decsystem10

LINK-10 Programmer's Reference Manual

digital

DEC-10-ULKMA-B-D

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LINK-10 PROGRAMMER'S REFERENCE MANUAL

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CDP	DIGITAL	INDAC	PS/8
COMPUTER LAB	DNC	KA10	QUICKPOINT
COMSYST	EDGRIN	LAB-8	RAD-8
COMTEX	EDUSYSTEM	LAB-8/e	RSTS
DDT	FLIP CHIP	LAB-K	RSX
DEC	FOCAL	OMNIBUS	RTM
DECCOMM	GLC-8	OS/8	RT-11
DECTAPE	IDAC	PDP	SABR
DIBOL	IDACS	PHA	TYPESET 8
			UNIBUS

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FOREWORD

This manual is the reference document on the DECsystem-10 Linking Loader, LINK-10. It is aimed at the intermediate-level applications programmer and contains complete documentation on LINK-10, including descriptions of the LINK Item Types generated by the DECsystem-10 Translators.

Chapter 1 is an introduction to LINK-10 and describes the two methods of initializing the Linking-Loader. Chapter 2 discusses the automatic use of LINK-10 through the COMPIL-class commands, and Chapter 3 discusses the direct use of LINK-10 through the R LINK system command. LINK-10 switches are described in alphabetical order in Chapter 4. The overlay capability of LINK-10 is described in Chapter 5. Chapter 6 illustrates via examples the many uses of LINK-10. The Appendices and Glossary contain supplementary information.

A beginning user of LINK-10 can benefit from this manual by reading Chapters 1 and 2, whereas an advanced user would be more interested in Chapters 3, 4, and 5. A user who has been employing the LOADER program will find Appendix F a valuable aid in the transition to the LINK-10 program.

CHAPTER 1

INTRODUCTION TO LINK-10

LINK-10, the DECsystem-10 Linking Loader, is the system utility program that merges independently-translated modules of a user's program into a single module. Its main function is to prepare and link this input with other modules required by the user into a form that can be executed by the operating system.

1.1 INPUT TO LINK-10

LINK-10 accepts as its primary input the output from the DECsystem-10 translators in order to produce an executable version of the user's program. This output, known as object modules, is in the form of binary files which contain the user's programs and additional information generated by the translators. This additional information is necessary for linking separately-translated modules, for debugging, and for generating auxilary output such as map, log, and save files.

1.1.1 Relocatable Code

Most object modules contain relocatable code so that the module's position in core can be determined by LINK-10. Relocatable code is a benefit to both the user and the system. The user benefits because he is able to code all of his modules without regard to where they will be located in core. He need not be concerned with the location where one module ends and another one begins. The system benefits because a module written in relocatable code can be placed anywhere in core memory. When moving the relocatable object modules into the areas of core memory at which they will be executed, LINK-10 adjusts all relocatable addresses in the modules into actual machine locations. In reality, LINK-10 places the modules in a user virtual address space (refer to the Glossary) and the operating system, as it schedules the usage of the system, transfers the modules to and from core memory. However, for simplicity, the user virtual address space is referred to as core memory in the remainder of the manual.

1.1.2 Symbols and Libraries

In addition to relocating and loading the user's object modules, LINK-10 is also responsible for linking these modules with other modules required for execution. Linkages among modules are provided through the use of symbols. By including symbols in his programs, the user is delaying the assignment of actual values until load time. This method of assigning values is advantageous because:

- It allows the user to change only the definition of the symbol instead of changing every occurrence of the value, and
- Only the module containing the definition of the symbol must be retranslated when a change occurs. Since other modules using the symbol are bound to it at load time, they do not have to be retranslated.

Although a user can define and use a symbol entirely within a single module, he usually refers to additional symbols that are defined in other modules. It is these modules that must be linked to the user's program for execution. In most cases, these required modules are contained in a library of relocatable binary programs. Modules within a library can either be created and translated previously by the user or be part of the system's repertoire of programs. For instance, most higher-level languages have associated with them a library containing commonly-used mathematical, input/output, and data conversion routines. The user refers to modules in the library via symbols in his program and these symbols are then linked to the proper location in the library modules themselves. By linking these symbols and loading the required modules, LINK-10 provides communication between independently-translated modules and library routines.

In order to satisfy any undefined symbols, the required system libraries are usually searched after all loading specified by the user has been performed. However, the user can indicate that libraries be searched at a particular point in the loading procedure by specifying the appropriate switch to LINK-10 (refer to /SEARCH and /SYSLIB in Chapter 4). When LINK-10 processes the switch, the indicated libraries are searched and the required modules are loaded. The user also has the option of specifying by name which modules he wants (or does not want) loaded from a library or of inhibiting the search of the library altogether.

1.2 OUTPUT FROM LINK-10

When LINK-10 has performed the tasks of loading the user's object modules in core, bringing in and linking any other modules required for execution, and adjusting all the addresses, there is in core an executable version of the user's program. This executable version is the primary output of LINK-10. Since the loaded program at this point reflects the state of the user's core memory, it is usually referred to as his core image. Having arrived at this state, the user can request LINK-10 to either:

- Transfer control to the core image for immediate execution (using the EXECUTE or START system commands, or the /DEBUG, /EXECUTE, or /TEST switches in LINK-10), or
- Output the core image to a device for storage (using the SAVE or SSAVE system commands, or the /SAVE or /SSAVE switches in LINK-10) in order to avoid the loading procedure in the future.

If the complete, loaded program is saved on a device in core image form, it can be brought into core and executed at a later time (using the GET and RUN system commands). The loading process does not have to be repeated since the results of all of LINK-10's actions are contained in the core image. However, if the user wishes to revise the modules that made up his core image, he must once again use LINK-10.

While the primary output of LINK-10 is the executable version of the user's program, the user can request auxilary output from LINK-10 in the form of map, log, save, symbol, and expanded core image files (XPN files). Thi' additional output is not automatically generated by LINK-10 and the user must include the appropriate switches to obtain this output (refer to Chapter 4 for a description of the switches). This output is for the user's convenience when debugging his program.

1.3 OVERLAY FACILITY

LINK-10 has an overlay facility to be used when the total core required by a program is more than the core available to the user. The user organizes his program so that only some parts of the program are required in core at any one time. The remaining parts reside in a disk file and are transferred in and out of core. During execution, these transferable parts are brought into core as required. The part brought into core may overlay the part currently in that area. Because these parts of the program reside in the same area of core at different times, the amount of core required for the entire program is reduced.

When using the overlay facility of LINK-10, the user must have a good understanding of how his program operates. He then diagrams, via a tree-like structure, the relationships among the modules in his programs. Once he has decided on his overlay structure, the user can invoke overlays via runtime routines called from his user program or automatically via calls to subroutines outside the current overlay. Most programs do not need to explicitly call a runtime routine since LINK-10 attempts to define all external references to symbols automatically. Refer to Chapter 5 and Appendix B for additional information on LINK-10's overlay capability.

1.4 MISCELLANEOUS FEATURES

LINK-10 has a large number of options in order that the user can gain precise control over the loading process. The user can set various loading parameters and can control the loading of symbols and modules. By setting switches in his input command strings to LINK-10, he can specify the core size of LINK-10 modules, the start address of modules, the size of the symbol table, the messages that he will see on his terminal or in his log file, and the severity level and verbosity of the messages. He can control the loading of modules by specifying the modules that should be loaded and the files that should be searched for symbol definitions. He has control over the number of segments to be allowed and the segment into which the symbol table will be placed.

The user has control over file specifications that LINK-10 examines to determine device names and filenames. He can accept the LINK-10 defaults for components in a file specification or he can set his own defaults which will be used automatically when he omits a component from his command string. He can also position devices, allocate space and assign protections to output files, and clear directories of DECtapes.

Some options available to the user are interactive. In the process of producing a core image, LINK-10 attempts to satisfy all requests for symbols defined in other modules and allows the user to interactively ask for a list of undefined symbols during the loading procedure. The user then has the opportunity to define them without reloading.

1.5 INITIALIZATION OF LINK-10

LINK-10 is initialized by the user in one of two ways:

- Automatically through the use of the LOAD, EXECUTE, or DEBUG system commands. This is the most common usage of LINK-10.
- Directly through the use of the R LINK system command. This is recommended for very large and relatively complex loading procedures.

1.5.1 Using LINK-10 Automatically

LINK-10 is automatically initiated when the user issues one of the system commands LOAD, EXECUTE, or DEBUG. These commands are known as COMPIL-class commands because they use the COMPIL program to control the actions of DECsystem-10 translators and LINK-10. COMPIL's job is to accept the command string typed by the user, interpret it, and construct and pass new command strings to various system programs, including the translators and LINK-10. This action taken by COMPIL is a convenience to the user since it saves him from typing the command strings to LINK-10. Once the command string to COMPIL is processed, the user does not interactively communicate with the translators or LINK-10. LINK-10 processes the appropriate command strings passed to it by COMPIL and supplies intelligent defaults for any parameters not specified by the user. If LINK-10 obtains an error condition, it terminates the load and returns control to the operating system for further instructions. Otherwise, it loads the program and, depending on the COMPIL-class command used, either exits or starts the loaded program. Refer to Chapter 2 for the descriptions and use of the COMPIL-class commands.

In general, the extremely fine control of the loading process that is provided by manually running LINK-10 is not required for the average user because the COMPIL program supplies reasonable defaults to LINK-10.

1.5.2 Using LINK-10 Directly

Direct use of LINK-10 is useful for those who are developing large and complex programs, loading from devices other than disk, using the overlay capability, manipulating symbol tables for complex debugging situations, and performing segment manipulations.

