LEFTM=0,                         X
            RIGHTM=79,                       X
            TOPM=0,                          X
            BOTM=23
```

This statement defines the loading terminal as a static screen. The label TERM defines the name you will use in other instructions in the program. The BUFFER operand identifies IOBUF as the buffer that will be associated with the screen. The OVFLINE operand tells the system to continue a line that exceeds the right margin on the next line. The next four operands (LEFTM, RIGHTM, TOPM, and BOTM) define the static screen as the entire physical screen (lines 0 – 23 and columns 0 – 79).

Note: Remember that to continue a line, the continued line must begin in column 16.

For information on defining logical screens, see Appendix C, "Static Screens and Device Considerations."

Reading the Screen Image into a Buffer

To read the screen you have created, you need to do the following things:

1 Code the name and volume of the screen in a TEXT statement:

```
DSNAME  TEXT  'AP08CSCR,EDX002'
```

This TEXT statement refers to data set AP08CSCR on volume EDX002. This data set contains the screen you saved when you used the $IMAGE utility.

2 Reserve storage for the screen with a BUFFER statement:

```
DISKBFR BUFFER  1024,BYTES
```

The amount of storage you reserve depends on how many bytes $IMAGE used to store the screen image. For example, if $IMAGE used 900 bytes to store a screen image, use 1024 bytes (the next highest 256-byte increment). See "Coding for Device Independence" on page 8-26 for more information about calculating additional buffer requirements for $IMAGE for the 3101, 3151, 3161, 3163 and 3164 terminals.

3 Specify the type of image data set you have created or specify four blank characters for the data stream of the terminal type:

```
TERMTYPE  DATA  C'    '
```

The type of image data set refers to the way you stored the data set. The system always saves a 4978/4979/4980 screen image. You may, however, choose that the system also save 31xx screen information.

Note: A 31xx screen image is used for a 3101, 3151, 3161, 3163, or 3164 terminal in block mode.

4 Use the CALL instruction to read the screen:

```
CALL   $IMOPEN,(DSNAME),(DISKBFR),(TERMTYPE)
```

The $IMOPEN subroutine reads the screen from the data set defined by DSNAME and puts the screen into DISKBFR. TERMTYPE refers to the DATA statement that defines the type of image data set.

Getting Exclusive Access to the Terminal

Before you can use a terminal as a static screen, you must get exclusive access to it. Use the ENQT instruction as follows:

```
ENQT  TERM
```

The operand TERM is the name you used to define the terminal in the IOCB instruction.

Displaying the Screen and Positioning the Cursor

Displaying the screen and positioning the cursor involves three instructions.

The first instruction, the CALL $IMPROT instruction, prepares the protected fields for display:

```
CALL   $IMPROT,(DISKBFR),(FTABLE)
```

The presence of the third operand (in this case, FTABLE) causes the instruction to construct what is called a field table. A *field table* shows the location and length of each unprotected field on the screen. Define the field table as follows:

```
FTABLE  BUFFER  15,WORDS
```

The field table requires 3 words for each unprotected field.

The second instruction positions the cursor after the first prompt:

```
PRINTEXT LINE=1,SPACES=9
```

Finally, the third instruction displays the screen:

```
TERMCTRL DISPLAY
```

Reserving Storage for Data

To reserve storage for a data item that you read, you must know its maximum length. To reserve storage for a text string of 5 characters, use the TEXT statement as follows:

```
ZIP     TEXT     LENGTH=5
```

The name of the storage is ZIP. This storage area will eventually contain five bytes of data in our example (the zip code).

Waiting for a Response

After you issue the prompts, you must wait for the operator to respond. To wait for a response, use the WAIT instruction as follows:

```
WAIT    KEY
```

The operand KEY means that the program will wait until the operator presses either the enter key or one of the Program Function (PF) keys.

Reading a Data Item

Reading a data item involves reading all unprotected data from the screen. Use the READTEXT instruction as in the following example:

```
READTEXT IOBUF,MODE=LINE,LINE=0,SPACES=0
```

The instruction reads all unprotected data into the buffer called IOBUF. The operands LINE=0 and SPACES=0 cause the system to look for the data starting in the first position of the screen. MODE=LINE allows for blanks in the input data.

To move each data item into its own storage area, use the following instructions:

```
MOVEA  #1,IOBUF
MOVE   NAME,(0,#1),(30,BYTE)
```

The MOVEA instruction moves the address of IOBUF which contains the unprotected fields. The MOVE instruction moves the 30 bytes at the start of the buffer to NAME.

For each additional field, increment register 1 to the next field in IOBUF and move the field to its data area:

```
ADD    #1,FTABLE+4
MOVE   ADDR,(0,#1),(30,BYTE)
```

The ADD instructions adds the size of the first field (NAME) to register 1. The MOVE instruction moves the 30 bytes at IOBUF+30 to ADDR.

Writing a Data Item

Writing a data item means transferring a data item from a storage area to the screen. A PRINTEXT instruction might look like this:

```
PRINTEXT NAME,LINE=11
```

The instruction writes the data item from the storage area called NAME. The operand LINE=11 causes the system to display the data starting in the first position of the twelfth line of the screen.

If you wanted to display another data item on the next line, you could use the SKIP operand:

```
PRINTEXT CITY,SKIP=1
```

The SKIP=1 causes the system to skip to the first position of the next line before displaying the data item CITY.

To display another data item on the same line, you could use the SPACES operand:

```
PRINTEXT ST,SPACES=1
```

SPACES=1 causes the system to skip one space on the same line before displaying the data item ST.

Link Editing the Program

Using the $IMAGE subroutines ($IMOPEN, $IMDEFN, $IMPROT, and $IMDATA) means that you must do one more thing when you link edit the program. You must reference the $IMAGE subroutines you have used. An EXTRN statement must be coded for each subroutine name your program references.

You must supply the linkage editor, $EDXLINK, the following "control statements":

```
AUTOCALL $AUTO,ASMLIB
INCLUDE ASMOBJ,EDX002
LINK AP08C,EDX40 REPLACE END
```

The first control statement refers to a library of IBM-supplied routines. Unless you have moved the library, you can code this statement as you see it here.

The second control statement refers to where you put the output of the compiler.

The third control statement says to put the output of the link edit on volume EDX40, call it AP08C, and replace it if it already exists. END tells $EDXLINK not to expect any other control statements.

You can either create a data set containing these control statements or enter the statements "interactively" each time you execute $EDXLINK.

For more information on link editing, see Chapter 5, "Preparing an Object Module for Execution."

Example

Prompt the operator for name, address, city, state, and zip code. Then display the five data items. Use the screen AP08CSCR on volume EDX002 (already defined with the $IMAGE utility).

```
1  TEST       PROGRAM   BEG
2             EXTRN     $IMOPEN,$IMDEFN,$IMPROT,$IMDATA
3  TERM       IOCB      SCREEN=STATIC,                              C
               BUFFER=IOBUF,OVFLINE=YES,LEFTM=0,                    C
               RIGHTM=79,TOPM=0,BOTM=23
4  BEG        CALL      $IMOPEN,(DSNAME),(DISKBFR),(TERMTYPE)
5             MOVE      CODE,TEST+2
6             IF        CODE,NE,-1
                PRINTEXT 'OPEN ERROR CODE = ',SKIP=1
                PRINTNUM CODE
                GOTO     END
              ENDIF
7             ENQT      TERM
8             CALL      $IMPROT,(DISKBFR),(FTABLE)
9             PRINTEXT  LINE=1,SPACES=9
10            TERMCTRL  DISPLAY
11            WAIT      KEY
12            READTEXT  IOBUF,MODE=LINE,LINE=0,SPACES=0
13            MOVEA     #1,IOBUF
14            MOVE      NAME,(0,#1),(30,BYTE)
15            ADD       #1,FTABLE+4
              MOVE      ADDR,(0,#1),(30,BYTE)
              ADD       #1,FTABLE+10
              MOVE      CITY,(0,#1),(30,BYTE)
              ADD       #1,FTABLE+16
              MOVE      ST,(0,#1),(2,BYTE)
              ADD       #1,FTABLE+22
              MOVE      ZIP,(0,#1),(5,BYTE)
16            PRINTEXT  NAME,LINE=11
17            PRINTEXT  ADDR,SKIP=1
              PRINTEXT  CITY,SKIP=1
18            PRINTEXT  ST,SPACES=1
              PRINTEXT  ZIP,SPACES=2
              DEQT
   END        PROGSTOP
19 DSNAME     TEXT      'AP08CSCR,EDX002'
20 DISKBFR    BUFFER    1024,BYTES
21 TERMTYPE   DATA      C'4978'
22 FTABLE     BUFFER    15,WORDS
23 IOBUF      BUFFER    1920,BYTES
   CODE       DC        F'0'

   NAME       TEXT      LENGTH=30
   ADDR       TEXT      LENGTH=30
   CITY       TEXT      LENGTH=30
   ST         TEXT      LENGTH=2
   ZIP        TEXT      LENGTH=5
              ENDPROG
              END
```

1 Begin the program and execute the instruction at label BEG.

2 Define as external references the $IMAGE subroutines that the program uses. The linkage editor resolves these external references when you use the autocall option.

3 Define the screen as static.

4 Read the screen from the data set defined by DSNAME. Put the screen in the buffer defined by DISKBFR.

5 Move the return code that resulted from the $IMOPEN subroutine to CODE.

6 If the return code that resulted from the $IMOPEN subroutine does not indicate "successful completion," display an error message and end the program.

7 Get exclusive use of the terminal.

8 Prepare the protected fields for display.

9 Position the cursor on the tenth space (SPACES=9) of the second line of the screen (LINE=1).

10 Display the screen.

11 Wait for the operator to respond to the prompts. Resume execution when the operator presses either the enter key or one of the Program Function keys.

12 Read all unprotected data. Look for the data in the first space (SPACES=0) of the first line of the screen (LINE=0) and allow blanks in the data (MODE=LINE).

13 Move the address of the buffer (IOBUF) that contains the unprotected data into register 1.

14 Move the first 30 characters from the buffer to NAME.

15 Increment register 1 to point to the next data item (address).

16 Display the data item NAME. Begin displaying the data on the first position of the twelfth line of the screen (LINE=11).

17 Display the data item ADDR. Begin displaying the data on the first position of the next line (SKIP=1). (In this example, ADDR would appear on the thirteenth line of the screen.)

18 Display the data item ST. Begin displaying the data after leaving one space (SPACES=1). (In this example, data item ST would appear one space to the right of data item CITY.)

19 Point to the data set (AP08CSCR on volume EDX002) that contains the screen created with the $IMAGE utility.

20 Reserve storage for the screen. (Except for screens much larger than the one in this example, 1024 bytes is enough storage.)

21 Define the type of image data set to be read. C'4978' allows you to write the screen to a 4978, 4979, 4980, 3101, 3151, 3161, 3163, or 3164 terminal, regardless of what screen image was saved on disk. C'3101' allows you to write the screen to a 3101 terminal if you saved the 31xx screen image. C'3161' allows you to write the screen to a 3151/3161 if you saved the 31xx screen image. C'3163' allows you to write the screen to a 3163 if you saved the 31xx screen image. C'3164' allows you to write the screen to a 3164 if you saved the 31xx screen image. If you code C' ', you can write the screen to whatever terminal has been enqueued.

22 Reserve storage for the field table.

23 Reserve storage for the unprotected data.

Designing Device-Independent Static Screens

The following sections mention both the $IMAGE utility and the $IMAGE subroutines. For a complete description of the $IMAGE utility, refer to the *Operator Commands and Utilities Reference*. For descriptions of the $IMAGE subroutines, see "$IMAGE Subroutines" on page C-3.

Designing Static Screens

This section describes how to design terminal independent static screens and discusses a limitation in compatibility between the terminal types.

The $IMAGE utility and subroutines treat an unprotected field as a string of unprotected characters. Unprotected characters are denoted as null characters. If the $IMAGE null character were the "percent sign" character, (%), then an unprotected field, eight characters long, could be defined as:

```
ENTER NAME HERE ==>  %%%%%%%%
```

If you do not place attribute characters around an unprotected field, $IMAGE automatically inserts the default attribute in 31xx screen images for the 3101, 3151, 3161, 3163, and 3164 terminals. Refer to the *Operator Commands and Utilities Reference* for information on the characteristics of the default attribute. If you do not want to define unique attributes (such as blinking), you can design screens for the 4978, 4979, or 4980 and use them on 3101, 3151, 3161, 3163, and 3164 terminals with default attributes.

You can also design 31xx screens with unique attribute characters. In this case, a 31xx screen image is created by $IMAGE as well as a 4978/4979/4980 image. The 31xx information is ignored for display on the 4978, 4979, or 4980. If the "pound sign" character ,(#), were defined as the blinking attribute, both fields in the previous example could be made to blink as follows:

```
#ENTER NAME HERE ==> #%%%%%%%@
```

On a 3101, 3151, 3161, 3163, or 3164, a blinking, protected attribute byte would replace the first pound sign and a blinking, unprotected attribute byte would replace the second pound sign. The pound sign does not change the protect status of the field, merely its display properties; the "null" character determines whether the field is protected or unprotected. The screen could be reset to nonblinking by placing the default attribute (in this case, @) at the end of the protected field.

Compatibility Limitation

This scheme has a limitation because an attribute byte is displayed as a protected blank. This character, the attribute byte, which precedes a field (protected or unprotected) is always displayed as a blank on a 3101, 3151, 3161, 3163, or 3164 terminal, even if a protected (nonblank) character appears on a 4978, 4979, or 4980. For example, the following screen is designed to display the month, day, and year as MM/DD/YY:

```
%%/%%/%%
```

On a 4978, 4979, or 4980, the date would appear as:

```
10/30/80
```

On a 3101, 3151, 3161, 3163, or 3164, however, the date would appear as:

```
10 30 80
```

The slash characters on the 4978, 4979, or 4980 are replaced by attribute bytes on the 3101, 3151, 3161, 3163, and 3164. Therefore, screens designed for the 4978, 4979, or 4980 do not have to be changed for use on the 3101, 3151, 3161, 3163, and 3164. However, you have to alter them if you do not want protected characters to disappear when displayed on a 3101, 3151, 3161, 3163, or 3164.

Coding for Device Independence

To achieve static screen device independence between the 4978, 4979, or 4980 Display Terminal and the 3101, 3151, 3161, 3163, and 3164 Display Terminal, you must use functionally equivalent terminal instructions on the terminals. The following considerations show one approach which provides some device independence.

- Use the 4978/4979/4980 screen images produced by $IMAGE for 4978, 4979, 4980 and 3101, 3151, 3161, 3163, 3164 compatible applications.
- Specify an image type of C'4978' on calls to $IMOPEN.
- Specify FTAB on calls to $IMPROT. The FTAB buffer is initialized to describe each unprotected field on the screen and requires three words per entry.
- Use calls to $IMDATA to "scatter write"the unprotected data to either type terminal.

  PRINTEXT MODE=LINE does not produce a scatter write operation on the 3101, 3151, 3161, 3163, or 3164 (as it does on the 4978, 4979, or 4980). A call to $IMDATA, specifying the FTAB produced by the prior call to $IMPROT and the user buffer, performs the scatter write operation on the 4978, 4979, or 4980 and simulates the scatter write on the 3101, 3151, 3161, 3163, or 3164.

  $IMDATA can be used to write either default unprotected data from the screen image or user data contained in a user buffer.

- For "gather read" operations use:

```
READTEXT MODE=LINE,TYPE=DATA,LINE=0,SPACES=0
```

  Read operations from the 3101 running in block mode start with the first data field encountered, beginning with the upper left corner and continuing to the end of the screen. Specifying LINE=0,SPACES=0 makes the READTEXT from the 4978, 4979, or 4980 functionally equivalent to the 3101 running in block mode.

  On the 3151, 3161, 3163, and 3164 terminals, if the first position of the screen is unprotected, unpredictable results will occur when reading the screen. To achieve static screen independence, ensure that the first character position on the screen is protected from operator input. The first character should be either an attribute character or a protected data character on the 3151, 3161, 3163, or 3164, never a null character.

  In addition, the 3101 prefixes each field transmitted with three bytes of control information; this results in a 3101 data stream. The 3151 and 3161 prefixes each field transmitted with four bytes of control information; this results in a 3161 data stream. The 3163 and 3164 prefix each field transmitted with six bytes of control information; this results in a 3164 data stream. Although EDX removes this control information, the user buffer must be large enough to contain the entire data stream that is transmitted.

- Using care, individual fields can be changed with:

  ```
  PRINTEXT MODE=LINE,LINE= ,SPACES=
  ```

  - When issued to a 3101, 3151, 3161, 3163, or 3164, the PRINTEXT instruction first writes an attribute byte, followed by the text data. The data field thus appears displaced one position to the right when compared to the result of a PRINTEXT issued to the 4978, 4979, or 4980.

    To suppress the writing of an attribute byte to the screen, use:

    ```
    TERMCTRL SET,ATTR=NO
    ```

    prior to the PRINTEXT(s). After the last PRINTEXT, code TERMCTRL SET,ATTR=YES. The 4978, 4979, and 4980 ignore these TERMCTRL instructions.

  - Be careful to ensure that the data being sent to the 3101, 3151, 3161, 3163, or 3164 does not extend beyond one data field; if it does, it will overlay and eliminate existing attribute characters. Once the screen attributes are changed, the FTAB no longer represents the screen and $IMDATA operations will produce undesired results.

  - Writing protected nulls to create additional unprotected 4978, 4979, or 4980 fields is not supported for the 3101, 3151, 3161, 3163, or 3164 running in block mode. Avoid this practice.

- Avoid the combination of "count" and TYPE=DATA in the ERASE instruction. On the 3101, 3151, 3161, 3163, or 3164, the erase starts at the current cursor position and continues to the end of screen; the count operand is ignored.

- Avoid the combinations of TYPE=DATA,MODE=LINE and TYPE=DATA,MODE=FIELD in the ERASE instruction. Although these combinations work as anticipated on the 4978, 4979, or 4980, the 3101, 3151, 3161, 3163, and 3164 force the MODE= parameter to SCREEN.

- Avoid the combination of "count," TYPE=ALL and MODE=FIELD in the ERASE instruction. The 3101, 3151, 3161, 3163, and 3164 force MODE=FIELD to MODE=LINE. The operation ends when the count reaches zero or the current line ends, whichever occurs first.

- To erase unprotected fields that do not end at end-of-line or end-of-screen, use one of the following techniques:

  - Use a PRINTEXT instruction with LINE and SPACES parameters to write blank characters to each individual field, being careful not to change or eliminate 3101, 3151, 3161, 3163, or 3164 attribute bytes.

    Note: If the screen attributes are changed or eliminated, then the screen format will no longer match the FTAB and the data will not be directed to the correct locations on the screen. To re-establish the screen, call $IMPROT before calling $IMDATA.

  - Use READTEXT TYPE=DATA to read all unprotected data from the screen into a user buffer. Next, blank out (or change) the appropriate fields in the buffer. Then use the "USER" buffer features of $IMDATA to rewrite the unprotected data.

Using the $IMAGE Subroutines for Device Independence

This section presents a way to write terminal-independent applications that use static screens. Using this method, the $IMAGE utility creates screen images and stores them on disk or diskette. Later, your application program can display and use the images by calling system-provided subroutines. Collectively these subroutines are called the "$IMAGE subroutines." See "$IMAGE Subroutines" on page C-3 for individual descriptions of each subroutine.

This section describes the basic steps in an application program which displays and processes a static screen (with a size of 24 lines and 80 characters per line):

- Retrieve the screen
- Display the protected data
- Display and retrieve the unprotected data.

Retrieving the Screen Format

The first step is to retrieve the screen image by calling $IMOPEN. The type operand of $IMOPEN specifies the type of image to be retrieved. If the type operand is set to blanks, the image retrieved corresponds to the type of terminal upon which the program is running, if that image was saved. If a particular screen image is needed but unavailable, the 4978/4979/4980 format is retrieved and converted dynamically. For example:

```
         CALL     $IMOPEN,(DSNAME),(FORMAT),(TERMTYPE)

DSNAME   TEXT     LENGTH=15     format data set name
FORMAT   BUFFER   n,BYTES       format buffer
TERMTYPE DATA     CL4'    '     adapt to running terminal
```

Displaying the Protected Data

The screen format itself (the protected data) can be displayed with a call to $IMPROT.

```
         CALL     $IMPROT,(FORMAT),(FTAB)

FTAB     BUFFER   n,WORDS       field table
```

The field table (FTAB) is required for the 3101, 3151, 3161, 3163, and 3164 terminals. For a description of the field table, see "$IMPROT Subroutine" on page C-8.

Displaying the Unprotected Data

At this point many applications generate and then display some data in the unprotected fields. On a 4978, 4979, or 4980 you can use PRINTEXT MODE=LINE to perform a scatter write operation. However, since this is not supported on a 3101, 3151, 3161, 3163, or 3164, you should use $IMDATA to perform the scatter write operation and thus preserve device independence.

$IMDATA writes all the unprotected fields in a screen image. You must call $IMDATA if any of your unprotected fields have the right justify or must enter characteristics. When directing data to the 3101, 3151, 3161, 3163, or 3164, the field table generated by $IMPROT must be used. To write default unprotected data, use the buffer containing the screen image or specify a user buffer containing the application-provided data.

When $IMDATA is used with a user buffer, the application program must:

- Set the characters "USER" in the first four positions of the buffer
- Set the message length, excluding "USER", in the buffer index word (buffer−4).

```
         MOVE    USERDATA,CUSER,DWORD set up user message
         MOVE    DATALEN,8           set message length
         MOVE    USERDATA+4,MESSAGE,(8,BYTES) get message
         CALL    $IMDATA,(USERDATA),(FTAB)
          •
          •
          •
USERDATA BUFFER  12,BYTES,INDEX=DATALEN  for user data
MESSAGE  DATA    CL8'HI THERE'           data
CUSER    DATA    CL4'USER'
```

Retrieving the Unprotected Data

After the operator has entered data, all the data in the unprotected fields can be read by a single statement. The 4978, 4979, 4980, 3101, 3151, 3161, 3163, and 3164 support a "gather read" using READTEXT MODE=LINE.

```
          READTEXT SCRNDATA,MODE=LINE
            •
            •
            •
SCRNDATA BUFFER   n,BYTES
```

There are a number of considerations when using a READTEXT with MODE=LINE and a buffer from a 3101 screen. A READTEXT instruction issued to the 3101 always reads from the beginning of the screen, regardless of the cursor position specified by LINE and SPACES. The 3101 has only three read options: read the entire screen (TYPE=ALL), read all the unprotected fields (TYPE=DATA), or read only the modified unprotected data (TYPE=MODDATA). (For more information on 3101 read options, see "Reading Modified Data on the 3101" on page 8-42).

The data will be read and concatenated into the buffer. But the buffer must be large enough to accommodate the data. On the 3101, the buffer must accommodate the data plus three bytes (TYPE=DATA and TYPE=ALL) or four bytes (TYPE=MODDATA) per unprotected field. On the 3151, 3161, 3163, and 3164 terminals, the buffer must be large enough to accommodate the data plus four bytes (TYPE=MODDATA) per unprotected field. On the 3151 and 3161, the buffer must accommodate the data plus four bytes (TYPE=DATA and TYPE=ALL) per unprotected field. On 3163 and 3164, the buffer must accommodate the data plus six bytes (TYPE=DATA and TYPE=ALL) per unprotected field. This extra data includes escape sequences and attribute bytes which are edited out of the buffer before presentation to the application program (as long as the default of STREAM=NO is in effect).

Although the 4978, 4979, and 4980 terminals have the capability to read a specific unprotected field, the 3101, 3151, 3161, 3163 and 3164 do not. To perform a similar operation, the application can read all the unprotected data and then use the field table lengths to displace into the buffer and arrive at the desired data field.

Suppressing Attribute Bytes

The 4978, 4979, 4980, 3101, 3151, 3161, 3163, and 3164 terminals can do a PRINTEXT with LINE and SPACES to a specific screen coordinate. However, issuing this instruction on the 3101, 3151, 3161, 3163, or 3164 affects subsequent I/O to the screen. When a PRINTEXT is issued without a previous TERMCTRL SET,ATTR=NO, the terminal support inserts an attribute byte. This attribute byte appears as a protected blank at the screen coordinate specified by LINE and SPACES, and the data follows. Normally, this displaces the data one byte to the right, and therefore the data writes over the next attribute byte (which usually describes a protected field).

For example, assume the screen coordinate 5,5 (LINE=5,SPACES=5) contains a ten-byte unprotected field which the application wants to fill with ten Xs. If a PRINTEXT LINE=5,SPACES=5 of ten Xs is issued with no previous TERMCTRL SET,ATTR=NO, then an attribute byte is added and written at location 5,5 and the tenth X overwrites the next attribute byte for the following protected field. This leaves the screen with one large unprotected field instead of a 10 byte unprotected field followed by a protected field.

A subsequent READTEXT of the unprotected data will result in much more data being returned to the application than expected. In addition, the returned data stream might contain escape sequences and attribute bytes which on a subsequent PRINTEXT from the same buffer will cause the cursor to act unpredictably. Also, the data will be written incorrectly on the screen.

To avoid such problems, a TERMCTRL SET,ATTR=NO should always be issued before a PRINTEXT with LINE and SPACES. A TERMCTRL SET,ATTR=YES should follow the PRINTEXT.

Converting 4978 Screens

Many 4978-based applications can be converted to run on the 3101, 3151, 3161, 3163, or 3164. In some cases, it is sufficient to convert uses of PRINTEXT MODE=LINE to calls to $IMDATA. If the application uses READTEXT to specify screen coordinates with LINE and SPACES, the technique described above in "Suppressing Attribute Bytes" can be used.

Some screens may require changes because the attribute bytes are displayed as protected blanks on the 3101, 3151, 3161, 3163, and 3164. See the "Compatibility Limitation" on page 8-25.

Reading and Writing to a 3101, 3151, 3161, 3163, or 3164

This section describes how to read data from and write data to a 3101, 3151, 3161, 3163, or 3164 Display Terminal. It describes the characteristics of these terminals and some things you should know when you design programs that use these terminals.

This section focuses on a sample program, describing the instructions in the same sequence that they appear in the program. The sample program uses a 3101 terminal, the TERMCTRL instruction to set attribute bytes, and EBCDIC escape sequences to control data transmission. Wherever similarities exist, notations for the 3151, 3161, 3163, and 3164 terminals have been made. The sample program, which appears at the end of this chapter:

1. Defines the format of the screen
2. Enqueues the screen
3. Change the attribute byte
4. Erases the screen
5. Protects the first field
6. Creates unprotected fields
7. Creates protected fields
8. Writes a nondisplay field
9. Reads a data item
10. Writes a blinking field

11 Erases an individual field

12 Blanks a blinking field

13 Writes more than one data item

14 Prompts the operator for data

15 Changes the attribute byte to a protected blank

16 Displays a nondisplay field

17 Creates a new unprotected field

18 Reads modified data

19 Forces the modified data tag on

20 Reads modified data

21 Erases to the end of the screen

22 Reads all unprotected data

23 Reads a data item.

Characteristics of the Terminal

Attribute Characters

The 3101, 3151, 3161, 3163, and 3164 terminals use attribute characters (or bytes) to define fields on the screen. An attribute byte defines the start of each field and the properties of the field (such as high/low intensity, underline, or blink). Each attribute byte appears as a protected blank on the screen.

The collection of attribute characters, special sequences required by the terminal, and user data is called a data stream. Any invalid (unprintable) characters encountered in the data stream will cause the terminal to beep. This condition might occur, for instance, if you try to display a non-EBCDIC disk or diskette record. The message "HOST PROGRAM WRONG" is issued if any invalid (unprintable) characters are encountered in the 3151, 3161, 3163, or 3164 data stream.

Transmitting Data

On a static screen, the application program must determine where the output data is positioned, relative to the first position of the screen. When you issue a READTEXT instruction on a 3101, the system reads the data from the beginning of the screen. Whether you read all the data, unprotected data, or modified data depends on how you code the TYPE operand of the READTEXT instruction. See "Coding for Device Independence" on page 8-26 for more information about using the READTEXT instruction on the 3151, 3161, 3163, and 3164 terminals.

In response to a read request, the 3101, 3151, 3161, 3163, and 3164 terminals transmit the attribute characters that precede the input field. To suppress the attribute characters from the data stream, EDX removes these special characters and left-justifies the data.

An application program can have complete control of the input/output data transmitted. To do this, the program must build the complete data stream, either in EBCDIC or ASCII codes. The basic terminal I/O support simply handles the transmission of the data stream.

Refer to the description of the TERMCTRL SET,STREAM = YES/NO instruction and the XLATE parameter of PRINTEXT/READTEXT instructions in the *Language Reference* when this mode of data transmission is desired.

Design Considerations

The following list contains items you should consider when designing a static screen application.

- Each of the 3101, 3151, 3161, 3163 and 3164 terminals uses a different data stream to tell the terminal to do something. A data stream is a collection of special characters, commands, and data transmitted in a single operation.
- A simple PRINTEXT of "HI THERE" results in a data stream appropriate for the terminal that is running.

  ```
  On the 3101:        ESC.Y.ROW.COL.ESC.3.ATTR.HI THERE
  On the 3151/3161:   ESC.Y.ROW.COL.ESC.3.PA1.PA2.HI THERE
  On the 3163/3164:   ESC.Y.ROW.COL.ESC.3.PA1.PA2.PA3.PA4.HI THERE
  ```

  where ESC.Y is a set cursor address command followed by row and column position, and ESC.3 is a start-of-field sequence followed by one or more attribute bytes defining the field.
- An attribute byte defines how data will appear on the screen. It occupies one character position on the screen and appears as a protected blank. Note that a start-of-field sequence containing multiple attribute bytes will require only one character position on the screen.
- Special attribute characteristics supported by the 3101 are high intensity, low intensity, blinking field, and nondisplay. The 3151, 3161, 3163, and 3164 terminals support these special attributes with the TERMCTRL instruction, in addition to other attributes through the $IMAGE utility. Refer to the *IBM 3151 ASCII Display Station Reference Manual*, GA18-2634, *IBM 3161/3163 ASCII Display Station Description*, GA18-2310 and the *IBM 3164 ASCII Color Display Station Description*, GA18-2317 for a listing of all the attributes available for your terminal.

- Use the TERMCTRL SET,ATTR= instruction or the ATTR command of $IMAGE to set the attribute bytes for the 3101. Use the ATTR command of $IMAGE to set attribute bytes for the 3151, 3161, 3163, and 3164 terminals.
- If an attribute is not required on the 3101, code a TERMCTRL SET,ATTR=NO before coding a PRINTEXT to a specific location.
- Unprotected static screen read operations for a block mode 3101 terminal start with the first data field encountered and continue to the end of the screen. The first data field encountered is in the upper left corner (row 1, column 1). The first data field for the 3151, 3161, 3163, and 3164 terminals in block mode, however, may be wrapped. In other words, the data field beginning in the upper left corner is considered by the terminal to be the last or part of the last unprotected field in the screen for all read operations. The 3151, 3161, 3163, and 3164 terminal read operations read data from this field into the buffer following all other unprotected fields in the screen. Applications performing read operations should always, therefore, compensate for wrapped fields when reading from the 3151, 3161, 3163, and 3164 block mode terminals.

  To prevent the wrapping of unprotected fields, design screen images so that the first character position is either a protected character or an attribute character, never an unprotected character.
- Escape sequences take up space in the buffer. Therefore, it takes more than 1920 bytes to read a complete screen. Data streams for the 3151, 3161, 3163, and 3164 require more space than those for the 3101. The 3151 and 3161 require one additional byte per field and the 3163 and 3164 require three additional bytes per field. Ensure that the buffer is larger enough to hold all the data.
- The terminal type and the TERMCTRL SET ATTR= and STREAM= parameters determine the number of bytes required in the buffer. For example, a PRINTEXT instruction could require a buffer length equal to the data length plus ten times the number of fields. A READTEXT instruction could require a buffer length equal to the data length plus six times the number of fields when TYPE=ALL and TYPE=DATA.

  The following table lists the number of bytes needed in the buffer, in addition to the data length.

Instruction	3101	3151/3161	3163/3164
PRINTEXT	7 x # of fields	8 x # of fields	10 x # of fields
READTEXT	3 x # of fields	4 x # of fields	6 x # of fields

Figure 8-1. Additional Buffer Requirements

A READTEXT instruction requires a buffer length equal to the data length plus four times the number of fields when TYPE=MODDATA.

- A READTEXT TYPE=DATA reads all unprotected data. If MODE=WORD, fields are separated by blanks. If MODE=LINE, fields are concatenated.
- A WAIT KEY prior to a READTEXT TYPE=MODDATA should be satisfied with a PF key and not the SEND key. If MODE=WORD, fields are separated by blanks. If MODE=LINE, fields are concatenated.
- A READTEXT without a prompt transmits data from the beginning of the screen, regardless of the cursor position.
- After the SEND key is pressed, an RDCURSOR returns as the cursor position the first position of the next line. If a PF key is pressed, it does not move the cursor.

Defining the Format of the Screen

A *screen format* is a representation of the protected fields on a screen. References to the 3101 Display Terminal in this section mean a 3101 model 2x operating in block mode as used in the sample program.

Like the 4978, 4979, or 4980, the format of a 3101, 3151, 3161, 3163, or 3164 screen is defined by how the data is written, either protected or unprotected. However, on the 3101, 3151, 3161, 3163, and 3164, the field definitions are not transparent to the user because attribute bytes separate protected and unprotected fields.

- An attribute byte defines the start of each field and the properties of the field.
- Each field continues until another attribute byte is encountered.
- Each attribute byte occupies one character position on the screen and is displayed as a protected blank preceding the field.
- Attribute bytes are like any other character on the screen in that they can be overwritten by data or another attribute byte. When an attribute byte is overwritten, the screen format can change.

On a 3101, 3151, 3161, 3163, and 3164, you cannot do a scatter write with a PRINTEXT instruction; however, you can specify screen coordinates on output (PRINTEXT LINE=,SPACES=). You can do a gather read by specifying READTEXT MODE=LINE. However, the input of a specific field (by means of READTEXT LINE=,SPACES=) always executes as though LINE=0 and SPACES=0 had been coded.

As a result of these differences, writing terminal independent code using the READTEXT/PRINTEXT instructions can be difficult. However, you can use $IMAGE to perform terminal independent input/output.

Enqueuing the Screen

The sample program must enqueue the 3101 to change the function to static screen. The screen size is forced to 24 x 80 and a CCB buffer is used. The CCB buffer size is terminal dependent; the 3101 requires 203 bytes, the 3151 and 3161 require 201 bytes, and the 3163 and 3164 require 200 bytes.

```
IOCB1    IOCB     SCREEN=STATIC
                  •
                  •
                  •
ENQT     IOCB1
```

Changing the Attribute Byte

On the 3101,the default attribute is high intensity. After it is changed, the sample program always restores the default attribute to high intensity.

```
TERMCTRL SET,ATTR=LOW
```

Erasing the Screen

Erasing the screen defaults the count to 1920 for the 3101 used in the sample program.

```
ERASE    TYPE=ALL
```

Protecting the First Field

In the sample program, the first field defined is a protected field at 0,0. This ensures that the whole screen will be formatted and that no unformatted data areas will be returned on whole screen reads, whether the read is TYPE=ALL, TYPE=DATA or TYPE=MODDATA.

Printing the null character (defined in the DATA statement ATTRBUTE) with STREAM=NO in effect with LINE/SPACES causes EDX to:

- Generate the set cursor address sequence to the LINE/SPACES specified
- Generate the start field sequence, including the current attribute which will create or cause an attribute at LINE/SPACES to be rewritten.

The 3101 data stream is shown below; the attribute byte is shown as "#".

```
ESC.Y.ROW.COL.ESC.3.#.X'00'
```

The null data is required to force the start field sequence; however, a null character is ignored by the 3101.

```
          DATA   X'0101'          DUMMY TEXT STATEMENT CNT=1 LGTH=1
ATTRBUTE  DATA   X'0000'          NULL TO FORCE ATTRIBUTE TO WRITE
           •
           •
           •
          PRINTEXT ATTRBUTE,LINE=0,SPACES=0,PROTECT=YES
          TERMCTRL SET,ATTR=HIGH     RESTORE ATTRIBUTE
```

The code shown above would apply also for the 3151, 3161, 3163, and 3164 terminals, if the following data streams are used:

```
On the 3151/3161:   ESC.Y.ROW.COL.ESC.3._.C.X'00'
On the 3163/3164:   ESC.Y.ROW.COL.ESC.3._#.!.@.X'00'
       where _ represents a blank.
```

Creating Unprotected Fields

To create unprotected fields on the screen ("holes" in which the operator can enter data), the sample program starts each field with an unprotected attribute byte and ends it with a protected attribute byte.

```
PRINTEXT   ATTRBUTE,LINE=4,SPACES=29
  •
  •
  •
TERMCTRL   SET,ATTR=LOW
PRINTEXT   ATTRBUTE,LINE=4,SPACES=34,PROTECT=YES
```

Creating Protected Fields

The next step is to create protected field descriptions. This could be done with ATTR=NO since the screen is already defined as protected in these areas. The sample program, however, uses a standard PRINTEXT to write a protected attribute byte at LINE/SPACES, followed by the literal data.

```
PRINTEXT HEAD1,LINE=1,SPACES=20,PROTECT=YES
PRINTEXT 'ENTER A NUMBER',LINE=4,SPACES=2,PROTECT=YES
```

Writing a Nondisplay Field

The sample program uses a field description which is not initially displayed on the screen. To create a nondisplay field, set the attribute to blank.

```
NONDISP  TERMCTRL SET,ATTR=BLANK
         PRINTEXT 'ENTER ANOTHER NUMBER',LINE=12,SPACES=2,PROTECT=YES
         TERMCTRL SET,ATTR=HIGH     RESTORE ATTRIBUTE
```

Reading a Data Item

Two EDL instructions that have an implied wait are:

- READTEXT with prompt
- GETVALUE with prompt.

The LINE and SPACES parameters of these instructions specify the position of the attribute byte of the unprotected prompt field. Printing a null prompt field positions the attribute byte and cursor differently than for a prompt which is data. For example:

```
Normal GETVALUE       = #prompt#_
Null prompt GETVALUE = #_
```

```
NULPRMPT TEXT     LENGTH=0         USED ON IMPLIED WAIT INSTRUCTIONS
           •
           •
           •
GETVAL   GETVALUE FIELD1NO,NULPRMPT,LINE=4,SPACES=29
```

Writing a Blinking Field

The sample program also uses a protected blinking field.

```
BLINK   TERMCTRL SET,ATTR=BLINK
        PRINTEXT 'FIELD1 MUST BE EVEN ',LINE=2,SPACES=5,PROTECT=YES
        TERMCTRL SET,ATTR=HIGH    RESTORE ATTRIBUTE
```

Erasing an Individual Field

The sample program erases individual fields using the erase end-of-field/end-of-line function. To do this, an ESC.I is sent as data. The field to be erased is specified by LINE/SPACES, and the current attribute byte is rewritten followed by the ESC.I. The data stream on the 3101 follows:

```
        ESC.Y.ROW.COL.ESC.3.#.ESC.I


        DATA     X'0202'         ERASE END OF FIELD
ERASEFLD DATA    X'27C9'         ESC.I
          •
          •
          •
ERASEF   PRINTEXT ERASEFLD,LINE=4,SPACES=29
```

To erase a field, do an ERASE with a count value equal to the field length + 1 and TYPE=ALL. The + 1 is for the unprotected attribute.

```
ERASEF2  ERASE    5,TYPE=ALL,LINE=4,SPACES=29   ERASE FLD1
```

Blanking a Blinking Field

Once an even number is entered, the blinking field is blanked out by changing the attribute byte to nondisplay.

```
        TERMCTRL SET,ATTR=BLANK
        PRINTEXT ATTRBUTE,LINE=2,SPACES=5,PROTECT=YES
```

Writing More Than One Data Item

In the sample program using a 3101, a horizontal tab character is inserted between fields to simulate a scatter write. This is done using PUTEDIT; however, you could also use the CONCAT instruction or indexed moves. The 3101 data stream is shown below. X'05' represents an EBCDIC horizintal tab character.

```
       ESC.Y.ROW.COL.ESC.3.#.DATA1.HT.DATA2

        DATA     X'0101'          HORIZONTAL TAB
TAB     DATA     X'0500'          TAB TO NEXT FIELD
          •
          •
          •
SCATTER  PUTEDIT FORMAT1,TEXTOUT,(AS,TAB,BS),LINE=6,SPACES=29
          •
          •
          •
FORMAT1  FORMAT   (A15,A1,A15),PUT
TEXTOUT  TEXT     LENGTH=31        SIZE OF DATA STREAM
```

Prompting the Operator for Data

The sample program uses a standard QUESTION instruction.

```
QUEST    QUESTION 'WANT TO SEE MORE ?',NO=ENDIT,LINE=10,SPACES=5
```

An invalid response to a QUESTION (anything other than Y or N) is handled by the supervisor, which reissues the read. This results in a string of two new fields: a question mark and a response field.

```
#PROMPT#?#?#?#?#_
```

Changing the Attribute Byte to a Protected Blank

To clear this string of fields, you could overwrite them with a protected field of blanks. Instead, the sample program finds each field and changes the attribute to blank protected.

```
         RDCURSOR LINE,SPACES       FIND CURSOR
         PRINTEXT LINE=LINE,SPACES=SPACES
         TERMCTRL DISPLAY           FORCE SOFT CURSOR ADDRESS
*                                   TO BE UPDATED
         DO       UNTIL,(SPACES,EQ,5),AND,(LINE,EQ,10)
```

A backtab command is sent as data to position the cursor in the first position of the unprotected field preceding the current cursor address. SET,ATTR=NO is used to prevent EDX from generating the attribute byte and preceding start field sequence. The 3101 data stream follows:

```
         ESC.2


         DATA     X'0202'
BACKTAB  DATA     X'27F2'           BACK TAB TO FIRST CHARACTER
*                                  POSITION OF NONPROTECTED FIELD
           •
           •
           •
           TERMCTRL SET,ATTR=NO
           PRINTEXT BACKTAB
           RDCURSOR LINE,SPACES     FIND NONPROTECTED FIELD CURSOR
*                                   IS IN
           SUB      SPACES,1        ADJUST TO ATTRIBUTE BYTE
           TERMCTRL SET,ATTR=BLANK  PREPARE TO BLANK IT
           PRINTEXT ATTRBUTE,LINE=LINE,SPACES=SPACES,PROTECT=YES
         ENDDO
```

Displaying a Nondisplay Field

Now the sample program displays the nondisplay field previously discussed (ENTER ANOTHER NUMBER). The attribute that is currently blank protected is rewritten to low protected.

```
LIGHT    TERMCTRL SET,ATTR=LOW
         PRINTEXT ATTRBUTE,LINE=12,SPACES=2,PROTECT=YES
```

Creating a New Unprotected Field

Next the sample program creates a new unprotected field with the cursor in place; this is useful for data entry. To create an unprotected field on demand with the cursor in place, write the end-of-field attribute first and then the start of field attribute.

```
CREATEU  TERMCTRL SET,ATTR=LOW
         PRINTEXT ATTRBUTE,LINE=12,SPACES=34,PROTECT=YES
         TERMCTRL SET,ATTR=HIGH     RESTORE ATTRIBUTE
         PRINTEXT ATTRBUTE,LINE=12,SPACES=29
         WAIT     KEY
```

Reading Modified Data

A read of modified data has several implications:

- A field is modified by entering data or erasing the field. The modified data tag (MDT) in the attribute byte is turned on by the 3101, 3151, 3161, 3163, and 3164 terminals.
- The modified data tag could be on when the attribute byte is written. $IMAGE provides this capability.
- Group 2, switch 4 on the 3101 enables the SEND key to function as the SEND LINE key. When the SEND key is pressed, the data that is on the same line as the cursor is sent. The type of data that is sent depends on the type of read in effect, namely all data, unprotected or modified.
- Once a modified field is sent to the Series/1 through the SEND key or a read buffer, the modified data tag in the attribute byte is turned off.

At this point during the sample program execution, another number (FIELD4 data) has been entered and the SEND key has been pressed. The cursor was probably on the same line as FIELD4; if it was, FIELD4 data was sent to satisfy the WAIT KEY and the modified data tag was turned off. A subsequent READTEXT of TYPE=MODDATA would not return FIELD4 unless the cursor were moved to a line not containing modified fields, or a PF key were used to satisfy the WAIT KEY.

To read only the fields in which numbers were entered, the sample program rewrites the attribute bytes for those two fields with the modified data tags on. Before the modified fields are read, there is an intervening write, so the program locks the keyboard.

```
         TERMCTRL LOCK
         TERMCTRL SET,ATTR=NO       TO WRITE MDT ON ATTRIBUTE
```

Forcing the Modified Data Tag On

A start field sequence with an unprotected, high intensity attribute (with MDT on) is written as data. The 3101 data stream follows:

```
        ESC.Y.ROW.COL.ESC.3.E


        DATA    X'0303'         TO FORCE MODIFIED DATA TAG ON
SETMOD  DATA    X'27F3'         START FIELD SEQUENCE
        DATA    X'C500'         ATTRIBUTE=HIGH,UNPROTECTED,MDT ON
         •
         •
         •
        PRINTEXT SETMOD,LINE=12,SPACES=29
        PRINTEXT SETMOD,LINE=4,SPACES=29
```

The data streams for the 3151, 3161, 3163 and 3164 are longer because more parameters are needed to indicate the attribute:

```
       On the 3151/3161:   ESC.Y.ROW.COL.ESC.3.(.A


        DATA    X'0404'         TO FORCE MODIFIED DATA TAG ON
SETMOD  DATA    X'27F3'         START FIELD SEQUENCE
        DATA    X'4DC1'         ATTRIBUTE=HIGH,UNPROTECTED,MDT ON
         •
         •
         •
       On the 3163/3164:   ESC.Y.ROW.COL.ESC.3.(.!.$.@


        DATA    X'0606'         TO FORCE MODIFIED DATA TAG ON
SETMOD  DATA    X'27F3'         START FIELD SEQUENCE
        DATA    X'4D5A5B7C'     ATTRIBUTE=HIGH,UNPROTECTED,MDT ON
         •
         •
         •
```

Now the sample program issues a READTEXT with TYPE=MODDATA; this reads all the modified data on the screen, in this case two fields.

```
READMOD  READTEXT MTEXT,TYPE=MODDATA,MODE=LINE
         IF       (MTEXT,NE,MTEXT+4,4)   PSEUDO TESTING
          •
          •
          •
MTEXT    TEXT     LENGTH=8         READ OF MODDATA:  STREAM
*                                  LENGTH = DATA + (4*NOFLDS) = 16
```

Reading Modified Data on the 3101

On the 3101, 3151, 3161, 3163, and 3164, an unprotected field is considered to be a modified field when:

- Any character within the field is changed by the operator
- Certain ERASE instructions are executed
- The modified data tag (MDT) in the attribute byte is on.

The modified data tags are reset when the data is read by a READTEXT TYPE=MODDATA instruction or transmitted by pressing the SEND key. To return a protected field using READTEXT TYPE=MODDATA, design the field with the modified data tag set on in the attribute byte.

To read all the modified fields from a screen, the operator must position the cursor on a protected line which does not contain any modified fields. If the cursor is not on such a line and the operator presses the enter key to satisfy a WAIT KEY instruction, the MDTs on that line are reset. A subsequent READTEXT would therefore not return to the program the modified data on that line. If a PF key instead of the SEND key is used to satisfy the WAIT KEY, the MDTs are not changed.

The IOCB BUFFER= parameter or the CCB buffer must be large enough to contain the received 3101, 3151, 3161, 3163, or 3164 data stream prior to the editing of the ESC sequences. If the CCB buffer is not large enough, use the IOCB buffer.

Erasing to the End of the Screen

To prepare to erase the remaining fields, the sample program positions the cursor to the second field.

```
PRINTEXT LINE=6,SPACES=29
TERMCTRL DISPLAY
```

Using ERASE with TYPE=DATA, all the unprotected fields from the current cursor position to the end of screen are erased. The count value is not used and mode is forced to screen.

```
ERASUNP  ERASE    TYPE=DATA          ERASE REMAINING UNPROTECT FIELDS
```

Reading All Unprotected Data

The sample program uses GETEDIT to get all the unprotected fields under format control. You could also use a READTEXT without a prompt; this would read all the unprotected data from the start of the screen.

```
GETALL   GETEDIT  FORMAT2,TEXTAMT,(NO1,ALPH1,ALPH2,NO2)
           •
           •
           •
TEXTAMT  TEXT     LENGTH=38          GETEDIT STREAM LENGTH =
*                                    DATA + (3*NOFLDS) = 50
FORMAT2  FORMAT   (I4,A15,A15,I4),GET
```

Writing a Data Item

The sample program uses a standard PRINTNUM to write to LINE/SPACES.

```
PRINTNUM NO1,FORMAT=(5,0,I),LINE=18,PROTECT=YES
```

Reading a Data Item

To do a read from LINE/SPACES, a prompt field is required. The null prompt text statement (NULPRMPT) is used.

```
TERMCTRL SET,ATTR=HIGH
READTEXT TEXTIN,NULPRMPT,LINE=23,SPACES=70
```

Data Stream Considerations

Applications that generate complex data streams for the 3151, 3161, 3163, and 3164 terminals running in block mode (or 3101 emulation block mode) should provide their own pacing support. Repeated writing of large data streams containing multiple escape sequences may cause the terminal's internal buffer to be overrun. This results in truncation of the data stream. A sufficient delay should occur between terminal output operations which involve this type of data stream.

Example

```
    SAMPLE    PROGRAM   START
    IOCB1     IOCB      SCREEN=STATIC
*****************************************************************
*   THIS PROGRAM USES A 3101 TERMINAL TO ILLUSTRATE*
*   EBCDIC ESC SEQUENCES AND DATA STREAMS VIA PRINTEXT*
*****************************************************************
 1            DATA      X'0202'
 2  ERASEFLD  DATA      X'27C9'
 3            DATA      X'0303'
 4  SETMOD    DATA      X'27F3'
 5            DATA      X'C500'
 6            DATA      X'0101'
 7  ATTRBUTE  DATA      X'0000'
 8            DATA      X'0202'
 9  BACKTAB   DATA      X'27F2'
10            DATA      X'0101'
11  TAB       DATA      X'0500'
12  NULPRMPT  TEXT      LENGTH=0
    START     EQU        *
              ENQT       IOCB1
              TERMCTRL   SET,ATTR=LOW
              ERASE      TYPE=ALL
13            PRINTEXT   ATTRBUTE,LINE=0,SPACES=0,PROTECT=YES
14     TERMCTRL   SET,ATTR=HIGH
15            PRINTEXT   ATTRBUTE,LINE=4,SPACES=29
15            PRINTEXT   ATTRBUTE,LINE=6,SPACES=29
15            PRINTEXT   ATTRBUTE,LINE=8,SPACES=29
16            TERMCTRL   SET,ATTR=LOW
              PRINTEXT   ATTRBUTE,LINE=4,SPACES=34,PROTECT=YES
              PRINTEXT   ATTRBUTE,LINE=6,SPACES=45,PROTECT=YES
              PRINTEXT   ATTRBUTE,LINE=8,SPACES=45,PROTECT=YES
17            PRINTEXT   HEAD1,LINE=1,SPACES=20,PROTECT=YES
17            PRINTEXT   'ENTER A NUMBER',LINE=4,SPACES=2,          C
                        PROTECT=YES
17            PRINTEXT   'THIS IS FIELD2',LINE=6,SPACES=9,          C
                        PROTECT=YES
17            PRINTEXT   'THIS IS FIELD3',LINE=8,SPACES=9,          C
                        PROTECT=YES
18  NONDISP   TERMCTRL   SET,ATTR=BLANK
              PRINTEXT   'ENTER ANOTHER NUMBER',LINE=12,SPACES=2,   C
                        PROTECT=YES
```

1 Define a dummy TEXT statement with length of 2 and count of 2.

2 Erase end of field sequence.

3 Define a dummy TEXT statement with length of 3 and count of 3.

4 Start field sequence.

5 Set ATTR=HIGH, unprotected, with modified data tag on.

6 Define a dummy TEXT statement with length of 1 and count of 1.

7 Null (to force attribute to write).

8 Define a dummy TEXT statement with length of 2 and count of 2.

9 Back tab to first character position of unprotected field.

10 Define a dummy TEXT statement with length of 1 and count of 1.

11 Horizontal tab to next field.

12 Used on implied wait instructions.

13 Start screen with protected field at 0,0.

14 Set intensity to high.

15 Set the start of unprotected field.

16 Set the intensity to low. Now set the end of unprotected fields.

17 Create protected literals as new fields. This could be done with ATTR=NO as screen is protected.

18 Nondisplay this literal field at this time.

```
18          TERMCTRL  SET,ATTR=HIGH
*           NORMAL    GETVALUE =   #PROMPT#_
*           NULL      PROMPT GETVALUE =   #_
    GETVAL  GETVALUE  FIELD1NO,NULPRMPT,LINE=4,SPACES=29
            DIVIDE    FIELD1NO,2,RESULT=DUMMY
            IF        (SAMPLE,NE,0)
19 BLINK    TERMCTRL  SET,ATTR=BLINK
            PRINTEXT  'FIELD1 MUST BE EVEN ',LINE=2,SPACES=5,        C
                      PROTECT=YES
20          TERMCTRL  SET,ATTR=HIGH
21 ERASEF   PRINTEXT  ERASEFLD,LINE=4,SPACES=29
            GOTO      GETVAL
            ELSE
22          TERMCTRL  SET,ATTR=BLANK
            PRINTEXT  ATTRBUTE,LINE=2,SPACES=5,PROTECT=YES
            TERMCTRL  SET,ATTR=HIGH        RESTORE ATTRIBUTE
            *          *
23 SCATTER  PUTEDIT   FORMAT1,TEXTOUT,(AS,TAB,BS),LINE=6,           C
                        SPACES=2
            ENDIF
            *
24 QUEST    QUESTION  'WANT TO SEE MORE ?',NO=ENDIT,LINE=10,          C
                                              SPACES=5
    *       *         QUESTION AND INVALID RESPONSES CAN YIELD
    *       *         #PROMPT#?#?#?#?#_
    *       *         NEED TO FIND ALL ATTRIBUTES '#' AND CLEAR
25          RDCURSOR  LINE,SPACES       FIND CURSOR
25          PRINTEXT  LINE=LINE,SPACES=SPACES
            TERMCTRL  DISPLAY
            DO        UNTIL,(SPACES,EQ,5),AND,(LINE,EQ,10)
            TERMCTRL  SET,ATTR=NO
            PRINTEXT  BACKTAB
26          RDCURSOR  LINE,SPACES
27          SUB       SPACES,1
28          TERMCTRL  SET,ATTR=BLANK
            PRINTEXT  ATTRBUTE,LINE=LINE,SPACES=SPACES,PROTECT=YES
            ENDDO
29 LIGHT    TERMCTRL    SET,ATTR=LOW
            PRINTEXT  ATTRBUTE,LINE=12,SPACES=2,PROTECT=YES
            PRINTEXT  'ON A WAIT KEY NOW',LINE=13,SPACES=9,           C
                        PROTECT=YES
30 CREATEU  TERMCTRL  SET,ATTR=LOW
            PRINTEXT  ATTRBUTE,LINE=12,SPACES=34,PROTECT=YES
31          TERMCTRL  SET,ATTR=HIGH
            PRINTEXT  ATTRBUTE,LINE=12,SPACES=29
            WAIT      KEY
```

18 Restore attribute.

19 Create new protected blinking field.

20 Restore attribute.

21 Going to erase an individual field using erase.

22 Blank out blinking field by going nondisplay.

23 Do scatter write by inserting tab character.

24 Going to do standard question.

25 Force soft cursor address to be updated.

26 Find unprotected field cursor is in.

27 Adjust to attribute byte.

28 Prepare to blank it.

29 Light up nondisplay field4 prompt.

30 Create new unprotected field with cursor in place.

31 Restore attribute.

```
32          TERMCTRL  LOCK
33          TERMCTRL  SET,ATTR=NO
            PRINTEXT  SETMOD,LINE=12,SPACES=29
            PRINTEXT  SETMOD,LINE=4,SPACES=29
            TERMCTRL  SET,ATTR=YES   RESTORE
  READMOD   READTEXT  MTEXT,TYPE=MODDATA,MODE=LINE
34          IF         (MTEXT,NE,MTEXT+4,4)
            TERMCTRL  SET,ATTR=BLINK
            PRINTEXT  'FLD4 MUST = FLD1  ',LINE=13,SPACES=9,      C
                       PROTECT=YES
35          TERMCTRL  SET,ATTR=HIGH
36 ERASEF2  ERASE     5,TYPE=ALL,LINE=4,SPACES=29
            PRINTEXT  LINE=6,SPACES=29
            TERMCTRL  DISPLAY
37 ERASEUNP ERASE     TYPE=DATA
            TERMCTRL  UNLOCK
            GOTO      GETVAL
            ENDIF
            TERMCTRL  UNLOCK
  GETALL    GETEDIT   FORMAT2,TEXTAMT,(NO1,ALPH1,ALPH2,NO2)
            TERMCTRL  SET,ATTR=BLINK
            PRINTEXT  'YOU ENTERED:',LINE=16,PROTECT=YES
            TERMCTRL  SET,ATTR=HIGH
            PRINTNUM  NO1,FORMAT=(5,0,I),LINE=18,PROTECT=YES
            PRINTEXT  ALPH1,LINE=19,PROTECT=YES
            PRINTEXT  ALPH2,LINE=20,PROTECT=YES
            PRINTNUM  NO2,FORMAT=(5,0,I),LINE=21,PROTECT=YES
            TERMCTRL  DISPLAY
  ENDIT     EQU       *
            TERMCTRL  SET,ATTR=LOW
            PRINTEXT  'IF YOU WANT TO SEE IT AGAIN ENTER ''AGAIN'', C
                      LINE=23,SPACES=5,PROTECT=YES
            TERMCTRL  SET,ATTR=HIGH
38          READTEXT  TEXTIN,NULPRMPT,LINE=23,SPACES=70
            IF        (TEXTIN,EQ,CAGAIN,5),GOTO,START
            PROGSTOP  LOGMSG=NO
  FORMAT1   FORMAT    (A15,A1,A15),PUT
39 TEXTOUT  TEXT      LENGTH=31
  LINE      DATA      F'0'
  SPACES    DATA      F'0'
  FIELD1NO  DATA      F'0'
  HEAD1     TEXT      '*** 3101 SAMPLE PROGRAM ***'
40 MTEXT    TEXT      LENGTH=8
  DATABFR   DATA      C'AAAAAAAAAAAAAAAABBBBBBBBBBBBBB'
  AS        EQU       DATABFR
  BS        EQU       AS+15
41 TEXTAMT  TEXT      LENGTH=38
  FORMAT2   FORMAT    (I4,A15,A15,I4),GET
  NO1       DATA      F'0'
  NO2       DATA      F'0'
  ALPH1     TEXT      LENGTH=15
  ALPH2     TEXT      LENGTH=15
  CAGAIN    DATA      C'AGAIN'
  TEXTIN    TEXT      ' ',LENGTH=5
  DUMMY     DATA      F'0'
            ENDPROG
            END
```

32 Lock the keyboard.

33 To write MDT on attribute.

34 Pseudo testing. Read these two fields with TYPE=MODDATA.

35 Restore.

36 Erase FLD 1.

37 Erase remaining unprotected fields.

38 Finally a READTEXT to line and space.

39 Size of data stream.

40 Read of Moddata LGTH= DATA +(4*NOFLDS).

41 Getedit stream LGTH= DATA + (3*NOFLDS).

Chapter 9. Designing Programs

This chapter discusses designing EDL programs.

All of the programs shown so far have had one thing in common: they are all short, self-contained groups of instructions that perform a simple function without interacting with any other program.

This chapter:

- Defines the terms *program* and *task* and describes how to create a program that consists of more than one task
- Describes how to use the same group of instructions from more than one program
- Shows how to use the same storage more than once for different parts of a program (overlays)
- Shows how to improve performance by using storage as a buffer area.

What Is a Task?

A *task* is a unit of work that you form by combining instructions. In its simplest form, a task consists of a TASK statement, instructions, and an ENDTASK statement.

Each task runs independently, competing equally with other tasks for system resources.

When you code a task, you assign a priority to the task. A *priority* is a number that determines the rank of the task. The supervisor uses priority to determine which task receives system resources. The highest priority is 1 and the lowest is 510.

In the following example, TASK01 is the name of a task. START01 is the label on the first instruction to be executed, and 140 is the priority of the task.

```
TASK01  TASK  START01,140
        •
        •
        •
        ENDTASK
```

The supervisor places each task in one of five states:

State	*Description*
Inactive	Task is detached or is not yet attached
Waiting	Task is waiting for the occurrence of an event or the availability of a resource
Ready	Task is ready but is not the highest priority task
Active	Task is attached and is the highest priority task on its level
Executing	Task is using the processor.

Only one task can be active on each of four machine hardware levels. (The supervisor executes on hardware level 1; application programs usually execute on hardware level 2 or 3.)

The active task in each hardware level is the ready task that has the highest priority and is not waiting for an event or a resource.

Initiating a Task

You can initiate a task either by loading or attaching it. The system places the primary task in the ready state when you load the program. You can initiate a secondary task with the ATTACH statement if the task is not already active *and* you do either of the following:

- You write a program that consists of a primary task and a secondary task.
- You link edit a primary task with another task. (You must code an EXTRN statement in the primary task and an ENTRY statement in the secondary task.)

You return a task to the inactive state when you execute either a DETACH instruction or ENDTASK instruction. The DETACH instruction suspends the task and allows it to be attached again.

Only one copy of a task may be active at a time. A task in processor storage remains until you execute an ENDPROG statement in the associated primary task.

What Is a Program?

A *program* is a disk- or diskette-resident collection of one or more tasks that can be loaded into storage for execution. Although program and task are sometimes used synonymously (when a program contains a single task), the basic *executable* unit is the task; a program is the unit that the system loads into storage.

You can divide a program into two or more tasks if, for example, you need to synchronize execution between the tasks. Another reason to divide a program into tasks is to have more than one task active at the same time.

The name of a program is the name of the data set in which the program resides. A program can be brought into storage either by a terminal operator, a program, or a supervisor program such as the job stream processor. It can be loaded more than once, either in the same partition or in a different partition.

Creating a Single-Task Program

Most applications consist of a single task in a single program. The program contains no execution overlay. The task competes for system resources with other tasks currently in the system.

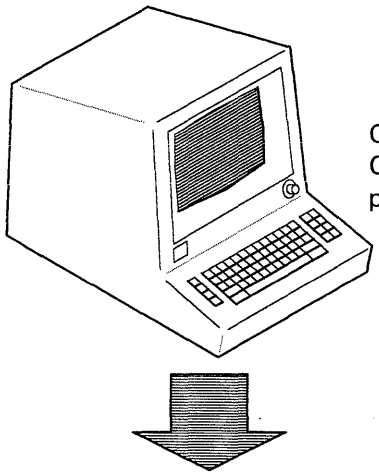
The following example shows the structure of a single-task program:

```
BEGIN  PROGRAM  START
       •
       •
       •
       PROGSTOP
       ENDPROG
       END
```

In this example, BEGIN is the name of the task, and START is the label of the first instruction to be executed.

Note that even though the TASK statement is not required in a simple program, the program still consists of a single task.

Figure 9-1 on page 9-4 is an example of a single-task program structure.



Operator request loads
CUSTOMER FILE UPDATE
program

```
UPDATE

1.  GET CUSTOMER NAME FROM TERMINAL (OPERATOR INPUT)

2.  SEARCH CUSTOMER FILE FOR NAME

3.  READ CUSTOMER RECORD

4.  DISPLAY CUSTOMER RECORD ON TERMINAL

5.  ACCEPT UPDATE FROM TERMINAL (OPERATOR INPUT)

6.  WRITE UPDATED RECORD TO CUSTOMER FILE

7.  GO BACK TO STEP 1 IF MORE RECORDS TO UPDATE

8.  ELSE, END UPDATE PROGRAM
```

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Figure 9-1. Single-Task Application Example

Creating a Multitask Program

A multitask program contains more than one task. For example:

```
BEGIN  PROGRAM  START
       •
       •
       •
       ATTACH   CALC
       •
       •
       •
       PROGSTOP
CALC   TASK
       instructions
       ENDTASK
       ENDPROG
       END
```

Note that the PROGRAM and PROGSTOP statements define a task called the *primary task*. The TASK and ENDTASK statements define a *secondary task*, loaded by the ATTACH instruction.

Figure 9-2 illustrates multitasking in a single program. When you load the program, the system loads PROGA, called the primary task. The other tasks shown in PROGA start when an active task issues a command (such as an ATTACH instruction) that tells the tasks to begin.

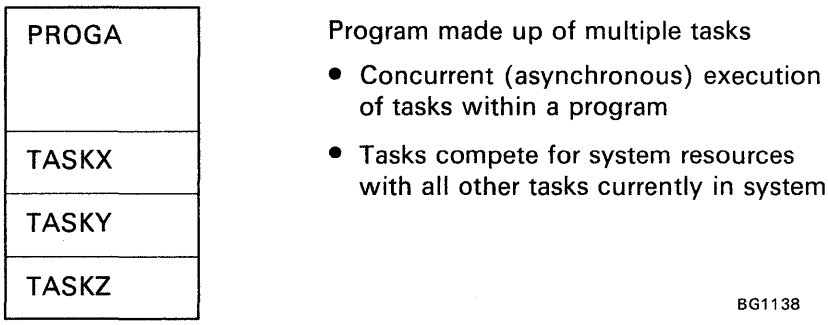

Figure 9-2. Multitask Program Structure

Once in execution, all tasks within a program compete with one another and with all other tasks active in the system. The supervisor considers each task as a discrete unit of work and assigns processor time based on task priority, regardless of whether a task is the primary task of a program. All tasks compete for resources based on assigned priorities.

If a primary task ends before the secondary task, the secondary task runs to completion.

Synchronizing Tasks

You can synchronize tasks with the WAIT and POST instructions or with the DETACH and ATTACH instructions. If you use the WAIT and POST instructions, the waiting task must contain an event control block (ECB) that can be posted by the POST instruction. Execution then continues in the waiting task at the first instruction after the WAIT instruction. A task can also wait for the operator to press a Program Function (PF) key, for a time interval to occur, or for a program to finish execution.

While waiting to be posted, the task enters a waiting state. The task also enters a waiting state if it is waiting for a read or write operation to occur or if it has executed a DETACH instruction.

You can use the DETACH and ATTACH instruction to synchronize tasks the same way you use the WAIT and POST instruction, with the following differences:

- The attached task becomes enqueued to the currently active terminal for the task that issued the ATTACH instruction.
- The system provides the ECB.
- You cannot use the ATTACH and DETACH instructions from within subroutines.

Defining and Calling Subroutines

In a program, certain functions may need to be repeated at different points in a program. For example, you do not need to code the same sequence of instructions each time your program needs to perform a given arithmetic function. You can code the instructions once and define them as a subroutine. You can than enter and execute that subroutine from as many points in your program as needed. You can also use the subroutine in another program by including it at link-edit time.

The following instructions provide the means for defining and calling subroutines:

CALL	Transfers control to a subroutine
RETURN	Returns control from the subroutine to the calling program
SUBROUT	Defines the entry point and parameters of a subroutine
EXTRN	Defines an external reference
ENTRY	Defines a program entry point.

Defining a Subroutine

Use SUBROUT to define the entry point of a subroutine. You can specify up to five parameters as arguments in the subroutine. The subroutine must include a RETURN instruction to provide linkage back to the calling task. You can have nested subroutines, and a maximum of 99 subroutines are permitted per program. If you assemble your subroutine as an object module that can be link edited, you must code an ENTRY statement for the subroutine entry point name.

You can call a subroutine from more than one task. When called, the subroutine executes as part of the calling task. Because subroutines are not reentrant, you should ensure serial use of the subroutine with the ENQ and DEQ instructions.

Note: Do not code a TASK statement within a subroutine.

The syntax of the SUBROUT instruction is as follows:

```
label     SUBROUT name,par1,...,par5

Required: name
Defaults: none
Indexable: none
```

Code the *name* operand with the symbolic name of the subroutine to be referred to by other instructions. The *label* field is optional. Do not confuse the *label* field with the subroutine name you specify in the *name* operand.

Passing Parameters in a Subroutine (Example)

Par1 through *par5* are the parameter names to be passed to the subroutine when it is entered. These names must be unique to the whole program. All parameters defined outside the subroutine are known within the subroutine. Thus, you need to define only parameters that may vary with each call to a subroutine.

For instance, assume two calls are made to the same subroutine. The first call passes parameters A and C and the second CALL passes parameters B and C. Because C is common to both, you need not define it in the SUBROUT instruction.

In the following example, a program calls subroutine CHKBUFF, passing two parameters. The first (BUFFLEN) is a variable containing the maximum allowable buffer count. The second (BUFFEND) is the address of the instruction to be executed if the buffer is full.