The user runs LINK-10 directly by using the system command R LINK. LINK-10 responds with an asterisk which indicates that the user can type his input as a series of specifications which are to be used in the loading process. LINK-10 accepts input until the user specifies the exit condition; at which point it finishes all of its tasks and exits or begins the program, as specified by the user.

This method of running LINK-10 gives the user access to its full capability. The user does not have to accept LINK-10's default conditions, but can supply his own set of defaults. He can interactively monitor the loading process by setting internal parameters, requesting values of particular items, specifying modules and files to be loaded, and controlling the format and contents of output files. Refer to Chapter 3 for the description of the LINK-10 command string, and Chapter 4 for the switches used when directly running LINK-10.

CHAPTER 2

AUTOMATIC USE OF LINK-10

The user causes LINK-10 to be run automatically whenever he types the LOAD, EXECUTE, and DEBUG system commands. These commands accept a simple command string format and are converted internally to a series of more complex command strings that are directly processed by various system programs, including language translators and LINK-10. The aforementioned commands are used to compile, load, and execute programs, to obtain output in the form of maps, to search files in library search mode, and to invoke the various debugging aids. The following paragraphs describe each of these system commands.

NOTE

The information in this chapter is a subset of the material available on the LOAD, EXECUTE, and DEBUG commands. The subset presented here assumes that the source files have previously been translated, and thus only the switches directly applicable to loading the binary files are listed. Complete reference documentation on the COMPIL-class commands, their valid command formats, and all available switches can be obtained from the appropriate command descriptions in DECsystem-10 OPERATING SYSTEM COMMANDS, DEC-10-MRDD-D, located in the DECsystem-10 SOFTWARE NOTEBOOKS and in the DECsystem-10 USERS HANDBOOK, DEC-10-NGZB-D.

The LOAD command translates the user-specified source files into relocatable object modules (if necessary) and loads these object modules to form a core image. This command does not cause execution of the resulting core image. After completion of this command, the user can either execute his program (START system command) or save the core image (SAVE or SSAVE system command) for future execution.

Automatic Use of LINK-10

The EXECUTE commmand translates the user-specified source files (if necessary), loads the object modules into a core image, and, in addition, begins execution of the program. The action of this command is the same as that of the LOAD command followed by the START system command.

The DEBUG command translates the user-specified source files (if necessary), loads the object modules into a core image, and prepares for debugging by additionally loading a system debugging program. Usually this debugging program is loaded first, followed by the user's program and other information required by the debugging program (e.g., the symbol table). However, when COBOL programs are being loaded, COBDDT (the COBOL debugging program) is loaded after the user's program. Upon completion of loading, control is transferred to the debugging program, rather than the user's program, so that the user can check out his program by examining and modifying the contents of locations. This examination and modification can occur both before program execution begins and during execution if the user specifies breakpoints in the program at which execution is to be suspended.

The debugging program can be COBDDT, MANTIS, or DDT, depending on the first source file in the command string. If the first file is a COBOL file, COBDDT (the COBOL debugging program) is loaded. If the first file is a FORTRAN source file, FORDDT (the FORTRAN debugging program) is loaded. If the first file is any other file, DDT (the Dynamic Debugging Technique) is loaded. When the first file has previously been compiled (i.e., the file has an extension of .REL, meaning relocatable binary object module), COMPIL does not determine the type of source file from which it came so DDT is loaded with the binary files. In this case, if the user desires COBDDT or FORDDT, he must explicitly specify this debugging program via the appropriate switch (refer to the /COBOL and /FORDDT switches in DECsystem-10 OPERATING SYSTEM COMMANDS).

2.1 GENERAL COMMAND FORMAT

The LOAD, EXECUTE, and DEBUG system commands have the same general command format. They all accept a list of file specifications.

```
LOAD output file spec = concatenated input file specs

EXECUTE output file spec = concatenated input file specs

DEBUG output file spec = concatenated input file specs
```

An input or output file specification consists of a device name, a filename with or without a filename extension, and a directory enclosed in square brackets. Only one output file specification can be given on the left of each equals sign, but any number of input file specifications can occur on the right. Input file specifications are separated from each other by commas or plus signs. If commas are used, the translator produces separate relocatable object modules for each output file. If plus signs are used, the input files separated by plus signs will be translated into a single relocatable object module. Plus signs must be used when a collection of files must be concatenated to produce an acceptable module as input to a translator. The sequence of "output file spec = concatenated input file specs" can be given repeatedly in a command string by separating each sequence with a comma.

Automatic Use of LINK-10

The output file specification and the equals sign can be omitted, in which case the object module is placed in the user's default directory on the disk with a name derived from the source file and the extension .REL. The filename given to the output file depends upon the form of the user's input file specifications. If the user has only one input file, the output file is given the name of the input file. If the user has more than one input file and the files are separated by commas, the name of each output file is the name of the corresponding input file. If the user has plus signs separating the file specifications, the name given to the output file is the name of the last input file in the series of files separated by plus signs.

2.2 COMPIL SWITCHES

Switches can be included on the LOAD, EXECUTE, and DEBUG command strings to direct LINK-10 in its processing. These switches are used to generate listings, to create libraries, to search user libraries, and to obtain loader maps. Each switch is preceded by a slash and can be either temporary or permanent. A temporary switch applies only to the file immediately preceding it. Characters (including spaces or commas) cannot separate the filename and the switch. A permanent switch applies to all files following it until modified by a subsequent switch. It is separated from the file it precedes by a space or a comma.

LINK-10 switches described in Chapter 4 can be passed on the COMPIL-class command strings by preceding the switch specification with a % character instead of a / character. Following the % character is the LINK-10 switch specification preceded and followed by a delimiter. The delimiter can be any character; however, the user must be careful that the character he uses does not have a specific meaning to the COMPIL program. For example, the @ character indicates an indirect command file, and the semicolon causes the remainder of the line to be treated as a comment and thus ignored. The recommended delimiter is a single or double quote character. The beginning and ending delimiter must be the same character. A LINK-10 switch specification consists of the switch name and optionally a keyword and a value. The items in the specification are separated by colons. (Refer to Chapter 4 for the formats of the individual LINK-10 switches.) Note that LOADER switches (those beginning with a % but without enclosing delimiters) are illegal when passed to LINK-10. As an aid to users, a warning message is printed if the LINK-10 switch delimiter is one that could be interpreted as a LOADER switch (e.g.,A-Z,a-z,0-9,&, and -).

Since the first function of each of these three commands is to determine if the source files need translating (i.e., compiling or assembling), there are many switches that pertain to the translating process. The purpose of this manual is to describe the use of LINK-10 and switches pertaining to the translation of the source file are not included. All switches that can be placed on the command string are described in DECsystem-10 OPERATING SYSTEM COMMANDS.

Table 2-1
COMPIL Switches Pertaining to Loading

Switch	Meaning
/DDT	Loads DDT regardless of the extension of the first file in the command string. This is a permanent switch in that it applies to all subsequent files regardless of its position in the command string.
/FOROTS	Loads the file with FOROTS (the FORTRAN-10 object time system) instead of FORSE. This switch affects FORTRAN files only.
/FORSE	Loads the file with FORSE (the F40 object time system) instead of FOROTS. This switch affects FORTRAN files only.
/LIBRARY	The action is identical to that of the /SEARCH switch. The use of the /SEARCH switch is recommended since it is the complement of /NOSEARCH.
/LINK	Causes the files to be loaded by the LINK-10 program instead of the LOADER program. Since this the default action, this switch is needed only if the installation has specified LOADER as the default linking-loader.
/LMAP	Produces a loader map during the loading process (same action as /MAP) containing the local symbols.
/LOADER	Causes the file to be loaded by the LOADER program instead of the LINK-10 program. If used, this switch must be placed before any file specifications (either implied or or explicit) since the COMPIL program may have to generate load-control switches.
/MAP	Produces a load map during the loading process. The map does not contain local symbols. When this switch is encountered, a loader map is requested from LINK-10. After the library search of the default system libraries, the map is written in the user's disk area with the filename specified by the user (e.g., /MAP:dev:file.ext[directory]) or the default filename (e.g., the name of the last program seen with a start address or nnnLNK.MAP (where nnn is the user's job number) if there is no such program). This switch is an exception to the permanent switch rule in that it causes only one map to be produced even though it may appear as a permanent switch.
/NOSEARCH	Loads all routines of the file whether the routines are referenced or not. Since this is the default action, this switch is used only to turn off library search mode (/LIBRARY or /SEARCH).

Table 2-1 (Cont.)
COMPIL Switches Pertaining to Loading

Switch	Meaning
/NOSEARCH (Cont.)	This switch is not equivalent to the /NOSYSLIB switch of LINK-10, which does not search any libraries, including the default system libraries. The /NOSEARCH default is to search the default system libraries.
/SEARCH	Loads the files in library search mode. This mode causes a module in a special library file to be loaded only if one or more of its declared entry symbols satisfies an undefined global request. The default system libraries are always searched regardless of the state of this switch.

2.3 SPECIFYING DISK AREAS OTHER THAN SYS

When translating his source files, the user has the option of selecting the disk area from which the language translator is obtained. The disk areas are [1,3] for OLD, [1,4] for SYS, [1,5] for NEW, and the user's area for DSK and are specified by the switches /OLD, /SYS, /NEW, and /SELF, respectively. (These four switches are described in DECsystem-10 OPERATING SYSTEM COMMANDS.) For example, if the user is translating his source files with a FORTRAN compiler that is on the OLD disk area of [1,3], he gives the following command string:

```
COMPILE/OLD FILEA.F4,FILEB.F4,FILEC.F4
```

The FORTRAN compiler is then obtained from area [1,3].