```
         SUBROUT  CHKBUFF,BUFFLEN,BUFFEND
          •
          •
          •
         SUBTRACT BUFFLEN,1
         IF       (BUFFLEN,GE,MAX)
            GOTO  (BUFFEND)
         ENDIF
         ADD      BUFFLEN,1
         RETURN
          •
          •
          •
MAX      DATA     F'256'
```

Calling a Subroutine

Use the CALL instruction to execute your subroutine.

If the called subroutine is a separate object module to be link edited with your program, then you must code an EXTRN statement for the subroutine name in the calling program.

The syntax of the CALL instruction is as follows:

```
label     CALL    name,par1,...,par5,P1=,...,P6=

Required: name
Defaults: none
Indexable: none
```

The *name* operand is the name of the subroutine to be executed.

Par1 through *par5* are the parameters associated with the subroutine. You can pass up to five single-precision integers, labels of single-precision integers, or null parameters to the subroutine. The actual constant or the value at the named location moves to the corresponding subroutine parameter.

If you enclose the parameter name in parentheses, the address of the variable passes to the subroutine. The address can be the label of the first word of any type of data item or data array. Within the subroutine, you must move the passed address of the data item into index registers #1 or #2 to reference the data item. If the parameter name enclosed in parentheses is a symbol defined by an EQU instruction, the system passes the value of the symbol.

If the parameter to be passed is the value of a symbol defined by an EQU instruction, it can also be preceded by a plus (+) sign. This causes the value of the EQU to be passed to the subroutine. If not preceded by a +, the EQU is assumed to represent an address and the data at that address is passed as the parameter.

Subroutine Call Examples

The following example passes the value 5 to the subroutine PROG:

```
CALL   PROG,5
```

The following example passes the value 5 and the null parameter 0 to the subroutine CALC:

```
CALL   CALC,5,
```

The following example passes the contents of PARM1, the address of PARM2, and the value of the EQU symbol FIVE:

```
CALL   SUBROUT,PARM1,(PARM2),+FIVE
```

Calling a Subroutine Passing Integer Parameters (Example)

The following example shows a program that passes integers to a subroutine:

```
SUBEXAMP    PROGRAM     START
START       CALL        CALC,50,SUM1
              •
              •
              •
C2          CALL        CALC,SUM1,SUM2
              •
              •
              •
            PROGSTOP
INTEGERA    DATA         F'10'
INTEGERB    DATA         F'15'
SUM1        DATA         F'0'
SUM2        DATA         F'0'
SUB1        SUBROUT      CALC,XVAL,YVAL
A1          ADD          INTEGERA,XVAL,RESULT=YVAL
            RETURN
            ENDPROG
            END
```

In the first CALL, the first parameter (the integer value 50) corresponds to the first parameter defined in the subroutine (XVAL). Program location SUM1 corresponds to the second parameter (YVAL). When the ADD instruction executes, the system substitutes 50 for XVAL and location SUM1 for YVAL. After the ADD instruction, SUM1 equals 60, the sum of INTEGERA and 50.

The second call causes 70, the sum of SUM1 and INTEGERA, to be put in location SUM2. Because INTEGERA does not change, you do not need to pass it as a parameter.

Reusing Storage using Overlays

You can reuse a single storage area allocated to a program by using overlays. EDL provides two kinds of overlays: overlay segments and overlay programs.

An *overlay segment* is a self-contained portion of a program that is called and executed as a synchronous task. The program that calls the overlay segment need not be in storage while the overlay segment is executing. Overlay segments perform a specific function and generally execute only once.

An *overlay program* is a self-contained portion of a program that is loaded and executed as an asynchronous task. Overlay programs require a main *control program* that controls the execution of up to nine overlay programs.

Using Overlay Segments

Figure 9-3 shows the structure of an application program that is split into a root segment and three overlay segments.

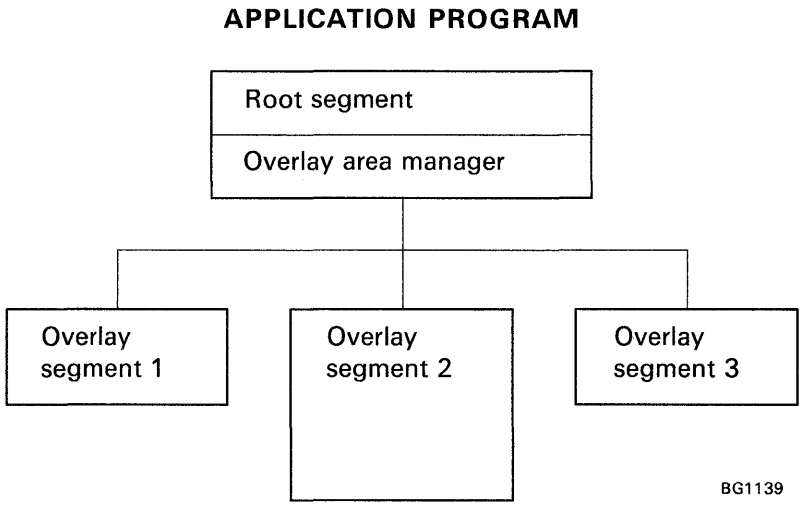

Figure 9-3. Application Overlay Segments

When you load the main program, the loader reserves enough space for the root segment, the overlay area manager, the overlay control table, and the largest overlay segment as shown in Figure 9-4.

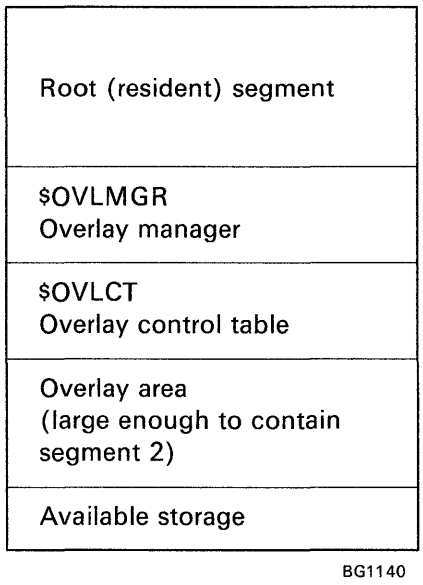

Figure 9-4. Overlay Segments in Series/1 Storage

The following example shows a root segment and three overlay segments:

```
BEGIN  PROGRAM  START
       EXTRN    CALC,UPDATE,WRITE
        •
        •
        •
       CALL     CALC
        •
        •
        •
       CALL     UPDATE
        •
        •
        •
       CALL     WRITE
        •
        •
        •
       PROGSTOP
       ENDPROG
       END
*********************************************************************
*      OVERLAY SEGMENT 1                                            *
*********************************************************************
       SUBROUT  CALC
       ENTRY    CALC
         instructions
       RETURN
       END
*********************************************************************
*      OVERLAY SEGMENT 2                                            *
*********************************************************************
       SUBROUT  UPDATE
       ENTRY    UPDATE
         instructions
       RETURN
       END
*********************************************************************
*      OVERLAY SEGMENT 3                                            *
*********************************************************************
       SUBROUT  WRITE
       ENTRY    WRITE
         instructions
       RETURN
       END
```

Each of the overlay segments is a subroutine that you can compile separately.

Creating an Overlay Structure

To create an overlay structure, use the linkage editor $EDXLINK. The linkage editor allows you to combine the overlay segments you link edited separately into a program segment overlay structure. $EDXLINK automatically includes an overlay manager with the root segment, along with an overlay area equal to the largest overlay segment. A CALL (or transfer of control) to a module within an overlay segment triggers the overlay area manager to load the overlay segment into the overlay area and transfer control to it. Overlay segments execute as synchronous tasks. An overlay segment cannot call another overlay segment.

Overlay segments are specified in the OVERLAY statement of $EDXLINK which is discussed in detail in Chapter 5, "Preparing an Object Module for Execution."

Overlay Programs

An *overlay program* is a program in which certain control sections can use the same storage location at different times during execution. Overlay programs execute concurrently as asynchronous tasks with other programs and are specified in the PROGRAM statement in the main program.

With overlay programs, the main program loads the overlay programs. The loader allocates the overlay area for overlay programs at main program load time. The overlay area is equal to the largest overlay program listed in the main program header.

In Figure 9-5, the application is split into separate programs. PHASE1, the primary program, loads the overlay programs (PHASE2, PHASE3, and PHASE4) as requested.

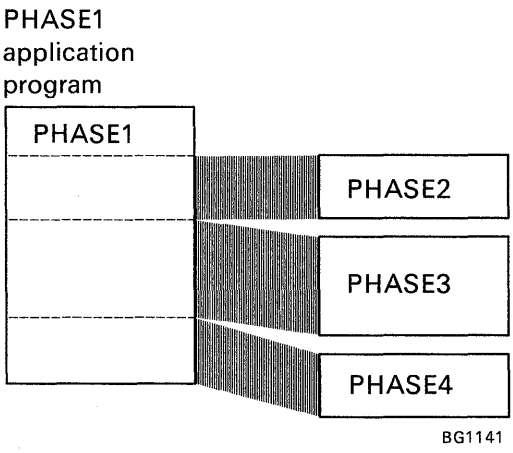

Figure 9-5. EDL Overlay Programs

When PHASE1 is loaded, the loader recognizes that overlay programs are referenced. The loader looks at each overlay program and reserves enough storage to hold PHASE1 plus the largest overlay program (PHASE3) as shown in Figure 9-6.

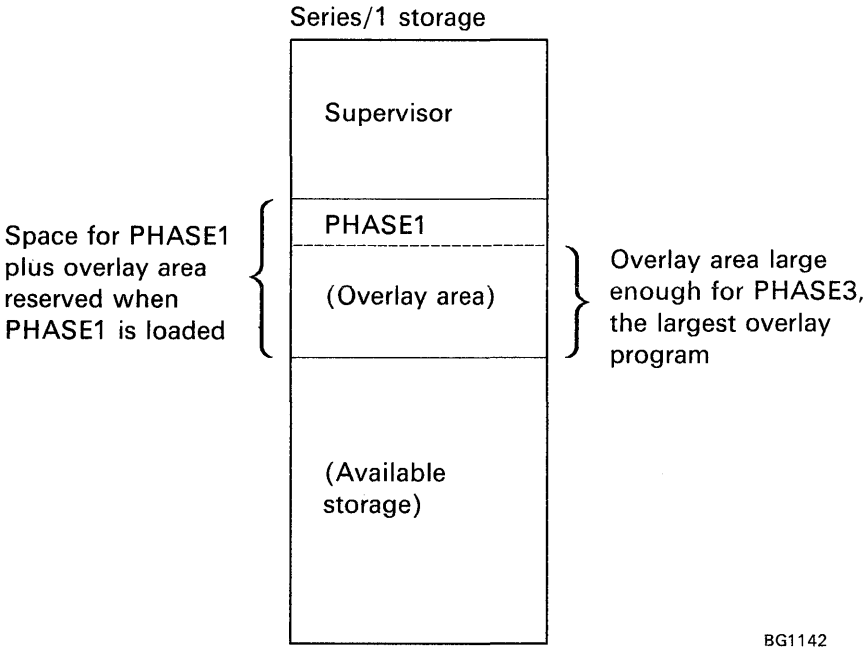

Figure 9-6. EDL Overlay Programs in Series/1 Storage

As each overlay program completes execution, PHASE1 loads the next overlay program, until all required programs have run. When PHASE1 terminates, the system releases the storage reserved for PHASE1 and its overlay programs. Refer to the *Language Reference* for information on coding the PROGRAM statement for overlays.

Using Large Amounts of Storage (Unmapped Storage)

Unmapped storage allows you to write a program that uses large amounts of storage. Unmapped storage allows you to store large amounts of data and retrieve data faster than you could retrieve it from disk or diskette. This section describes setting up, obtaining, accessing, and releasing unmapped storage.

What Is Unmapped Storage?

Unmapped storage is physical storage that has not been reserved by the SYSPARTS statement during system initialization.

Setting up Unmapped Storage

Use the STORBLK statement to define the size and number of the unmapped storage areas a program will use. The TWOKBLK operand defines the size of each unmapped storage area. For example, if you need unmapped storage areas to accommodate 6000 bytes of data, code TWOKBLK=3 (6K = 6144 bytes). The maximum size of an unmapped storage area is 63,488 bytes (TWOKBLK=31).

The MAX operand defines the number of unmapped storage areas. For example, if you need ten unmapped storage areas, code MAX=10.

In the following example, HOLD defines 16 (MAX=16) 2K-byte areas of unmapped storage.

```
HOLD  STORBLK  TWOKBLK=1,MAX=16
```

The STORBLK statement also sets up a mapped storage area the same size as the unmapped storage area.

Obtaining Unmapped Storage

Use the GETSTG instruction to obtain the mapped and unmapped storage areas you defined in the STORBLK statement. For example:

```
GETSTG  HOLD,TYPE=ALL
```

This instruction obtains the mapped and unmapped storage that you defined in the STORBLK statement with the label HOLD. The size of the area depends on the TWOKBLK operand of the STORBLK statement. The operand TYPE=ALL tells the system to obtain the unmapped and mapped storage areas. The number of unmapped storage areas the system obtains depends on the MAX parameter of the STORBLK statement.

If you want to obtain only one unmapped storage area, code the GETSTG instruction as follows:

```
GETSTG   HOLD,TYPE=NEXT
```

The instruction causes the system to obtain an unmapped storage area that you defined in the STORBLK statement with the label HOLD. The size of the area depends on the TWOKBLK operand of the STORBLK statement. The system obtains one unmapped storage area. For example, if you specified MAX=24 on the STORBLK statement and the system had already obtained fifteen unmapped storage areas, the system would obtain the sixteenth one.

Using an Unmapped Storage Area

You can use an unmapped storage area just like you would use any other storage area. For example, you can move data into the area or perform calculations on data within the area.

The SWAP instruction allows you to use an unmapped storage area. For example:

```
SWAP   HOLD,USANO
```

The instruction allows you to access the unmapped storage area defined by the STORBLK statement at label HOLD. The operand USANO refers to the label of a DATA statement that defines the number of the unmapped storage area you want to access. For example, if USANO contains "5," the SWAP instruction allows the program to access the fifth unmapped storage area.

You can also code the number of the unmapped storage area you want to use:

```
SWAP   HOLD,10
```

This instruction allows you to use the tenth unmapped storage area defined by the STORBLK statement at label HOLD. Until you execute another SWAP instruction, you can use only the tenth unmapped storage area.

Notes:

1. You can use only one unmapped storage area at a time.
2. While you are using an unmapped storage area, you cannot use the mapped storage area.

Releasing Unmapped Storage

Use the FREESTG instruction to release any unmapped storage area that you obtained with the GETSTG instruction. For example:

```
FREESTG   HOLD,TYPE=ALL
```

This instruction releases the unmapped storage areas defined by the STORBLK statement at label HOLD. The operand TYPE=ALL causes the instruction to release all of the storage areas. For example, if the STORBLK statement specifies MAX=16, this instruction causes all sixteen unmapped storage areas and the mapped storage area to be released.

Example

The following example uses ten unmapped storage areas to create a table of actuarial data. The table for each of the ten countries consists of four-digit mortality rates. The program accumulates 100 rates for both men and women. The unmapped storage the program uses is determined by the country number.

The input records have the following format:

```
Country number      2 bytes
Age                 2 bytes
Death rate          4 bytes
Sex code            1 byte
```

The program:

```
     INSURE   PROGRAM  ST,DS=((ACTTAB,EDX40),(ACTOUT,EDX40))
1             COPY     STOREQU
2    ST       GETSTG   HOLD,TYPE=ALL
3             MOVE     USANO,1
4             MOVE     #1,HOLD+$STORMAP
5             DO       10
6               SWAP     HOLD,USANO,ERROR=SWAPERR
7               MOVE     (+MENTBL,#1),C' ',(800,BYTE)
8               ADD      USANO,1
              ENDDO
9    READ     READ     DS1,MORTAL,1,END=STOP
10            CONVTD   CNTRYC,CNTRY,PREC=S,FORMAT=(2,0,I)
11            MOVE     #1,HOLD+$STORMAP
12            SWAP     HOLD,CNTRYC,ERROR=SWAPERR
13            CONVTD   AGEC,AGE,PREC=S,FORMAT=(2,0,I)
14            MOVE     #2,AGEC
15            MULT     #2,4
16            ADD      #1,#2
17            IF       (SEX,EQ,ONE,BYTE)
18              MOVE     (+MENTBL,#1),RATE,(4,BYTES)
              ELSE
                MOVE     (+WMNTBL,#1),RATE,(4,BYTES)
              ENDIF
              GOTO     READ
19   STOP     MOVE     USANO,1
20            MOVE     #1,HOLD+$STORMAP
21            DO       10
22              SWAP     HOLD,USANO,ERROR=SWAPERR
23              MOVE     OUTAREA,(+MENTBL,#1),(400,BYTES)
24              WRITE    DS2,OUTAREA,2,0,END=EOFILE,ERROR=WRERR
25              MOVE     OUTAREA,(+WMNTBL,#1),(400,BYTES)
26              WRITE    DS2,OUTAREA,2,0,END=EOFILE,ERROR=WRERR
27              ADD      USANO,1
              ENDDO
              GOTO     END
```

1 Copy the storage control block equates into the program.

2 Obtain the mapped and unmapped storage (one 2K-byte mapped storage area and ten 2K-byte unmapped storage areas) specified in the STORBLK statement with the label HOLD.

3 Initialize USANO to 1.

4 Move the address of the mapped storage area to register 1.

5 Begin a loop to initialize all ten unmapped storage areas to blanks.

6 Access an unmapped storage area.

7 Move blanks to the first 800 positions of the unmapped storage area.

8 Add 1 to USANO so that the SWAP instruction accesses the next unmapped storage area.

9 Read an input record from data set ACTTAB on volume EDX40 into the buffer with the label MORTAL.

10 Convert the country number in the input record to binary and put the result in CNTRYC.

11 Move the address of the mapped storage area into register 1.

12 Use the country number (in CNTRYC) to access the appropriate unmapped storage area.

13 Convert the age in the input record to binary and put the result in AGEC.

14 Move the age (in AGEC) into register 2.

15 Multiply the age by 4 to arrive at the proper offset into the table.

16 Add the offset to the address of the mapped storage area.

17 Test the sex code for 1 (1 = men).

18 Move the mortality rate into the appropriate slot in the MENTBL (the men's mortality rate table).

19 Initialize USANO to 1.

20 Move the address of the mapped storage area to register 1.

21 Begin a loop to write records from the unmapped storage areas.

22 Access an unmapped storage area.

23 Move a man's mortality rate table to OUTAREA.

24 Write an output record to data set ACTOUT on volume EDX40 from the buffer with the label OUTAREA.

25 Move a woman's mortality rate table to OUTAREA.

26 Write an output record to data set ACTOUT on volume EDX40 from the buffer with the label OUTAREA.

27 Add 1 to USANO so that the SWAP instruction accesses the next

```
EOFILE   EQU      *
         PRINTEXT '@** ACTUARIAL FILE HAS EXCEEDED DISK SPACE'
         GOTO     END
SWAPERR  EQU      *
         MOVE     TASKRC,INSURE
         IF       (TASKRC,EQ,1)
           PRINTEXT '@** INVALID UNMAPPED STORAGE NUMBER'
         ENDIF
         IF       (TASKRC,EQ,2)
           PRINTEXT '@** SWAP AREA NOT INITIALIZED'
         ENDIF
         IF       (TASKRC,EQ,100)
           PRINTEXT '@** NO UNMAPPED STORAGE SUPPORT'
         ENDIF
         GOTO     END
WRERR    EQU      *
         PRINTEXT '@** DISK WRITE ERROR ON ACTUARIAL DATA SET'
         GOTO     END
END      EQU      *
         PROGSTOP
ONE      DATA     F'1'
USANO    DATA     F'0'
TASKRC   DATA     F'0'
AGEC     DATA     F'0'
CNTRYC   DATA     F'0'
OUTAREA  BUFFER   512,BYTES
28 HOLD  STORBLK  TWOKBLK=1,MAX=10
MENTBL   EQU      0
WMNTBL   EQU      MENTBL+300
MORTAL   BUFFER   256,BYTES
CNTRY    EQU      MORTAL
AGE      EQU      MORTAL+2
RATE     EQU      MORTAL+4
SEX      EQU      MORTAL+8
         ENDPROG
         END
```

28 Set up a 2K-byte mapped storage area and ten 2K-byte unmapped storage areas.

Chapter 10. Performing Data Management from a Program

This section describes ways to accomplish data management from a program. Topics discussed are:

- Allocating, deleting, opening, and renaming a data set
- Opening a data set
- Setting logical end of file
- Finding the device type.

To perform other data management functions from an application program such as allocating, deleting, and renaming volumes, see Chapter 13, "Communicating with Other Programs (Virtual Terminals)."

Allocating, Deleting, Opening, and Renaming a Data Set

The $DISKUT3 program enables you to perform the following data management operations from a program:

- Allocate a data set
- Allocate a data set with extents
- Open a data set
- Delete a data set
- Release unused space in a data set
- Rename a data set
- Set the end-of-data indicator in a data set.

$DISKUT3 allows you to open and set the end-of-data indicator on disk, diskette, or tape data sets. You can perform the other operations (allocating, deleting, releasing unused space, and renaming) on disk or diskette data sets only.

For more information on $DISKUT3, including a list of return codes, refer to the *Language Reference*.

When to Use $DISKUT3

You might use $DISKUT3 for any of the following reasons:

- Your program requires more than nine data sets.
- You do not know, at the time you load a program, whether or not the program will need a data set.
- You need to perform several data management functions in one program.
- You want the processor storage that $DISKUT3 requires to be available when $DISKUT3 finishes executing.

To use $DISKUT3, you should be aware of the following factors:

- $DISKUT3 requires about 6.25K bytes of processor storage.
- If you need only to open a data set, $DISKUT3 will be slower than DSOPEN.
- You need to perform error recovery if the system cannot load $DISKUT3.

Allocating a Data Set

The following example shows how to allocate a data set from an application program. An explanation of the numbered items follows the program.

```
    TASK     PROGRAM GO
    GO       EQU     *
             •
             •
             •
1            LOAD    $DISKUT3,LISTPTR1,EVENT=DSK3EVNT
2            WAIT    DSK3EVNT
             •
             •
             •
             PROGSTOP
3   DSK3EVNT ECB     0
4   LISTPTR1 DC      A(LIST1)
5   LIST1    DC      A(REQUEST1)
6            DC      F'0'
7   REQUEST1 DC      F'2'
8            DC      A(DSX)
9            DC      D'50'
10           DC      F'1'
11           DSCB    DS#=DSX,DSNAME=DATA4
12           COPY    DSCBEQU
             ENDPROG
             END
```

1 Load $DISKUT3 to allocate data set DATA4. Specify the address (LISTPTR1) of the list of requests (in this case, a single request). Identify the event (EVENT=DSK3EVNT) to be posted when $DISKUT3 completes.

2 Wait for the system to indicate the end of $DISKUT3 by posting DSK3EVNT.

3 Set the initial state of the event control block to zero.

4 Point to the list of requests at LIST1.

5 Point to the specific allocate request.

6 Indicate the end of the list of requests.

7 Request an allocate (2).

8 Point to the DSCB for the data set to be allocated. (The allocate function requires that the data set being allocated be defined by a DSCB.)

9 Indicate that 50 records are to be allocated.

10 Indicate that the data set type is *data*.

11 Define a DSCB for the data set to be allocated.

12 Copy the DSCB equates into the program.

If you attempt to allocate a data set that already exists, $DISKUT3 considers the operation successful if the *type* and *size* of the data set that already exists matches the *type* and *size* of the data set that you are allocating.

Allocating a Data Set with Extents

The following example shows how to allocate a data set with extents from an application program. An explanation of the numbered items follows the program.

```
        TASK    PROGRAM     GO
        GO      EQU         *
                •
                •
                •
1               LOAD        $DISKUT3,LISTPTR1,EVENT=DSK3EVNT
2               WAIT        DSK3EVNT
                •
                •
                •
3       DSK3EVNT ECB        0
4       LISTPTR1 DC         A(LIST1)
5       LIST1   DC          A(REQUEST1)
6               DC          F'0'
7       REQUEST1 DC         F'8'
8               DC          A(DSX)
9               DC          D'1000'
10              DC          F'1'
11              DC          4F'0'
12              DC          F'100'
13              DSCB        DS#=DSX,DSNAME=DATA45
14              COPY        DSCBEQU
                ENDPROG
                END
```

1 Load $DISKUT3 to allocate data set DATA45. Specify the address (LISTPTR1) of the list of requests (in this case, a single request). Identify the event (EVENT=DSK3EVNT) to be posted when $DISKUT3 completes.

2 Wait for the system to indicate the end of $DISKUT3 by posting DSK3EVNT.

3 Set the initial state of the event control block to zero.

4 Point to the list of requests at LIST1.

5 Point to the specific allocate request.

6 Indicate the end of the list of requests.

7 Request an allocate with data set extents (8).

8 Point to the DSCB for the data set to be allocated. (The allocate function requires that the data set being allocated be defined by a DSCB.)

9 Indicate that the size of the primary data set is 1000 records.

10 Indicate that the data set type is *data* (You can only allocate data-type data sets with this request.)

11 Allocate four words of zeroes. These fields are reserved.

12 Indicate that the size of each extent is to be 100 records.

13 Define a DSCB for the data set to be allocated.

14 Copy the DSCB equates into the program.

If you attempt to allocate a data set that already exists, $DISKUT3 considers the operation successful if the *type* and *size* of the data set that already exists matches the *type* and *size* of the data set that you are allocating.

Opening a Data Set

If you have defined a data set with a DSCB, you need to open the data set from your application program.

The following example shows how to open a data set from an application program. An explanation of the numbered items follows the program.

```
          TASK     PROGRAM GO
          GO       EQU     *
                   •
                   •
                   •
1                  LOAD    $DISKUT3,LISTPTR1,EVENT=DSK3EVNT
2                  WAIT    DSK3EVNT
                   •
                   •
                   •
3         DSK3EVNT ECB     0
4         LISTPTR1 DC      A(LIST1)
5         LIST1    DC      A(REQUEST1)
6                  DC      F'0'
7         REQUEST1 DC      F'1'
8                  DC      A(DSY)
9                  DC      D'0'
10                 DC      F'-1'
11                 DSCB    DS#=DSY,DSNAME=DATA4
12                 COPY    DSCBEQU
                   ENDPROG
                   END
```

1 Load $DISKUT3 to open data set DATA4. Specify the address (LISTPTR1) of the list of requests (in this case, a single request). Identify the event (EVENT=DSK3EVNT) to be posted when $DISKUT3 completes.

2 Wait for the system to indicate the end of $DISKUT3 by posting DSK3EVNT.

3 Set the initial state of the event control block to zero.

4 Point to the list of requests at LIST1.

5 Point to the specific open request.

6 Indicate the end of the list of requests.

7 Request an open (1).

8 Point to the DSCB for the data set to be opened.

9 This doubleword is not used for an open request.

10 Tell $DISKUT3 to return the type of the data set being opened (0 for undefined, 1 for data, 3 for program).

11 Define a DSCB for the data set to be opened.

12 Copy the DSCB equates into the program.

Deleting a Data Set

The following example shows how to delete a data set (with or without extents) from an application program. An explanation of the numbered items follows the program.

```
          TASK     PROGRAM GO,DS=((MASTER,EDX002),(UPDATE,EDX003))
          GO       EQU     *
                   •
                   •
                   •
1                  LOAD    $DISKUT3,LISTPTR1,EVENT=DSK3EVNT
2                  WAIT    DSK3EVNT
                   •
                   •
                   •
3         DSK3EVNT ECB     0
4         LISTPTR1 DC      A(LIST1)
5         LIST1    DC      A(REQUEST1)
6                  DC      F'0'
7         REQUEST1 DC      F'4'
8                  DC      A(DS2)
9                  DC      D'0'
10                 DC      F'-1'
11                 COPY    DSCBEQU
                   ENDPROG
                   END
```

1 Load $DISKUT3 to delete data set UPDATE on volume EDX003. Specify the address (LISTPTR1) of the list of requests (in this case, a single request). Identify the event (EVENT=DSK3EVNT) to be posted when $DISKUT3 completes.

2 Wait for the system to indicate the end of $DISKUT3 by posting DSK3EVNT.

3 Set the initial state of the event control block to zero.

4 Point to the list of requests at LIST1.

5 Point to the specific delete request.

6 Indicate the end of the list of requests.

7 Request a delete (4).

8 Point to the DSCB for the data set to be deleted (UPDATE on volume (EDX003).

9 This doubleword is not used for a delete request.

10 Tell $DISKUT3 to return the type of the data set being deleted (0 for undefined, 1 for data, 3 for program).

11 Copy the DSCB equates into the program.

If you try to delete a data set that does not exist, $DISKUT3 considers the operation to be successful.

Releasing Unused Space in a Data Set

The following example shows how to release unused space in a data set from an application program. An explanation of the numbered items follows the program.

```
    TASK     PROGRAM GO
    GO       EQU     *
             •
             •
             •
1            LOAD    $DISKUT3,LISTPTR1,EVENT=DSK3EVNT
2            WAIT    DSK3EVNT
             •
             •
             •
3   DSK3EVNT ECB     0
4   LISTPTR1 DC      A(LIST1)
5   LIST1    DC      A(REQUEST1)
6            DC      F'0'
7   REQUEST1 DC      F'5'
8            DC      A(DSX)
9            DC      D'100'
10           DC      F'-1'
11           DSCB    DS#=DSX,DSNAME=TRANS
12           COPY    DSCBEQU
             ENDPROG
             END
```

1 Load $DISKUT3 to release space on data set TRANS. Specify the address (LISTPTR1) of the list of requests (in this case, a single request). Identify the event (EVENT=DSK3EVNT) to be posted when $DISKUT3 completes.

2 Wait for the system to indicate the end of $DISKUT3 by posting DSK3EVNT.

3 Set the initial state of the event control block to zero.

4 Point to the list of requests at LIST1.

5 Point to the specific release request.

6 Indicate the end of the list of requests.

7 Request a release (5).

8 Point to the DSCB for the data set on which space to be released (TRANS).

9 Indicate the number of records you want the data set to contain. (This number must be greater than zero and less than the current number of records.)

10 Tell $DISKUT3 to return the type of the data set on which space is being released (0 for undefined, 1 for data, 3 for program).

11 Define a DSCB for the data set on which to release unused space.

12 Copy the DSCB equates into the program.

Renaming a Data Set

The following example shows how to rename a data set from an application program. An explanation of the numbered items follows the program.

```
        TASK    PROGRAM GO,DS=((MASTER,EDX003))
        GO      EQU     *
                .
                .
                .
1               LOAD    $DISKUT3,LISTPTR1,EVENT=DSK3EVNT
2               WAIT    DSK3EVNT
                .
                .
                .
3       DSK3EVNT ECB    0
4       LISTPTR1 DC     A(LIST1)
5       LIST1   DC      A(REQUEST1)
6               DC      F'0'
7       REQUEST1 DC     F'3'
8               DC      A(DS1)
9               DC      F'0'
10              DC      A(NEWNAME)
11              DC      F'-1'
12              COPY    DSCBEQU
13      NEWNAME DC      CL8'NEWMAST '
                ENDPROG
                END
```

1 Load $DISKUT3 to rename data set MASTER. Specify the address (LISTPTR1) of the list of requests (in this case, a single request). Identify the event (EVENT=DSK3EVNT) to be posted when $DISKUT3 completes.

2 Wait for the system to indicate the end of $DISKUT3 by posting DSK3EVNT.

3 Set the initial state of the event control block to zero.

4 Point to the list of requests at LIST1.

5 Point to the specific rename request.

6 Indicate the end of the list of requests.

7 Request a rename (3).

8 Point to the DSCB for the data set to be renamed (MASTER on volume EDX003).

9 This word is not used for a rename request.

10 Point to the new data set name.

11 Tell $DISKUT3 to return the type of the data set being renamed (0 for undefined, 1 for data, 3 for program).

12 Copy the DSCB equates into the program.

13 Define the new name for the data set.

Setting End-of-Data on a Data Set

If you define a data set with a DSCB, you need to set the end-of-data indicator from your application program.

The following example shows how to set the end-of-data indicator on a data set from an application program. An explanation of the numbered items follows the program.

```
    TASK     PROGRAM GO,DS=((MASTER,EDX003))
    GO       EQU     *
             •
             •
             •
1            LOAD    $DISKUT3,LISTPTR1,EVENT=DSK3EVNT
2            WAIT    DSK3EVNT
             •
             •
             •
3   DSK3EVNT ECB     0
4   LISTPTR1 DC      A(LIST1)
5   LIST1    DC      A(REQUEST1)
6            DC      F'0'
7   REQUEST1 DC      F'6'
8            DC      A(DS1)
9            DC      D'0'
10           DC      F'-1'
11           COPY    DSCBEQU
             ENDPROG
             END
```

1 Load $DISKUT3 to set the end-of-data indicator on data set MASTER. Specify the address (LISTPTR1) of the list of requests (in this case, a single request). Identify the event (EVENT = DSK3EVNT) to be posted when $DISKUT3 completes.

2 Wait for the system to indicate the end of $DISKUT3 by posting DSK3EVNT.

3 Set the initial state of the event control block to zero.

4 Point to the list of requests at LIST1.

5 Point to the specific end-of-data request.

6 Indicate the end of the list of requests.

7 Request end-of-data (6).

8 Point to the DSCB for the data set on which to set the end-of-data indicator (MASTER on volume EDX003).

9 Indicate that the last record is full. (If the last record is not yet full, this field would contain the number of bytes in the last record.)

10 Tell $DISKUT3 to return the type of the data set on which the end-of-data indicator is being set (0 for undefined, 1 for data, 3 for program).

11 Copy the DSCB equates into the program.

Performing More Than One Operation at Once

$DISKUT3 allows you to perform more than one operation during the execution of a program. For example, you can delete two data sets and allocate a third without loading $DISKUT3 more than once.

The following example shows how to delete two data sets and allocate one data set. An explanation of the numbered items follows the program.

```
    TASK     PROGRAM GO,DS=((MASTER,EDX003),(UPDATE,EDX002))
    GO       EQU     *
             •
             •
             •
1            LOAD    $DISKUT3,LISTPTR1,EVENT=DSK3EVNT
2            WAIT    DSK3EVNT
             •
             •
             •
3   DSK3EVNT ECB     0
4   LISTPTR1 DC      A(LIST1)
5   LIST1    DC      A(REQUEST1)
6            DC      A(REQUEST2)
7            DC      A(REQUEST3)
8            DC      F'0'
9   REQUEST1 DC      F'4'
10           DC      A(DS1)
11           DC      D'0'
12           DC      F'-1'
13  REQUEST2 DC      F'4'
14           DC      A(DS2)
             DC      D'0'
             DC      F'-1'
15  REQUEST3 DC      F'2'
16           DC      A(DSA)
17           DC      D'300'
18           DC      F'1'
19           COPY    DSCBEQU
20           DSCB    DS#=DSA,DSNAME=NEWMAST,VOLSER=EDX003
             ENDPROG
             END
```

1 Load $DISKUT3 to delete the data sets MASTER and UPDATE and to allocate data set NEWMAST. Specify the address (LISTPTR1) of the list of requests (in this case, a single request). Identify the event (EVENT=DSK3EVNT) to be posted when $DISKUT3 completes.

2 Wait for the system to indicate the end of $DISKUT3 by posting DSK3EVNT.

3 Set the initial state of the event control block to zero.

4 Point to the list of requests at LIST1.

5 Point to the request to delete data set MASTER.

6 Point to the request to delete data set UPDATE.

7 Point to the request to allocate data set NEWMAST.

8 Indicate the end of the list of requests.

9 Request a delete (4).

10 Point to the DSCB for the first data set to be deleted (MASTER on volume EDX003).

11 This doubleword is not used for delete requests.

12 Tell $DISKUT3 to return the type of the data set being deleted (0 for undefined, 1 for data, 3 for program).

13 Request a delete (4).

14 Point to the DSCB for the second data set to be deleted (UPDATE on volume EDX002).

15 Request an allocate (2).

16 Point to the DSCB for the data set to be allocated (NEWMAST).

17 Allocate 300 records.

18 Indicate that the data set type is *data*.

19 Copy the DSCB equates into the program.

20 Define a DSCB for the data set being allocated (NEWMAST on volume EDX003).

Opening a Data Set (DSOPEN)

You can open a disk, diskette, or tape data set from a program with the DSOPEN copy code. DSOPEN does the same thing that the system does when you specify a data set in the PROGRAM statement and load the program with either the $L operator command or the LOAD instruction.

Note: Only one DSCB can be open to a tape at a time. If you open a tape data set, you must close the data set before you can open another tape data set.

You might use DSOPEN for any of the following reasons:

- Your program requires more than nine data sets.
- You do not know, at the time you load a program, whether or not the program will need a data set.
- You need to open a data set and do not want to load $DISKUT3 (the system does not need to load DSOPEN).
- The processor storage that $DISKUT3 requires is not available (DSOPEN requires about 1.5K bytes and $DISKUT3 requires about 6.25K bytes).

DSOPEN performs the following functions:

- Verifies that the specified volume is online
- Verifies that the specified data set is in the volume
- Initializes the DSCB.

To use DSOPEN, you must first copy the source code into your program by coding:

```
COPY  TCBEQU
COPY  PROGEQU
COPY  DDBEQU
COPY  DSCBEQU
COPY  DSOPEN
```

Note: You must code the equates in the order given.

During execution, load DSOPEN with the CALL instruction as follows:

```
CALL  DSOPEN,(dscb)
```

Error Exits

If an error occurs while DSOPEN executes, the system transfers control to one of several error exit routines. You must define these routines in your program and move their addresses to labels that are contained in DSOPEN before you call DSOPEN. The routines cannot be subroutines.

The labels and their meanings are as follows:

Label	*Description*
$DSNFND	Data set name not found in directory. If DSOPEN cannot find the data set, then it does not fill in the DSCB.
$DSBVOL	Volume not found in disk directory. The system sets the DDB pointer in the DSCB to 0 ($DSCBVDE does not equal 0).
$DSIOERR	Read error occurred while DSOPEN was searching the directory. For additional information, refer to the READ instruction return codes in the *Language Reference*.
$$EXIT	The address of an EDL instruction which receives control after DSOPEN has completed. $$EXIT must be zero to open the device directory ($DSCBNAM is $$EDXVOL). $$EXIT must be zero to open the volume directory ($DSCBNAM is $$EDXLIB or $$).
$DSDCEA	Address of an area for DSOPEN to store the directory control entry (DCE). This label contains a 0 if this area does not exist.

If you define an error exit routine as a word of zeroes or move a zero to one of the labels, DSOPEN transfers control to the next sequential instruction after the CALL instruction.

In the following example the instruction causes control to return to the next sequential instruction if DSOPEN cannot find the data set:

```
          MOVE  $DSNFND,LIBEXIT
          •
          •
          •
LIBEXIT   DATA   F'0'
```

The following instruction causes control to return to the next sequential instruction if DSOPEN cannot the volume:

```
          MOVE  $DSBVOL,0
```

DSOPEN Considerations

Note the following considerations when using DSOPEN:

- You must have a 256-byte work area labeled DISKBUFR in your program as follows:

  ```
  DISKBUFR  DC  128F'0'
  ```

- The DSCB to be opened can be DS1-DS9 or a DSCB defined in your program with the DSCB statement. The DSCB must be initialized with a six-character volume name in $DSCBVOL and an eight-character data set name in $DSCBNAM.
- If you specify the volume name as six blanks, DSOPEN searches the IPL volume for the data set.

- After DSOPEN completes, #1 contains the number of the directory record containing the member entry and #2 contains the displacement within DISKBUFR to the member entry.
- The fields $DSCBEND and $DSCBEDB contain the next available logical record data, if any, placed in the directory by SETEOD.
- You can open only one data set on any tape volume at a time.

DSOPEN Example

The following example shows how to open a data set when the data set is not known when the program is loaded. Program MAINPGM, the primary task, prompts the operator for the data set name and volume and calls secondary task OPENPGM. If the operator does not enter the volume name, the program uses the IPL volume.

```
1   MAINPGM   PROGRAM  START,MAIN=YES
2             EXTRN    OPENPGM
3   START     MOVEA    #1,DS1
4   READDS    READTEXT RESPONSE,'@@ENTER DSNAME,VOLUME - '
5             IF       (RESPONSE-1,EQ,X'00',BYTE),THEN
               GOTO READDS
              ENDIF
6             MOVE     ($DSCBVOL,#1),IPLVOL,(6,BYTE)
7             MOVE     WHERE,0
8             FIND     C',',RESPONSE,15,WHERE,DSONLY
9             MOVE     #2,WHERE
10            MOVE     ($DSCBVOL,#1),(1,#2),(6,BYTE)
11            MOVE     (0,#2),BLANK8,(8,BYTE)
12  DSONLY    MOVE     ($DSCBNAM,#1),RESPONSE,(8,BYTE)
13            CALL     OPENPGM,(DS1)
14            MOVE     CODE,DS1
15            IF       (CODE,NE,-1),THEN
               PRINTEXT  '@ERROR DURING DSOPEN.  RETURN CODE = '
               PRINTNUM  CODE
              ELSE
16             •
               •
               •
              ENDIF
              PROGSTOP
17            COPY     DSCBEQU
18  CODE      DC       F'0'
19  IPLVOL    EQU      *
    BLANK8    DC       CL8'        '
20  WHERE     DC       F'0'
21  RESPONSE  TEXT     ' ',LENGTH=15
22            DSCB     DS#=DS1,DSNAME=DUMMY
              ENDPROG
              END
```

1 Begin the program at START and identify this task as the primary task (MAIN=YES).

2 Identify as an external entry the subroutine that this task will call.

3 Place the address of the DSCB in register 1.

4 Prompt the operator for the data set name. When the operator responds, the system places the response in RESPONSE.

5 Test for a null entry. RESPONSE−1 contains the length of the operator's response.

6 Initialize the volume field (DSCBVOL) of the DSCB to blanks.

7 Initialize the comma locator to zero.

8 Find a comma in the operator's response. If no comma exists, branch to DSONLY.

9 Move the position of the comma to register 2.

10 Move the volume name to the volume field (DSCBVOL) of the DSCB.

11 Blank the volume name and the comma preceding it.

12 Move the data set name to the data set name field (DSCBNAM) of the DSCB.

13 Call the routine that opens the data set. Pass the address of the DSCB (pointed to by DS1) to the subroutine.

14 Move the return code into CODE.

15 If the return code does not indicate successful completion (−1), print an error message and the return code.

16 Process the data set with READ/WRITE instructions. ($DSCBEND contains the number of records in the data set.)

17 Cause the DSCB equates to be copied into the program.

18 Reserve storage for the subroutine return code.

19 Set up a default value for the IPL volume.

20 Reserve storage for an index to be used in locating the comma.

21 Reserve storage for the operator's response.

22 Generate a data set control block (DSCB). Give the data set name field (DSCBNAM) the temporary name DUMMY.

Program OPENPGM consists of a subroutine and error exit routines for DSOPEN. The subroutine calls DSOPEN.

```
1  OPENPGM    PROGRAM  MAIN=NO
2             ENTRY    OPENPGM
3             SUBROUT  OPENPGM,ADSN
4             MOVE     SAVE1,#1
5             MOVE     SAVE2,#2
6             MOVE     #1,ADSN
7             MOVE     (0,#1),-1
8             MOVEA    $DSNFND,LIBEXIT
9             MOVEA    $DSBVOL,VOLEXIT
10            MOVEA    $DSIOERR,IOEXIT
11            CALL     DSOPEN,ADSN
              GOTO     RETURN
12   LIBEXIT  EQU      *
13            MOVE     #1,ADSN
14            MOVE     (0,#1),1
              PRINTEXT '@DATA SET NOT FOUND DURING DSOPEN@'
              GOTO     RETURN
15   VOLEXIT  EQU      *
16            MOVE     #1,ADSN
17            MOVE     (0,#1),2
              PRINTEXT '@VOLUME NOT FOUND DURING DSOPEN@'
              GOTO    RETURN
18   IOEXIT   EQU      *
19            MOVE     #1,ADSN
20            MOVE     (0,#1),3
              PRINTEXT '@ERROR ENCOUNTERED DURING DSOPEN@'
              GOTO      RETURN
21   RETURN   MOVE     #1,SAVE1
22            MOVE     #2,SAVE2
23            RETURN
24            COPY     TCBEQU
25            COPY     PROGEQU
26            COPY     DDBEQU
27            COPY     DSCBEQU
28            COPY     DSOPEN
29   DISKBUFR  DC       128F'0'
30   SAVE1     DC       F'0'
31   SAVE2     DC       F'0'
             END
```

1 Identify the name of the subroutine as OPENPGM. Specify that it is not the main program (MAIN=NO).

2 Identify the name of the subroutine as an entry. (In conjunction with the EXTRN statement in the main program, this statement allows the linkage editor to resolve external references.)

3 Define a subroutine with the name OPENPGM. Define a parameter (ADSN) that is passed by the calling program.

4 Save index register 1.

5 Save index register 2.

6 Move the parameter that was passed from the calling program (the address of the DSCB) to register 1.

7 Initialize the return code to indicate successful completion (−1).

8 Move the address of the data-set-not-found routine to the proper error exit within DSOPEN.

9 Move the address of the invalid-volume routine to the proper error exit within DSOPEN.

10 Move the address of the I/O error routine to the proper error exit within DSOPEN.

11 Call DSOPEN, passing the address of the DSCB.

12 Indicate the beginning of the data-set-not-found exit routine.

13 Move the address of the DSCB to register 1.

14 Move a 1 to the first word of the DSCB, indicating data set not found.

15 Indicate the beginning of the invalid-volume exit routine.

16 Move the address of the DSCB to register 1.

17 Move a 2 to the first word of the DSCB, indicating an invalid volume.

18 Indicate the beginning of the I/O error exit routine.

19 Move the address of the DSCB to register 1.

20 Move a 3 to the first word of the DSCB, indicating an I/O error.

21 Restore index register 1.

22 Restore index register 2.

23 Return to the calling program.

24 Cause the TCB equates to be copied into the program.

25 Cause the PROGRAM equates to be copied into the program.

26 Cause the DDB equates to be copied into the program.

27 Cause the DSCB equates to be copied into the program.

28 Cause the DSOPEN equates to be copied into the program.

29 Reserve a 256-byte area for DSOPEN. (This area must have the label DISKBUFR.)

30 Reserve an area in which to save register 1.

31 Reserve an area in which to save register 2.

Coding for Volume Independence

You may code your applications so that they are independent of the volume in which they reside. To achieve volume independence, place all programs and data sets in a single volume on any system and specify the characters ## in the volume name field of any DS= operand or PGMS= operand of the PROGRAM statement. (For information on the PROGRAM statement, refer to the *Language Reference*.)

You can also insert the volume name from which your program was loaded into any DSCB you have coded in your program. If you insert the volume name into a DSCB, you must do so before loading $DISKUT3 or calling in DSOPEN. The volume name, a six-byte field, is located in the $PRGVOL field of the program header.

The following example shows a routine that retrieves the volume name and loads DSOPEN to open the data set JOURNAL, located in the same volume from which the program was loaded.

```
            COPY   TCBEQU
            COPY   PROGEQU
            COPY   DDBEQU
            COPY   DSCBEQU
            COPY   DSOPEN
             •
             •
             •
1 ENTER     TCBGET TCBADDR
2           MOVE   #1,TCBADDR
3           MOVE   #2,($TCBPLP,#1)
4           MOVEA  #1,INDS
5           MOVE   ($DSCBVOL,#1),($PRGVOL,#2),(6,BYTE)
6           CALL   DSOPEN,(INDS)
             •
             •
             •
7           DSCB   DS#=INDS,DSNAME=JOURNAL
8 DISKBUFR  DC     128F'0'
9 TCBADDR   DC     F'0'
```

1 Get the address of the task control block (TCB).

2 Move the address of the TCB into register 1.

3 Move the address of the program header into register 2.

4 Move the address of the data set control block (DSCB) into register 1.

5 Move the volume into the DSCB.

6 Call DSOPEN, passing the DSCB as a parameter.

7 Define the DSCB.

8 Define a work area for DSOPEN.

9 Define an area for the TCB address.

Setting Logical End of File (SETEOD)

The copy code routine SETEOD allows you to indicate the logical end of file on disk. If your program does not use SETEOD when creating or overwriting a file, the READ end-of-data exception will occur at either the physical or logical end that was set by some previous use of the data set.

The relative record number of the last full physical record is placed in the $$FPMF field of the directory member entry (DME).

Notes:

1. If the $DSCBEDB field is zero, the $$FPMF field is set to the next record pointer field ($DSCBNEX) minus one.
2. If the $DSCBEDB field is not zero, the $$FPMF field is set to the $DSCBNEX minus two.

If the last physical record is partially filled, the number of bytes contained in this record is placed in the $$FPMD of the DME. Otherwise, a zero is placed in this field. (This is done by copying the $DSCBEDB field of the DSCB directly into the DME.) (Further information on the DME can be found in the *Internal Design*.)

If the next record pointer field ($DSCBNEX) in the DSCB is 1 when SETEOD is executed, the DME is set to indicate that the data set is empty and $DSCBEND is set to X'FFFF' indicating that the data set is empty. If $DSCBEOD is zero, the data set is unused.

SETEOD can be used before, during, or after any READ or WRITE operation. It does not inhibit further I/O and can be used more than once. The only requirement is that the DSCB passed as input must have been previously opened.

The POINT instruction modifies the $DSCBNEX field. If SETEOD is used after a POINT instruction, the new value of $DSCBNEX is used by SETEOD.

SETEOD requires that the DSOPEN copy code, PROGEQU, TCBEQU, DDBEQU, and DSCBEQU be copied in your program.

To use SETEOD, copy the source code into your program and allocate a work data set as follows:

```
         COPY  TCBEQU
         COPY  PROGEQU
         COPY  DDBEQU
         COPY  DSCBEQU
         COPY  DSOPEN
         COPY  SETEOD
DISKBUFR DC    128F'0'          WORK AREA FOR DSOPEN
```

Load SETEOD as a subroutine through the Event Driven Language CALL statement, passing the DSCB and an I/O error exit routine pointer as parameters.

```
CALL   SETEOD,(DS1),(IOERROR)
```

where:

DS1 Names a previously opened DSCB

IOERROR Names the routine in the application program to which control is passed if an I/O error occurs

The following program writes a record three times and then sets the logical end of file. If an I/O error occurs, the system prints the message "I/O ERROR OCCURRED" and then prints a return code.

```
     SET        PROGRAM   START,DS=((ANY,EDX003))
                PRINT     OFF
 1               COPY      TCBEQU
 2               COPY      PROGEQU
 3               COPY      DDBEQU
 4               COPY      DSCBEQU
 5               COPY      DSOPEN
 6               COPY      SETEOD
                PRINT     ON
 7  START        EQU       *
 8               MOVE      BUFF,DATA,(256,BYTES)
 9               DO        3,TIMES
10               WRITE     DS1,BUFF,1,ERROR=IOERROR
11               ENDDO
12               CALL      SETEOD,(DS1),(IOERROR)
13               PROGSTOP
14  IOERROR      EQU       *
15               TCBGET    RC,$TCBCO
16               PRINTEXT  'I/O ERROR OCCURRED',SKIP=1
17               PRINTEXT  'ERROR RETURN CODE='
18               PRINTNUM  RC,SKIP=1
19               PROGSTOP
20  DATA         DC        256C'A'
21  DISKBUFR     DC        128F'0'
22  BUFF         BUFFER    256,BYTES
23  RC           DATA      F'0'
                ENDPROG
                END
```

1 Copy the TCB equates into the program.

2 Copy the PROGRAM equates into the program.

3 Copy the DDB equates into the program.

4 Copy the DSCB equates into the program.

5 Copy the DSOPEN routine into the program.

6 Copy the SETEOD routine into the program.

7 Indicate the beginning of the executable instructions.

8 Move 256 bytes of data into the buffer area.

9 Indicate the beginning of a DO loop.

10 Write 1 record to the data set ANY on volume EDX003 from the buffer with the label BUFF.

11 End the loop.

12 Call the subroutine SETEOD to set the end of data on the data set ANY on volume EDX003. If an error occurs transfer control to IOERROR.

13 End program execution.

14 Indicate the beginning of the error routine.

15 Obtain the return code from the first word of the task control block (TCB) and place it in RC.

16 Print the message "I/O ERROR OCCURRED."

17 Print the message "ERROR RETURN CODE=."

18 Print the return code. The return code indicates the type of I/O error the system encountered.

19 End program execution.

20 Define a 256-byte storage area labeled DATA.

21 Reserve a 256-byte work area for DSOPEN. This area must be labeled DISKBUFR. (This is a requirement for DSOPEN.)

22 Define a 256-byte storage area labeled BUFF.

23 Reserve a data area for RC (the I/O error return code).

Finding the Device Type (EXTRACT)

The *inline* copy code routine EXTRACT determines the device type from the device descriptor block. This routine is provided for applications that are sensitive to device type. For example, an application may need to allocate a data set unless the data set were to reside on a tape. Before attempting to execute instructions that would not execute successfully, the EXTRACT routine can be used to determine the device type.

To use EXTRACT, you must copy the source code into your program. The routine requires the address of a DSCB in #1 and returns the device type in #1.

```
MOVEA #1,DS1
COPY  EXTRACT
IF    (#1,EQ,X'3186'),GOTO,TAPEDS
```

In this example, X'3186' is the device ID of an IBM 4969 Magnetic Tape.

To get a list of the device IDs on your system, use the LD command of the $IOTEST utility.

Chapter 11. Reading and Writing to Tape

This chapter describes the tape facilities you can use when using tape as part of your EDL program.

For information on how to allocate tape data sets, copy data sets from one medium to another, and change tape attributes, refer to the $TAPEUT1 utility in the *Operator Commands and Utilities Reference* or the *Operation Guide*.

For more information on how to access magnetic tape data sets, refer to the *Language Reference*.

For information on data set naming conventions, see "Specifying Data Sets" on page 6-3.

What Is a Standard-Label Tape?

A standard-label tape consists of data sets separated by 80-character label records and tapemarks.

A *label record* is a record that the system writes on a tape to do such things as identify the volume, indicate the beginning of a data set, and indicate the end of a data set.

Standard label tapes contain a volume label (VOL1) and a header label (HDR1) before each data set and a trailer label (EOF1) after each data set. For the contents of the labels, see Appendix A, "Tape Labels."

A *tapemark* is a control character that the system writes on a tape. The hardware uses tapemarks to recognize such things as the beginning or end of a data set.

You would use standard-label tapes to maintain data security or to control an extensive library of tapes.

What Is a Nonlabeled Tape?

A nonlabeled tape consists of data sets separated only by tapemarks. Nonlabeled tapes allow you to read tapes that have unknown record length or an unknown label. You would use nonlabeled tapes if you do not need to maintain strict data security or if you use only a small number of tapes.

Processing Standard-Label Tapes

This section describes how to:

- Read a standard-label tape
- Write a standard-label tape
- Close a standard-label tape
- Bypass standard labels
- Process a tape containing more than one data set.

Reading a Standard-Label Tape

The READ instructions allows you to retrieve a record from 18 to 32767 bytes long.

In the following example:

```
TASK04  PROGRAM START,DS=(UPDATES,(MASTER,56390))
        •
        •
        •
        READ    DS2,BUFF,1,120,END=NMRCDS,ERROR=OOPS,WAIT=YES
        •
        •
        •
BUFF    DATA    60F'0'
```

the system reads one record (indicated by 1 in the third operand) from the second file listed on the PROGRAM statement (data set MASTER on volume serial 56390) into BUFF. (The term *volume serial* means the same as the term *volume*.)

The size of the record is 120 bytes (indicated by 120 in the fourth operand). If no more records exist on the data set, control transfers to NMRCDS. If an error occurs, control transfers to OOPS. The system waits (WAIT = YES) for the read operation to complete before executing the next sequential instruction.

The following READ instruction reads 2 records into BUFF2. BUFF2 must be 654 bytes long.

```
TASK37  PROGRAM BEGIN,DS=((UPDATES,73499),(MASTER,56390))
        •
        •
        •
        READ    DS1,BUFF2,2,327,END=END1,ERROR=ERR,WAIT=YES
        •
        •
        •
BUFF2   DATA    327F'0'
```

The system reads two records (indicated by 2 in the third operand) from the first data set (UPDATES on volume serial 73499) listed on the PROGRAM statement. The size of the record is 327 bytes (indicated by 327 in the fourth operand). If no more records exists on the data set, control transfers to END1. If an error occurs, control transfers to ERR. The system waits (WAIT = YES) for the read operation to complete before executing the next sequential instruction.

Writing a Standard-Label Tape

The WRITE instruction allows you to write a record from 18 to 32767 bytes long.

In the following example:

```
TASK04  PROGRAM START,DS=(UPDATES,(MASTOUT,00032))
          •
          •
          •
        WRITE   DS2,BUFF,1,120,ERROR=GOOF,WAIT=YES
          •
          •
          •
BUFF    DATA    60F'0'
```

the system writes one record (indicated by 1 in the third operand) to the second file listed on the PROGRAM statement (data set MASTOUT on volume serial 00032) from BUFF. The size of the record is 120 bytes (indicated by 120 in the fourth operand). If an error occurs, control transfers to GOOF. The system waits (WAIT = YES) for the write operation to complete before executing the next sequential instruction.

The following WRITE instruction writes 2 records from BUFF2. BUFF2 must be 656 bytes long.

```
TASK74  PROGRAM BEGIN,DS=((DATES,28345),(MASTER,56390))
          •
          •
          •
        WRITE   DS1,BUFF2,2,328,ERROR=ERROR,WAIT=YES
          •
          •
          •
BUFF2   DATA    328F'0'
```

The system writes two records (indicated by 2 in the third operand) to the first data set (DATES on volume serial 28345) listed on the PROGRAM statement. The size of the record is 328 bytes (indicated by 328 in the fourth operand). If an error occurs, control transfers to ERROR. The system waits (WAIT = YES) for the read operation to complete before executing the next sequential instruction.

Note: To write an uneven number of bytes to a 4969 Tape Unit, you must have the latest Engineering Changes installed on the device.

Closing Standard-Label Tapes

Whether you read or write a standard-label tape, you should close the tape data set when you finish reading or writing. Closing a tape data set causes the system to write trailer labels. Use the CONTROL instruction to close a tape data set as follows:

```
TASK98  PROGRAM BEGIN,DS=((DATES,28345),(MASTER,56390))
          •
          •
          •
        CONTROL DS1,CLSOFF
          •
          •
          •
```

The system closes the first data set (DATES on volume serial 28345) listed on the PROGRAM statement. CLSOFF causes the system to rewind the tape and set the tape drive offline.

For information on other ways to close a tape, refer to the *Language Reference*.

Bypassing Labels

If you want to bypass the labels on a standard-label tape, you must have defined a tape drive as BLP during system generation or changed the label processing attribute with the $TAPEUT1 utility. For information on defining a BLP drive, refer to the *Installation and System Generation Guide*.

The following sample program shows how to bypass standard labels.

```
1 PROG8    PROGRAM  START,DS=((XYZ,TAPE01))
  START    EQU      *
2          READ     DS1,BUFFER,1,80,ERROR=ERR1
3          READ DS1,BUFFER,1,80,ERROR=ERR1
4          CONTROL DS1,FSF
  LOOP     EQU      *
5          READ DS1,BUFFER,1,50,ERROR=ERR2,END=ALLDONE
           GOTO     LOOP
  ALLDONE  EQU      *
6          READ DS1,BUFFER,1,80,ERROR=ERR1
  ENDIT    EQU      *
           PROGSTOP
  ERR1     EQU      *
           PRINTEXT '@LABEL ERROR - RC= '
           PRINTNUM DS1
           GOTO     ENDIT
  ERR2     EQU      *
           PRINTEXT '@READ ERROR - RC= '
           PRINTNUM DS1
           QUESTION '@DO YOU WANT TO CONTINUE? ',                    C
             YES=LOOP,NO=ENDIT
  BUFFER   DATA    40F'0'
           ENDPROG
           END
```

1 Identify the tape as data set XYZ on tape ID TAPE01. The system ignores the data set name but you must supply it.

2 Read the first of the standard label records (the VOL1 label) into BUFFER. (You can insert instructions after this instruction to process the label.)

3 Read the second of the standard label records (the HDR1 label) into BUFFER. (You can insert instructions after this instruction to process the label.)

4 Forward space the file one tapemark. This instruction causes the system to skip any remaining blocks in the header and position itself at the first record of the file.

5 Process the data. This instruction reads a 50-character record (indicated by 50 in the third operand) into BUFFER. If an error occurs, control transfers to ERR2. If no more records exist on the data set, control transfers to ALLDONE.

6 Read the trailer label (the EOF1 label) into BUFFER. You can insert instructions after this instruction to process the label.

Processing a Tape Containing More than One Data Set

To process a tape that contains more than one data set, use the $VARYON operator command to position the tape to the data set you want to read. For example, to position a tape at address 4C to the fourth data set, issue the following command:

```
> $VARYON 4C 4
```

The system responds as follows:

```
TAPE01 ONLINE
```

TAPE01 is the ID that was assigned to the tape drive at system generation.

After you use the $VARYON operator command, you can process the data set as you would any other tape data set.

Reading a Multivolume Data Set

To read a multivolume data set, you must add instructions to your program to process the data set. The following program reads a multivolume data set.

```
1  PROGX    PROGRAM START,DS=??
   START    EQU      *
2           READ   DS1,BUFFER,1,80,ERROR=ERR1,END=CHKEND
                   •
                   •
                   •
           GOTO      START
   ENDIT   EQU       *
           PROGSTOP
   CHKEND  EQU       *
3          CONTROL DS1,CLSOFF
4          IF    (DS1,EQ,33)
5          PRINTEXT '@EOV ENCOUNTERED - ENTER VOL1 OF NEXT VOLUME@'
6          READTEXT NEWVOL
7          MOVEA #1,DS1
8          MOVE  ($DSCBVOL,#1),NEWVOL,(3,WORD)
9          MOVEA $DSNFND,ERRDSN
           MOVEA    $DSBVOL,ERRVOL
           MOVEA    $DSIOERR,ERRIO
10         QUESTION '@REPLY Y WHEN NEXT VOLUME MOUNTED AND ONLINE@',    C
                NO=ENDIT
11         CALL  DSOPEN,(DS1)
12         GOTO     START
           ENDIF
           GOTO     ENDIT
   ERRDSN  EQU      *
           MOVEA    MSGX,MSG1
           GOTO     ERRMSG
   ERRVOL  EQU      *
           MOVEA    MSGX,MSG2
           GOTO     ERRMSG
   ERRIO   EQU      *
           MOVEA    MSGX,MSG3
   ERRMSG  EQU      *
           PRINTEXT '@DSOPEN ERROR -@'
           PRINTEXT MSG1,P1=MSGX
           PRINTEXT SKIP=1
           GOTO     ENDIT
   MSG1    TEXT     'DATA SET NOT FOUND'
   MSG2    TEXT     'VOLUME NOT FOUND'
   MSG3    TEXT     'I/O ERROR'
   ERR1    EQU      *
           PRINTEXT '@READ ERROR - RC='
           PRINTNUM DS1
           GOTO     ENDIT
   BUFFER  DATA     40F'0'          80 BYTE BUFFER
   NEWVOL  TEXT     '      '        HOLDS NEW VOLUME #
   REPLY   TEXT     LENGTH=2
           COPY     DSOPEN
           COPY     DSCBEQU
           COPY     PROGEQU
           COPY     DDBEQU
   DISKBUFR DC      128F'0'
           ENDPROG
           END
```

1 Cause the system to issue a prompt for the data set name and volume of the input data set.

2 Read an 80-character record into BUFFER. If an error occurs transfer control to ERR1. If no more records exist, transfer control to CHKEND.

3 Close the input data set, rewind the tape, and set the tape drive offline.

4 Test for a return code of 33, indicating that the system found an end-of-volume label.

5 Prompt the operator for the volume serial of the next tape.

6 Read the volume serial into NEWVOL.

7 Move the address of the DSCB for the data set into software register 1.

8 Move the volume serial into the $DSCBVOL field of the DSCB.

9 Set the DSOPEN error exits in this instruction and in the next two instructions.

10 Prompt the operator for a response when he/she has mounted the tape.

11 Call the DSOPEN routine to open the next volume of the data set.

12 Resume processing the data.

Processing Nonlabeled Tapes

This section describes how to:

- Define a nonlabeled tape
- Initialize a nonlabeled tape
- Read a nonlabeled tape
- Write a nonlabeled tape.

Defining a Nonlabeled Tape

To read and write from a nonlabeled tape, you must define the drive as nonlabeled. If the tape drive hasn't already been defined as nonlabeled, you must:

1. Vary the tape drive offline.
2. Change the label processing attribute to nonlabeled using the $TAPEUT1 utility.
3. Vary the tape drive online.

To vary the tape drive offline, use the $VARYOFF operator command as follows:

```
> $VARYOFF 4C
TAPE01 OFFLINE
```

The command varies offline the tape drive at address 4C. TAPE01 is the ID that was assigned during system generation.

The following example shows how to use the $TAPEUT1 utility to change the label processing attribute:

```
> $L $TAPEUT1
      •
      •
      •
COMMAND (?)  CT

ENTER TAPEID (1-6 CHARS): TAPE01
TAPE TAPE01 AT ADDR 4C is SL 1600 BPI

DO YOU WISH TO MODIFY?: Y

LABEL (NULL,SL,NL,BLP)?: NL
DENSITY (NULL,800,1600)?: 800

TAPE TAPE01 AT ADDRESS 4C IS NL 800 BPI

COMMAND ?  EN
```

This example changes tape TAPE01 to nonlabeled 800 bytes per inch.

To vary the tape drive online, use the $VARYON operator command as follows:

```
> $VARYON 48
TAPE01 ONLINE
```

The command varies online the tape drive at address 48. TAPE01 is the ID that was assigned during system generation.

Initializing a Nonlabeled Tape

To initialize a nonlabeled tape, you must:

1. Vary the tape drive offline.
2. Initialize the tape.
3. Vary the tape drive online.

To vary the tape drive offline, use the $VARYOFF operator command as follows:

```
> $VARYOFF 4C
TAPE01 OFFLINE
```

The command varies offline the tape drive at address 4C. TAPE01 is the ID that was assigned during system generation.

To initialize the tape, use the $TAPEUT1 utility as follows:

```
> $L $TAPEUT1
      •
      •
      •
COMMAND (?)  IT

TAPE ADDR (1 - 2 HEX CHARS): 4C

NO LABEL 800 BPI? Y

TAPE INITIALIZED

COMMAND ?  EN
```

To vary the tape drive online, use the $VARYON operator command as follows:

```
> $VARYON 4C
TAPE01 ONLINE
```

The command varies online the tape drive at address 4C. TAPE01 is the ID that was assigned during system generation.

Reading a Nonlabeled Tape

The READ instructions allows you to retrieve a record from a nonlabeled tape. The records can be from 18 to 32767 bytes long.

In the following example:

```
TASK04  PROGRAM START,DS=(UPDATES,(MASTER,TAPE01))
          •
          •
          •
        READ    DS2,BUFFER,1,80,END=NOMORE,ERROR=ERROR,WAIT=YES
          •
          •
          •
BUFFER  DATA    60F'0'
```

the system reads one record (indicated by 1 in the third operand) from the second file listed on the PROGRAM statement (data set MASTER on tape ID TAPE01) into BUFFER. The size of the record is 80 bytes (indicated by 80 in the fourth operand). If no more records exist on the data set, control transfers to NOMORE. If an error occurs, control transfers to ERROR. The system waits (WAIT=YES) for the read operation to complete before executing the next sequential instruction.

Writing a Nonlabeled Tape

The WRITE instruction allows you to write a nonlabeled record from 18 to 32767 bytes long.

In the following example:

```
TASK04  PROGRAM START,DS=(UPDATES,(MASTOUT,TAPE01))
          •
          •
          •
        WRITE   DS2,BUFF,1,120,ERROR=GOOF,WAIT=YES
          •
          •
          •
BUFF    DATA    60F'0'
```

the system writes one record (indicated by 1 in the third operand) to the second file listed on the PROGRAM statement (data set MASTOUT on tape ID TAPE01) from BUFF. The size of the record is 120 bytes (indicated by 120 in the fourth operand). If an error occurs, control transfers to GOOF. The system waits (WAIT=YES) for the write operation to complete before executing the next sequential instruction.

Adding Records to a Tape File (UPDATE)

The copy code routine UPDTAPE allows you to add records to an existing (or new) tape file. The records added are placed after existing records on the file. On standard label tapes, the routine updates the block count counters in the EOF1 label.

To use UPDTAPE, you must copy the source code into your program by coding:

```
COPY  UPDTAPE
```

You load UPDTAPE as a subroutine through the CALL instruction, passing the DSCB as a parameter.

```
CALL   UPDTAPE,(DS1)
```

where DS1 is a previously opened DSCB.

After the CALL, you must check the return code in the first word of the DSCB for the tape motion return codes. A −1 return code indicates that the tape is positioned correctly for writing records.

The following example adds 1000 records to a tape data set. The program prompts the operator for the data set name and volume.

```
1 UPDTAP  PROGRAM START,DS=((TAPEDS,??))
  START   EQU     *
2         CALL    UPDTAPE,(DS1)
3         IF      (DS1,NE,-1)
            PRINTEXT  '@ERROR - UPDTAPE RC ='
            PRINTNUM  DS1
            PRINTEXT  SKIP=1
            GOTO      ENDIT
          ENDIF
4         DO      1000,TIMES
5           WRITE  DS1,BUFF,ERROR=ERR
            ADD   BUFFNUM,1
          ENDDO
  ENDIT   EQU     *
          IF     (DS1,EQ,-1)
            PRINTEXT  '@TAPE UPDATED SUCCESSFULLY@'
            CONTROL   DS1,CLSRU
            IF     (DS1,NE,-1)
              PRINTEXT  '@CLOSE ERROR - RC ='
              PRINTNUM  DS1
              PRINTEXT  SKIP=1
            ENDIF
          ENDIF
          PROGSTOP
  ERR     EQU       *
          PRINTEXT  '@WRITE ERROR - RC ='
          PRINTNUM  DS1
          PRINTEXT  SKIP=1
          GOTO      ENDIT
  BUFF    DC        127X'FFFF'
  BUFFNUM DC        F'1'
          COPY      DSCBEQU
          COPY      TDBEQU
          COPY      DDBEQU
          COPY      UPDTAPE
          ENDPROG
          END
```

1 Cause the system to prompt for the name and volume of the tape data set.

2 Call the subroutine, passing the DSCB as a parameter.

3 Check the return code from the subroutine.

4 Add 1000 records to the tape data set.

5 Write a record to the data set from buffer BUFF. If an error occurs, branch to ERR.

Chapter 12. Communicating with Another Program (Cross-Partition Services)

To communicate with another program, you can use cross-partition services. Cross-partition services require synchronization logic in your programs but no additional storage in the supervisor.

Communication is possible between two programs within the same partition and between programs in different partitions. Cross-partition services permit asynchronous but coordinated execution of application programs running in different partitions.

Use these services when interrelated programs and tasks in your application cannot be accommodated in a single partition.

When your task is attached, its TCB ($TCBADS) is updated to contain the number of the address space in which it is executing. The address space value (the partition number minus one) is also known as the hardware address key. This key, along with an address you supply, is used to calculate the target address used in cross- partition services. For some functions, you put the address key of the target partition in $TCBADS.

The following sections contain examples of the different uses of the cross-partition services.

Loading Other Programs

In the following example, PROGA loads PROGB into partition 2 and passes the parameters at PROGASW1 to it. When PROGB terminates, the supervisor posts the ECB at ENDWAIT, signaling PROGA that PROGB has ended.

In this example, the system queues the program loaded (PROGB) to the terminal that is enqueued by the loading program (PROGA).

$TCBADS is not modified by the LOAD instruction. PROGA, the loading program, looks like this:

```
1 PROGA    PROGRAM START,1,MAIN=YES
2 ATLIS    ATTNLIST (CA,PROGASTP)
  PROGASTP EQU     *
3          MOVE    #1,PROGASW1
4          MOVE    (0,#1),1,TKEY=1
           ENDATTN
  START    EQU     *
5          TCBGET  PROGAKEY,$TCBADS
6          LOAD    PROGB,PROGASW1,EVENT=ENDWAIT,LOGMSG=YES,PAR T=2
7          IF      (PROGA,EQ,-1),THEN
             WAIT    ENDWAIT
           ELSE
             PRINTEXT  'LOAD FAILED',SKIP=1
           ENDIF
           PROGSTOP
  ENDWAIT  ECB
  PROGASW1 DATA   A(PROGASW1)
  PROGAKEY DATA   F'0'
           ENDPROG
           END
```

Notes on PROGA are as follows:

1 Define the primary task (MAIN = YES). Assign priority 1 to the task.

2 Define an attention-interrupt-handling routine. When the operator enters "CA" and presses the attention key, branch to PROGASTP.

3 Move PROGASW1 into register 1. (When this instruction executes, PROGASW1 contains the address of CANCELSW in PROGB.)

4 Move 1 to address (0,#1). Indicate the address key of the loaded program (TKEY = 1). Address (0,#1) points to the address of CANCELSW. In PROGB, the IF instruction finds that CANCELSW contains a 1 and passes control to the label STOP.

5 Put PROGA's address key into PROGAKEY.

6 Load PROGB, passing the parameters beginning at label PROGASW1. Identify the event to be posted when PROGB completes (EVENT = ENDWAIT), indicate that the PROGRAM LOADED message is to appear on the terminal, and load the program into partition 2 (PART= 2).

7 If PROGB loads successfully, wait for PROGB to post the event ENDWAIT.

The following program, PROGB, is the program being loaded.

When the operator presses the attention key and enters "CA," the attention-interrupt-handling routine at label CANCEL in PROGA begins executing.

```
1  PROGB     PROGRAM START,509,PARM=2
   START     EQU     *
2            PRINTEXT 'TO CANCEL HIT > CA',SKIP=1
             PRINTEXT SKIP=1
3            MOVEA    PROGAWRK,CANCELSW
4            MOVE     #1,$PARM1
5            MOVE     (0,#1),PROGAWRK,TKEY=$PARM2
6  LOOP      IF       (CANCELSW,EQ,1),GOTO,STOP
             GOTO     LOOP
   STOP      EQU      *
7            PROGSTOP -1,LOGMSG=NO
   PROGAWRK  DATA   F'0'
   CANCELSW  DATA   F'0'
             ENDPROG
             END
```

1 Specify the length of the parameter list that PROGB receives from PROGA (PARM=2). The system recognizes each word in the parameter list by the label $PARMx, where "x" indicates the position of the word in the list. $PARM1 refers to the first word in the list (PROGASW1) and $PARM2 refers to the second word in the list (PROGAKEY).

2 Display a prompt that tells the operator how to cancel PROGB.

3 Move the address of CANCELSW into PROGAWRK.

4 Move the first parameter (the address of PROGASW1) into software register 1.

5 Move the contents of PROGAWRK to the address (0,#1) in PROGA. The TKEY operand of the MOVE instruction supplies the address key of PROGA.

6 Loop until the operator cancels the program.

7 Post the loading program (PROGA) with a −1. Suppress the PROGRAM ENDED message (LOGMSG=NO).

Note: When you execute a LOAD instruction for any type of program, the default terminal address or the currently active terminal address of the program issuing the LOAD is placed in the program header of the loaded program. This address is taken from $PRGCCB in the issuing program's program header and placed into $PRGCCB of the loaded program's program header. This address is a CCB address.

Finding Other Programs

The following example uses the WHERES instruction to find another program and return the address key and the load point of a program.

```
1           WHERES  PROGB,ADDRB,KEY=KEYB
                    •
                    •
                    •
2  PROGB    DATA    C'PROGB   '
3  ADDRB    DATA    F'0'
4  KEYB     DATA    F'0'
```

1 Find program PROGB. Put the load point address in ADDRB and the address key in KEYB.

2 Define the program to be found (the name you give the program when you link-edit it).

3 Define storage for the load-point address.

4 Define storage for the address key.

Starting Other Tasks

You can start a task in another partition with the ATTACH instruction.

In the following example, PROGA starts (or "attaches") the task labeled TASKADDR in PROGB.

```
   PROGA    PROGRAM  START
1           COPY     PROGEQU
2           COPY     TCBEQU
   START    EQU      *
3           WHERES   PROGB,ADDRB,KEY=KEYB
4           IF       (PROGA,EQ,0),THEN
              PRINTEXT  'PROGRAM NOT FOUND',SKIP=1
              GOTO      DONE
            ENDIF
5           TCBGET   SAVEKEY,$TCBADS
6           TCBPUT   KEYB,$TCBADS
7           ADD      ADDRB,X'34',RESULT=TASKADDR
8           ATTACH   *,P1=TASKADDR
9           TCBPUT   SAVEKEY,$TCBADS
                     •
                     •
                     •
   DONE     PROGSTOP
   SAVEKEY  DATA     F'0'
10 PROGB    DATA     C'PROGB   '
   ADDRB    DATA     F'0'
   KEYB     DATA     F'0'
            ENDPROG
            END
```

1 Copy the PROGRAM equates into the program.

2 Copy the task control block (TCB) equates into the program.

3 Find the load-point address and address key of PROGB. Place the load-point address of PROGB into ADDRB and the address key of the program into KEYB.

4 If the WHERES instruction returns a zero, indicating an error, print an error message and end the program.

5 Save PROGA's address key in SAVEKEY.

6 Move PROGB's address key to the address key field ($TCBADS) of the TCB.

7 Add X'34' to the load point of PROGB. Put the result of the addition in TASKADDR. (PROGA assumes that PROGB defines the task to be attached immediately after the PROGRAM statement. The PROGRAM statement generates 52 bytes (X'34') of code.)

8 Attach the task. Assume that the address of the task to be attached is contained in TASKADDR (calculated by the ADD instruction).

9 Restore PROGA's address key from SAVEKEY.

10 Indicate the name of the program to be found. (The name of the program is the name assigned to it when the program was link edited.)

The following program contains task NEXT that PROGA attaches. This program must be in storage when PROGA issues the WHERES instruction.