The first disk area seen in the command string is also the area from which LINK-10 is obtained. Thus, in the command string:

```
LOAD /OLD FILEA.F4,FILEB.F4,FILEC.F4
```

not only is the FORTRAN compiler obtained from OLD, but also the LINK-10 linking-loader. If LINK-10 is not found on the specified area, then the SYS disk area of [1,4] is searched. However, if the first disk area seen is the user's area (as indicated by the /SELF switch), only the areas specified in the user's job search list, which may include a user library (LIB), are searched. The searching does not continue onto the NEW, OLD, and SYS areas. Thus, a user who is using a copy of a translator in his disk area but who does not have a copy of LINK-10 in that area must use two disk area specifications. For example,

```
LOAD /SYS /SELF FILEA.FOR,FILEB.FOR,FILEC.FOR
```

LINK-10 is obtained from the SYS disk area and the FORTRAN compiler from the user's disk area. Since SYS will be searched for LINK-10 on all disk specifications other than SELF, the user needs to specify two disk areas only when he is using a translator from his area.

2.4 SAVE AND SSAVE SYSTEM COMMANDS

After loading is completed, the loaded program may be written onto an output device so that it can be executed at some future date without rerunning LINK-10. The SAVE and SSAVE system commands output the core image onto the specified device as one or two files. If the SAVE command is used, the program will be nonsharable when it is later loaded into core. When the SSAVE command is used, the high segment (if any) of the program will be sharable when the program is loaded. The general command format of the two commands is the same:

```
SAVE dev:file.ext[directory]core

SSAVE dev:file.ext[directory]core
```

where

dev: is the name of the device on which to write the saved file. If omitted, DSK: is assumed.

file is the name of the saved file. If omitted, the job's current name is used. This name is set by the last R, RUN, GET, SAVE, or SSAVE system command, the last command which ran a program (e.g., DIRECT), or the last SETNAM UUO.

.ext is the extension of the low segment file. If omitted, the following extensions are assigned:

> If the program has one segment, the extension .SAV is assigned.
>
> If the program has two segments, the low segment file has the extension .LOW, and the high segment file has the extension .HGH when a SAVE command is used and the extension .SHR when a SSAVE command is used.

[directory] is the area in which to save the file. If omitted, the user's default directory is used.

core is the amount of core in which to save the program. If omitted, the minimum required is assigned.

Refer to DECsystem-10 OPERATING SYSTEM COMMANDS for complete descriptions on the SAVE and SSAVE commands.

2.5 EXAMPLES

In the following example, the user is translating, loading, and executing a MACRO program. The /LINK switch requests that the LINK-10 linking loader be used instead of the LOADER.

```
.EXECUTE /SIMPLE.MAC⤸
MACRO: SIMPLE
LINK:  LOADING
[EXECUTION]
THIS IS A VERY SIMPLE TWO-SEGMENT MACRO PROGRAM.

EXIT

.
```

In the example below, the user is compiling, loading, and executing three COBOL programs. The /MAP:PROGMP.MAP switch requests the generation of a map file with the name PROGMP.MAP.

```
.EXECUTE /MAP:PROGMP FILA,FILB,FILC⤸
COBOL:  CBS08A  [FILA.CBL]
COBOL:  CBS08B  [FILB.CBL]
COBOL:  CBS08C  [FILC.CBL]
LINK:   LOADING
[EXECUTION]
RUNNING CBS08A
RUNNING CBS08B
RUNNING CBS08C

EXIT

.
```

The map file is now on the user's disk area. He can print the file with the following command:

```
.PRINT PROGMP.MAP⤸
TOTAL OF 3 BLOCKS IN LPT REQUEST
```

The following is a listing of the map file generated.

```
                 LINK-10 SYMBOL MAP OF    PROGMP           PAGE 1
            PRODUCED BY LINK-10 VERSION (32) ON  2-APR-73 AT  8:25:10

LOW  SEGMENT STARTS AT        0 ENDS AT    2416 LENGTH     2416 = 2K
        STARTING ADDRESS IS   1250, LOCATED IN PROGRAM CBS08A

                *************

JOBDAT-INITIAL-SYMBOLS

        ZERO LENGTH MODULE

                *************

LIBOL-STATIC-AREA
        LOW  SEGMENT STARTS AT     140 ENDS AT    1200 LENGTH     1040 (OCTAL), 544 (DECIMAL)

        .COMM.          140    COMMON          LENGTH         544     (DECIMAL)

                *************

CBS08A  FROM DSK:FILA.REL[27,235]       CREATED BY COBOL ON  2-APR-73 AT  8:24:00
        LOW  SEGMENT STARTS AT    1200 ENDS AT    1355 LENGTH      155 (OCTAL), 109 (DECIMAL)

        CBS08A          1270    ENTRY  POINT    RELOCATABLE

                *************

CBS08B  FROM DSK:FILB.REL[27,235]       CREATED BY COBOL ON  2-APR-73 AT  8:24:00
        LOW  SEGMENT STARTS AT    1355 ENDS AT    2040 LENGTH      463 (OCTAL), 307 (DECIMAL)

        CBS08B          1464    ENTRY  POINT    RELOCATABLE

                *************
```

```
CBS08C  FROM DSK:FILC.REL[27,235]       CREATED BY COBOL ON  2-APR-73 AT  8:25:00
        LOW  SEGMENT STARTS AT    2040 ENDS AT    2407 LENGTH      347 (OCTAL). 231 (DECIMAL)

        CBS08C          2140    ENTRY  POINT    RELOCATABLE

                ************

TRACED  FROM SYS:LIBOL.REL[1,4] CREATED ON 23-MAR-73 AT 16:40:00
        LOW  SEGMENT STARTS AT    2407 ENDS AT    2416 LENGTH        7 (OCTAL). 7 (DECIMAL)

        BTRAC.          2412    ENTRY  POINT    RELOCATABLE
        CBDDT.          2413    ENTRY  POINT    RELOCATABLE
        PTFLG.          2414    GLOBAL SYMBOL   RELOCATABLE
        TRACE.          2407    ENTRY  POINT    RELOCATABLE
        TRPD.           2412    ENTRY  POINT    RELOCATABLE
        TRPOP.          2412    ENTRY  POINT    RELOCATABLE

                ************

        [END OF LINK-10 MAP OF  PROGMP]
```

2.6 SUMMARY

The LOAD, EXECUTE, and DEBUG system commands, along with the switches described in Table 2-1, are sufficient for loading and executing most programs. The user can load separately-compiled programs and debugging programs, obtain maps, search files in a library search mode, and execute the program. To produce a saved file of his core image, the user can employ the system commands SAVE and SSAVE. More complex loading procedures can be performed by directly using LINK-10, as described in Chapter 3.

CHAPTER 3

USING LINK-10

The user runs LINK-10 directly by issuing the system command

```
          R LINK
```

LINK-10 responds with an asterisk at which point the user types in his command strings. The LINK-10 program interprets all of the input typed by the user up to the end of the command string. A command string is defined as a series of characters terminated by a carriage return-line feed. A carriage return-line feed is generated when the user depresses the RETURN key on his terminal. The RETURN key is represented in this manual by the symbol ↵. If the user needs to continue a command string on another line, he can place a hyphen as the last non-blank, non-comment character before the carriage return-line feed. Continuation lines are considered part of the current command string, and the current string is not considered terminated until a carriage return-line feed is seen without a preceding hyphen. Comments may be added to any line by preceding the comment with a semicolon. Trailing spaces and tabs (including those before comments) are always ignored.

When the command string is terminated, LINK-10 processes the data in the command string by performing the actions specified by the user. This usually entails setting relevant internal conditions and storing information for later use. Each command string is completely scanned and processed before LINK-10 accepts a new one. After scanning and processing the current command string, LINK-10 returns with another asterisk signifying its readiness to accept more input. The program accepts command string input until the user gives the exit condition switch (/GO) indicating that LINK-10 is to finish all loading tasks. At this point control is either returned to the operating system or given to the loaded program for execution, depending upon the preceding command strings.

3.1 LINK-10 COMMAND STRINGS

Command strings to LINK-10 contain a series of input and/or output file specifications and non-conflicting switches to direct the loading process. The general command string format is as follows:

```
          *output specifications=input specifications
```

Any number of specifications can be included in the command string by separating each specification from other specifications with a comma. Although the equals sign is not required, it is recommended that the user include it so that he can distinguish his output specifications from his input ones. If the user does not include an equals sign, he must use a comma to separate the specifications. The input and output specifications are then distinguished by the type of switch associated with the specification, and the specifications can appear in any order (e.g., input specifications can precede output specifications).

An input or output specification consists of a file specification and switches appearing before and/or after the file specification. A file specification is in the form

```
dev:file.ext[directory]
```

and the individual switches that can be used in the command string are described in Chapter 4.

When items in a file specification are missing, LINK-10 has a set of initial values to be used as defaults. On input specifications, the default values assumed for missing items in a file specification are as follows:

Device	DSK:
Filename	A blank filename
Extension	.REL
Directory	The user's default directory

On output specifications, the default values are as follows:

Device	DSK:
Filename	Name of the last program containing a start address. If there is no program with a start address, the name nnnLNK, where nnn is the user's job number, is used.
Extension	Dependent on the type of output file requested via switches.
Directory	The user's default directory.