```
   PROGB    PROGRAM  START
1  TASKADDR TASK     NEXT
2  NEXT     ENQT     $SYSPRTR
            PRINTEXT '@SUBTASK IS ATTACHED'
             •
             •
             •
            DEQT
            ENDTASK
   START    EQU      *
3           PRINTEXT '@PROGB STARTED'
4           WAIT     KEY
             •
             •
             •
            PROGSTOP
            ENDPROG
            END
```

1 Define a task with the name TASKADDR.

2 Enqueue the system printer ($SYSPRTR).

3 Print the message PROGB STARTED.

4 Wait for the operator to press the enter key. (The example assumes that the operator will not press the enter key until the task labeled TASKADDR in PROGB has executed.)

Note: When you issue an ATTACH instruction, the system stores the address of the terminal from which the main task was loaded in the $TCBCCB field of the attached task. In this way, the same terminal is active for both tasks.

Sharing Resources with the ENQ/DEQ Instructions

You can share serially-reusable resources with programs in other partitions by using the ENQ and DEQ instructions.

In the following example, SQROOT is a subroutine that has been link edited by several other programs. The subroutine is serially reusable because only one program can use the subroutine at a time. PROGA attempts to enqueue the queue control block (QCB) in PROGB. PROGA must enqueue the QCB before it can call the subroutine labeled SQROOT.

```
    PROGA    PROGRAM  START
1            COPY     TCBEQU
2            EXTRN    SQROOT
    START    EQU      *
3            WHERES   PROGB,ADDRB,KEY=KEYB
4            IF       (PROGA,EQ,0),THEN
               PRINTEXT  'PROGRAM NOT FOUND',SKIP=1
               GOTO      DONE
             ENDIF
5            TCBGET   SAVEKEY,$TCBADS
6            TCBPUT   KEYB,$TCBADS
7            ADD      ADDRB,X'34',RESULT=PROGBQCB
8            ENQ      *,BUSY=CANTHAVE,P1=PROGBQCB
9            CALL     SQROOT
10           MOVE     PRGBQCB,PROGBQCB
11           DEQ     *,P1=PRGBQCB
12           TCBPUT   SAVEKEY,$TCBADS
             GOTO     DONE
    CANTHAVE EQU      *
             PRINTEXT '@RESOURCE BUSY'
             TCBPUT   SAVEKEY,$TCBADS
               •
               •
               •
    DONE     PROGSTOP
    SAVEKEY  DATA     F'0'
13  PROGB    DATA     C'PROGB   '
    ADDRB    DATA     F'0'
    KEYB     DATA     F'0'
             ENDPROG
             END
```

1 Copy the task control block (TCB) equates into the program.

2 Identify the subroutine as an external entry (to be resolved at link-edit time).

3 Find the load-point address and address key of PROGB. Place the load-point address of PROGB into ADDRB and the address key of the program into KEYB.

4 If the WHERES instruction returns a zero, indicating an error, print an error message and end the program.

5 Save PROGA's address key in SAVEKEY.

6 Move PROGB's address key to the address key field ($TCBADS) of the TCB.

7 Add X'34' to the load point of PROGB. Put the result of the addition in PROGBQCB. PROGA assumes that PROGB defines the queue control block (QCB) immediately after the PROGRAM statement. The PROGRAM statement generates 52 bytes (X'34') of code.

8 Enqueue the subroutine. Assume that the address of the task to be attached is contained in PROGBQCB (calculated by the ADD instruction).

9 Call the SQROOT subroutine.

10 Move the contents of PROGBQCB to PRGBQCB.

11 Dequeue the queue control block (PRGBQCB).

12 Restore PROGA's address key from SAVEKEY.

13 Indicate the name of the program to be found. (The name of the program is the name assigned to it when the program was link edited.)

The subroutine link edited with PROGA looks like:

```
SUBROUT  SQROOT
ENTRY    SQROOT
PRINTEXT '@SUBROUTINE HAS BEGUN'
 •
 •
 •
RETURN
END
```

PROGB could look like this:

```
PROGB    PROGRAM  START
QCB1     QCB
START    EQU      *
1        WAIT     KEY
         PROGSTOP
         ENDPROG
         END
```

1 Wait for an operator to press the enter key. (The program contains the QCB and should remain active while other programs in the system are using the SQROOT subroutine.)

Synchronizing Tasks in Other Partitions

You can synchronize two or more tasks in different partitions with the WAIT and POST instructions. The following programs show how to issue a POST instruction to a program in another partition.

The first program, PROGA, finds the second program, PROGB, finds its event control block (ECB), and posts the ECB. In this example, PROGB must be loaded before PROGA.

PROGA assumes that PROGB contains an ECB immediately following the PROGRAM statement.

```
   PROGA    PROGRAM  START
1           COPY     TCBEQU
   START    EQU      *
2           WHERES   PROGB,ADDRB,KEY=KEYB
3           IF       (PROGA,EQ,0),THEN
            PRINTEXT  'PROGRAM NOT FOUND'
            GOTO      DONE
            ENDIF
4           TCBGET   SAVEKEY,$TCBADS
5           TCBPUT   KEYB,$TCBADS
6           ADD      ADDRB,X'34',RESULT=PGMBECB
7           POST     *,-1,P1=PGMBECB
8           MOVE     SAVEKEY,$TCBADS
   DONE     PROGSTOP
9  PROGB    DATA     C'XP12B   '
   SAVEKEY  DATA     F'0'
   ADDRB    DATA     F'0'
   KEYB     DATA     F'0'
            ENDPROG
            END
```

1 Copy the task control block (TCB) equates into the program.

2 Find the program defined at PROGB, put the address of the program in ADDRB, and put the address key of the program in KEYB.

3 If the WHERES instruction returns a zero, print an error message and end the program.

4 Save PROGA's address key in SAVEKEY.

5 Move PROGB's address key to the address key field ($TCBADS) of the TCB.

6 Add X'34' to the load point address returned by the WHERES instruction. Put the results of the addition in PGMBECB. PROGA assumes that PROGB defines an ECB immediately after the PROGRAM statement. The PROGRAM statement generates 52 bytes (X'34') of code.

7 Post the ECB with a −1. The operand P1=PGMBECB allows the ECB to be calculated by the ADD instruction.

8 Restore PROGA's address key from SAVEKEY.

9 Indicate the name of the program to be found. The name of the program is the name assigned to it when the program was link edited.

The following program shows how PROGB receives the POST from PROGA. This program must be in storage when PROGA issues the WHERES instruction.

```
1 PROGB   PROGRAM  START
2 ECB1    ECB
  START   EQU      *
3         WAIT     ECB1
            •
            •
            •
          PROGSTOP
          ENDPROG
          END
```

1 Identify the label at which to start executing (START).

2 Define an event control block (ECB). The program defines the ECB here because it will always be 52 bytes (X'34') from the program load point.

3 Wait for PROGA to post the program.

Moving Data Across Partitions

You can also move data across partitions. The following programs show how to move data to a program in another partition. The first program, PROGA, finds the second program, PROGB, stores its address key, and moves data to the dynamic storage area of PROGB. In this example, PROGB must be loaded before PROGA.

```
    PROGA    PROGRAM  START
1            COPY     PROGEQU
2            COPY     TCBEQU
    START    EQU      *
3            WHERES   PROGB,ADDRB,KEY=KEYB
4            IF       (PROGA,EQ,0),THEN
               PRINTEXT  'PROGRAM NOT FOUND'
               GOTO      DONE
             ENDIF
5            READTEXT MSG,'@ENTER UP TO 30 CHARACTERS',MODE=LINE
6            MOVE     #2,ADDRB
7            MOVE     PROGBBUF,($PRGSTG,#2),FKEY=KEYB
8            TCBGET   SAVEKEY,$TCBADS
9            TCBPUT   KEYB,$TCBADS
10           MOVE     #2,PROGBBUF
11           MOVE     (0,#2),MSG,(30,BYTE),TKEY=KEYB
12           TCBPUT   SAVEKEY,$TCBADS
    DONE     PROGSTOP
    MSG      TEXT     LENGTH=30
    PROGBBUF DATA     F'0'
13  PROGB    DATA     C'PROGB   '
    SAVEKEY  DATA     F'0'
    ADDRB    DATA     F'0'
    KEYB     DATA     F'0'
             ENDPROG
             END
```

1 Copy the PROGRAM equates into the program.

2 Copy the task control block (TCB) equates into the program.

3 Find the program defined at PROGB, put the address of the program in ADDRB, and put the address key of the program in KEYB.

4 If the WHERES instruction returns a zero, print an error message and end the program.

5 Prompt the operator for data and place the operator's response in MSG.

6 Move the address of PROGB in register 2.

7 Move the address of PROGB's dynamic storage area to PROGBBUF. Indicate PROGB's address key (FKEY=KEYB). PROGB has STORAGE=256 on its PROGRAM statement. This operand causes the system to acquire a 256-byte area of storage when it loads PROGB. The address of this area is in PROGB's program header (at $PRGSTG).

8 Save PROGA's address key in SAVEKEY.

9 Move PROGB's address key to the address key field ($TCBADS) of the TCB.

10 Move the address of PROGB's dynamic storage area to register 2.

11 Move the data that the operator entered (MSG) into PROGB's dynamic storage area. Move 30 bytes and indicate the address key of the program to which the data is being moved (TKEY=KEYB).

12 Restore PROGA's address key from SAVEKEY. Note that $TCBADS is immediately restored to its original value. Doing so avoids unpredictable results.

13 Indicate the name of the program to be found. The name of the program is the name assigned to it when the program was link edited.

The following program shows how PROGB receives the data from PROGA. The program must be in storage when PROGA issues the WHERES instruction.

```
1  PROGB    PROGRAM  START,STORAGE=256
   START    EQU      *
2           •
            •
            •
3           MOVE     #1,$STORAGE
4           MOVE     MSG2,(0,#1),(30,BYTE)
5           PRINTEXT  '@THE DATA THAT WAS PASSED WAS'
            PRINTEXT  MSG2
            PROGSTOP
   MSG2     TEXT     LENGTH=30
            ENDPROG
            END
```

1 Identify the label at which to start executing (START). Specify 256 bytes of dynamic storage. (Even though the program requires only 30 bytes, the system rounds up to a multiple of 256.)

2 Insert instructions here to wait for PROGA to send data.

3 Move the address of the dynamic storage area (contained in $STORAGE) to register 1.

4 Move 30 bytes from the dynamic storage area to MSG2.

5 Print the data.

$TCBADS is used to calculate the partition and address to/from which data will be transferred.

Reading Data across Partitions

You can read data across partitions with the READ instruction.

In the following example, program PROGA reads data and passes it to a buffer in program PROGB. PROGA assumes that PROGB is in another partition.

```
1  PROGA    PROGRAM  START,DS=ACCOUNTS
2           COPY     PROGEQU
3           COPY     TCBEQU
   START    EQU      *
4           WHERES   PROGB,ADDRB,KEY=KEYB
5           IF       (PROGA,EQ,0),THEN
             PRINTEXT  'PROGRAM NOT FOUND',SKIP=1
             GOTO      DONE
            ENDIF
6           MOVE     #2,ADDRB
7           MOVE     PROGBBUF,($PRGSTG,#2),FKEY=KEYB
8           TCBGET   SAVEKEY,$TCBADS
9          TCBPUT   KEYB,$TCBADS
10          READ     DS1,*,P2=PROGBBUF
11          TCBPUT   SAVEKEY,$TCBADS
   DONE     PROGSTOP
   SAVEKEY  DATA     F'0'
12 PROGB    DATA     C'PROGB   '
   ADDRB    DATA     F'0'
   KEYB     DATA     F'0'
            ENDPROG
            END
```

1 Define data set ACCOUNTS on the IPL volume.

2 Copy the PROGRAM equates into the program.

3 Copy the task control block (TCB) equates into the program.

4 Find the load-point address and address key of PROGB. Place the load-point address of PROGB into ADDRB and the address key of the program into KEYB.

5 If the WHERES instruction returns a zero, indicating an error, print an error message and end the program.

6 Move the address key of PROGB into software register 2.

7 Move the address of PROGB's dynamic storage area into PROGBBUF in PROGA. The STORAGE= operand on the PROGRAM statement of PROGB causes the system to acquire a 256-byte storage area when it loads the program. The address of this storage area is in PROGB's program header (at $PRGSTG).

8 Save PROGA's address key in SAVEKEY.

9 Moves PROGB's address key to the address key field ($TCBADS) of the TCB.

10 Read one record from the data set ACCOUNTS into PROGBBUF. Because PROGBBUF is the label of the P2= operand on the READ instruction, the system uses the contents of PROGBBUF as the location where the data is to be stored.

11 Restore PROGA's address key from SAVEKEY.

12 Indicate the name of the program to be found. (The name of the program is the name you give the program when you link edit it.)

The following program shows how PROGB receives the data from PROGA. The program must be in storage when PROGA issues the WHERES instruction.

```
1 PROGB   PROGRAM  START,STORAGE=256
  START   EQU      *
            •
            •
            •
2           MOVE     #1,$STORAGE
3           MOVE     OUTPUT,(0,#1),(50,BYTE)
4           PRINTEXT '@THE DATA RECEIVED FROM PROGA IS :'
5           PRINTEXT OUTPUT,SKIP=1
  OUTPUT    TEXT     LENGTH=50
            ENDPROG
            END
```

1 Identify the label at which to start executing (START). Specify 256 bytes of dynamic storage. (Even though the program requires only 50 bytes, the system rounds up to a multiple of 256.)

2 Move the address of the dynamic storage area (contained in $STORAGE) to software register 1.

3 Move 50 bytes of data from the dynamic storage area into OUTPUT.

4 Print a message.

5 Print the data.

Chapter 13. Communicating with Other Programs (Virtual Terminals)

A *virtual terminal* is a logical EDX device that simulates the actions of a physical terminal. An EDL application program can acquire control of, or enqueue, a virtual terminal just as it would an actual terminal. By using virtual terminals, programs can communicate with each other as if they were terminal devices. One program (the primary) loads another program (the secondary) and takes on the role of an operator entering data at a physical terminal.

The secondary program can be an application program or a system utility, such as $COPYUT1. You can use virtual terminals, for example, to provide simplified menus for running system utilities. An operator could load a virtual terminal program, select a utility to run, and allow the program to pass predefined parameters to the utility.

Virtual terminals simulate roll screen devices. The terminals communicate through EDL terminal I/O instructions contained in the virtual terminal programs. The programs use a set of virtual terminal return codes to synchronize communication.

For example, an EDL program, the primary program, loads a system utility such as $COPYUT1. The program cannot distinguish between connection to a real terminal or a virtual terminal. The program uses the READTEXT instruction to read the prompts from the utility. Then it uses the PRINTEXT instruction to send replies to the utility.

Defining Virtual Terminals

To define a virtual terminal connection during system generation, you must:

- Define two TERMINAL configuration statements.
- Include the supervisor module IOSVIRT.

For information on how to define TERMINAL statements and include IOSVIRT, refer to the *Installation and System Generation Guide.*

You can find out if your system has virtual terminals by using the LA command of the $TERMUT1 utility. If your system has virtual terminals, $TERMUT1 lists the virtual terminals as follows:

```
 NAME     ADDR   TYPE     PART   HARDCOPY  ON-LINE

CDRVTA     **    VIRT      1             YES CONNECTED CDRVTB  SYNC=YES
CDRVTB     **    VIRT      1             YES CONNECTED CDRVTA
  •
  •
  •
```

The output from $TERMUT1 indicates that CDRVTA is the primary program (SYNC = YES).

The DEVICE and ADDRESS parameters of the TERMINAL statement define the terminals as virtual terminals. The two TERMINAL statements must reference each other, as shown below.

```
CDRVTA    TERMINAL  DEVICE=VIRT,ADDRESS=CDRVTB,SYNC=YES
CDRVTB    TERMINAL  DEVICE=VIRT,ADDRESS=CDRVTA
```

The SYNC parameter of terminal CDRVTA designates it as the terminal to which synchronization events will be posted. The synchronization between virtual terminals is discussed in "Interprogram Dialogue."

Loading from a Virtual Terminal

When an EDX program is loaded from a real terminal, that terminal becomes its "primary" communication port. When one program loads another, the current terminal of the first program is "passed" and becomes the primary terminal of the second. It is this convention that allows a new program to establish a virtual terminal as the primary port for the loaded program. For example:

```
          •
          •
          •
          ENQT      SEC
          LOAD      $TERMUT1,LOGMSG=NO,EVENT=ENDWAIT
          ENQT      PRIM
          •
          •
          •
PRIM      IOCB      CDRVTA
SEC       IOCB      CDRVTB
```

After this sequence, $TERMUT1 has CDRVTB (the "other" end of the channel) as its primary port, and the loading program has CDRVTA ("this" end of the channel) as its current port.

Interprogram Dialogue

Once the connection between the two communicating programs has been established, you can use the PRINTEXT, READTEXT, PRINTNUM and GETVALUE instructions to send and receive data. You can generate attention interrupts with the TERMCTRL instruction. (Refer to the *Language Reference* for information on the TERMCTRL instruction.) The usual conventions with respect to output buffering and advance input apply.

To use virtual terminals, you must know something about communications protocol (such as knowing when a program is ready for input or has ended). You can use the task code word to find out this information.

Sample Program

The following sample program uses virtual terminals to process the prompt/reply sequence of the $INITDSK utility. The program initializes volume EDX003.

The replies to $INITDSK prompts begin at label REPLIES+2. (The six bytes in each TEXT statement is preceded by two length/count bytes.)

Each reply is 8 bytes long (six bytes of text plus two length/count bytes). The program issues a READTEXT until $INITDSK prompts for input. Then the program issues a PRINTEXT to send the reply to the $INITDSK prompt. After $INITDSK ends, the program prints a completion message to the terminal.

```
INIT     PROGRAM   BEGIN
A        IOCB      CDRVTA                    SYNC TERMINAL
B        IOCB      CDRVTB
DEND     ECB
BEGIN    EQU       *
         ENQT      B
         LOAD      $INITDSK,LOGMSG=NO,EVENT=DEND
         ENQT      A                  GET SYNC TERMINAL
         MOVEA     #1,REPLIES+2
         DO        6,TIMES            REPLY TO PROMPTS
           DO      UNTIL,(RETCODE,EQ,8)   BREAK CODE
             READTEXT  LINE,MODE=LINE  LOOP FOR PROMPT MSGS
             MOVE      RETCODE,INIT    SAVE RETURN CODE
           ENDDO
          PRINTEXT (0,#1)              SEND REPLY
          ADD      #1,8                NEXT REPLY
         ENDDO
         READTEXT  LINE,MODE=LINE      PGM END MSG
         WAIT      DEND                WAIT FOR END EVENT
         DEQT
         PRINTEXT  'EDX003 INITIALIZED'
         PROGSTOP
RETCODE  DATA      F'0'                RETURN CODE
LINE     TEXT      LENGTH=80
REPLIES  EQU       *
         TEXT      'IV    '            COMMAND?
         TEXT      'EDX003'            VOLUME?
         TEXT      'Y     '            CONTINUE?
         TEXT      '60    '            NBR OF DATA SETS?
         TEXT      'N     '            VERIFY?
         TEXT      'EN    '            COMMAND?
         ENDPROG
         END
```

Chapter 14. Designing and Coding Sensor I/O Programs

This chapter provides the information you need to code a sensor I/O application program. Topics covered include:

- Sensor I/O devices
- Symbolic I/O assignments
- Sensor I/O instructions.

The chapter also provides several examples.

What is Digital Input/Output?

A unit of digital sensor I/O is a physical group of sixteen contiguous points. The entire group of sixteen points is accessed as a unit on the I/O instruction level. Programming support allows logical access down to the single point level.

Digital input (DI) is usually used to acquire information from instruments which present binary encoded output or to monitor contact/switch status (open/closed). *Digital output* (DO) is used to control electrically-operated devices through closing relay contacts, such as pulsing stepping motors.

Process interrupt (PI) is a special form of digital input. If a point of digital input changes state, and then changes state again, without an intervening READ operation from the program, the status change will be undetected. With process interrupt, a point changing from the off state to on generates a hardware interrupt that is then routed through software support to an interrupt-servicing application program that can respond to the external event that caused the interrupt. Process interrupt is often used for monitoring critical or alarm conditions that must be serviced quickly, the occurrence of which must not go undetected.

What is Analog Input/Output?

A physical unit of analog input (AI) can be a group of eight points or sixteen points, depending on the type. Analog output (AO) is installed in groups of two points. Each point of analog input or analog output is accessed separately.

Analog input is used to monitor devices that produce output voltages proportional to the physical variable or process being measured. Examples include laboratory instruments, strain gauges, temperature sensors, or other nondigitizing instruments. Digital input was described as monitoring an on/off status; only two conditions were possible. With analog input, the information is carried in the amplitude of the voltage sensed rather than in its presence or absence.

The starter supervisor contains no support for sensor I/O. You must perform a tailored system generation to include the required support modules in your own supervisor.

Figure 14-1 shows how sensor devices are connected to a Series/1 through the 4982 sensor I/O unit. The devices (DI, DO, PI, AO, and AI) attach to a controller, which in turn attaches to the Series/1. The sensor I/O attachment (controller), and each of the devices attaching to it, have unique hardware addresses. In this figure, the physical connections are there, and the hardware addresses are assigned (wired in), but the starter supervisor in storage lacks the support necessary to operate the devices.

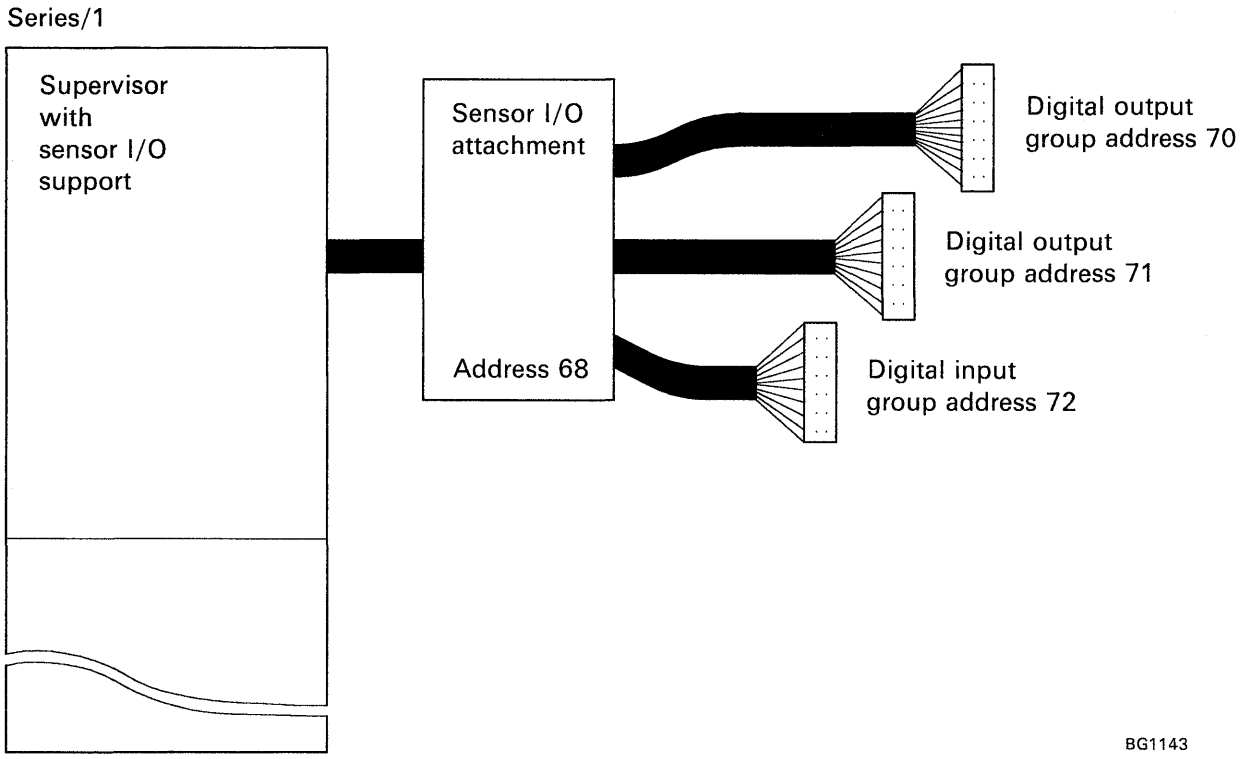

Figure 14-1. Sensor Device Connections

Building a tailored supervisor involves the assembly of a series of system configuration statements that reflect the I/O configuration you wish to support. For more information on system configuration statements, refer to the *Installation and System Generation Guide*. When programs reference these devices, they use symbolic references, rather than actual addresses. The I/O definition statement (IODEF) establishes the logical link between the addresses defined in the supervisor, and the symbols used to read from and write to the devices at those addresses from an application program.

All sensor-based input/output operations are performed by executing a sensor-based I/O (SBIO) instruction. The type of operation is determined by the type of device referenced in the instruction. For more information on the SBIO statement, refer to the *Language Reference*. The symbolic reference to a logical device in the SBIO statement is linked to the definition in the IODEF statement, which relates that device to the hardware address specified by the system configuration statement at system generation time.

What are Sensor-Based I/O Assignments?

The sensor-based I/O instruction (SBIO) refers to the I/O devices using a 3-or 4-character name. The first two characters identify the type of device: AI, DI, PI, AO, and DO for analog input, digital input, process interrupt, analog output, and digital output, respectively. The next one or two characters are the identification for the device, a number between 1 and 99. For example, if you have three analog input terminals, you may identify them as AI1, AI2, and AI3. Before the application program is compiled, the sensor-based I/O definition statement (IODEF) assigns the actual physical addresses. All SBIO instructions are independent of the physical location of the sensor I/O points.

The assignment of sensor I/O symbolic addresses is described under "Providing Addressability (IODEF)" on page 14-4. Figure 14-2 shows the relationship between sensor-based I/O instructions, definition statements, and configuration statements.

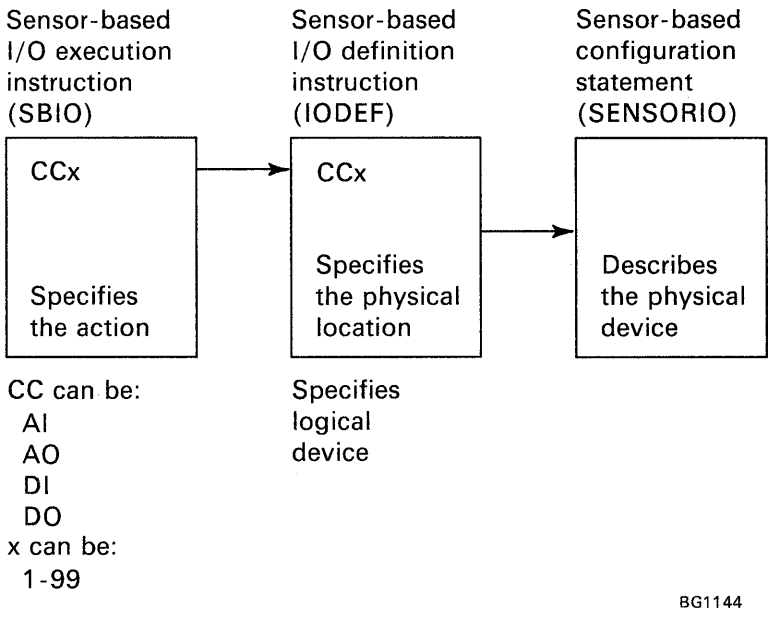

Figure 14-2. Sensor-Based Symbolic I/O Assignment

Coding Sensor-Based Instructions

This section describes the instructions used in sensor-based I/O applications. The following instructions are defined:

- IODEF - provides addressability by specifying physical location
- SBIO - specifies the I/O operation to be performed
- SPECPIRT - allows control to be returned to the supervisor from a special process-interrupt routine.

Providing Addressability (IODEF)

Use the IODEF instruction to provide addressability for the sensor-based I/O facilities which are referenced symbolically in an application program. The specific form used varies with the type of I/O being performed.

Group all IODEF statements of the same form (AI, AO, DI, DO, or PI) together in the program and place them ahead of the SBIO instructions that reference them.

All IODEF statements must be in the same assembly module as the TASK or ENDPROG statement. For high level languages, see the appropriate manual for instructions on how to accomplish this. If the SBIO instructions are to be in a separate module, you can provide addressability using ENTRY/EXTRN statements.

Each IODEF statement creates an SBIOCB control block. The contents of the SBIOCB is described in the *Internal Design*.

The IODEF statement generates a location into/from which data is read/written. You must create a separate IODEF for each task; different tasks cannot use the same IODEF statement.

Refer to the *Language Reference* for the syntax of PI, DO, DI AO, and AI.

Examples

The following IODEF instructions define two process interrupts, a digital output group, a digital output group as external sync, a digital input group, an analog input point, and an analog output point.

```
IODEF  PI1,ADDRESS=48,BIT=2
IODEF  PI2,ADDRESS=49,BIT=15
IODEF  DO1,TYPE=GROUP,ADDRESS=4B
IODEF  DO2,TYPE=EXTSYNC,ADDRESS=4A
IODEF  DI1,TYPE=GROUP,ADDRESS=49
IODEF  AI1,ADDRESS=72,POINT=1,RANGE=50MV,ZCOR=YES
IODEF  AO2,ADDRESS=75,POINT=1
```

The SBIO instruction references the digital and analog I/O points as described under the SBIO instruction. Process interrupts are referenced by the POST and WAIT instructions and are described under the respective instruction. Further examples of IODEF statements are shown following the SBIO instruction.

SPECPI - Process Interrupt User Routine

The SPECPI option of the IODEF statement defines a special process interrupt routine. The supervisor executes a routine written in Series/1 assembler language when the defined interrupt occurs. The purpose is to provide the minimum delay before service of the interrupt, by bypassing the normal supervisor interrupt servicing. Multiple special process-interrupt routines are allowed in a program.

TYPE = BIT The system gives control to the specified routine when an interrupt occurs on the specified bit. On return to the supervisor, the contents of register 1 (R1) must be the same at entry to the user's routine and R0 must contain either "0" or a POST code. In the latter case, R3 must contain the address of an ECB to be posted by the POST instruction. R7 contains the supervisor return address upon entry. If the user routine is in partition 1, you can return to the supervisor with the BXS (R7) instruction. Otherwise, you must return with the SPECPIRT instruction. You can use SPECPIRT in partition 1. The value that is in R7 upon entry may be used to return to the supervisor using BXS (R7) only if the user routine is in partition 1.

TYPE = GROUP The system gives control to the specified routine you provide if an interrupt occurs on any bit in the PI group. The PI group is not read or reset; reading or resetting the PI group is the responsibility of your routine. Control returns to the supervisor with a branch to the entry point SUPEXIT. You must include the module $EDXATSR with your program to use SUPEXIT. If the routine processes the interrupt on level 0, it can issue a Series/1 hardware exit level instruction (LEX) instead of returning to SUPEXIT. Issuing the LEX instruction greatly improves performance.

Note: To use TYPE = GROUP, you must be familiar with the operation of the Series/1 process interrupt feature. Your routine must contain all instructions necessary to read and reset the process-interrupt group to which it refers.

Using the Special Process-Interrupt Bit

```
                IODEF   PI2,ADDRESS=48,BIT=3,TYPE=BIT,SPECPI=FASTPI1

     FASTPI1    EQU     *

[1]             MVW     R1,SAVER1
                •
                •
                •
[2]             MVA     PI2,R3
[3]             MVWI    3,R0
[4]             MVW     SAVER1,R1
[5]             SPECPIRT
```

[1] Save R1.

[2] Put the address of PI2 in R3.

[3] Posting code in R0.

[4] Restore R1.

[5] Return to supervisor.

In the following example, control is given to the user at label FASTPI2.

```
          IODEF PI6,ADDRESS=49,TYPE=GROUP,SPECPI=FASTPI2

FASTPI2   EQU       *
```

Specifying I/O Operations (SBIO)

The SBIO instruction provides communication using analog and digital I/O. Options allow you to:

- Index using a previously defined BUFFER statement.
- Update a buffer address in the SBIO instruction after each operation.
- Use a short form of the instruction, omitting loc (data location) to imply a data address within the SBIOCB.

Options available with digital input and output provide PULSE output and the manipulation of portions of a group with the BITS=(u,v) keyword parameter.

SBIO instructions are independent of hardware addresses. The actual operation performed is determined by the definition of the sensor address in the referenced IODEF statement.

The IODEF statement generates a location into/from which data is read/written. You must create a separate IODEF for each task; different tasks cannot use the same IODEF statement.

A sensor based input/output control block (SBIOCB) is inserted into an application program for each referenced sensor I/O device. The SBIOCB, containing a data I/O area and an event control block (ECB), supplies information to the supervisor. When an SBIO instruction executes, the supervisor either stores data (for AI and DI operations) or fetches data (for AO and DO operations) from a location in the IOCB with the label of the referenced I/O point (for example, AI1, DI2, DO33, AO1). An application program can reference these locations the same way any other variable is referenced, allowing you to use the short form of the SBIO instruction (for example, SBIO DI1), and subsequently reference DI1 in other instructions. You can equate a more descriptive label to the symbolic names (for example SWITCH EQU DI15), but the SBIO instruction must use the symbolic name as described above.

Each control block also contains an ECB to be used by those operations which require the supervisor to service an interrupt and "post" an operation complete. These include analog input (AI), process interrupt (PI), and digital I/O with external sync (DI/DO). For process interrupt, the label on the ECB is the same as the symbolic I/O point (for example PIx). For analog and digital I/O, the label is the same as the symbolic I/O point with the suffix "END" (for example DIxEND).

Reading Analog Input (example)

This example shows SBIO instructions and IODEF statements to read analog input.

```
TASK    PROGRAM GO
        IODEF   AI1,ADDRESS=72,POINT=5

1       SBIO    AI1
2       SBIO    AI1,DAT
3       SBIO    AI1,BUF,INDEX
4       SBIO    AI1,(BUF,#1)
5       SBIO    AI1,BUF,2,SEQ=YES
6       SBIO    AI1,BUF,2
                 or
7       SBIO    AI1,BUF,2,SEQ=NO
```

1 Data into location AI1.

2 Data into location DAT.

3 AI1 into next location of BUF.

4 AI1 into location (BUF, #1).

5 Read 2 sequential AI points into next 2 locations of BUF.

6 Read the same point 2 times and put information in 2.

7 Locations of BUF.

Writing Analog Output (example)

This example shows SBIO instructions and IODEF statements to write analog output.

```
        IODEF  AO1,ADDRESS=63
1        SBIO  AO1
2        SBIO  AO1,DATA
3        SBIO  AO1,1000
4        SBIO  AO1,(0,#1)
5        SBIO  AO1,BUF,INDEX
```

1 Set AO1 to value in A01.

2 Set AO1 to value in DATA.

3 Set AO1 to 1000

4 Set AO1 to value in (0,#1)

5 Set AO1 to value in next location of BUF.

Reading Digital Input (example)

This example shows SBIO instructions and IODEF statements to read digital input.

```
          IODEF DI1,TYPE=GROUP,ADDRESS=49
          IODEF DI2,TYPE=SUBGROUP,ADDRESS=48,BITS=(7,3)
          IODEF DI3,TYPE=EXTSYNC,ADDRESS=62
1          SBIO  DI1
2          SBIO  DI1,DATA
3          SBIO  DI1,(0,#1)
4          SBIO  DI1,BUF,INDEX
5          SBIO  DI1,BDAT,BITS=(3,5)
6          SBIO  DI2
7          SBIO  DI2,DAT2
8          SBIO  DI2,D,BITS=(0,3)
9          SBIO  DI2,E,BITS=(0,1)
10         SBIO  DI2,F,BITS=(2,1),LSB=7
11         SBIO  DI3,G,128
```

1 Data into location DI1.

2 DI1 into location DATA.

3 DI1 into location (0,#1).

4 DI1 into next location of BUF.

5 Bits 3 to 7 of DI1 into BDAT.

6 Bits 7 to 9 of D12 into D12.

7 Bits 7 to 9 of D12 into DAT2.

8 Bits 7 to 9 of D12 into D.

9 Bit 7 of D12 into E.

10 Bit 9 of D12 into location F bit 7.

11 Read 128 words into G using external sync.

Writing Digital Output (example)

This example shows SBIO instructions and IODEF statements to write digital output.