Log file	.LOG
Map file	.MAP
Overlay file	.OVL
Plotter file	.PLT
Saved file	.SHR,.HGH,.SAV,.LOW
Symbol file	.SYM
Expanded save file	.XPN

These defaults are applied just prior to initializing the device and opening the file, and are used only if the user has not given values for items in a file specification. The initial LINK-10 defaults for items in a file specification are used only when a value for the item does not appear in the command string or until the value is seen if it is after the beginning of the string.

If a component of a file specification is given before the filename, it remains in effect until changed by a value given subsequently by the user for the same component or until the end of the command string. For example, a user can specify a device name at the beginning of the string and not have to repeat the device name for each specification if he is using the same device for all specifications in the command string. However, once the device name is changed, the new name is used as the default device for the reaminder of the command string.

As another example, the user can specify an extension and a directory to be used by issuing a command string such as

```
     *.BIN[10,7]DSKB:FIL1,DSKC:FIL2.REL[10,20],DSKA:FIL3
```

The extension .BIN and the directory [10,7] are used for any specifications that do not include an extension or directory. The above command string is equivalent to

```
     *DSKB:FIL1.BIN[10,7],DSKC:FIL2.REL[10,20],DSKA:FIL3.REL[10,7]
```

3.2 CHANGING DEFAULTS

The /DEFAULT switch is used to change the initial values that are assumed when the user does not include a component of a file specification in his command string. The values specified with this switch remain in effect for the entire load unless changed by another /DEFAULT switch. The form of the /DEFAULT switch is as follows:

```
          components of file specification /DEFAULT:keyword
```

where

components of file specification are the components which the user wants as his default components.

keyword is either INPUT or OUTPUT to change the default components for the input or output specifications, respectively. If this argument is omitted, INPUT is assumed.

For example, the following specification

```
          DSKB:  .BIN[10,20]/DEFAULT
```

changes the values to be used as defaults for the input specifications to be DSKB: for the device, .BIN for the extension, and [10,20] for the directory.

NOTE

Because the extensions for output files depend upon the types of file being requested, the user cannot change the output extensions. Any attempt to do so is ignored.

3.3 LINK-10 SWITCH ALGORITHMS

LINK-10 allows the user to request various loading parameters via switches in the command string. Switches are used to specify output files, to set defaults, to control the loading of programs, to set values, to format maps and symbol tables, to request values of symbols, and to position devices. Some switches merely change the status of LINK-10 by setting internal values; others request immediate action to be taken.

LINK-10 has several categories of switches with a specific algorithm for the handling of each category. These categories are:

- Device Switches
- File Dependent Switches
- Output Switches
- Immediate Action Switches
- Delayed Action Switches
- Switches that create implicit file specifications

3.3.1 Device Switches

Switches in this category (e.g., /SKIP, /REWIND) affect the device within an input or output specification. The switch is in effect after the device is initialized and, depending on its position, either before or after the file is read or written. If the switch appears before the filename, the appropriate action is taken before the file is processed, and if it appears after the filename, action is taken after the file is processed. Switches in this category apply only to the current input or output specification and do not carry over to subsequent devices. In other words, once the requested action is performed, it is not performed again unless another device switch is given.

For example, the following specification may be given by the user:

```
/SKIP:2 MTA1:MYFILE/UNLOAD,
```

After the magnetic tape is initialized, LINK-10 skips forward over two files (/SKIP:2), reads the file called MYFILE, and after reading the file, rewinds and unloads the tape (/UNLOAD).

3.3.2 File Dependent Switches

Switches belonging to this category (e.g.,/NOLOCAL, /SEARCH) modify the loading or the contents of a file. These switches are either temporary or permanent in nature. A temporary switch applies only to the file specification immediately preceding it. An intervening comma cannot separate the file specification and the switch. A permanent switch appears before the file specification and applies to all file specifications following it until modified by a subsequent switch or until the end of the current command string is reached. (Remember that continuation lines are considered part of the current command string). This means that permanent file-dependent switches, unlike device switches, continue to apply to following specifications (i.e., the action requested by the switch is not terminated at the comma which separates specifications).

For example, the following specifications may be issued by the user:

```
,/NOLOCAL DTA3:MAIN1,MAIN2,MYLIB/SEARCH,
```

Two files, MAIN1 and MAIN2, are loaded in their entirety from DTA3 without their local symbols. The file MYLIB is searched and parts of it are loaded only if required (i.e., they are required to satisfy any undefined symbol requests); if needed, they are also loaded without local symbols.

3.3.3 Output Switches

Switches in this category (e.g.,/MAP, /LOG, /OVERLAY, /SAVE) initialize the output devices and create the output files. Each output specification must contain one of these switches because LINK-10 does not create output files unless explicitly requested to do so. Each switch represents a specific type of output file and is used with a file specification to indicate the device and filename of the file. Only one output switch can be used with each output specification. If the switch is the only item appearing in the output specification, the device name and filename are taken from the previous specification or from the LINK-10 defaults for output.

For example, if the user desires a saved file and a map file on DSKB: and both with the name OUTPUT, he can issue the following specifications:

```
DSKB:OUTPUT/SAVE,/MAP=
```

The two files will have the same filename (OUTPUT) but, by default, the extensions will be different (refer to Paragraph 3.1). The comma separating the two switches is required to indicate that two output files are desired. If the user is satisfied with accepting the LINK-10 defaults for output specifications, he can give the following

```
/SAVE,/MAP=
```

NOTE

Although the /LOG switch is considered an output switch, it is handled in a slightly different fashion from the remaining output switches. By assigning a device the logical name LOG before initializing LINK-10, the user receives the log file on the device assigned as LOG, even if he does not include the /LOG switch in his command string. The filename associated with the log file is nnnLNK.LOG, where nnn is the user's job number. The /LOG switch can then be used in the LINK-10 command string to change the filename of the log file. For example,

```
.ASSIGN DSKC:LOG:↵
.R LINK↵
*DSKC:MYLOG/LOG↵
```

renames the log file on DSKC: from nnnLNK.LOG to MYLOG.LOG. If the logical device is not assigned, then the building of the log file begins when the /LOG switch is seen. This results in the initialization timings not being included in the file.

3.3.4 Immediate Action Switches

Switches in this category (e.g., /UNDEF, /VALUE, /NOINITIAL, /NOSYM) are processed by LINK-10 as soon as they are seen. These switches are divided into two types:

- Those that request typeout from LINK-10.
- Those that change the status of the loading procedure.

Type-out switches (e.g., /UNDEF) request information from LINK-10 and are not dependent upon a particular specification. For this reason, they can appear anywhere in the command string but are usually on a command line by themselves because the user is interactively requesting information to determine if he may have forgotten to specify needed parameters. After processing the switch (i.e., at the end of the command string), LINK-10 returns the requested information immediately. Once the information is returned to the user, the switch is cleared.

Status changing switches (e.g.,/NOINITIAL, /NOSYM) are related to the entire loading procedure and not to an individual specification. They are placed in the command string at the point at which the user wants the action to be performed. Once the action has been taken, it is in effect for the entire loading process and cannot be overridden. For example, once the user gives the /NOSYM switch to notify LINK-10 not to generate a local symbol table, he cannot, in the same load, give a switch to LINK-10 to nullify this action.

3.3.5 Delayed Action Switches

Switches in this category (e.g., /MAXCOR, /HASHSIZE) are used to change operational parameters of LINK-10 to the specified values. When the switch is seen, LINK-10 accepts the value but does not use it until it is needed. For example, there is a preset value for the maximum core LINK-10 can occupy during loading. Use of the /MAXCOR switch changes this value immediately but LINK-10 does not examine the value until it needs to expand its core size.

3.3.6 Switches that Create Implicit File Specifications

Switches in this category (e.g., /DEBUG, /SYSLIB) cause LINK-10 to create one or more input file specifications for programs that must be loaded along with the user's program and to set various other switches related to the implicitly specified file. As an example, the /DEBUG switch indicates that a debugging program is to be loaded and that subsequent modules are to be loaded with local symbols, unless otherwise specified by the user. If one of these switches appears before the file specification, the program implied by the switch is loaded before the current file. If the switch is after the file specification, the program is loaded after the current file. Once the program implied by the switch is loaded, the switch is cleared.

3.4 LINK-10 SWITCHES

Switches to LINK-10 have one of the following forms:

```
/switch
/switch:arg
/switch:(arg,...,arg)
/switch:value
/switch:arg:value
/switch:(arg:value,...,arg:value)
```

where

/switch	is the name of the desired switch. This name can be truncated to a unique abbreviation. The first six characters of the name are sufficient to ensure uniqueness.
arg	is a keyword or a symbol name. Keywords can be truncated to a unique abbreviation.
value	is either a decimal or octal number. An octal value can be used with a switch that accepts decimal values by preceding the octal value with a number sign (#).
:	is the separator between components in a switch specification and must be present if more than one item is given.
( )	are used to enclose multiple keywords and/or values to a switch. They are required if more than one argument appears with the switch.

Each switch specification must be terminated with a space; however, spaces cannot appear within a switch specification (i.e., between the slash and the end of the value). If spaces do appear within the switch specification, the command scanner will either interpret the switch specification incorrectly or return an error message if it cannot decipher the switch. For example, in the switch specification

```
/SEA RCH FILE1
```

the command scanner interprets the characters RCH as a filename and complains about two filenames, RCH and FILE1.

Table 3-1 briefly describes the switches that can be used on the LINK-10 command string, and Chapter 4 contains the complete descriptions of the switches in alphabetical order.

Table 3-1
LINK-10 Switches

Switch	Meaning
/BACKSPACE	Spaces backwards over the specified number of files.
/COMMON	Allocates a COMMON area.
/CONTENTS	Specifies the types of symbols to be output in a map.
/CORE	Specifies LINK-10's initial low segment size.
/COUNTER	Lists the relocation counters and their values.
/CPU	Specifies the processor on which the program will run.
/DEBUG or /D	Loads and specifies execution of a debugging program.
/DEFAULT	Changes default values for missing components in a file specification.
/DEFINE	Assigns values to undefined global symbols interactively.
/ENTRY	Lists library search symbols.
/ERRORLEVEL	Selectively suppresses messages to the terminal.
/ESTIMATE	Allocates disk space for an output file.
/EXCLUDE	Inhibits the loading of specified modules.
/EXECUTE or /E	Specifies execution of the program upon completion of loading.
/FOROTS	Loads FOROTS, if required, during default system library searching.
/FORSE	Loads FORSE, if required, during default system library searching.

Table 3-1 (Cont.)
LINK-10 Switches

Switch	Meaning
/FRECOR	Specifies the amount of free core guaranteed after each expansion.
/GO or /G	Terminates the loading progress.
/HASHSIZE	Specifies the size of the global symbol table.
/INCLUDE	Forces the loading of specified modules from a library.
/LINK	Outputs the current core image to the overlay file.
/LOCALS or /L	Loads with local symbols.
/LOG	Causes a log file to be generated.
/LOGLEVEL	Suppresses messages to the log file.
/MAP or /M	Causes a map file to be generated.
/MAXCOR	Specifies LINK-10's maximum low segment core size.
/MPSORT	Sorts the symbol table for output to the map file.
/MTAPE	Performs magnetic tape functions.
/NODE	Returns LINK-10 to the end of the specified link.
/NOENTRY	Causes LINK-10 to ignore the specified symbol as a library search symbol.
/NOINITIAL	Clears the initial global symbol tables.
/NOLOCAL or /N	Loads without local symbols.
/NOREQUEST	Prevents generation of references to other links.
/NOSEARCH	Turns off user library search mode.
/NOSTART	Ignores starting addresses.
/NOSYMBOL	Inhibits the generation of a symbol table in core.

Table 3-1 (Cont.)
LINK-10 Switches

Switch	Meaning
/NOSYSLIB	Prevents a search of the default system libraries.
/NOUSERLIBRARY	Terminates the automatic searching of the specified user library.
/ONLY	Loads only the high, or the low, segment of a .REL file.
/OTS	Indicates the segment for the object time system.
/OVERLAY	Causes an overlay file to be generated.
/PATCHSIZE	Allocates patch space.
/PLOT	Causes a plotter file to be generated.
/REQUEST	Types references to other links.
/REQUIRE	Generates global requests for the specified symbols.
/REWIND	Rewinds the DECtape or magnetic tape.
/RUNCOR	Assigns the initial low segment core size for the program.
/RUNAME	Assigns the program name.
/SAVE	Causes a saved file to be generated.
/SEARCH or /S	Turns on user library search mode.
/SEGMENT	Specifies the segment in which to load the modules.
/SET	Defines the values of a relocation counter.
/SEVERITY	Defines the fatality level of errors.
/SKIP	Spaces forward on a magnetic tape.
/SPACE	Allocates core at the end of the current link.
/SSAVE	Causes a sharable saved file to be generated.

Table 3-1 (Cont.)
LINK-10 Switches

Switch	Meaning
/START	Specifies the start address of a program.
/SYMBOL	Causes a symbol file to be generated.
/SYMSEG	Moves the symbol table to the specified segment.
/SYSLIB	Performs a search of the default system libraries.
/SYSORT	Sorts the symbol table for output to the symbol file.
/TEST	Loads a debugging program.
/UNDEFINED or /U	Types undefined global symbols on the terminal.
/UNLOAD	Rewinds and unloads the DECtape or magnetic tape.
/USERLIBRARY	Searches the specified user libraries automatically.
/VALUE	Lists the current values of the specified global symbols.
/VERBOSITY	Specifies the amount of text to be printed for a message.
/VERSION	Sets or changes the version number of a file or the core image.
/XPN	Creates or saves the expanded core image file.
/ZERO	Clears the specified DECtape directory.

CHAPTER 4

LINK-10 SWITCHES

/BACKSPACE

Function

The /BACKSPACE switch is used to space backwards over the specified number of files. This switch has an effect only on tape devices and is ignored for non-tape devices.

Switch Format

/BACKSPACE:n

n is a decimal number representing the number of files to backspace over. If n is omitted, n=1 is assumed.

Category of Switch

Device Switch (refer to Paragraph 3.3.1)

Examples

```
,MTA0:/BACK:3,

     Backspace MTA0 by three files.
```

/COMMON

Function

The /COMMON switch is used to allocate an area of storage of the specified size before loading any more code. An array of storage (a COMMON area) is reserved into which data can be placed in order that it may be shared by several programs and routines. Because the FORTRAN language contains a statement that reserves space for a COMMON area, this switch is used to reserve COMMON arrays when loading non-FORTRAN programs or to allocate a different size area than given via the COMMON statement in a FORTRAN program. However, if this switch is used to allocate a larger size area of the same name as that given in the FORTRAN program, the switch specification must be given before the FORTRAN program is loaded.

The name of each labeled area of COMMON storage is defined as an internal symbol whose value is the address of the first word of the COMMON area. These symbols may be used by other programs as external symbols.

Switch Format

/COMMON:name:n

Name is the symbolic name of up to six SIXBIT characters of the COMMON area. Blank COMMON can be designated with either the symbolic name ".COMM." or a null name as in /COMMON::n.

n is a decimal number representing the size of the area in words.

Restrictions

Although various modules may redefine COMMON areas of the same name, the size of a COMMON area cannot be increased during the loading process. Therefore, the largest definition of a given COMMON area must be loaded first. Any attempt to increase the size of a COMMON area by redefinition will result in a fatal error. This applies to both modules defining COMMON areas and the /COMMON switch.

Category of Switch

Immediate Action Switch (refer to Paragraph 3.3.4)

Examples

```
/COMMON:.COMM.:1000
```

Allocate blank COMMON to be 1000 words.

/CONTENTS

Function

The /CONTENTS switch gives the user control over the contents of the map file by allowing him to specify the types of symbols to be included in the file. Each symbol is marked as to its type by the translator that processed the module containing the symbol. Some symbols may be of more than one type. For example, a symbol may be both a global symbol and a relocatable symbol. To insure the inclusion of such a symbol in the map file, the user must specify both the GLOBAL and the RELOCATABLE keywords in the /CONTENTS switch.

Each specification of the /CONTENTS switch is cumulative; keywords set by the first specification are not automatically cleared by the second specification. If the user desires to clear a keyword set in a previous specification, he must explicitly specify its complement.

NOTE

This switch does not produce a map file. The user must specify the /MAP switch on an output specification in order to obtain the file. Unless the /MAP is given, the /CONTENTS switch has no meaning and is ignored.

Switch Format

```
/CONTENTS:keyword

/CONTENTS:(keyword,. . ., keyword)
```

Keywords are as follows:

ABSOLUTE	include all absolute symbols (usually flags, accumulators, and masks). Complement of NOABSOLUTE.
ALL	include all symbols. Complement of NONE.
COMMON	include all COMMON symbols. Complement of NOCOMMON.

DEFAULT	include the symbols according to LINK-10's default setting, that is: COMMON, GLOBAL, ENTRY, ABSOLUTE, RELOCATABLE, NOLOCAL, and NOZERO. This keyword is used to reset the /CONTENTS switch to the original default setting.
ENTRY	include all entry name symbols. Complement of NOENTRY.
GLOBAL	include all global symbols including COMMON and ENTRY symbols unless these symbols are suppressed with the NOCOMMON and NOENTRY keywords. Complement of NOGLOBAL.
LOCALS	include all local symbols. Complement of NOLOCAL.
NOABSOLUTE	do not include absolute symbols (i.e., turn off the condition corresponding to absolute symbols). Complement of ABSOLUTE.
NOCOMMON	do not include COMMON symbols. Complement of COMMON.
NOENTRY	do not include entry name symbols. Complement of ENTRY.
NOGLOBAL	do not include global symbols including COMMON and ENTRY symbols unless these symbols are requested with the COMMON and ENTRY keywords. Complement of GLOBAL.
NOLOCAL	do not include local symbols. Complement of LOCALS.
NONE	do not include any symbols of any kind. However, header information is still output in the map. Complement of ALL.
NORELOCATABLE	do not include relocatable symbols. Complement of RELOCATABLE.
NOZERO	do not include symbols from zero length programs. Complement of ZERO.
RELOCATABLE	include symbols that are relocatable (usually addresses). Complement of NORELOCATABLE.
ZERO	include symbols from zero length modules (usually parameter files). A zero length module is one which defines symbols but generates no code. Complement of NOZERO.

If the /CONTENTS switch is not specified, the default setting is COMMON, GLOBAL, ENTRY, RELOCATABLE, ABSOLUTE, NOLOCAL, and NOZERO. When the user specifies a keyword, the keyword is either added to the default setting or deleted from the default setting. For example, if the user issues the /CONTENTS:ZERO switch, the condition for symbols in zero length programs is added to the default setting. However, the keywords ALL, NONE, and DEFAULT reset the default setting to their respective meanings.

This switch applies to all files loaded, not just to those which appear after it in the command string.

Category of Switch

Delayed Action Switch (refer to Paragraph 3.3.5)

Examples

/CONTENT:(ZERO,LOCAL),

> Include in the map local symbols and symbols from zero length modules, in addition to the types of symbols in LINK-10's default setting.