```
          IODEF DO3,TYPE=GROUP,ADDRESS=4B
          IODEF DO12,TYPE=SUBGROUP,ADDRESS=4A,BITS=(5,4)
          IODEF DO13,TYPE=EXTSYNC,ADDRESS=4F
1          SBIO  DO3
2          SBIO  DO3,DODATA
3          SBIO  DO3,1023
4          SBIO  DO3,(DATA,#1)
5          SBIO  DO3,7,BITS=(3,3)
6          SBIO  DO12,15
7          SBIO  DO12,X,BITS=(0,4)
8          SBIO  DO12,1,BITS=(0,1)
9          SBIO  DO13,Y,80
```

1 Value of location DO3 to DO3.

2 Value of DODATA to DO3.

3 Set DO3 to 1023.

4 Value at (DATA,#1) to DO3.

5 Set bits 3 to 5 of DO3 to 7.

6 Set bits 5 to 8 of DO12 to 15.

7 Set bits 5 to 8 of DO12 to value in X.

8 Set bit 5 of DO12 to 1.

9 Write 80 locations of "Y" to DO13 external sync.

Pulse Digital Output (example)

This example shows pulse digital output.

```
          IODEF DO13,TYPE=SUBGROUP,BITS=(3,1)
          IODEF DO14,TYPE=SUBGROUP,BITS=(7,4)
1          SBIO  DO13,(PULSE,UP)
2          SBIO  DO14,(PULSE,DOWN)
```

1 Pulse DO13 bit 3 to on and then off.

2 Pulse DO14 bits 7 to 10 off and then on.

Returning from the Process-Interrupt Routine (SPECPIRT)

Use the SPECPIRT instruction to return control to the supervisor from a special process interrupt (SPECPI) routine. If the user routine is in partition 1, a branch instruction is used to return. Return from another partition requires execution of a Series/1 assembler SELB instruction after registers R0 and R3 are saved in the level block to be selected. SPECPIRT is used only for TYPE=BIT SPECPI routines. See the description of IODEF (SPECPI) for additional information.

```
label     SPECPIRT

Required:  none
Defaults:  none
Indexable: none
```

Analog Input Sample

This program takes 256 samples from analog input address AI1 at a sampling rate of 10 points/second. Set the run light on in the lab at the start of the run and turn it off at the end. The run light is connected to bit 3 of group DO2.

```
    TKNAME     PROGRAM   START
               IODEF     DO2,TYPE=GROUP,ADDRESS=87
               IODEF     AI1,ADDRESS=83
1     START    SBIO       DO2,1,BITS=(3,1)
2              DO         256,TIMES
3              STIMER     100
4              SBIO       AI1,BUFR,INDEX
                        WAIT     TIMER
5              ENDDO
6              SBIO        DO2,0,BITS=(3,1)
                        .
                        .
                        .
7     BUFR     BUFFER     256
```

1 Turn on run light.

2 Set up for 256 points.

3 Set timer for 100 MS.

4 Read AI1 with automatic indexing into the buffer BUFR. and then wait for the timer to expire.

5 End of loop.

6 Turn off run light.

7 256 word buffer.

The program begins by writing a 1 into bit 3 of digital output group DO2. A DO loop initializes for 256 cycles. At this point, a software timer is set up for 100 milliseconds to provide sampling at 10 points/second. The analog data is read into BUFR using the SBIO instruction with automatic indexing. After the data is read, the program waits for the timer to expire before returning for the next sample. When all the data is collected, the run light is turned off by writing a 0 into bit 3 of DO2.

Analog Input With Buffering To Disk

This program takes analog data readings at equal time intervals. The number of data points and the time interval in milliseconds are read in from the operator's terminal. The program will allow from 10 to 10,000 data points to be taken at time intervals between 10 milliseconds and 10 seconds (10,000 msec). The data collection is initiated by a process interrupt start signal. The program is ended by using the keyboard function "AB." Also, a second keyboard function, "NP," is used to print a status switch. The switch will be equal to zero if the start signal has not been received or equal to the number of data points to be read if the start signal has been received and data collection has begun.

```
            TITLE    'SAMPLE ANALOG DATA ACQUISITION PROGRAM'
   READATA  PROGRAM  BEGIN,DS=??
            ATTNLIST (AB,ABORT,NP,SWPRNT)
1  ABORT    MOVE     SWITCH,1
            ENDATTN
   SWPRNT   PRINTEXT TXT10
2           PRINTNUM SWITCH
            PRINTEXT SKIP=1
            ENDATTN
            IODEF    AI1,ADDRESS=91,POINT=0
            IODEF    PI1,ADDRESS=94,BIT=15
*           EXPERIMENT INITIALIZATION
   BEGIN    PRINTEXT TXT1
3           GETVALUE RUNUM,TXT2
4  GETINT   GETVALUE INTVL,TXT3
            IF       (INTVL,LT,10),OR,(INTVL,GT,10000),GOTO,GETINT
5  GETPTS   GETVALUE NPTS,TXT4
            IF       (NPTS,LT,10),OR,(NPTS,GT,10000),GOTO,GETPTS
6           WRITE    DS1,RUNUM
            RESET    SWITCH
```

1 End the experiment.

2 Print experiment switch.

3 Request run identifier.

4 Request time interval.

5 Request number of points.

6 Run parameters in first sector.

```
7                PRINTEXT TXT9
8                WAIT     PI1,RESET
9                MOVE     SWITCH,NPTS
10               DO       NPTS
11               STIMER   INTVL
12               SBIO     AI1,BUFFER,INDEX
13               IF       (BUFINDEX,EQ,128),GOTO,ATTACH
14               IF       (BUFINDEX,NE,256),GOTO,TWAIT
15               MOVE     BUFINDEX,0
16               ADD      POINTCNT,256
17   ATTACH      IF       (DISK,NE,-1),GOTO,STOP
18               ATTACH   DISKTASK
19   TWAIT       WAIT     TIMER
20               IF       (SWITCH,EQ,1),GOTO,STOP
     ENDLOOP     ENDDO
                 IF       (BUFINDEX,EQ,0),OR,(BUFINDEX,EQ,128),GOTO,STOP
21               WAIT     DS1
22               ADD      POINTCNT,BUFINDEX
23               ATTACH   DISKTASK
24   STOP        WAIT     DS1
25               ENQT
26               PRINTEXT TXT6
                 PRINTNUM POINTCNT
                 PRINTEXT TXT7
27               DEQT
                 PROGSTOP
```

7 Print ready message.

8 Wait for start signal.

9 Set switch to NPTS.

10 Begin the data acquisition portion of the program. Perform the loop the number of times set in step 3.

11 Time interval set above.

12 Read a data point.

13 First buffer full?

14 No, is second full?

15 Yes, reset buffer index.

16 Increment data counter.

17 Is disk task attached?

18 Start the disk output task.

19 Wait for end of time interval.

20 Test for "end."

21 Wait for disk write.

22 Update data counter.

23 Start last disk output.

24 Wait for last output operation.

25 Get control of terminal.

26 Print terminating message.

27 Release terminal.

The following is the data recording task. It is attached by the data acquisition task each time that 128 words of data have been read. One portion of the buffer will be transferred to disk while data is being read into the other portion of the buffer. The task runs on level 3 at a lower priority than the data acquisition task in order to maximize timing accuracy.

```
DISKTASK TASK     DISK1,300,EVENT=DISK
DISK1    WRITE    DS1,BUFFER1,ERROR=DISKERR
1        DETACH   -1
         WRITE    DS1,BUFFER2,ERROR=DISKERR
2        DETACH   -1
         GOTO     DISK1
3 DISKERR MOVE    ERROR,DISKTASK
4        ENQT
         PRINTEXT TXT5
5        PRINTNUM ERROR
         PRINTEXT SKIP=1
6        DEQT
7        ENDTASK  1
TXT1     TEXT '@SAMPLE ANALOG DATA ACQUISITION PROGRAM@'
TXT2     TEXT '@ENTER RUN NUMBER '
TXT3     TEXT '@ENTER INTERVAL IN MS (10-10000) '
TXT4     TEXT '@ENTER NO. OF POINTS (10-10000) '
TXT5     TEXT '@DISK ERROR '
TXT6     TEXT '@RUN ENDED AFTER '
TXT7     TEXT ' POINTS@'
TXT9     TEXT '@READY FOR PI SIGNAL TO BEGIN TAKING DATA@'
TXT10    TEXT '@EXPERIMENT SWITCH = '
```

1 Successful completion.

2 Successful completion.

3 Save error code.

4 Get control of terminal.

5 Print disk error message.

6 Release terminal.

7 Detach with code = 1.

```
1 POINTCNT DATA   F'0'
2 SWITCH   DATA   F'0'
3 RUNUM    DATA   F'0'
4 INTVL    DATA   F'0'
5 NPTS     DATA   F'0'
  ERROR    DATA   F'0'
6 BUFFER   BUFFER 256,INDEX=BUFINDEX
7 BUFFER1  EQU    BUFFER
8 BUFFER2  EQU    BUFFER+256
           ENDPROG
           END
```

1 Number of points taken.

2 Set to "1" for "end."

3 Run identifier.

4 Time interval.

5 Number of points to take.

6 Data buffers.

7 First 128 words.

8 Second 128 words.

Digital Input and Averaging

This example illustrates the programming of a simple time-averaging application. The program reads digital input group DI1 every time a process interrupt occurs on PI2. One complete scan is 128 data points. Each scan is added to a double-precision averaging buffer. The number of scans is read from the terminal as an initialization parameter. Also, the program asks whether to reset the averaging buffer before starting to scan. The maximum number of scans must be less than 1000.

```
1   START    GETVALUE  NSCAN,TXT1
             IF        (NSCAN,GE,1000),GOTO,ERROR
             RESET     PI2
2             QUESTION  TXT2,NO=BEGIN
3             MOVE      ABUFR,0,256
4   BEGIN     DO        NSCAN
5             DO        128
6             WAIT      PI2
7             RESET     PI2
8             SBIO      DI1,BUFR,INDEX
              ENDDO
9             ADDV      ABUFR,BUFR,128,PREC=D
10            MOVE      I,0
              ENDDO
              PRINTEXT  TXT3
                •
                •
                •
    ERROR     PRINTEXT  TXT4
11            GOTO      START
    TXT1      TEXT      '@NUMBER OF SCANS - '
    TXT2      TEXT      ' RESET AVERAGING BUFFER? '
    TXT3      TEXT      ' ALL SCANS COMPLETE@'
    NSCAN     DATA      F'0'
    BUFR      BUFFER    128,INDEX=I
    ABUFR     BUFFER    256
    TXT4      TEXT      ' TOO MANY SCANS - RE-ENTER@'
```

1 Get number of scans.

2 Reset average buffer?

3 Yes, reset it.

4 Set up for NSCANS.

5 Set up for 128 points.

6 Wait for interrupt.

7 Reset interrupt.

8 Read DI1 (Indexing).

9 One scan is complete. Move the data to the averaging buffer.

10 Reset buffer index.

11 Return for input.

In this example, the number of scans to be done is read from the terminal and checked against 1000. If it is greater than or equal, an error message is printed and the program returns for a new input parameter. The operator is asked if the averaging buffer is to be reset. If yes, the MOVE instruction sets the averaging buffer (ABUFR) to 0. A loop is initialized for the number of scans desired. A second loop is set up for a single scan of 128 points. The program waits for an interrupt on PI2 and, when it occurs, resets the interrupt for the next point, reads the digital input DI1 using automatic indexing into the buffer BUFR. When a scan is complete, the data is added to the ABUFR buffer. The buffer index, I, is reset to 0. When all scans are complete, a message is printed. The output from the program is illustrated in the following example:

```
NUMBER OF SCANS - 33
 RESET AVERAGING BUFFER? Y
 ALL SCANS COMPLETE
```

Chapter 15. Designing and Coding Graphic Programs

The Event Driven Executive provides various graphics-oriented tools that can assist you in the development of a graphics application.

The graphics tools you can use are the EDL graphics instructions and the graphics utilities. This section describes the graphic instructions supported by the Event Driven Executive. The graphic utilities are described in the *Operator Commands and Utilities Reference*.

Graphics Instructions

Seven graphics instructions are provided by the Event Driven Executive. These graphics instructions, used with the terminal support described, can aid in the preparation of graphic messages, allow interactive input, and draw curves on a display terminal.

These instructions are only valid for ASCII terminals that have a point-to-point vector graphics capability and are compatible with the coordinate conversion algorithm described in the *Internal Design* for graphics mode control characters. The function of the various ASCII control characters used by a terminal are described in the appropriate device manual. Such terminals can be connected to the Series/1 through the #7850 Teletypewriter Adapter.

You use the graphics instructions in the same manner as other Event Driven Language instructions, except that the supporting code is included in your program rather than in the supervisor. If you code all the instructions in a program, this code requires approximately 1500 bytes of storage.

When using the graphics instructions described, detailed manipulation of terminal instructions and text messages is not required.

All graphics instructions deal with ASCII data. Therefore, when you send an ASCII text string to the terminal, code the XLATE=NO parameter on the PRINTEXT instruction.

Use of the graphics instructions requires that your object program be processed by the linkage editor, $EDXLINK, to include the graphics functions which are supplied as object modules. See Chapter 5, "Preparing an Object Module for Execution" for the description of the autocall option of $EDXLINK, and for information on the use of the "AUTO=$AUTO,ASMLIB" option of $EDXLINK.

The following is a list of the graphics instructions provided by the Event Driven Executive. These instructions are described in detail in the *Language Reference*.

- The CONCAT statement concatenates two text strings or a text string and a graphic control character.
- The GIN instruction allows you to specify unscaled coordinates interactively, rings the bell, displays cross hairs, waits for the operator to position the cross hairs and key in any single character, returns the coordinates of the cross-hair cursor, and optionally returns the character entered by the user.

- The PLOTGIN instruction allows you to specify scaled coordinates, rings the bell, displays the cross hairs, and waits for the operator to position the cross hairs and key any character.
- The SCREEN instruction converts x and y numbers representing a point on the screen of a terminal to the 4-character text string that will be interpreted by the terminal as the graphic address of the point.
- The XYPLOT instruction is used to draw a curve on the display connecting points specified by arrays of x and y values.
- The YTPLOT instruction draws a curve on the display connecting points equally spaced horizontally and having heights specified by an array of y values. Data values are scaled to screen addresses according to the plot control block, and points outside the range are placed on the boundary of the plot area.

The Plot Control Block

The plot control block is required by the PLOTGIN, XYPLOT, and YTPLOT instructions.

The plot control block is 8 words of data defined by DATA statements which provide definition of size and position of the plot area on the screen and the data values associated with the edges of the plot area. Indirectly, the scale of the plot is specified. The format of a plot control block is:

```
label   DATA    F'xls'
        DATA    F'xrs'
        DATA    F'xlv'
        DATA    F'xrv'
        DATA    F'ybs'
        DATA    F'yts'
        DATA    F'ybv'
        DATA    F'ytv'
```

All 8 explicit values (no addresses) are required and have the following meaning:

xls x screen location at left edge of plot area

xrs x screen location at right edge of plot area

xlv x data value plotted at left edge of plot

xrv x data value plotted at right edge of plot

ybs y screen location at bottom edge of plot

yts y screen location at top edge of plot

ybv y data value plotted at bottom edge of plot

ytv y data value plotted at top edge of plot.

Example

In the following example, the graphic control characters (GS, US, ESC, an so on) are assumed to have certain meanings for the terminal. A different terminal may require the use of different control characters to perform a similar function.

The example shows the use of the graphics instructions described on the preceding pages. This program:

- Prints a message
- Plots a curve with axes
- Puts the cross hairs on the screen
- Waits for the user to position the cross hairs press a key and carriage return
- Displays the character entered and x,y coordinates of the cross-hair position.

You can then end the program or start it again.

```
    GTEST     PROGRAM     START
    START     EQU         *
1             PRINTEXT 'GRAPHICS TEST PROGRAM PRESS ENTER @'
              READTEXT    TEXT1
2             CONCAT   TEXT1,ESC,RESET
3             CONCAT   TEXT1,FF
4             PRINTEXT TEXT1,XLATE=NO
5             STIMER   1000,WAIT
6             CONCAT   TEXT1,GS,RESET
7             SCREEN   TEXT1,520,300,CONCAT=YES
8             CONCAT   TEXT1,US
9             PRINTEXT TEXT1,XLATE=NO
              PRINTEXT    TEXT3
10            YTPLOT   YDATA,X1,PCB,NPTS,1
11            XYPLOT   YAXISX,YAXISY,PCB,TWO
              XYPLOT      XAXISX,XAXISY,PCB,TWO
12            PLOTGIN  X,Y,CHAR,PCB
13            PRINTEXT TEXT4
              PRINTEXT CHAR,XLATE=NO
              PRINTEXT    TEXT5
              PRINTNUM    X,2
14            QUESTION TEXT6,NO=START
              PROGSTOP
    TEXT1     TEXT        LENGTH=30
    TEXT3     TEXT        'X-AXIS LABEL'
    TEXT4     TEXT        '@CHARACTER STRUCK WAS '
    TEXT5     TEXT        '@X,Y COORDINATES ='
    TEXT6     TEXT        '@END PROG (Y/N)? '
              DATA        X'0201'
    CHAR      DATA        F'0'
    YDATA     DATA        F'0'
              DATA        F'1'
              DATA        F'0'
              DATA        F'2'
              DATA        F'0'
              DATA        F'1'
              DATA        F'-2'
              DATA        F'-1'
```

```
X1        DATA      F'0'
NPTS      DATA      F'8'
YAXISX    DATA      2F'0'
YAXISY    DATA      F'-5'
          DATA      F'5'
XAXISX    DATA      F'0'
          DATA      F'10'
XAXISY    DATA      2F'0'
TWO       DATA      F'2'
PCB       DATA      F'500'
          DATA      F'1000'
          DATA      F'0'
          DATA      F'10'
          DATA      F'100'
          DATA      F'600'
          DATA      F'-5'
          DATA      F'5'
X         DATA      F'0'
Y         DATA      F'0'
          ENDPROG
          END
```

1 Print the message "GRAPHICS TEST PROGRAM PRESS ENTER."

2 Reset the text string character count and put the ESC code into TEXT1.

3 Put the FF character into TEXT1.

4 Erase the screen and send the alpha cursor to the home position (upper left corner).

5 Delay for a second to allow the erase sequence to complete.

6 Reset the text string again and insert the graph mode character (GS) to the text string.

7 Form the 4 characters required to draw a dark vector to the screen address (520,300). The 4 characters represent the Hi Y, Lo Y, Hi X, and Lo X values.

8 Write an axis label at this position by returning to alpha mode (US).

9 Perform the full operation. Prevent conversion of data (XLATE=NO), as it is already in ASCII.

10 Plot the data, YDATA (8 points). The plot area and coordinates are given by the 8 words at the label PCB. The plot area in screen addresses is 500 to 1000 in the x-direction (horizontal) and 100 to 600 in the y-direction (vertical). The corresponding plot area in the user's coordinates is 0 to 10 in the x-direction and -5 to 5 in the y-direction.

11 Draw the X and Y axes with this and the next instruction. Each of these is simply a 2-point plot, from the origin to the end point.

12 Put the cross-hair cursor on the screen. The operator should position the cursor and enter a character. When the program receives the character, it converts the cursor position to the plot coordinates as specified at PCB, and stores the results at X and Y.

13 Print the results.

14 Ask if the operator wishes to end the program.

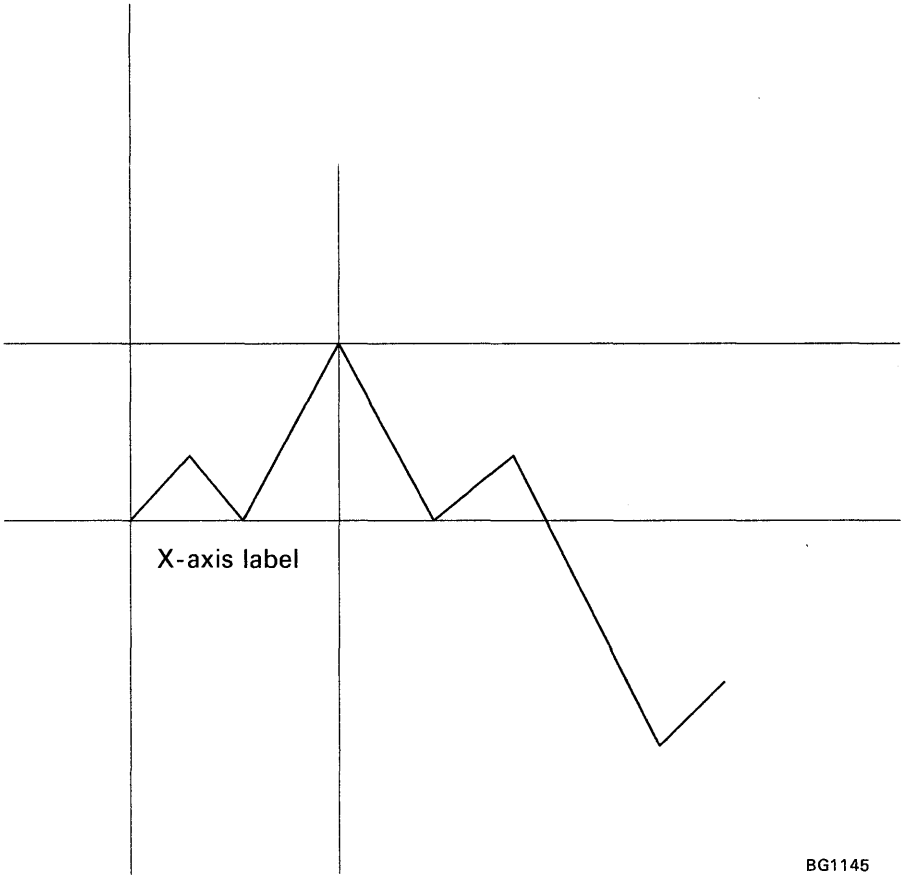

Figure 15-1. Graphics Program Output. This figure shows the result of the preceding program.

Chapter 16. Controlling Spooling from a Program

What Is Spooling?

Spooling is the process of writing to disk or diskette an output listing that you eventually want to print or display.

You might use spooling for any of the following reasons:

- Your program writes more than one output listing to the same printer.
- You want a program to finish processing more quickly. (Most programs can generate output faster than the printer can print it.)
- You want to delay printing an output listing until some time after a program has executed.
- You want more than one copy of an output listing.
- Two or more programs write output listings to the same printer at the same time.

Spooling the Output of a Program

An application program can control the printing and handling of its spooled output with a spool-control record.

The Spool-Control Record

The spool-control record consists of a special print record. It must be the first item printed by the program after you enqueue the device.

The spool-control record allows the application program to specify:

- Whether or not the spool job should be held and not printed
- Whether or not the spool job should be kept after printing
- The type of forms to be used to print the output
- The number of copies to be printed
- The separator page heading to be printed
- Whether forms alignment should be done.

The spool-control record applies only to the spool job that follows it. Therefore, if a program creates more than one spool job, and is to control the printing and handling of each spool job, each spool job must have its own spool-control record.

Note: The $S ALT operator command overrides the spool-control record.

The format of the spool-control record is as follows:

Position	Contents
1 – 8	***SPOOL
9	blank
10 – 12	Number of copies to print (1-127)
13	blank
14	Whether spool job should be held (Y = yes, N = no)
15	blank
16	Whether spool job should be kept (Y = yes, N = no)
17	blank
18 – 21	Forms type
22	blank
23 – 30	Report identification
31	blank
32	Forms alignment (Y = yes, N = no)

If you use the spool-control record, specify the fields exactly as shown. The fields with a Y/N option default to N. If you enter a character other than a Y or N, the system uses the default.

Note: Do not generate the spool-control record in an application program unless spooling has been activated. If spooling is not active, the line is printed as ordinary text to the printer (see "Determining Whether Spooling Is Active" on page 16-7 for a description of how an application program can determine if the spooling facility is active).

Example

The following program uses the spool-control record to create 10 copies with report identification SPOOLPRG, to hold and keep the output in effect, specify forms type ABCD, and specify no forms alignment. The report printed consists of two messages.

```
SPOOL  PROGRAM  START
PRTR   IOCB     MPRTR
START  EQU      *
1      ENQT     PRTR
2      PRINTEXT '***SPOOL 010 Y Y ABCD SPOOLPRG N'
3      PRINTEXT '@MESSAGE 1'
       PRINTEXT '@MESSAGE 2'
       DEQT
       PROGSTOP
       ENDPROG
       END
```

1 Obtain exclusive use of the system printer.

2 Create a spool-control record. Specify the number of copies as 10 (010), that you want to hold and keep the output (Y Y), that the type of forms is ABCD, that the report identification is SPOOLPRG, and that you do not require forms alignment (N).

3 Create a line of output.

Executing the Example

To execute the example, you must do the following:

1. Make sure that your system includes the spooling facility. To use the spooling facility, you must include IOSPOOL at system generation time. (For information on how to include IOSPOOL in your supervisor, refer to the *Installation and System Generation Guide*.)

2. Find out whether the device you want to use is a spool device. Use the $TERMUT1 utility as follows:

```
> $L $TERMUT1
```

The system responds:

```
LOADING $TERMUT1    nnP, hh:mm:ss, LP= xxxx, PART= yy

*** TERMINAL CONFIGURATOR ***

COMMAND (?):
```

Respond with the CT (Configure Terminal) command:

```
COMMAND (?): CT
```

The system prompts for the terminal name. Respond with the terminal name as follows:

```
ENTER TERMINAL NAME: MPRTR
```

The system then displays, one at a time, the parameters that define how the terminal operates. Since we are changing only the parameters, concerning whether or not the terminal is a "spoolable device," simply press enter until the system displays the SPOOLABLE prompt:

```
PAGE SIZE          (NOW IS     24):
                                 VALUE NOT CHANGED
                    .
                    .
                    .
OUTPUT PAUSE             (NOW IS N):
                                 VALUE NOT CHANGED
SPOOLABLE (Y/N)          (NOW IS N):
```

If the system displays "NOW IS N," the terminal is not a spoolable device. Change the parameter to **Y**.

```
SPOOLABLE (Y/N)       (NOW IS N): Y
```

Continue pressing enter until the COMMAND prompt appears. Then end the utility:

```
COMMAND (?): EN
```

3 Tell the spool facility that a device is a spool device. Use the $SPLUT1 utility as follows:

```
> $L $SPLUT1
```

The system responds:

```
LOADING $SPLUT1    nnP, hh:mm:ss, LP= xxxx, PART= yy

*****************************************************
**                EDX SPOOL UTILITY                **
** CHANGES EFFECTIVE THE NEXT TIME $SPOOL IS LOADED **
*****************************************************

DSNAME---VOLUME-MAXJOBS-MAXACTV-RESTRT-GRPS-GRPSZ-SEP--DEVICES-AUTO-FORM

SPOOL    EDX003    10       4      Y    10   100   Y   $SYSPRTR  Y

COMMAND (?):
```

If the restart option is Y, change it to N. Enter the RS command:

```
COMMAND (?): RS
```

The system responds:

```
RESTART Y/N?
```

Enter **N** and press enter.

The system responds:

```
DSNAME---VOLUME-MAXJOBS-MAXACTV-RESTRT-GRPS-GRPSZ-SEP--DEVICES-AUTO-FORM
SPOOL    EDX003    10       4       N    10    100    Y    $SYSPRTR  Y
COMMAND (?):
```

Respond with the CD (Change Spool Devices) command:

```
COMMAND (?): CD
```

The system prompts for the terminal name. Respond with the terminal name as follows:

```
DEVICE NAME (ENTER BLANK TO END): MPRTR
```

The system then asks whether you want the spool job (the output of a program that generates spool output) to print as soon as the program completes. It also asks for the form number you want to use and whether you want to change another spool device.

In this example, we are responding that we do not want the spool job to begin printing as soon as the program completes, that the forms code is ABCD, and that we do not want to change another spool device.

```
WRITER AUTOSTART ? (Y/N): N
ENTER FORMS CODE: ABCD
DEVICE NAME (ENTER BLANK TO END):
```

Then end the utility:

```
COMMAND (?): EN
```

4 Load the spooling facility as follows:

```
> $L $SPOOL
```

Note: Do not use the session manager to start the spool facility.

If the spooling facility was not included at system generation time, the system responds with return code 8.

Otherwise, the system responds:

```
LOADING $SPOOL      nnP, hh:mm:ss, LP= xxxx, PART= yy

SPOOL INITIALIZATION COMPLETE
```

5 Start the program that generates the output that is to be spooled (in this case, program AP16A on volume EDX40).

```
> $L AP16A,EDX40
```

The system executes the program and places the output on the spool data set.

Printing Output That Has Been Spooled

To print output that has been spooled, use the $S operator command as follows:

```
> $S WSTR
```

The system prompts you for the writer name. Respond with the name of the device on which you want the spool job displayed or printed:

```
WRITER NAME: MPRTR
```

The system then prompts for the forms code. Respond with the one- to four-character forms code (in our example, ABCD):

```
FORMS: ABCD
```

The system responds:

```
WRITER STARTED
```

and begins to print or display the spool job.

Stopping Spooling

To stop spooling, use the $S operator command as follows:

```
> $S STOP
```

Determining Whether Spooling Is Active

An EDL application might be such that it should not be run unless spooling has been activated (or deactivated). Such an application can determine if spooling is active and use that information to instruct the operator to activate or deactivate spooling. An application program can also decide whether or not to print a spool-control record, depending on whether or not spooling is activated.

The following EDL coding example shows how an application program can determine if the spooling facility has been activated:

```
1       MOVE  #2,$CVTSPL,FKEY=0
2       IF    #2,NE,0
3         MOVE  #2,(+$IOSPSPM,#2),FKEY=0
        ENDIF
4       IF    #2,NE,0
         •
         •
         •
        ENDIF
         •
         •
         •
5       COPY  PROGEQU
6       COPY  $IOSPTBL
```

1 Move the address of the spool control table to register 2.

2 Test whether module IOSPOOL was included at system generation time.

3 If so, move the address of SPM to register 2.

4 Test whether spooling has been activated.

5 Copy the program equates to the program.

6 Copy the spool table equates to the program.

High-level language programs can call this type of EDL subroutine to determine if spooling is active.

Preventing Spooling

You can prevent a program from spooling its output by coding a parameter on the ENQT command. The parameter is coded as follows:

```
ENQT  SPOOL=NO
```

This instruction causes the printer to be enqueued directly, when available, and prevents output spooling. The system ignores the SPOOL= parameter on an ENQT instruction if the device is not designated as a spool device or if spooling is not active.

The default is ENQT SPOOL=YES. This allows output spooling.

Note: ENQT SPOOL=NO without the BUSY= operand coded causes the program to wait if a spool writer is started to the device, even if the writer is temporarily stopped. The writer must be terminated to free the device. Refer to the *Language Reference* for additional information.

Separating Program Output into Several Spool Jobs

When spooled output is directed to one printer, spooling treats the spooled output from each task within a main program as a separate spool job. If there is a spool job open which belongs to the main task, and an overlay program generates spooled output, the system attaches this output to the main task's spool job. The system opens a spool job for an overlay program when a spool job for the main task does not exist.

You can produce more than one spool job within a **single** task. To do so, code the DEQT instruction as follows after you create each spool job.

```
DEQT  CLOSE=YES
```

Each time you issue this instruction, the spool job just created becomes ready for printing. A subsequent ENQT to the same printer indicates the start of a new spool job.

The CLOSE= operand is ignored if coded on a DEQT to a device not designated as a spool device or if spooling is not active.

Note: DEQT CLOSE=NO is the default. It causes any later output of the program directed to the same printer to be attached to the output already spooled.

Programming Considerations

After printing each spool job, the spool writer restores the default values established for the printer at system generation. Coding the PDEN, PMODE, LPI, and CHARSET operands on the TERMCTRL instruction does not change these defaults. You can spool a job using values for PDEN, PMODE, LPI, or CHARSET that differ from the default values by:

- Changing the values for the PDEN, PMODE, LPI, or CHARSET operands on a TERMCTRL SET instruction inside the program being spooled
- Using $TERMUT1 to change the values for the PDEN, PMODE, LPI, or CHARSET operands before the spool writer is started.

If you want to spool a job changing only the value for the LPI operand, you can run a program that changes this value on the TERMCTRL SET instruction before $SPOOL is loaded.

Chapter 17. Creating, Storing, and Retrieving Program Messages

When designing EDL programs, you can save storage space or coding time by placing prompt messages and other message text in a separate message data set. EDL instructions enable your program to retrieve the appropriate message text when the program executes.

By storing messages in a data set, you can change the text of a message without having to alter and recompile each program that uses that message.

You can store program messages in two ways. You can store them on disk or diskette. You can also store them as a module that you can link edit with a program.

Creating and using your own program messages involves the following steps:

1. Creating a data set for your source messages
2. Entering your source messages
3. Formatting and storing your source messages using the message utility, $MSGUT1
4. Retrieving program messages using the COMP statement and the MESSAGE, GETVALUE, QUESTION or READTEXT instructions.

The following sections describe how to create, store, and retrieve program messages.

Creating a Data Set for Source Messages

You create a data set for source messages with the text editor described in Chapter 3, "Entering a Source Program." You can create one or more source message data sets and can store them on any volume. Messages can be simple statements or questions, or they can include variable fields which are filled with parameters supplied by your program.

To enter your source messages, observe the following rules:

- Begin each message in column 1.
- Precede each variable field with two *less than* symbols (< <) and follow each variable field with two *greater than* symbols (> >).
- End each message with the characters: /*
- Begin and end comments with double slashes (//comment//). A comment must be associated with a message.
- Use the *at sign* (@) to cause the message to skip to the next line.
- Code source messages a maximum length of 253 bytes long. You can calculate the length of a message by adding one byte for each character in the text and one byte for each variable field.
- Continue a message on a new line by coding any nonblank character in column 72. Begin the continued line in the first column.

The system identifies each message by its position in the source message data set. For example, the system assigns a message number of 3 to the third message in the source message data set. Once you format your source messages with the $MSGUT1 utility, you should add any new messages you have to the end of the source message data set. If you no longer need a certain message, you should leave it in the source message data set or replace it with a new message to preserve the numbering scheme.

Coding Messages with Variable Fields

To construct a message that can return information supplied or generated by your program, you can code a message with one or more variable fields. When you execute your program, the system inserts the appropriate parameters in these variable fields and prints a complete message. For example, if you want to construct a message that tells a program operator how many records are in a particular data set on a particular volume, you could code the following:

```
THERE ARE <<SIZE>S> RECORDS IN <<DATA SET NAME>T> ON <<VOLUME>T>./*
```

The variable fields in the previous example are the number of records in the data set (SIZE), the data set name, and the volume name. The variable field names do *not* need to correspond with names in a program.

Note: To print or display a message with variable fields, you must have included the FULLMSG module in your system during system generation.

The variable fields are set off from the message text with two *less than* and two *greater than* symbols (< < > >). The symbols should enclose a description of the field. The system treats the field description as a comment. You can include up to eight variable fields within a single message.

As shown in the previous example, all variable fields must also contain a **control character** that describes the type of parameter your program will pass to the variable field. *S* is the control character in the field << SIZE > S >; *T* is the control character in the field << VOLUME > T >. The following is a list of valid control characters and their descriptions:

C Character data. Specify a length for the data by coding a value from 1 to 253 before the "C" (for example, << NAME > 8C >). There is no default.

T Text. No length is necessary. (The system derives the length from the TEXT statement.)

H Hexadecimal data. The length is four EBCDIC characters.

S Single-word integer. Specify a length for the data by coding a value from 1 to 6 before the "S". The default is six EBCDIC characters. The valid range for a single-word integer value is from −32768 to 32767.

D Double-word integer. Specify a length for the data by coding a value from 1 to 11 before the "D." The default is six EBCDIC characters. The valid range for a double-word integer value is from −2147483648 to 2147483647.

Your program passes parameters to a message in the order you specified the parameters in the instruction. The following example shows a message instruction with the parameter list operand (PARMS=):

```
MSG       PROGRAM   START,DS=((MSGSET,EDX003))
                      •
                      •
                      •
          MESSAGE   2,COMP=ID,PARMS=(DSNAME,VOLUME,SIZE)
                      •
                      •
                      •
ID        COMP      'SRCE',DS1,TYPE=DSK
SIZE      DC        F'100'
DSNAME    TEXT      'DATA SET 1'
VOLUME    TEXT      'EDX002'
```

The instruction will retrieve message number 2. The source message for message number 2 appears as follows:

```
<<DATA SET NAME>T> ON <<VOLUME>T> IS ONLY <<SIZE>S> RECORDS./*
```

The system places the first parameter (DSNAME) in the first variable field, the second parameter (VOLUME) in the second field, and the third parameter (SIZE) in the third field.

You may, however, want to alter or reword the message in the previous example. To change the order of the variable fields in your source message without changing the order of the parameter list in your program, you can code an additional number after the control character. This number, from 1 to 8, points to the parameter that the system should insert into the variable field. The number corresponds to the position of the parameter in the parameter list. For example, <<NAME>C3> tells the system to retrieve the third parameter in a parameter list.

In the following example, the order of the variable fields in message number 2 has been switched, but a number following the control character points to the correct parameter for the variable field:

```
THERE ARE ONLY <<SIZE>S3> RECORDS IN <<DATA SET NAME>T1> ON   C
<<VOLUME>T2>./*
```

"S3" points to the third parameter in the list (SIZE), "T1" points to the first parameter in the list (DSNAME), and "T2" points to the second parameter in the list (VOLUME).

Sample Source Message Data Set

The following is sample of a source message data set. The data set is named SOURCE on volume EDX40.