/CORE

Function

The /CORE switch is used to specify the initial size of LINK-10's low segment. Generally, this size is less than or equal to MAXCOR (the maximum size of LINK-10's low segment). If the size specified in the /CORE switch is greater than MAXCOR, the core will be assigned. However, the next time LINK-10 needs to expand core, the size will be reduced to MAXCOR.

Switch Format

/CORE:n

n is a decimal number that represents the initial low segment core size for LINK-10. An octal value can be given by preceding it with a number sign (#). N is expressed in units of 1024 words or 512 words (a page) by following the number with K or P respectively. If K or P is omitted, K (1024 words) is assumed.

Category of Switch

Immediate Action Switch (refer to Paragraph 3.3.4)

Examples

/CORE:17K

Specify 17K words as the initial size of LINK-10's low segment.

/COUNTER

Function

The /COUNTER switch is used to output to the terminal the relocation counters, their initial and current values, and for undefined counters, the length of code depending on them. When a relocation counter is not known, a count of the amount of core used by the counter is kept so that loading can be resolved. Code depending on the counter is stored on the disk until the counter is defined.

Although LINK-10 is designed to handle an indefinite number of relocation counters to provide efficient program construction, it currently uses only two relocation counters, the low segment counter (.LOW.) and the high segment counter (.HIGH.). These counters are listed in a map file with their initial and final value.

Switch Format

/COUNTER

Category of Switch

Immediate Action Typeout Switch (refer to Paragraph 3.3.4)

Examples

/COUNTER

```
[LNKRLC    RELOC. CTR.   INITIAL VALUE     CURRENT VALUE(OCTAL)]
           .LOW.               0               140
           .HIGH.         400000           400010
```

/CPU

Function

The /CPU switch is used to indicate the central processor on which the program will run once it has been loaded.

Switch Format

/CPU:keyword

Keyword is either KA10 or KI10. If the keyword is omitted, KA10 is assumed. If the /CPU switch is omitted, the machine on which the program is loaded is assumed.

Category of Switch

Delayed Action Switch (refer to Paragraph 3.3.5)

Examples

/CPU:KI10

Run the program on the KI10 processor.

/DEBUG

Function

The /DEBUG switch is used to load a debugging program and to specify that execution of the load will begin at the normal start address of the debugging program instead of the user's program. The debugging programs available are DDT, MANTIS, and COBDDT. This switch does not cause termination of the loading procedure; the /GO switch is needed for termination. The /EXECUTE switch is not used for execution when the /DEBUG switch is given.

The /DEBUG switch turns on the load with local symbols mode and causes it to be in effect for the remainder of the load unless overridden by the /NOLOCALS switch. However, since the /NOLOCALS switch is file dependent, it is cleared at the end of the command string in which it appears and local symbols mode is reinstated. Note that the /LOCALS switch is also file dependent; therefore, the use of the /LOCALS switch and the implicit use of the /LOCALS switch in the /DEBUG switch context have different results (i.e., the /LOCALS switch is cleared at the end of the command string and the load with local symbols mode implied by the /DEBUG switch is not).

The /DEBUG switch does not cause the local symbols of the debugging program to be loaded, regardless of the state of the /LOCALS switch.

Switch Format

/DEBUG:keyword

Keyword is one of the following: COBDDT, COBOL, DDT, FORTRAN, MACRO, MANTIS. (COBOL can be abbreviated to the single letter C.) SAIL and FAIL can also be given as keywords and cause a special version of DDT (called SDDT) to be loaded. However, SAIL, FAIL, and SDDT are not DEC-supported programs. When a compiler or the assembler is specified, the debugging aid associated with that translator is used. For example, if MACRO is specified, the loading of DDT is implied. If the keyword is omitted, DDT is assumed.

Category of Switch

Creates an implicit file specification (refer to Paragraph 3.3.6)

Examples

,/DEBUG:DDT DTA3:FILEA.MAC,

/DEFAULT

Function

The /DEFAULT switch is used to change LINK-10's initially-assumed values for components missing in a file specification. A file specification is in the form dev:file.ext[directory]. The initial defaults for input specifications are

DSK:.REL [user's default directory]

and for output specifications are

DSK:name of main program.ext dependent on type of output file [user's default directory].

Thus, the user cannot change the extensions of output files, and any attempt to do so is ignored.

Values specified via the /DEFAULT switch are in effect for the entire loading process or until the user issues another /DEFAULT switch.

Switch Format

/DEFAULT:keyword

Keyword is either INPUT or OUTPUT to specify default conditions for input and output specifications, respectively. If the keyword argument is omitted, INPUT is assumed.

Category of Switch

Immediate Action Switch (refer to Paragraph 3.3.4)

Examples

```
DSK:MAIN,/DEFAULT .BIN[10,7],
```

Load the file MAIN.REL from the user's default directory of the disk and then change the input defaults to load .BIN files from the [10,7] area of the disk.

/DEFINE

Function

The /DEFINE switch is used interactively by the user to assign values to undefined global symbols in order to satisfy global requests before LINK-10 terminates the load with undefined symbols. The user can employ the /UNDEF switch to obtain a list of the undefined symbols and then use the /DEFINE switch to satisfy the requests for these symbols.

Switch Formats

/DEFINE:symbol:value

/DEFINE:(symbol:value, . . .,symbol:value)

Symbol is the name of the symbol to be defined. If the name given is one of an already-defined symbol, the user receives an error message.

Value is the decimal number to be associated with the symbol. An octal value can be given by preceding it with a number sign (#).

Category of Switch

Immediate Action Switch (refer to Paragraph 3.3.4)

Examples

```
*/UNDEF
1 UNDEFINED SYMBOL
NOW 400123
*/DEFINE:NOW:897
*/DEFINE:OCT:#1234
```

/ENTRY

Function

The /ENTRY switch is used to type out all library search symbols (i.e., entry points) that have been loaded up to the time the switch is given. These symbols are recognized by a specific condition set in the first word of the symbol by the translator that processed the module containing the symbol. The user defines symbols as library search symbols with an ENTRY statement in a MACRO-10 or BLISS-10 module, with a SUBROUTINE, FUNCTION, or ENTRY statement in a FORTRAN module, or with a SUBROUTINE statement in a COBOL module.

When used with the overlay facility, the /ENTRY switch lists the library search symbols in the current link. The symbols that are both listed and referenced in other links appear in the INTTAB table (refer to Appendix B) for this link.

Switch Format

```
/ENTRY
```

Category of Switch

Immediate Action Typeout Switch (refer to Paragraph 3.3.4)

Examples

```
*/ENTRY
[LNKLSS   LIBRARY SEARCH SYMBOLS (ENTRY POINTS)]
          SQRT.  3456
```

/ERRORLEVEL

Function

The /ERRORLEVEL switch is used to selectively suppress LINK-10 messages to the user's terminal. Associated with each message is a decimal number from 0 to 31 called the message level. Via this switch, the user can decide that messages with a message level less than or equal to a specific number are not to be output to his terminal. A user would normally want to suppress informative messages rather than error messages. The higher the message level, the more serious the message. Refer to Appendix E for the message level of each LINK-10 message.

Switch Format

/ERRORLEVEL:n

n is a decimal number from 0 to 30. Messages with a message level less than or equal to n will not be output to the terminal. Note that a message with a level of 31 cannot be suppressed. If this switch, or the value of the switch, is omitted, informative messages are suppressed.

Category of Switch

Delayed Action Switch (refer to Paragraph 3.3.5)

Examples

```
/ERRORLEVEL:10
```

/ESTIMATE

Function

The /ESTIMATE switch is used to reserve disk space for an output file and must be associated with an output specification. Because each occurrence of the switch allocates space for only one file, the user must issue an /ESTIMATE switch for each file that needs space reserved.

This switch is not required for space allocation for an output file, but its use can both help the user stay within his quota allotment and reduce the number of (RIB) pointers associated with the file.

Switch Format

/ESTIMATE:n

n is a decimal number representing the estimated number of blocks of 128 words of the output file. A warning message is given if LINK-10 fails to allocate the requested size.

If this switch is omitted, or if an insufficient estimate is given, space is allocated automatically as needed.

Category of Switch

Output Switch (refer to Paragraph 3.3.3)

Examples

```
DSKC:OUTPUT/MAP/ESTIMATE:50,/SAVE/ESTIMATE:200,
```

Allocate 50 blocks for the map file and 200 blocks for the save file.

/EXCLUDE

Function

The /EXCLUDE switch is used to inhibit the loading of certain modules in a file when loading the file in the current mode (either search or nonsearch mode). This switch is useful when the user is searching a library file and definitely knows he does not want certan modules, even though his program may reference the names of these modules. For example, if a library file has several modules with the same library search symbols (e.g., as in dummy routines) and the user wants to load a module other than the first one, he can use this switch to prevent the loading of the modules not desired. Another use of the /EXCLUDE switch is to satisfy global symbol definitions during library searching by excluding the modules that would cause multiply-defined symbols.

When the user specifies an overlay structure, he can use the /EXCLUDE switch to delay the loading of certain modules. Since the default system libraries are searched after every /LINK switch, a module for a library may be loaded in a link before the user actually wants it loaded. Thus, he can use the /EXCLUDE switch to inhibit the loading of the module for that link.

The /EXCLUDE switch is file dependent and applies to all modules in the link if it is placed before a file specification. Each specification of a permanent /EXCLUDE switch is cumulative for the command string in which it appears; modules excluded by the first permanent specification are added to the modules excluded in the second specification. If the user desires to include a module that has been permanently excluded in the command string, he must specify its inclusion with the /INCLUDE switch. Refer to the /INCLUDE switch description for the relationship of these two switches when they are used together to control the placement of subroutines in individual links.