```
//THIS IS A COMMENT                                                    //+
DO YOU WANT TO ENTER A NUMBER? /*
ENTER <<TYPE OF VALUE>T> VALUE LESS THAN <<VALUE>S>./*
THE PROGRAM HAS PROCESSED THE INPUT DATA./*
ENTER YOUR <<FIRST/LAST/FULL NAME>10C>./*
//THIS IS ANOTHER COMMENT.  //                                          +
ALL INPUT DATA HAS BEEN RECEIVED./*
THE VALUE YOU ENTERED IS: <<VALUE>S1> /*
THE DATA YOU ENTERED IS: <<DATA>T> /*
THE DEVICE <<ID>H1> AT ADDRESS <<DEVICE ADDRESS>H2> IS IN USE./*
THIS MESSAGE WILL BE CONTINUED @ ON THE NEXT LINE./*
```

Formatting and Storing Source Messages (using $MSGUT1)

Once you have created a source message data set, you must use the message utility, $MSGUT1, to convert the source messages into a form the system can use. The utility copies the source messages, formats them, and stores the formatted messages in another data set or module that you specify. (Refer to the *Operator Commands and Utilities Reference* for a detailed explanation of how to use the message utility.)

Each time you add new messages to the source message data set, you must reformat the data set with $MSGUT1.

The $MSGUT1 utility allows you to:

- Format a source message data set and store the formatted messages on disk or diskette.
- Format a source message data set as a module that you link edit with a program. Use this option for systems without disk or diskette storage or to improve performance.
- Obtain a hard-copy listing of the messages contained in a specific source message data set.

Before you load the $MSGUT1 utility, you must allocate a work file. You can use the AL command of the $DISKUT1 utility to allocate the work file. Allocate a data-type data set large enough to hold the source message data set (one record for every source message).

When you load $MSGUT1, the utility prompts you for the name and volume of the work file as follows:

```
WORKFILE (NAME,VOLUME):
```

Respond with the data set name and volume that you allocated with the $DISKUT1 utility.

Example 1

In the following example, $MSGUT1 formats the source message data SOURCE shown in the previous section. The example uses the DSK option and stores the formatted messages in the data set MESSAGE on volume EDX40.

```
COMMAND (?): DSK
MESSAGE SOURCE DATA SET (NAME,VOLUME): SOURCE,EDX40
DISK RESIDENT DATA SET (NAME,VOLUME): MESSAGE,EDX40
START OF DISK MESSAGE PROCESSING BEGINS
```

When the utility finishes formatting and storing the messages, it returns the following message:

```
DISK RESIDENT MESSAGES STORED IN MESSAGE,EDX40
```

Example 2

The following example uses the STG option and stores the module in data set MSG on volume EDX003.

```
COMMAND (?): STG
MESSAGE SOURCE DATA SET (NAME,VOLUME): MSGSRC,EDX003
STORAGE RESIDENT MODULE (NAME,VOLUME): MSG,EDX003
START OF STORAGE MESSAGE PROCESSING
```

When the utility finishes formatting and storing the messages, it returns the following message:

```
STORAGE RESIDENT MODULE STORED IN MSG,EDX003
```

If the $MSGUT1 utility encounters errors, it prints an error message on the system printer.

Retrieving Messages

To retrieve a message from storage and include it in your program, you must code a COMP statement and any one of the following instructions: MESSAGE, GETVALUE, QUESTION, and READTEXT. (Refer to the *Language Reference* for a full description of these instructions and how to code them to retrieve messages.)

The system retrieves program messages from the data set or module that you created with $MSGUT1. If you stored your formatted messages on disk or diskette, you must code the name of the data set that contains the messages and the volume it resides on in the PROGRAM statement for your program.

If you formatted the messages as a module, you must link edit your program with the module.

Defining the Location of a Message Data Set

The COMP statement defines the location of a message data set or the name you assigned the module when you used the STG option of the $MSGUT1 utility. To retrieve a message, the MESSAGE, GETVALUE, QUESTION, and READTEXT instructions must refer to the label of a COMP statement. More than one instruction can refer to the same COMP statement. You must code a separate statement, however, for each message data set your program uses.

If your messages are in a module, you must code the name of the module. If your message data resides on disk or diskette, you must indicate the data set in the PROGRAM statement. You indicate the correct data set by specifying its position in the data set list.

In addition to coding the location of the message data set, you must also code a 4-character prefix. The system prints this prefix and the number of the message you retrieved if you specify (MSGID=YES) on the MESSAGE, GETVALUE, QUESTION, or READTEXT instructions.

The following example shows a COMP statement that refers to the second data set on the PROGRAM statement. DS2 points to data set MESSAGE on volume EDX40.

```
MESSAGE    PROGRAM    START,DS=(DATA,(MESSAGE,EDX40))
                        •
                        •
                        •
           PROGSTOP
DISKMSG    COMP       'ERRS',DS2,TYPE=DSK
```

The following example shows a COMP statement that refers to a module that contains messages.

```
MESSAGE    PROGRAM    START
                        •
                        •
                        •
           PROGSTOP
STGMSG     COMP       'ERRS',MSG,TYPE=STG
```

The MESSAGE instruction

The MESSAGE instruction retrieves a message from a data set on disk, diskette, or from a module. Then the instruction prints or displays the message. You must code the number of the message you want displayed or printed and the label of the COMP statement that gives the location of the message (COMP=).

You can pass parameters to variable fields in a message by coding the parameters on the PARMS= operand of the instruction. If you code MSGID=YES, the system prints or displays the number of the message and the 4-character prefix you coded on the COMP statement in front of the message text.

In the following example, the MESSAGE instruction retrieves the third message in a message data set and passes the parameter PART# to the message. The COMP statement defines the message data set as the first data set in the PROGRAM statement list.

```
STOCK     PROGRAM   START,DS=(PARTS,DATA)
          MESSAGE   3,COMP=PARTS,PARMS=PART#,MSGID=YES
            •
            •
            •
          PROGSTOP
PARTS     COMP      'PART',DS1,TYPE=DSK
PART#     DC        F'56'
```

In the following example, the MESSAGE instruction retrieves the second message in a module that has been link edited with the program and passes the message the parameter PART#. The COMP statement defines the message data set as module MSG.

```
STOCK     PROGRAM   START
          MESSAGE   2,COMP=PARTS,PARMS=PART#,MSGID=YES
            •
            •
            •
          PROGSTOP
PARTS     COMP      'PART',MSG,TYPE=STG
PART#     DC        F'43'
```

The GETVALUE, QUESTION, and READTEXT Instructions

Instead of coding prompt messages on the GETVALUE, QUESTION, and READTEXT instructions, you can retrieve prompt messages from a message data set or module. You code the number of the message you want to retrieve for the second operand of the GETVALUE and READTEXT instructions and the first operand of the QUESTION instruction. In addition, you must code the label of the COMP statement that gives the location of the message (COMP=).

You can pass parameters to variable fields in a message by coding the parameters on the PARMS= operand of the instruction. By coding MSGID=YES, the system prints or displays the number of the message and the 4-character name you coded on the COMP statement at the front of the message text.

In the following example, the GETVALUE instruction retrieves the fifth message from a module, called MSGTEXT, that has been link edited with your program. The instruction also passes the message the parameters VALUE and SIZE to the message.

```
          GETVALUE   INPUT,5,COMP=PROMPT,PARMS=(VALUE,SIZE)
             •
             •
             •
          PROGSTOP
PROMPT    COMP       'TASK',MSGTEXT,TYPE=STG
VALUE     TEXT       'AN INTEGER'
SIZE      DC         F'75'
```

In the following example, the GETVALUE instruction retrieves the ninth message from a data set on disk or diskette. The instruction passes the message the parameters VALUE and SIZE.

```
BEGIN     PROGRAM    START,DS=MSGS
             •
             •
             •
          GETVALUE   INPUT,9,COMP=PROMPT,PARMS=(VALUE,SIZE)
             •
             •
             •
          PROGSTOP
PROMPT    COMP       'TASK',DS1,TYPE=DSK
VALUE     TEXT       'AN INTEGER'
SIZE      DC         F'75'
```

Sample Program

The following sample program retrieves five program messages from a disk data set formatted in the previous section. (See "Example 1" on page 17-5.) The name of the data set is MESSAGE and it resides on EDX40.

```
1   MESSAGE   PROGRAM   START,DS=((MESSAGE,EDX40))
2   START     QUESTION  1,NO=NAME,SKIP=1,COMP=DISKMSG
3             GETVALUE  A,2,SKIP=1,COMP=DISKMSG,PARMS=(P1,P2)
              PRINTEXT  '@THE NUMBER IS: '
4             PRINTNUM  A,SKIP=1
5   NAME      READTEXT  B,+MSG4,SKIP=1,COMP=DISKMSG,PARMS=TXT
              PRINTEXT  '@THE DATA ENTERED IS: '
6             PRINTEXT  B,SKIP=1
7             MESSAGE   +MSG6,COMP=DISKMSG,SKIP=2,PARMS=A,          C
                  MSGID=YES
8             MESSAGE   +MSG7,COMP=DISKMSG,SKIP=2,PARMS=B,          C
                  MSGID=YES
              MESSAGE  +MSG9,COMP=DISKMSG,SKIP=2,PARMS=B,           C
                  MSGID=YES
               PROGSTOP
9   MSG4      EQU       4
    MSG6      EQU       6
    MSG7      EQU       7
    MSG9      EQU       9
10  DISKMSG   COMP      'SRCE',DS1,TYPE=DSK
11  A         DATA      F'0'
    B         TEXT      LENGTH=40
    P1        TEXT      'AN INTEGER'
    P2        DATA      F'10'
    TXT       DATA      CL10'LAST NAME '
               ENDPROG
               END
```

1 Begin the program and identify the data set name and volume of the message data set (MESSAGE on volume EDX40).

2 Display the prompt message **DO YOU WANT TO ENTER A NUMBER?** The first operand (1) identifies the message as the first message in the data set MESSAGE. The COMP= operand refers to a COMP statement labeled DISKMSG. If the operator enters *Y*, the next sequential instruction, the GETVALUE instruction, executes. If the operator enters *N*, control passes to the label NAME.

3 Use the second message in the message data set as a prompt message. The instruction retrieves the prompt message and inserts parameters P1 and P2 into the message. The operator receives the prompt message **ENTER AN INTEGER VALUE LESS THAN 10**.

4 Print the number the operator enters.

5 Retrieve the fourth message (because MSG1 is equated to 4) from the message data set and inserts parameter TXT into the message. The operator receives the prompt message **ENTER YOUR LAST NAME**.

6 Print the name the operator enters.

7 Print or display the sixth message (because MSG6 is equated to 6) from the message data set. The COMP= operand refers to the COMP statement labelled DISKMSG. The instruction uses the integer value the operator entered as the parameter for the message. If the operator entered a 6, for example, the system would print or display:**THE VALUE YOU ENTERED IS 6.**

8 Print or display the seventh message (because MSG7 is equated to 7) from the message data set. The COMP= operand refers to the COMP statement labelled DISKMSG. The instruction uses the last name the operator entered as the parameter for the message. If the operator entered the name FRENCH, for example, the system would print or display: **SRCE0007 THE DATA YOU ENTERED IS FRENCH.**

9 Equate MSG4 to the fourth message in the message data set.

10 Define the message data set as the first data set on the PROGRAM statement. Identify the data set as a disk- or diskette-resident data set (TYPE=DSK). **SRCE** is the prefix that would appear if you coded MSGID=YES on a QUESTION, PRINTEXT, GETVALUE, or READTEXT instruction.

11 Define a parameter (used by the first MESSAGE instruction).

The program uses the following source message data set:

```
//THIS IS A COMMENT                                                    //+
DO YOU WANT TO ENTER A NUMBER? /*
ENTER <<TYPE OF VALUE>T> VALUE LESS THAN <<VALUE>S>./*
THE PROGRAM HAS PROCESSED THE INPUT DATA./*
ENTER YOUR <<FIRST/LAST/FULL NAME>10C>./*
//THIS IS ANOTHER COMMENT.  //                                          +
ALL INPUT DATA HAS BEEN RECEIVED./*
THE VALUE YOU ENTERED IS: <<VALUE>S1> /*
THE DATA YOU ENTERED IS: <<DATA>T> /*
THE DEVICE <<ID>H1> AT ADDRESS <<DEVICE ADDRESS>H2> IS IN USE./*
THIS MESSAGE WILL BE CONTINUED @ ON THE NEXT LINE./*
```

The program might produce output like the following:

```
DO YOU WANT TO ENTER A NUMBER? Y

ENTER AN INTEGER VALUE LESS THAN      10: 4

THE NUMBER IS:      4
ENTER YOUR LAST NAME : OLIVER

THE DATA ENTERED IS: OLIVER

SRCE0006 THE VALUE YOU ENTERED IS: 4

SRCE0007 THE DATA YOU ENTERED IS: OLIVER

SRCE0009 THIS MESSAGE WILL BE CONTINUED
 ON THE NEXT LINE.
```

Chapter 18. Queue Processing

You can use the queue processing instructions of EDL to store and retrieve large amounts of data. You can retrieve data from a queue on either a first-in-first-out or last-in-first-out basis.

Defining a Queue

To define a queue, use the DEFINEQ statement. The following DEFINEQ statement defines a queue with ten queue elements. A *queue element* is either an address or data that you want to store.

```
MSGQ   DEFINEQ  COUNT=10
```

The queue called MSGQ can contain ten 1-word addresses or 1-word data items.

If you want to store data items that are longer than one word, code the SIZE operand as follows:

```
QUEUE  DEFINEQ  COUNT=15,SIZE=30
```

The queue called QUEUE can contain 15 30-byte queue elements.

Putting Data into a Queue

To put data into a queue, use the NEXTQ instructions as follows:

```
       NEXTQ   MSGQ,ADDR
        •
        •
        •
ADDR   DATA    F'0'
```

The instruction puts ADDR into the queue called MSGQ. ADDR can contain either one word of data or an address.

To put more than one word of data into a queue, use the FIRSTQ instructions to find the address of the first storage area into which data can be moved.

```
       FIRSTQ  QUEUE,#1
        •
        •
        •
QUEUE  DEFINEQ COUNT=15,SIZE=20
```

The instruction puts into register 1 the address of the first storage area into which you can move twenty bytes of data.

You could use the following instructions to prompt the operator for data and store the response in QUEUE:

```
       READTEXT  ELEMENT,'ENTER YOUR NAME: '
       MOVE      (0,#1),ELEMENT,(20,BYTE)
```

The READTEXT instruction prompts the operator and places the response in ELEMENT. The MOVE instruction moves the response to the address retrieved by the FIRSTQ instruction.

Retrieving Data from a Queue

To retrieve data from a queue, use either the FIRSTQ or LASTQ instruction.

Use the FIRSTQ instruction to retrieve the oldest entry from a queue. The following example

```
        FIRSTQ  QUEUE,#2
```

puts into register 2 the address of the oldest element in the queue called QUEUE.

Use the LASTQ instruction to retrieve the newest entry from a queue. The following example

```
        LASTQ  QUEUE,ADDR
```

puts into ADDR the address of the oldest element in the queue called QUEUE.

To transfer control if the queue becomes empty, code the EMPTY operand as follows:

```
        FIRSTQ QUEUE,ADDR,EMPTY=MT
         •
         •
         •
MT      EQU    *
         •
         •
         •
ADDR    DATA   F
```

The instruction retrieves an element from the queue called QUEUE, puts the address of the element in ADDR, and causes a branch to MT if no more elements exist in the queue.

Example

The following example prompts the operator for 20 characters of data, stores the data in one queue, moves the addresses of the elements to another queue, and prints the elements on a first-in-first-out (FIFO) basis.

```
    QTEST   PROGRAM  START
    START   EQU      *
            DO       10,TIMES
1           FIRSTQ   QUEUE1,#1
2           READTEXT MSG,'ENTER UP TO 20 CHARACTERS: '
3           MOVE     (0,#1),MSG,(20,BYTE)
4           NEXTQ    QUEUE2,#1,FULL=FULLQ
            ENDDO
            GOTO       PRINT
    FULLQ   EQU        *
            PRINTEXT   '@QUEUE2 FULL.'
    PRINT   EQU        *
            DO         10,TIMES
5           FIRSTQ     QUEUE1,#1,EMPTY=DONE
6           MOVE       MSG,(0,#1),(20,BYTE)
7           PRINTEXT   MSG,SKIP=1
8           NEXTQ      QUEUE1,#1
            ENDDO
    DONE    PROGSTOP
9   QUEUE1  DEFINEQ    COUNT=10,SIZE=20
10  QUEUE2  DEFINEQ    COUNT=10
    MSG     TEXT       LENGTH=20
            ENDPROG
            END
```

1 Put the address of the oldest element into register 1.

2 Prompt the operator for twenty characters of data. Put the prompt in MSG.

3 Move the operator's response into QUEUE1, to the address retrieved by the FIRSTQ instruction.

4 Store in QUEUE2 the address where the response was stored in QUEUE1.

5 Retrieve the oldest element from QUEUE1 and put the address of the data into register 1.

6 Move twenty bytes from the address pointed to by register 1 to MSG.

7 Print the data, skipping a line between each data item (SKIP = 1).

8 Put back into QUEUE1 the element retrieved by the FIRSTQ instruction.

9 Define a queue large enough to accommodate ten 20-character data items.

10 Define a queue large enough to accommodate ten 1-word data items or addresses.

Chapter 19. Writing Reentrant Code

Reentrant code is a group of instructions that can be executed simultaneously by more than one task in the same partition. Only one copy of the program that contains the reentrant instructions exists in storage at a given time.

This chapter describes how to write reentrant EDL programs and subroutines and describes the following:

- When to use reentrant code
- Coding guidelines
- Examples.

When to Use Reentrant Code

You should consider writing reentrant code when:

- You *don't* want each task to have its own copy of the reentrant code. If the routine is called by several other tasks and occupies a large amount of processor storage, you may want to write reentrant code.
- You *don't* want to enqueue the routine each time a task needs it. If a routine is called frequently, you may want to write reentrant code to avoid the problem that occurs when several tasks are waiting for a serially-reusable resource to become available.

Coding Guidelines

To write reentrant code, use the following guidelines:

- Avoid self-modifying instructions such as the use of the parameter-naming operands P1, P2, and P3.
- Place all program variables in a storage area unique to the task that is executing. You can map these variables adjacent to the task control block (TCB) and access them as a displacement from the TCB.

  You can obtain the TCB address with the TCBGET instruction as follows:

  ```
  TCBGET    #1
  ```

  This instruction puts the address of the TCB in register 1.

  Notes:

  1. If you place the variables ahead of the TCB, avoid using the TCB generated by the ENDPROG statement because the compiler may put data between the mapped variables and the main task control block.
  2. If you place the variables after the TCB, ensure that all TCBs are the same length. Inconsistent use of the FLOAT operand of the TASK or PROGRAM statement can cause TCBs to be different lengths.

- Use only instructions that are reentrant.

  You can use the instructions that are not reentrant, however, by "protecting" them with the ENQ and DEQ instructions. For example, if you want to use a subroutine in reentrant code, a CALL to a subroutine might look like this:

```
•
•
•
ENQ    SUB4QCB
CALL   SUB4,...
DEQ    SUB4QCB
•
•
•
```

  Note: Any code that you place between the ENQ and DEQ statements is serially reusable but *not* reentrant.

  The following instructions are *not* reentrant:

  - CALL
  - CONCAT
  - DO x,TIMES
  - DSCB or any instruction that uses a DSCB:
    - GIN
    - LOAD $DISKUT3
    - LOAD PGMx
    - NOTE
    - POINT
    - READ
    - WRITE
  - GETEDIT
  - GETVALUE with the FORMAT operand
  - IODEF
  - PLOTGIN
  - PRINTNUM with the FORMAT operand
  - PUTEDIT
  - SCREEN
  - SUBROUT
  - XPLOT
  - YPLOT

Examples

This section contains two examples.

Example 1 consists of a main task and two subtasks. The main task, containing the reentrant code, and the two subtasks all transfer control to the reentrant code.

Example 2 shows how to make a nonreentrant routine into a reentrant routine. It also shows how to execute the reentrant routine from three tasks.

Example 1

The following example consists of a main task and two subtasks. The main task and the two subtasks all transfer control to a group of reentrant instructions with the label RENTER. The reentrant instructions perform two additions and print the result. Each task prints the results on a different terminal.

The next two pages contain the reentrant code and the main task. The two subtasks are contained on the two subsequent pages.

```
      TCB          PROGRAM  START
1     RENTER       ADD      (0,#1),(2,#1),RESULT=(4,#1)
2                  ADD      (0,#1),1
3                  PRINTEXT (10,#1)
4                  PRINTNUM (4,#1)
5                  GOTO     (6,#1)
6     START        LOAD     TASK1,PASSPARM,EVENT=ECB1
7                  LOAD     TASK2,PASSPARM,EVENT=ECB2
8                  MOVEA    #1,PARM
9                  ENQT     $SYSPRTR
10                 DO       100
11                 GOTO     RENTER
12    LM           ENDDO
13                 DEQT
14                 WAIT     ECB1
15                 WAIT     ECB2
                     PROGSTOP
16    PASSPARM     DC       A(RENTER)
17    ECB1         ECB      0
17    ECB2         ECB      0
18    PARM         DC       F'1'
18                 DC       F'1'
19                 DC       F'0'
20                 DC       A(LM)
21                 TEXT     '@ANSWER FROM MAIN TASK = '
                   ENDPROG
                   END
```

1 Begin the reentrant routine. Add the first two data areas in the parameter area and place the result in the third word of the parameter area.

2 Add 1 to the first word of the parameter area.

3 Print the message that begins at the fifth word of the parameter area.

4 Print the result of the ADD instructions.

5 Transfer control back to the task from which control was transferred.

6 Attach the first of the two subtasks (TASK1). Pass the address of the reentrant routine in PASSPARM. Identify ECB2 as the event to be posted when the task has completed.

7 Attach the second of the two subtasks (TASK2).

8 Move the address of PARM to register 1. PARM contains the numbers the reentrant instructions will add, a data area for the result, an address (to which the reentrant routine will branch), and a message used to display the result.

9 Get exclusive use of the system printer.

10 Begin a DO loop. Execute the DO loop 100 times.

11 Transfer control to the reentrant routine.

12 End the DO loop.

13 Release exclusive use of the system printer.

14 Wait for TASK1 to complete.

15 Wait for TASK2 to complete.

16 Define the address of the reentrant instructions as an address constant.

17 Define event control blocks for the two subtasks.

18 Define the data areas to be added. The main task uses these data areas.

19 Define the data area for the result of the ADD instruction.

20 Define the address to which the reentrant routine transfers control.

21 Define the message to be printed.

```
22  TCB       PROGRAM  START,PARM=1
23  START     MOVEA    #1,PARM1
24            ENQT     $SYSPRTR
25            DO       100
26            GOTO     ($PARM1)
    L1        ENDDO
27            DEQT
              PROGSTOP
              ENDPROG
28  PARM1     DC       F'1'
28            DC       F'2'
29            DC       F'0'
30            DC       A(L1)
31            TEXT     '@ANSWER FROM TASK1 = '
              END
32  TCB       PROGRAM  START,PARM=1
    START     MOVEA    #1,PARM1
              ENQT     $SYSPRTR
              DO       100
              GOTO     ($PARM1)
    L1        ENDDO
              DEQT
              PROGSTOP
              ENDPROG
33  PARM1     DC       F'1'
33            DC       F'5'
33            DC       F'0'
33            DC       A(L1)
33            TEXT     '@ANSWER FROM TASK2 = '
              END
```

22 Begin TASK1. Identify START as the first instruction to be executed and specify that one parameter will be passed to the program (PARM=1). The parameter being passed is the address of the reentrant routine.

23 Move the address of PARM1 to register 1. PARM1 contains the numbers the reentrant instructions will add, a data area for the result, an address (to which the reentrant routine will branch), and a message used to display the result.

24 Get exclusive use of $SYSPRTR.

25 Begin a DO loop. Execute the DO loop 100 times.

26 Transfer control to the reentrant routine.

27 Release exclusive use of $SYSLOG.

28 Define the data areas to be added.

29 Define the data area for the result of the ADD instruction.

30 Define the address to which the reentrant routine transfers control.

31 Define the message to be printed.

32 Begin TASK2. Identify START as the first instruction to be executed and specify that one parameter will be passed to the program (PARM = 1). The parameter being passed is the address of the reentrant routine.

33 Define the data areas for TASK2.

Example 2

This example consists of three sections. The first section shows instructions that are **not** reentrant. The second section shows the same instructions made reentrant. The third section shows one way the reentrant instructions can be executed.

The Nonreentrant Instructions

The following instructions produce a random number, add it to itself ten times, and print the result. The DO loops and the PRINTEXT and PRINTNUM instructions make the program nonreentrant.

```
     PROG1     PROGRAM   STPGM
               COPY      TCBEQU
1    STPGM     DO        10,TIMES
2              MOVE      COUNT,0
3              MOVE      SUM,0
4              MOVE      RNBR1,0
5              MULTIPLY  RNDCON,RNBR2,RESULT=RNBR1,PREC=DSD
6              SHIFTR    RNBR1,6,RESULT=COUNT
7              DO        10,TIMES
8              ADD       SUM,COUNT
                 ENDDO
9              STIMER    COUNT,WAIT
                PRINTEXT  '@A(TCB):'
10             PRINTNUM  PROG1+$TCBVER,MODE=HEX
                PRINTEXT  '   COUNT:'
11             PRINTNUM  COUNT
                PRINTEXT  '   SUM:'
12             PRINTNUM  SUM
               ENDDO
13             TERMCTRL  DISPLAY
               PROGSTOP
     RNDCON    DATA      D'65539'
     RNBR1     DATA      F'0'
     RNBR2     DATA      F'9999'
     COUNT     DATA      F'0'
     SUM       DATA      F'0'
               ENDPROG
               END
```

1 Execute the loop 10 times.

2 Initialize COUNT to 0.

3 Initialize SUM to 0.

4 Initialize RNBR1 to 0.

5 Generate a random number, using the number 9999 as a "seed." Put the result in RNBR1. (PREC=DSD causes the result to be placed in a two-word (double precision) data area, the first word of which is RNBR1. The rightmost word of the result, however, is placed in the next word (RNBR2). The second time this instruction executes, the result is different because operand 2 (RNBR2) has changed.)

Note: The instructions that generate the random numbers are used for illustrative purposes only.

6 Shift the result of the previous MULTIPLY instruction. Put the result in COUNT. This instruction takes the result of the MULTIPLY instruction and makes the number smaller.

7 Execute another loop ten times.

8 Add COUNT to SUM.

9 Tell the system to wait the number of milliseconds contained in COUNT.

10 Print the address of the TCB in hexadecimal (MODE=HEX).

11 Print the random number.

12 Print the result of the addition.

13 Display the data in the system buffer.

The Same Instructions Made Reentrant

The following instructions do exactly the same thing as the previous nonreentrant instructions. They produce a random number, add it to itself ten times, and print the result. The DO loops and the PRINTEXT and PRINTNUM instructions have been changed to make the instructions reentrant.

```
     PROG1     PROGRAM  STPGM
1              COPY     TCBEQU
2    STPGM     TCBGET   #1,$TCBVER
3              MOVE     (+LCNT1,#1),10
4              DO       WHILE,((+LCNT1,#1),NE,0)
5              SUBTRACT (+LCNT1,#1),1
6              MOVE     (+COUNT,#1),0
7              MOVE     (+SUM,#1),0
8              MOVE     (+RNBR1,#1),0
9              MULTIPLY RNDCON,(+RNBR2,#1),RESULT=(+RNBR1,#1),PR EC=DSD
10             SHIFTR   (+RNBR1,#1),6,RESULT=(+COUNT,#1)
11             MOVE     (+LCNT2,#1),10
12             DO       WHILE,((+LCNT2,#1),NE,0)
13             SUBTRACT (+LCNT1,#1),1
14             ADD      (+SUM,#1),(+COUNT,#1)
                ENDDO
15             STIMER   (+COUNT,#1),WAIT
16             ENQ      PRTLINE
                PRINTEXT '@A(TCB):'
17             PRINTNUM (+$TCBVER,#1),MODE=HEX
                PRINTEXT '   COUNT:'
17             PRINTNUM (+COUNT,#1)
                PRINTEXT '   SUM:'
17             PRINTNUM (+SUM,#1)
18             DEQ      PRTLINE
                ENDDO
19             TERMCTRL DISPLAY
                PROGSTOP
20   PRTLINE   QCB
     RNDCON    DATA       D'65539'
               ENDPROG
     TWKAREA   DATA       F'0'
     RNDSEED   DATA       F'9999'
               DATA       4F'0'
21   TCBADDR   EQU        *
22   RNBR1     EQU        *-PROG1
     RNBR2     EQU        RNBR1+2
     COUNT     EQU        RNBR2+2
     SUM       EQU        COUNT+2
     LCNT1     EQU        SUM+2
     LCNT2     EQU        LCNT1+2
               END
```

1 Copy the task control block (TCB) equates into the program.

2 Put the address of the TCB in register 1.

3 Initialize the loop counter to 10.

4 Execute the loop ten times.

5 Subtract 1 from the loop counter.

6 Initialize COUNT to 0.

7 Initialize SUM to 0.

8 Initialize RNBR1 to 0.

9 Generate a random number, using the number 9999 as a "seed." Put the result in RNBR1. (PREC=DSD causes the result to be placed in a 2-word (double precision) data area, the first word of which is RNBR1. The rightmost word of the result, however, is placed in the next word (RNBR2). The second time this instruction executes, the result is different because operand 2 (RNBR2) has changed.)

Note: The instructions that generate the random numbers are used for illustrative purposes only.

10 Shift the result of the previous MULTIPLY instruction. Put the result in COUNT. This instruction takes the result of the MULTIPLY instruction and makes the number smaller.

11 Initialize another loop counter.

12 Execute another loop ten times.

13 Subtract 1 from the loop counter.

14 Add COUNT to SUM.

15 Tell the system to wait the number of milliseconds contained in COUNT.

16 Gain exclusive control of the next six instructions. This instruction is necessary to avoid "interleaving" of output. Interleaving could occur if more than one task executed the six instructions at the same time.

17 Print the address of the TCB, COUNT, and SUM.

18 Relinquish control of the resource (the six output instructions).

19 Display the data in the system buffer.

20 Define a queue control block.

21 Point to the task control block. The ENDPROG statement generates a task control block.

22 Point to the area immediately preceding the task control block. TWKAREA minus TCBADDR produces a negative number. When the program loads the TCB address into register 1 and uses RNBR1, RNBR2, COUNT, SUM, LCNT1, or LCNT2 as a displacement, the result points to a variable with the unique storage area associated with the attaching task. The unique storage area must immediately precede the TCB.

Executing a Reentrant Program

The following instructions show how to execute the reentrant routine from three tasks. The reentrant routine begins at label STTSK.

```
     PROG3     PROGRAM  STPGM
1    STPGM     ATTACH   TASK1
2              ATTACH   TASK2
3              ATTACH   TASK3
4              WAIT     EVENT1
5              WAIT     EVENT2
6              WAIT     EVENT3
7              TERMCTRL DISPLAY
               PROGSTOP -1
8    TASK1     TASK     STTSK,EVENT=EVENT1
9              DATA     F'0'
9              DATA     F'9999'
9              DATA     4F'0'
10   TASK2     TASK     STTSK,EVENT=EVENT2
11             DATA     F'0'
11             DATA     F'9999'
11             DATA     4F'0'
12   TASK3     TASK     STTSK,EVENT=EVENT3
13             DATA     F'0'
13             DATA     F'9999'
13             DATA     4F'0'
14   RNBR1     EQU      *-TASK3
14   RNBR2     EQU      RNBR1+2
14   COUNT     EQU      RNBR2+2
14   SUM       EQU      COUNT+2
14   LCNT1     EQU      SUM+2
15   LCNT2     EQU      LCNT1+2
15   STTSK     TCBGET   #1,$TCBVER
                 •
                 •
                 •
16             ENDTASK
               ENDPROG
               END
```

1 Attach the first task (TASK1).

2 Attach the second task (TASK2).

3 Attach the third task (TASK3).

4 Wait for the completion of the first task (TASK1).

5 Wait for the completion of the second task (TASK2).

6 Wait for the completion of the third task (TASK3).

7 Display the contents of the buffer.

8 Define a task with the label TASK1. The label of the first instruction to be executed is STTSK. Identify EVENT1 as the event to be posted when the task completes.

9 Define data areas that are unique to TASK1.

10 Define a task with the label TASK2. The label of the first instruction to be executed is STTSK. Identify EVENT2 as the event to be posted when the task completes.

11 Define data areas that are unique to TASK2.

12 Define a task with the label TASK3. The label of the first instruction to be executed is STTSK. Identify EVENT3 as the event to be posted when the task completes.

13 Define data areas that are unique to TASK3.

14 Use equates to map the task data areas.

15 Begin the reentrant code.

16 End the reentrant code.

Chapter 20. Accessing $SYSCOM through a Program

You can access the system common data area (known as $SYSCOM) through an EDL program. Programs in any partition can access $SYSCOM and use the common data area to store information.

Before you can access $SYSCOM through a program, you must define $SYSCOM at system generation time. To do so, modify the $EDXDEF data set. For more information on how to do this, refer to the *Installation and System Generation Guide*.

This chapter provides two sample EDL programs that access $SYSCOM. The chapter describes how $SYSCOM must be defined in the $EDXDEF data set in order for the sample programs to execute.

Sample Program A

An explanation of the numbered items follows the program.

```
        PROGA     PROGRAM   START
1       START     MOVE      #1,$SYSCOM,FKEY=0
2                 TCBGET    SAVEADS,$TCBADS
3                 TCBPUT    ZERO,$TCBADS
4                 ENQ       (PRINTER,#1)
5                 DEQ       (PRINTER,#1)
6                 POST      (EVENT1,#1)
7                 TCBPUT    SAVEADS,$TCBADS
                  PROGSTOP
        SAVEADS   DATA      F'0'
        ZERO      DATA      F'0'
        PRINTER   EQU       0
        EVENT1    EQU       PRINTER+10
                  ENDPROG
                 END
```

1 Store the address of the data common area ($SYSCOM) in index register 1.

2 Save the current TCB address ($TCBADR).

3 Set the TCB address ($TCBADR) to zero for the QCB and ECB in $SYSCOM.

4 Obtain exclusive use of the resource PRINTER. (PRINTER is defined in the $EDXDEF data set.)

5 Release exclusive use of the resource PRINTER. (PRINTER is defined in the $EDXDEF data set.)

6 Post the ECB in the data common area called EVENT1.

7 Restore the TCB address ($TCBADR).

In order for Program A to execute, define $SYSCOM in the $EDXDEF data set as follows:

```
$SYSCOM         CSECT
PRINTER         QCB
EVENT1          ECB
                ENTRY       $EDXPTCH
$EDXPTCH        DATA        128F'0'
                END
```

Sample Program B

An explanation of the numbered items follows the program.