Switch Formats

```
/EXCLUDE:subroutine

/EXCLUDE:(subroutine, . . ., subroutine)
```

Subroutine is the name of the module.

Category of Switch

File Dependent Switch (refer to Paragraph 3.3.2)

Examples

```
,/SEARCH LIBFIL.REL/EXCLUDE:(MOD1,MOD2),
```

Search the file LIBFIL as a library but do not load the modules MOD1 and MOD2 from the file, even if they are referenced.

/EXECUTE

Function

The /EXECUTE switch is used to specify that the loaded program is to be started at the normal entry point (i.e., the start address) upon completion of loading. This switch does not cause the termination of loading; the /GO switch is needed to terminate loading.

The /EXECUTE and /DEBUG switches cannot be used together because one switch specifies execution of the user's program (/EXECUTE) and the other switch specifies execution of the debugging program (/DEBUG).

Switch Format

```
/EXECUTE
```

<u>Category of Switch</u>

Delayed Action Switch (refer to Paragraph 3.3.5)

<u>Examples</u>

```
/EXE
```

/FOROTS

<u>Function</u>

The /FOROTS switch is used to specify the object time system FOROTS, instead of FORSE, for use with FORTRAN programs. FOROTS is then loaded, if required, when LINK-10 searches the default system libraries.

<u>Switch Format</u>

```
/FOROTS
```

<u>Category of Switch</u>

Creates an implicit file specification (refer to Paragraph 3.3.6)

<u>Examples</u>

```
,/FOROTS DSK:MAIN,SUB1,
```

/FORSE

<u>Function</u>

The /FORSE switch is used to specify the object time system FORSE, instead of FOROTS, for use with FORTRAN programs. FORSE is then loaded, if required, when LINK-10 searches the default system libraries.

<u>Switch Format</u>

```
/FORSE
```

Category of Switch

Creates an implicit file specification (refer to Paragraph 3.3.6)

Examples

```
,DSK:MAIN.F4/FORSE,
```

/FRECOR

Function

The /FRECOR switch guarantees that the specified amount of free core will remain after LINK-10 expands specific areas in its low segment. Since LINK-10's default amount of free core is 2K, users do not need this switch when loading most modules. However, when the modules being loaded are quite large (e.g., monitor modules), a larger amount of FRECOR will result in a faster loading process because LINK-10 will not have to move areas around in core as often.

During the loading procedure, LINK-10 has five areas that can be expanded beyond their initial sizes. These areas are: the user's low segment code area (LC), the user's high segment code area (HC), the local symbol table area (LS), the fixup area (FX), and the global symbol table area (GS). Each area has a lower boundary, a maximum upper boundary, and an actual upper boundary. LINK-10 tries to maintain space between the actual upper boundary and the maximum upper boundary at all times. However, as the loading procedure progresses, LINK-10 may have to expand an area to accomodate the user's input. If the sum of the amount of free core between the actual upper boundary and the maximum upper boundary for all areas minus the size required for the expansion is less than FRECOR, core is expanded to an amount large enough to maintain FRECOR. If the required size of the low segment becomes greater than MAXCOR (the user specified limit) or CORMAX (the system limit) allows, no further expansion is attempted and core is obtained from the free space recovered by shuffling areas. When all of the free space has been obtained, some or all of the above-mentioned areas must overflow to the disk. Note that free core is not maintained when areas overflow to the disk.

Switch Format

```
/FRECOR:n
```

n is a decimal number representing the number of words of free core rounded to the next 128-word multiple. If this switch, or the value of this switch, is omitted, 2K words is assumed.

Category of Switch

Delayed Action Switch (refer to Paragraph 3.3.5)

Examples

```
/FRECOR:3K
```

/GO

Function

The /GO switch is used to terminate the loading process and is the only termination switch available. When LINK-10 executes the /GO switch, it finishes loading the current specification, searches default libraries (if this action has not been suppressed with the /NOSYSLIB switch), produces the requested output files, and either exits to the monitor or runs the core image produced depending upon the switches appearing in the input command strings. If the /DEBUG switch has been specified, execution begins at the normal start address of the appropriate debugging program. If the /EXECUTE or /TEST switch has been specified, execution begins at the normal start address of the user's program. If one of these switches has not been specified, LINK-10 exits to the monitor.

Switch Format

```
/GO
```

Category of Switch

Immediate Action Switch (refer to Paragraph 3.3.4)

Example

```
/GO

EXIT
.
```

/HASHSIZE

Function

The /HASHSIZE switch is used to specify the initial size of the global symbol table. LINK-10 uses the lowest prime number in its internal list that is greater than or equal to the given value as the hashsize for the symbol table. This switch can be employed by a user who knows before loading that the number of global symbols used by his program is going to be quite large. By setting the hashsize of the symbol table to a larger number, the user can save LINK-10 time and space that would be used in expanding the hash table. When the user receives the message REHASHING GLOBAL SYMBOL TABLE on a load, it serves as an indication that he should use the /HASHSIZE switch at the beginning of subsequent loads of the same programs. Refer to the LINK-10 Design Specification for the hashing technique used in symbol tables.

Switch Format

/HASHSIZE:n

n is a decimal number representing the estimated hashsize of the global symbol table. A recommended hashsize is a number 10% larger than the total number of global symbols in the load. The default size (initially 251) is an assembly parameter.

Category of Switch

Delayed Action Switch (refer to Paragraph 3.3.5)

Examples

/HAS:1000

LINK-10 uses the prime number 1021.

/INCLUDE

Function

The /INCLUDE switch is used to force the loading of specified modules in that file whether or not the user's program actually references them. For example, if the user does not have a global request for a desired module, he can use this switch to cause that module to be loaded.

The primary use of the /INCLUDE switch is with the overlay facility in order to load a required module into a link closer to the root link. For example, if two different links reference the same module, normally that module will be duplicated in each link when the default libraries are searched after the /LINK switch is given. However, by using the /INCLUDE switch to force the loading of the module into a link common to both links requiring it, the user saves overhead table space in the individual links.

The /INCLUDE switch is file dependent and as such, applies to all modules in the current link if it is placed before a file specification. When the user specifies search mode (i.e., /SEARCH), the subroutines given as arguments to the /INCLUDE switch, plus the subroutines normally loaded in search mode, are loaded. If the user has not specified search mode, only the subroutines given as arguments to the switch are loaded.

Each specification of a permanent /INCLUDE switch is cumulative for the command string in which it appears; modules included by the first permanent specification are added to the modules included in the second specification. If the user wants to exclude a module that has been permanently included in the command string, he must specify its exclusion with the /EXCLUDE switch.

The /INCLUDE and /EXCLUDE switches, with the same arguments, can be used together in the specification for the current link. If this is the case, the last one seen will be in effect if both switches are used as permanent or both used as temporary. However, if one is used as a permanent switch and one as a temporary one, the following rules apply.

1. If the user has specified search mode and there is a matching request, the subroutine will be loaded unless

   a. An /EXCLUDE switch is used as a temporary switch, or

   b. An /EXCLUDE switch is used as a permanent switch and there is not a temporary /INCLUDE switch for the same subroutine.

2. If the user has specified search mode and there is no matching request, no subroutines will be loaded unless

   a. An /INCLUDE switch appears as a temporary switch, or

   b. An /INCLUDE switch appears as a permanent switch and there is no temporary /EXCLUDE switch for the same subroutine.

3. If the user has not specified search mode, no subroutines will be loaded except ones specified as arguments to a temporary /INCLUDE switch or ones specified as arguments to a permanent /INCLUDE switch but not to a temporary /EXCLUDE switch.

4. If the user has not specified search mode and has not given a temporary /INCLUDE switch, all subroutines will be loaded except those specified as arguments to an /EXCLUDE switch.

Switch Format

/INCLUDE:subroutine

/INCLUDE:(subroutine, . . ., subroutine)

Subroutine is the module name of the desired module.

Category of Switch

File Dependent Switch (refer to Paragraph 3.3.2)

Examples

```
,SYS:FORLIB/INCLUDE:(SIN,COS,TAN),
```

> Search the library FORLIB, but always load the modules SIN, COS, and TAN.

/LINK

Function

The /LINK switch is used to output an overlay link to the overlay file. When LINK-10 processes this switch, it searches the default libraries (unless this action has been suppressed), writes the current core image to the file, and then returns to the user for more input. The current core image is that code loaded either from the time of the last /LINK switch or, if no /LINK switch has been seen, from the beginning of the load. LINK-10 also assigns the link a link number. The user can additionally assign a name to the individual link for the purpose of referring to it from other links.

Each specification of an overlay link must be terminated with the /LINK switch.

Switch Format

/LINK:link name

Link name is the name the user wants associated with this link. This argument is optional. If used, it can then appear as an argument to the /NODE switch. It is recommended that the /LINK switch be the last switch on the command line for the specified link. If this switch is not given by the user, links will not be output to the overlay file. When the switch is given without the user assigned link name argument, LINK-10 assigns only an absolute link number to the individual link.

Category of Switch

Immediate Action Switch (refer to Paragraph 3.3.4)

Examples

SPEXP/LINK:ALPHA

Load the module named SPEXP, output the core image to the overlay file, and call the link ALPHA.

/LOCALS

Function

The /LOCALS switch is used to load local symbols with the specified programs. Local symbols are not processed by LINK-10, but are useful to the user when debugging.

This switch does not cause local symbols to be saved as part of the core image requested by the /SAVE or /SSAVE switch. The /SYMSEG switch or an entry in the JOBDAT location .JBDDT is required if local symbols are to remain in core.