```
      PROGB     PROGRAM     START
1     START     MOVE        #1,$SYSCOM,FKEY=0
2               MOVEA       #2,BUF
3               MOVE        (NAME,#2),(NAME,#1),(20,BYTES),FKEY=0
4               MOVE        (STREET,#2),(STREET,#1),(20,BYTES),FKEY=0
5               MOVE        (CITY,#2),(CITY,#1),(20,BYTES),FKEY=0
6     BUF       DATA        60C' '
7     NAME      EQU         0
8     STREET    EQU         NAME+20
9     CITY      EQU         STREET+20
                PROGSTOP
                ENDPROG
                END
```

1 Move the address of the common area ($SYSCOM) to index register 1.

2 Move the address of BUF to index register 2.

3 Move NAME from the common area to the first 20 characters of BUF.

4 Move STREET from the common area to the second 20 characters of BUF.

5 Move CITY from the common area to the last 20 characters of BUF.

6 Define a 60-character area to receive the data items from the common area.

7 Map the structure of the common area.

8 Map the structure of the common area.

9 Map the structure of the common area.

In order for Program B to execute, define $SYSCOM in the $EDXDEF data set as follows:

```
$SYSCOM         CSECT
NAME            DATA        20C' '
STREET          DATA        20C' '
CITY            DATA        20C' '
                ENTRY       $EDXPTCH
$EDXPTCH        DATA        128F'0'
                END
```

Appendix A. Tape Labels

The following is the layout of the VOL1 label:

Field Name	Bytes	Initialized Contents
Label identifier	3	VOL
Volume label number	1	1
Volume serial	6	XXXXXX
Volume security	1	0
Data file directory	10	blanks
Reserved	10	blanks
Reserved	10	VOL
Owner name	10	NAME
Reserved	29	blanks

The following is the layout of the HDR1 label:

Field Name	Bytes	Initialized Contents
Label identifier	3	HDR
File label number	1	1
File identifier (DSN)	17*	Data set name (DSN)
File serial number	6	XXXXXX
Volume sequence number	4	0001
File sequence number	4	00NN
Generation number	4	blanks
Generation version number	2	blanks
Creation date	6	YYDDD
Expiration date	6	YYDDD
File security	1	0
Block count	6	000000
System code	13	IBMEDX1
Reserved	7	blanks

* EDX supports an 8-byte, nonblank data set name (DSN). EDX ignores the last 9 bytes of the DSN.

Appendix B. Interrupt Processing

Interrupts apply to the interaction between a program and a terminal operator. For example, a program can wait for an interrupt, such as an operator response to a prompt, or a terminal operator can cause an interrupt by pressing a Program Function key.

When an interrupt occurs, if it is completing an outstanding operation, control is returned to the next sequential instruction if there are no errors. If the interrupt was unsolicited (caused by the attention key or a PF key), then either the system or user ATTNLIST begins executing as an asynchronous task competing for system resources.

Interrupt Keys

The keys that can cause interrupts are the attention key, Program Function (PF) keys, and the enter key.

The Attention Key

When the attention key is recognized, the greater than symbol (>) is displayed and the operator can enter either a system function code (for example, $L) or a program function code defined in an ATTNLIST.

If you have this terminal type	Then this is your attention key
4978/4979	The key marked ATTN
Teletype	The ESC (escape) key
3101 Display Terminal	The ALT and F8 key
3151/316x Terminal	The F8 key

Note: The term 316x refers to the 3161, 3163 and 3164 terminals.

Program Function (PF) Keys

Any program function key on the 4978/4979, 3101, 3151 and 316x is recognized by the attention list code $PF (except for a PF key defined as the attention key). In addition, individual keys can be recognized separately by $PF1 to $PF254. You can provide separate entry points to the application code for particular keys, or a single entry point for all keys or a group of keys for rapid response.

The order of the PF keys in the attention list is significant because it defines the entry points to the application code. For example:

```
ATTNLIST  ($PF1,ENT1,$PF5,ENT2,$PF,ENT3)
```

causes the program to be entered at ENT3 for all PF keys except PF1 and PF5.

On the 4978/4979, pressing the PF6 key causes the screen image to be printed on any designated hard-copy terminal (unless that terminal is a spool device and spool is loaded). This is not true for PF6 on the 3101.

The 3101 keyboard has eight PF keys. EDX supports these keys when the 3101 is operated in both character and block mode. To use the PF keys on the 3101, hold down the ALT key (on the lower right-hand side of the keyboard) while you press the appropriate numeric key.

The 3151/316x keyboards have 12 PF keys (labeled F1 through F12). EDX supports these keys in either character or block mode.

Enter Key

The enter key indicates the end of typed input, for example, the end of the operator input for a READTEXT instruction. You also use it in conjunction with the WAIT KEY instruction.

If you have this terminal type	Then this is your enter key
4978/4979	The key marked ENTER
3101 in block mode	The Send key
3101 in character mode	The new line key
3151/316x in block mode	The Send key
3151/316x in character mode	The new line key

Instructions that Process Interrupts

Instructions that process interrupts are READTEXT, GETVALUE, WAIT KEY and ATTNLIST.

The READTEXT and GETVALUE Instructions

In many cases a program needs to wait for an interrupt, such as an operator response to a request for input. This program-wait capability is provided automatically by the READTEXT and GETVALUE instructions. These instructions have an "implied wait." They wait for the terminal operator to enter data and press the enter key.

The WAIT KEY Instruction

An application program can wait at any point for a 4978/4979 or 3101 terminal operator to press the enter or one of the PF keys. This is done by issuing the WAIT KEY instruction.

When the enter or a PF key is pressed, the program resumes operation, and the key is identified to the program in the second task code word at taskname+2. The code value for the enter key is 0. The value for a PF key is the integer corresponding to the assigned function code; 1 for PF1, 2 for PF2, and so on.

The PF keys do not initiate attention list processing during execution of the WAIT KEY instruction. They only cause the WAIT KEY instruction to terminate, allowing subsequent instructions to be executed.

The ATTNLIST Instruction

The ATTNLIST instruction provides entry to interrupt processing routines. When a PF key is pressed, the ATTNLIST task for that key gets control if ATTNLIST was coded in the application program. If ATTNLIST was not coded, the system search for a PF key match fails and the message "FUNCTION NOT DEFINED" is displayed on the screen. Except for the 4978/4979 hard-copy print key (normally PF6), the 4978 attention key (normally PF0) and the 3101 attention key (normally PF8), the PF keys are always matched against user-written ATTNLIST(s) as described above.

When the attention key on a terminal is pressed, the system prompts the operator for a command. This command is first matched against the system ATTNLIST and then against user-written ATTNLIST(s).

If the command matches the system ATTNLIST, appropriate system action is taken (for example, $D or $L) unless the task is busy. If the command entered was $C, $VARYON, or $VARYOFF and this task is busy, the message "> NOT ACKNOWLEDGED" is displayed; when the task is completed, $C, $VARYON, or $VARYOFF is then executed. If the command entered was $P or $D and this task is busy, the command is ignored.

If the command matches a user-written ATTNLIST, the corresponding ATTNLIST task gets control. The appropriate application program attention routine then runs under this task. If the attention key loaded the ATTNLIST and the task is already busy, the message "> NOT ACKNOWLEDGED" is displayed on the terminal.

If there is no match against any ATTNLIST, the message "FUNCTION NOT DEFINED" is displayed.

When the ATTNLIST task for a PF key gets control, the code for that key is placed in the second word of the ATTNLIST task control block. You can obtain the code for an interrupting key by coding the TCBGET instruction.

Advance Input

As a terminal user, your interaction with an application or utility program is generally conducted through prompts which request you to enter data. Once you have become familiar with the dialogue sequence, however, prompting becomes less necessary. The READTEXT and GETVALUE instructions include a conditional prompting option which enables you to enter data in advance and thereby inhibit the associated prompts.

Advance input is accomplished by entering more data on a line than has been requested by the program. Subsequent input instructions specifying PROMPT=COND will read data from the remainder of the buffered line, and issue a prompt only when the pre-entered data has been exhausted. If you specify PROMPT=UNCOND with an input instruction, an associated prompt is issued and the system waits for input. The prompt causes, as does every output instruction, cancellation of any outstanding advance input.

Appendix C. Static Screens and Device Considerations

Defining Logical Screens

A logical screen is a screen defined by margin settings, such as the TOPM, BOTM, LEFTM and RIGHTM parameters. Logical screens can be defined either during system generation (using the TERMINAL statement) or at the time an ENQT instruction is executed (using the IOCB statement).

Using TERMINAL to Define a Logical Screen

The following example of using the TERMINAL statement defines a static screen to be used for data entry and display. Programs can be loaded from the terminal, but the terminal I/O instructions issued will be interpreted for a static screen unless the configuration is changed to roll by an IOCB statement. This is a typical definition for a terminal to be used for data entry.

```
TERM2    TERMINAL  DEVICE=4979,ADDRESS=14,SCREEN=STATIC
```

The next example shows a split screen configuration. The roll screen is the bottom 12 lines of the screen; the top half can be used for other logical screens defined upon execution of ENQT.

```
TERM3    TERMINAL  DEVICE=4978,ADDRESS=24,TOPM=12,NHIST=6
```

The next example defines a roll screen occupying the upper-right quadrant of the screen. In general, logical screens with less than an 80-character line size suffer some performance disadvantages (such as slower erasure) but can be useful for special applications. Note that NHIST is zero here because screen shifting will not be performed; a nonzero value for NHIST would merely cause the history area to be unused.

```
TERM4    TERMINAL  DEVICE=4979,ADDRESS=34,LEFTM=39,                C
               BOTM=11,NHIST=0
```

The final example defines a static screen for the 3101 in block mode. The 3101, 3151, 3161, 3163, and 3164 terminals can have only a single roll screen or static screen. The Multifunction Attachment is used to connect the terminal to the Series/1.

```
TERM5    TERMINAL  DEVICE=ACCA,ADDRESS=59,MODE=3101B,             C
               SCREEN=STATIC,LMODE=RS422,ADAPTER=MFA
```

Using IOCB and ENQT to Define a Logical Screen

Logical screens can also be defined by the ENQT instruction referencing an IOCB. The IOCB statement is used to define many of the "soft" characteristics of a terminal (such as margins, page size or line length) and to establish the connection between the ENQT and TERMINAL statements at execution time. Using an ENQT instruction which references an IOCB, you can modify the soft characteristics of a specific terminal defined by the TERMINAL statement. The IOCB statement and its operands are described fully in the *Language Reference.*

In the following example, the IOCB labeled TOPHALF defines the top half of the screen (from which the program was loaded) as a static screen. If the terminal were defined as in TERM3 on the previous page, the program could have been loaded by entering $L program-name in the roll screen area (the bottom half of the screen). Since no terminal name is specified on the IOCB statement, the ENQT refers to the loading terminal. The program then might display tabular information on the static screen, execute DEQT and then end. The information displayed on the static screen part of the screen will remain on the screen while the terminal operator performs other operations using the roll screen.

```
DISPLAY   PROGRAM   BEGIN
TOPHALF   IOCB      BOTM=11,SCREEN=STATIC
BEGIN     ENQT      TOPHALF
          •
          •
          •
          DEQT
          PROGSTOP
          ENDPROG
          END
```

The next example shows terminal access by using the symbolic name of the terminal. TERM1, TERM2, TERM3, and TERM4 have all been defined with TERMINAL configuration statements. The use of a static screen ensures that only physical line 0 of each screen will be altered. (LINE=0 for roll screens causes a page eject and erasure of information.)

Note: On a 4979, unprotected fields should be of even length.

```
NOTICE    PROGRAM   BEGIN
TERMX     IOCB      SCREEN=STATIC
NAMETAB   DATA      CL8'TERM1'
          DATA      CL8'TERM2'
          DATA      CL8'TERM3'
          DATA      CL8'TERM4'
BEGIN     MOVEA     #1,NAMETAB
          DO        4
             MOVE       TERMX,(0,#1),(8,BYTES)
             ENQT       TERMX
             PRINTEXT   'SYSTEM ACTIVE',LINE=0
             DEQT
             ADD        #1,8
          ENDDO
          PROGSTOP
          ENDPROG
          END
```

Structure of the IOCB

The structure of the IOCB is given in the following table. The structure may change with future versions of the Event Driven Executive.

Field Name	Byte(s)	Contents
Terminal name	0 – 7	EBCDIC, blank filled
Flags	8	Bit 0 "off" indicates that the name is the only element of the IOCB. Further information on this field can be found in *Internal Design*.
Top of working area	9	Equal to TOPM + NHIST
Top margin	10	TOPM or zero
Bottom margin	11	BOTM, or X'FF' if unspecified
Left margin	12	LEFTM or zero
Page size	13	Equal to X'00' if unspecified
Line size	14 – 15	Equal to X'7FFF' if unspecified
Current line	16	Initialized to TOPM + NHIST
Current indent	17	Initialized to left margin
Buffer address	18 – 19	Zero if unspecified

$IMAGE Subroutines

You can create, save, and modify formatted screen images in disk and diskette data sets using the $IMAGE utility. The formatted screen subroutines retrieve and display these images. The $IMAGE subroutines provide support for any of the following:

- 4978 terminals
- 4979 terminals
- 4980 terminals
- 3101 terminals in block mode
- 3161 terminals in block mode
- 3151 terminals in block mode
- 3163 terminals in block mode
- 3164 terminals in block mode.

You can also use screen images created on a 4978, 4979, or 4980 on any of the terminals listed above by calling subroutines described in this appendix. Refer to the $IMAGE description in the *Operator Commands and Utilities Reference* for information on creating or exchanging terminal screen images for various terminals.

The $IMAGE subroutines perform screen formatting and input/output operations independent of the type of terminal upon which the application runs. The orientation is towards writing/reading all unprotected fields with one operation. In this context the data in unprotected fields is of primary concern.

Static screen applications use the $IMOPEN, $IMDTYPE, $UNPACK, $IMGEN, $IMGEN49, $IMGEN31, $IMGEN3X, and $IMCON31 subroutine packages to process static screens defined using the $IMAGE utility.

$IMDTYPE is required for all static screen applications. In addition, the $IMOPEN and $UNPACK subroutines are also required, plus one of the following:

- $IMGEN to intermix 4978, 3101, 3151, 3161, 3163, or 3164 screen images and to display these images on a 4978, 4979, 4980, 3101, 3151, 3161, 3163, or 3164 terminal. Special screen images can be displayed only on the same terminal type.
- $IMGEN3X to intermix both 3101 and 4978 images and to display those images on a 3101 terminal.
- $IMGEN49 for 4978 images and to display those images on a 4978 or 4979 terminal.
- $IMGEN31 for 3101 images and to display those images on a 3101 terminal.

If you wish to display 3101 images saved prior to EDX version 5.2 on a 3161, 3163, or 3164 terminal, you can:

1. use the $IMAGE EDIT and SAVE commands to convert the 3101 image to the new format or
2. code "3101" for the type operand in the CALL $IMOPEN instruction and include $IMCON31 when linking your application program.

During link-edit the $IMxxxx subroutines are included with your application through the use of the autocall library. Normally $IMGEN is included. If you want one of the alternate ($IMGENxx) routines, explicitly INCLUDE that module.

For formatted screen images presented on a 3101, storage requirements and internal conversion time is reduced when you select only subroutine support that processes 3101 images.

You must code an EXTRN statement for each subroutine name to which your program refers. You must also link-edit the subroutines with your application program. Specify $AUTO,ASMLIB as the autocall library to include the screen formatting subroutines. See Chapter 5, "Preparing an Object Module for Execution" for details on the AUTOCALL feature of $EDXLINK.

You call the formatted screen subroutines using the CALL instruction. The following section shows the CALL instruction syntax for each subroutine. Where an address argument is required by the subroutine, the label of the variable enclosed in parentheses causes the address of the variable to be passed (refer to the CALL instruction in the *Language Reference*).

If an error occurs, the terminal I/O return code is in the second word of the task control block (TCB). These errors can come from instructions such as PRINTEXT, READTEXT, and TERMCTRL.

$IMOPEN Subroutine

The $IMOPEN subroutine reads the formatted screen image from disk or diskette into your program buffer. You can also perform this operation by using the DSOPEN subroutine or defining the data set at program load time, and issuing the disk READ instruction. See the section "Screen Image Buffer Sizes" on page C-12 for a description of buffer sizes. $IMOPEN updates the index word of the buffer with the number of actual bytes read. To refer to the index word, code buffer−4.

Users of EDX Version 5.2 and subsequent releases

If you want to read images from disk or diskette using the DSOPEN subroutine instead of $IMOPEN and the images were saved prior to EDX Version 5.2, code the first 3 words of the buffer as follows:

```
word 1: C'I M'
word 2: C'A G'
word 3: xxxx, where xxxx is the address in the buffer
              which stores the 31xx terminal format
     or 0000, if the 31xx terminal format is not used
```

The $IMAGE screen is read in at BUFFER +6.

Note: To use $IMOPEN, you must code an EXTRN statement in your program. You must also link-edit the program with $EDXLINK and specify an autocall to $AUTO,ASMLIB.

Syntax:

label	**CALL**	**$IMOPEN,(dsname),(buffer),(type),** **P2=,P3=,P4=**
Required:	**dsname,buffer**	
Defaults:	**type=C'4978'**	
Indexable:	**none**	

Operands	*Description*
dsname	The label of a TEXT statement that contains the name of the screen image data set. You can include a volume label, separated from the data set name by a comma.
buffer	The label of a BUFFER statement that defines the storage area into which the image data will be read. Allocate the storage in bytes, as in the following example: `label  BUFFER  1024,BYTES`

type The label of a DATA statement that reserves a 4-byte area of storage and specifies the type of image data set to be read. The DATA statement must be on a full word boundary. Specify one of the following types:

C'4978' The system reads an image data set for a 4978 terminal with a 4978/4979/4980 terminal format. This is the default terminal format.

C'3101' The system reads an image data set for a 3101 terminal with a 31xx terminal format.

C'3151' The system reads an image data set for a 3151 terminal

C'3161' The system reads an image data set for a 3161 terminal with a 31xx terminal format.

C'3163' The system reads an image data set for a 3163 terminal with a 31xx terminal format.

C'3164' The system reads an image data set for a 3164 terminal with a 31xx terminal format.

Note: The 31xx terminal format is the format used for a 3101, 3151, 3161, 3163, or 3164 terminal.

C' ' The system reads an image data set whose format corresponds with the type of terminal enqueued. If neither a 4978, 4979, 4980, 3101, 3151, 3161, 3163, or 3164 is enqueued (ENQT), the system assumes the default 4978 image format.

If you use this option, $IMOPEN will try to use the screen image that corresponds with the device. If that is not available, $IMOPEN will use a 4978/4979/4980 screen image. This is the default condition when you do not code this parameter. For example, if you are enqueued on a 3151 or 3161 terminal, $IMOPEN will attempt to open a 31xx screen image. If it does not exist, $IMOPEN will use the 4978/4979/4980 screen image.

Px= Parameter naming operands. Refer to the CALL instruction and Chapter 1 in the *Language Reference*.

The following is an example of $IMOPEN:

```
         CALL    $IMOPEN,(IMGDS),(IMGBUFF),(IMGTYP)
          •
          •
          •
IMGDS    TEXT    'IMGDS,MYVOL'
IMGBUFF  BUFFER  1024,BYTES
IMGTYP   DATA    C'3101'
```

$IMOPEN Return Codes

The following are the return codes from the $IMOPEN subroutine. The return codes are placed in the second word of the task control block (TCB) of the program or task calling the subroutine. The label of the TCB is the label of your program or task (taskname). Look at taskname + 2.

Code	Condition
-1	Successful completion
1	Disk I/O error
2	Buffer too small for 3101, 3151, 3161, 3163, or 3164 terminal information (31xx screen image)
3	Data set not found
4	Incorrect header or data set length
5	Input buffer too small
6	Invalid volume name
7	No 3101 image available
8	Data set name longer than eight bytes

$IMDEFN Subroutine

The $IMDEFN subroutine creates an IOCB for the formatted screen image. You can code the IOCB directly, but the use of $IMDEFN allows the image dimensions to be modified with the $IMAGE utility without requiring a change to the application program. $IMDEFN updates the IOCB to reflect OVFLINE=YES. Refer to the TERMINAL configuration statement in the *Installation and System Generation Guide* for a description of the OVFLINE parameter.

Once you define an IOCB for the static screen, the program can then acquire that screen through ENQT. Once the screen has been acquired, the program can call the $IMPROT subroutine to display the image and the $IMDATA subroutine to display the initial unprotected fields.

Note: To use $IMDEFN, you must code an EXTRN statement in your program. You must also link-edit the program with $EDXLINK and specify an autocall to $AUTO,ASMLIB.

Syntax:

```
label     CALL     $IMDEFN,(iocb),(buffer),topm,leftm,
                   P2=,P3=,P4=,P5=

Required:  iocb,buffer
Defaults:  topm=0,leftm=0
Indexable: none
```

Operands	*Description*
iocb	The label of an IOCB statement defining a static screen. The IOCB need not specify the TOPM, BOTM, LEFTM nor RIGHTM parameters; these are "filled in" by the subroutine. The following IOCB statement would normally suffice: `label  IOCB  terminal,SCREEN=STATIC`
buffer	The label of an area containing the screen image in disk storage format. The format is described in the section "Screen Image Buffer Sizes" on page C-12.
topm	Indicates the screen position at which line 0 will appear. If its value is such that lines would be lost at the bottom of the screen, then it is forced to zero. This parameter must equal zero for all 3101, 3151, 3161, 3163, or 3164 terminal applications. The default is also zero.
leftm	Indicates the screen position at which the left edge of the image will appear. If its value is such that characters would be lost at the right edge of the screen, then it is forced to zero. This parameter must equal zero for all 3101, 3151, 3161, 3163, or 3164 terminal applications. The default is also zero.
Px=	Parameter naming operands. Refer to the CALL instruction and Chapter 1 in the *Language Reference*.

The following is an example of $IMDEFN:

```
        CALL    $IMDEFN,(IMGIOCB),(IMGBUFF),0,0
          •
          •
          •
        ENQT    IMGIOCB
          •
          •
          •
        PROGSTOP
IMGIOCB IOCB    SCREEN=STATIC
IMGBUFF BUFFER  1024,BYTES
```

$IMPROT Subroutine

The $IMPROT subroutine uses an image created by the $IMAGE utility to prepare the defined protected and blank unprotected fields for display. At the option of the calling program, a field table can be constructed. The field table gives the location (LINE and SPACES) and length of each unprotected field.

Upon return from $IMPROT, your program can force the protected fields to be displayed by issuing a TERMCTRL DISPLAY. This is not required if a call to $IMDATA follows because $IMDATA forces the display of screen data.

All or portions of the screen may be protected after $IMPROT executes. Because the operator cannot key data into protected fields, subsequent read instructions (such as QUESTION, GETVALUE and READTEXT) should be directed to unprotected areas of the screen, or the protected areas should be erased.

Notes:

1. To use $IMPROT, you must code an EXTRN statement in your program. You must also link-edit the program with $EDXLINK and specify an autocall to $AUTO,ASMLIB.
2. Do not call both $IMPROT and $IMDATA by separate tasks to operate simultaneously. Problems will occur because both call the $IMDTYPE subroutine.

Syntax:

label	**CALL**	**$IMPROT,(buffer),(ftab),P2=,P3=**
Required:	**buffer,ftab (see note)**	
Defaults:	**none**	
Indexable:	**none**	

Operands	*Description*
buffer	The label of an area containing the screen image in disk storage format. The format is described in the section "Screen Image Buffer Sizes" on page C-12.
ftab	The label of a field table constructed by $IMPROT giving the location (lines, spaces) and size (characters) of each unprotected data field of the image. **Note:** The ftab operand is required only if the application executes on a 3101, 3151, 3161, 3163, or 3164 terminal in block mode, or if a user buffer is used in $IMDATA.
Px=	Parameter naming operands. Refer to the CALL instruction and Chapter 1 in the *Language Reference*.

The field table has the following form:

label-4 (one word)	number of fields	label-2 number of words
	spaces	(one word)
	size	(one word)
	spaces	label+6
	size	line * FIELD 2
	•	
	•	
	•	
label+6(n-1)	line	* FIELD n
	spaces	
	size	

The field numbers correspond to the following ordering: left to right in the top line, left to right in the second line, and so on to the last field in the last line. Storage for the field table should be allocated with a BUFFER statement specifying the desired number of words using the WORDS parameter. The buffer control word at label−2 will be used to limit the amount of field information stored, and the buffer index word at buffer−4 is set with the number of fields for which information was stored, the total number of words being three times that value. If the field table is not desired, code zero for this parameter.

The following is an example of $IMPROT:

```
         CALL     $IMPROT,(IMGBUFF),(FTAB)
         PRINTEXT LINE=FTAB,SPACES=FTAB+2              POSITION CURSOR
         READTEXT INPUT,LINE=FTAB,SPACES=FTAB+2        OPERATOR INPUT
            •
            •
            •
IMGBUFF  BUFFER   1024,BYTES
FTAB     BUFFER   128,WORDS
INPUT    TEXT     LENGTH=20
```

$IMPROT Return Codes

The following are the return codes from the $IMPROT subroutine. The return codes are placed in the second word of the task control block (TCB) of the program or task calling the subroutine. The label of the TCB is the label of your program or task (taskname). Look at taskname+2.

Code	Condition
-1	Successful completion
9	Invalid format in buffer
10	Ftab truncated due to insufficient buffer size
11	Error in building ftab from 31xx terminal format; partial ftab created
12	Invalid terminal type

$IMDATA Subroutine

$IMDATA displays the initial data values for an image which is in disk storage format. Use $IMDATA:

- To display the unprotected data associated with a screen image, if the content of the buffer is a screen format retrieved with $IMOPEN.
- To "scatter write" the contents of a user buffer to the input fields of a displayed screen image.

Note: You must call $IMDATA if any of your unprotected fields have the right justify or must enter characteristics.

If the buffer is retrieved with $IMOPEN, the buffer begins with either the characters "IMAG," or "IM31," and the buffer index (buffer−4) equals the data length excluding the characters "IMxx."

You can specify a user buffer containing application-generated data. Set the first four bytes of the buffer to USER and set the buffer index (buffer−4) to the data length excluding the characters USER.

All or portions of the screen may be protected after $IMDATA executes. Because the operator cannot key data into protected fields, subsequent read instructions (such as QUESTION, GETVALUE and READTEXT) should be directed to unprotected areas of the screen, or the protected areas should be erased.

Notes:

1. To use $IMDATA, you must code an EXTRN statement in your program. You must also link-edit the program with $EDXLINK and specify an autocall to $AUTO,ASMLIB.
2. Do not call both $IMDATA and $IMPROT by separate tasks to operate simultaneously. Problems occur because both call the $IMDTYPE subroutine.

Syntax:

label	**CALL**	**$IMDATA,(buffer),(ftab),P2=,P3=**
Required:	**buffer,ftab (see note)**	
Defaults:	**none**	
Indexable:	**none**	

Operands	*Description*
buffer	The label of an area containing the image in disk-storage format.
ftab	The label of a field table constructed by $IMPROT giving the location (lines,spaces) and size (characters) of each unprotected data field of the image. **Note:** The ftab operand is required only if the application executes on a 3101, 3151, 3161, 3163, or 3164 terminal in block mode, or if a user buffer is used in $IMDATA.
Px=	Parameter naming operands. Refer to the CALL instruction and Chapter 1 in the *Language Reference*.

The following is an example of $IMDATA:

```
         CALL     $IMDATA,(IMGBUFF),(FTAB)
         PRINTEXT LINE=FTAB,SPACES=FTAB+2    POSITION CURSOR
          •
          •
          •
IMGBUFF  BUFFER   1024,BYTES
FTAB     BUFFER   300,WORDS
```

$IMDATA Return Codes

The following are the return codes returned from the $IMDATA subroutine. The return codes are returned in the second word of the task control block (TCB) of the program or task calling the subroutine. The label of the TCB is the label of your program or task (taskname). Look at taskname+2.

Code	Condition
-1	Successful completion
9	Invalid format in buffer
12	Invalid terminal type

Screen Image Buffer Sizes

Under normal circumstances, the size of the disk buffer can vary between 256 and 3096 bytes. Because data compression is used in storing the images, many images will require only 512 bytes, and 1024 bytes will be adequate for typical applications using a 4978/4979/4980 image. 3101, 3151, 3161, 3163 and, 3164 terminal data stream images (31xx screen images) are much larger.

The $IMAGE utility tells you the required buffer sizes for the 4978, 4979, 4980, 3101, 3151, 3161, 3163, and 3164 buffers. If your application program will run on any type of terminal, use the largest of the buffer sizes.

The display subroutines normally write images to the terminal in line-by-line fashion. Performance can be improved by providing a terminal buffer large enough to contain multiple lines. Since the display subroutines perform concatenated write operations whenever possible, using a larger buffer results in fewer such operations and, therefore, faster generation of the display image.

For example, for a full screen image (24 x 80), a time versus space trade-off can be made by choosing a buffer size that is a multiple of 80 bytes (1 line), up to a maximum of 1920 bytes. A temporary buffer can be defined by coding the BUFFER= parameter on the IOCB which is used to access the screen. This buffer should be unique and should not be confused with disk image buffer.

Example of Using $IMAGE Subroutines

The following program shows the $IMAGE subroutines in a general application program. Under direction of the terminal operator, this program displays on a 4978, 4979, 3101, 3151, 3161, 3163, or 3164 terminal any image stored on disk. For each image, a field table (ftab) is constructed and used to modify initial data values.

In this example, use of the field size from the field table is for illustrative purposes only. Each unprotected output operation is terminated by the beginning of the next protected field, unless MODE=LINE is coded.

Additional examples on the use of the $IMAGE subroutines are in the appendix of the *Language Reference*.

```
IMDISP   PROGRAM   BEGIN
         EXTRN     $IMOPEN,$IMDEFN,$IMPROT,$IMDATA
*
*          GET TERMINAL NAME FOR SCREEN PRINTOUT
*
BEGIN    READTEXT  IMAGE,'TERMINAL: '
*
*          GET IMAGE DATA SET NAME
*
         READTEXT  DSNAME,'DATA SET: ',PROMPT=COND
*
*          OPEN IMAGE DATA SET (4978 SCREEN IMAGE)
*
         CALL      $IMOPEN,(DSNAME),(DISKBFR)
         TCBGET    CODE,$TCBC02      * SAVE RETURN CODE
         IF        CODE,NE,-1        * CHECK RETURN CODE FOR ERRORS
           PRINTEXT  '@OPEN ERROR CODE'
           PRINTNUM  CODE            * PRINT ERROR CODE
           GOTO      NEXT            * ASK IF TRY AGAIN
         ENDIF
*
*        CONSTRUCT IOCB
*
         CALL      $IMDEFN,(IMAGE),(DISKBFR),0,0
         ENQT      IMAGE           *  ACQUIRE STATIC SCREEN
         TERMCTRL  BLANK           *  BLANK SCREEN
*                                  *  WRITE PROTECTED FIELDS
*                                  *  AND BUILD FIELD TABLE
*                                  *  AT FTAB
```

```
*       DISPLAY PROTECTED FIELD DATA ON
*       TERMINAL SCREEN
*
        CALL    $IMPROT,(DISKBFR),(FTAB)
*
*       DISPLAY DEFAULT DATA ON
*       TERMINAL SCREEN
*
        CALL    $IMDATA,(DISKBFR),(FTAB)
*                               *  SET CURSOR AT 1ST FIELD
        PRINTEXT LINE=FTAB,SPACES=FTAB+2
        TERMCTRL DISPLAY        *  UNBLANK SCREEN
        DEQT                    *  RETURN TO THIS TERMINAL
        WAIT    KEY             *  WAIT FOR OPERATOR
        ENQT    IMAGE           *  BACK TO TARGET TERMINAL
        TERMCTRL BLANK          *  BLANK SCREEN
*
*       DISPLAY #'S IN DATA FIELDS
*
        ENQT    IMAGE           *  ACQUIRE STATIC SCREEN
        CALL    $IMDATA,(REPBFR),(FTAB)
        DEQT
        WAIT    KEY             *  ALLOW VIEWING TIME
        ENQT    IMAGE           *  ACQUIRE STATIC SCREEN
        ERASE   LINE=0,MODE=SCREEN,TYPE=ALL  * ERASE
        DEQT                    *  BACK TO ROLL SCREEN
NEXT    QUESTION 'ANOTHER IMAGE? ',YES=BEGIN
        PROGSTOP
DSNAME  TEXT    LENGTH=16       *  DATA SET NAME
*
*       BUILD A BUFFER OF #'S FOR A SECOND DATA
*       FIELD DISPLAY
*
B1      DC      F'72'           * B1 AND B2 INDEX REPBFR
B2      DC      F'76'           * THAT HIGHLIGHTS THE DATA
REPBFR  DC      C'USER'         * FIELDS FOR USER
        DC      C'##################################'
        DC      C'##################################'
DISKBFR BUFFER  1064,BYTES      *  DISK BUFFER
        DC      X'0808'         *  TEXT CONTROL FOR NAME
IMAGE   IOCB    SCREEN=STATIC   *  IOCB FOR IMAGE
CODE    DC      F'0'            *  RETURN CODE
FTAB    BUFFER  300
LINE    TEXT    LENGTH=80
        ENDPROG
        END
```

$UNPACK and $PACK Subroutines

The $UNPACK and $PACK subroutines move and translate compressed/noncompressed byte strings. These subroutines are used internally by the $IMPROT and $IMDATA subroutines as well as by the $IMAGE utility. However, they can also be called directly by an application program.

The program preparation needed for applications calling $UNPACK and $PACK is similar to that needed for the $IMAGE subroutines. An EXTRN statement is required in the application and the autocall to $AUTO,ASMLIB is required in the link-control data set (input to $EDXLINK).

$UNPACK Subroutine

This subroutine moves a series of compressed and noncompressed byte strings and translates the byte strings to noncompressed form.

Syntax:

label	**CALL**	**$UNPACK,source,dest,P2=,P3=**
Required:	**source,dest**	
Defaults:	**none**	
Indexable:	**none**	

Operands	*Description*
source	The label of a fullword containing the address of a compressed byte string. (See Figure C-1 for the compressed format.) At completion of the operation, this parameter is increased by the length of the compressed string.
dest	The label of a fullword containing the address at which the expanded string is to be placed. The length of the expanded string is placed in the byte preceding this location. The $UNPACK subroutine can, therefore, conveniently be used to move and expand a compressed byte string into a TEXT buffer.

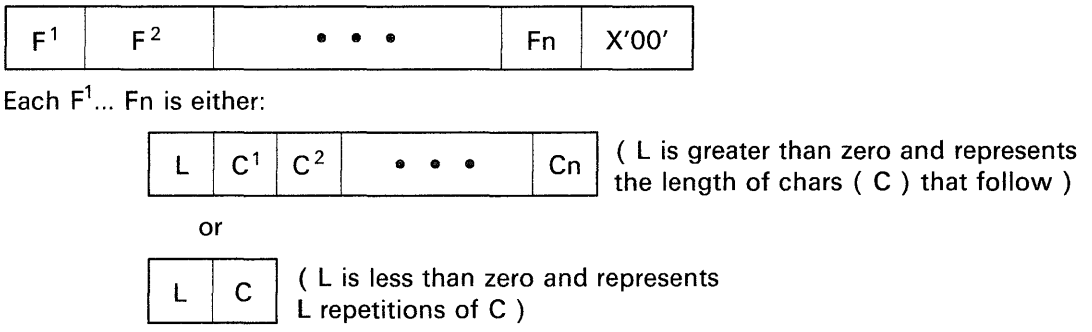

Figure C-1. Compressed Data Format

The following example shows how to unpack the compressed protected data of a $IMAGE screen format.

```
          •
          •
          •
          MOVEA   #1,OUTAREA          POINT TO EXPAND BUFFER
          MOVEA   CPOINTER,CBUF+12    POINT TO FIRST BYTE OF
*                                       COMPRESSED DATA
          MOVE    LINECNT,CBUF+4      INIT DO LOOP CTR
          MOVE    MOVELNG,CBUF+6      INIT MOVE LENGTH CODE
          DO      LINECNT
            CALL  $UNPACK,CPOINTER,STRGPTR    UNPACK COMPRESSED DATA
            MOVE  (0,#1),STRING,(0,BYTE),P3=MOVELNG    MOVE
*                                                       UNPACKED DATA
            ADD   #1,MOVELNG
          ENDDO
          •
          •
          •
OUTAREA   DATA    CL1920' '           WILL CONTAIN ALL OF THE
*                                       UNPACKED DATA
CPOINTER  DATA    A'0'                POINTER TO COMPRESSED DATA
LINECNT   DATA    F'0'                NBR OF FORMAT LINES TO UNPACK
STRGPTR   DATA    A(STRING)           ADDR OF TEMP LOCATION TO
*                                       RECEIVE UNPACKED DATA
STRING    TEXT    LENGTH=80           TEMP LOCATION TO RECEIVE
*                                       UNPACKED DATA
CBUF      BUFFER  1000,WORDS          CONTAINS $IMAGE FORMAT
                                        WITH PACKED DATA
```

$PACK Subroutine

This subroutine moves a byte string and translates it to compressed form.

Syntax:

label	**CALL**	**$PACK,source,dest,P2=,P3=**
Required:	**source,dest**	
Defaults:	**none**	
Indexable:	**none**	

Operands	*Description*
source	The label of a fullword containing the address of the string to be compressed. The length of the string is taken from the byte preceding this location, and the string could, therefore, be the contents of a TEXT buffer.
dest	The label of a fullword containing the address at which the compressed string is to be stored. At completion of the operation, this parameter is incremented by the length of the compressed string.

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