Switch Format

/LOCALS

Category of Switch

File Dependent Switch (refer to Paragraph 3.3.2)

Examples

,MYFILE,/LOCAL MYDATA,MYSUB,MYLIB,

Load local symbols with the programs MYDATA, MYSUB, and MYLIB.

/LOG

Function

The /LOG switch is used to specify an output log file into which LINK-10 places information that is useful for the user when he is debugging his program. This file is a report of LINK-10's progress in loading the user's program because the actions taken by LINK-10 are shown. The times at which these actions took place are also indicated.

This switch is not required to obtain a log file if the user assigns a device the logical name LOG before running LINK-10. Then all log information will be recorded in a file on this assigned device. The file is named nnnLNK.LOG where nnn is the user's job number. In this case, the /LOG switch merely causes the file to be renamed to the user's specifications.

If the user does not assign a device the logical name LOG prior to running LINK-10, he must use the /LOG switch in order to obtain a log file. However, any times and messages output before the /LOG switch is seen in the command string will not appear in the log file.

Switch Format

file specification/LOG

File specification is in the form dev:file.ext[directory] to specify the device and name associated with the log file. The default file specification is DSK:name of main program.LOG [user's default directory]. The user's terminal may be specified as the log device.

Category of Switch

Output Switch (refer to Paragraph 3.3.3)

Examples

```
DSKB:MYLOG/LOG
```

Create a log file on DSKB: with the name MYLOG.

/LOGLEVEL

Function

The /LOGLEVEL switch is used to suppress LINK-10 messages to the user's log file. This switch permits the user to set the level of messages that are to appear in the log file. Refer to the /ERRORLEVEL switch and Appendix E.

If the log file is output to the user's terminal (i.e., the log device is the user's terminal), the messages output are determined by the lower of the arguments specified in the /ERRORLEVEL and /LOGLEVEL switches. The user would rarely set the log device as the terminal because the /ERRORLEVEL switch with a low number allows him to obtain all messages on the terminal.

Switch Format

/LOGLEVEL:n

n is a decimal number from 0 to 30. Messages with a message level less than or equal to n will not be output to the log file. The user cannot suppress messages with a level of 31. If this switch, or the value of the switch is omitted, a message level of 0 is assumed (i.e., all messages are output to the log file).

Category of Switch

Delayed Action Switch (refer to Paragraph 3.3.5)

Examples

/LOGLEVEL:5

Do not output any message to the log file with a message level less than or equal to 5.

/MAP

Function

The /MAP switch is used to specify an output map file which consists of the types of symbols requested by the user with the /CONTENTS switch. The map file is useful to the user when he is debugging his program because it lists the symbols used by his program along with their values. Header information (e.g., relocation counters with their lengths and starting addresses) is also included in the map.

Switch Format

file specification/MAP:keyword

File specification is in the form dev:file.ext [directory] and specifies the device and name associated with the map file. The default specification is DSK:name of main program.MAP[user's default directory].

Keyword is one of the following:

END to produce a map file at the end of loading.

ERROR to produce a map file of the code loaded if a fatal error occurs (i.e.,an error from which LINK-10 cannot recover).

NOW to produce a map file at the time this keyword is seen. The map contains all of the information up to and including the last file loaded. Default libraries will not be searched unless specified. This keyword is normally used during debugging to determine how the load is progressing.

If the /MAP switch is not issued by the user, no map file will be generated. If the switch is given, but the keyword is omitted, the keyword END is assumed.

Category of Switch

Output Switch. Also, /MAP:NOW is an immediate action switch.

Examples

DSKB:MYMAP/MAP

Specify a map file on DSKB: with the name MYMAP.

/MAXCOR

Function

The /MAXCOR switch is used to specify the maximum amount of core LINK-10 may use as its low segment while loading. LINK-10 will expand to this size if required and then will overflow to the disk, rather than expanding in core, when it reaches the maximum core size allowed. When LINK-10 must overflow to the disk, it writes out part or all of the symbol area, the low code area, and/or the high core area in order that loading can continue. If the current amount of core used is greater than the size specified by the user, the next time LINK-10 requests more core, the size will decrease to the amount specified by the user and the remaining code will overflow to the disk. If the amount specified by the user is less than the minimum amount required by

LINK-10, he receives a warning message indicating the amount required. He should then respecify the switch with a larger argument.

Switch Format

/MAXCOR:n

n is a decimal number that represents the maximum low segment core size for LINK-10. An octal value can be given by preceeding it with a number sign (#). N is expressed in units of 1024 words or 512 words (a page) by following the number with K or P respectively. If K or P is omitted, K (1024 words) is assumed.

The maximum size is 128K (i.e., less than the origin of the high segment). The minimum size is dependent upon the code already loaded. The user receives a warning message if the value of MAXCOR is not within the required range.

Category of Switch

Delayed Action Switch (refer to Paragraph 3.3.5)

Examples

/MAXCOR:30K

> Allow LINK-10 to expand its low segment to 30K before overflowing to the disk.

/MPSORT

Function

The /MPSORT switch is used to arrange the symbol table for output to the map file in the order most convenient to the user.

Switch Format

/MPSORT:keyword

Keyword is one of the following:

> UNSORTED to print the symbols in the order in which they are placed in the symbol table. This keyword is the default.
>
> ALPHABETICAL to arrange the symbol table in alphabetical order for each module or for each block in a block-structured module.

NUMERICAL	to arrange the symbol table in numerical order according to the values of the symbols for each module.

NOTE

UNSORTED is the only keyword currently implemented. The other keywords listed above are ignored and a warning message is output.

Category of Switch

Delayed Action Switch (refer to Paragraph 3.3.5)

Examples

MYMAP/MAP/MPSORT:UNSORTED

Specify a map file with the name MYMAP and print the symbols in the order in which they appear in the symbol table.

/MTAPE

Function

The /MTAPE switch allows the user to perform magnetic tape functions such as rewind, backspace, and skip. If this switch is given in an input specification, the action is performed immediately. However, when the switch is part of an output specification, the action requested is not performed until the output device has been initialized.

Switch Format

/MTAPE:keyword

Keyword is one of the following:

MTWAT	to wait for spacing and I/O to finish,
MTREW	to rewind the tape to load point.
MTEOF	to write an EOF,
MTSKR	to skip one record.

MTBSR	to backspace one record.
MTEOT	to space to the logical end-of-tape.
MTUNL	to rewind and unload the tape.
MTBLK	to write 3 inches of blank tape.
MTSKF	to skip one file.
MTBSF	to backspace one file.
MTDEC	to initialize for Digital-compatible 9-channel tape.
MTIND	to initialize for industry-compatible 9-channel tape.

Category of Switch

Device Switch (refer to Paragraph 3.3.1)

Examples

```
MTA0:/MTAPE:MTEOT/MAP
```

Output the map file to MTA0: after spacing to the logical end of tape (i.e., to the first free block).

/NODE

Function

The /NODE switch is used to return LINK-10 to the end of a previously specified link in order to specify a new path or to complete the specification of an existing path. The argument to this switch will be considered the immediate ancestor of the link to which the switch is applied. For example, if the user has defined his root link and one path consisting of three links, he can use the /NODE switch to return LINK-10 to the end of the root link in order to define a second path originating from this link. This switch in effect places LINK-10 in the same position as if the user had just issued a /LINK switch for the specified link, in this case, for the root link.

Switch Format

```
/NODE:argument
```

Argument is one of the following:

1. The name of the link the user wishes to position LINK-10 after. This name is the one previously assigned by the user as the argument to a /LINK switch.

2. A negative number,-n, indicating that the user wishes to move back over the specified number of links on the path. For example, -2 backs up over two links.

3. The number of the link the user wishes to position LINK-10 after. This number is the one previously assigned by LINK-10. The user can also use 0 to position LINK-10 after the root link. It is recommended that the user use a link name or 0 and not a positive link number as an argument to the /NODE switch because of the potential danger of the number being different with different loads of the overlay structure.

Category of Switch

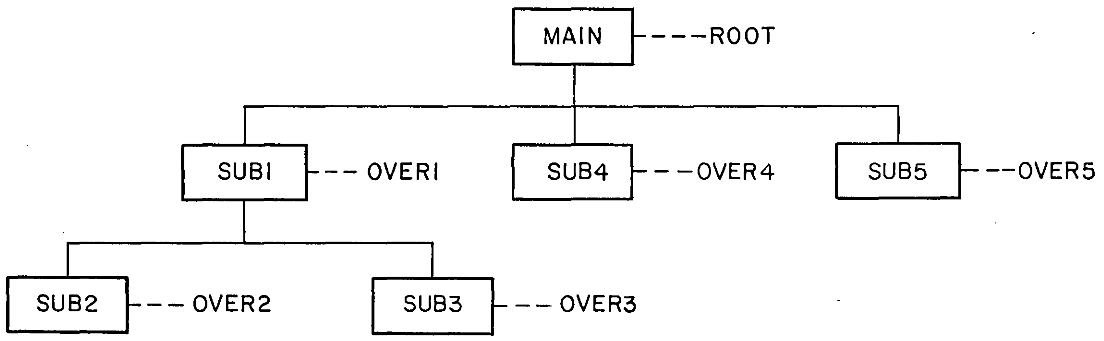
Immediate Action Switch (refer to Paragraph 3.3.4).
Also a required switch for specifying an overlay structure.

Examples

The command sequence:

```
.R LINK
*/OVERLAY = MAIN/LINK:ROOT
*SUB1/LINK:OVER1
*SUB2/LINK:OVER2
*/NODE:-1 SUB3/LINK:OVER3
*/NODE:ROOT SUB4/LINK:OVER4
*/NODE:0 SUB5/LINK:OVER5
```

generates the following overlay structure.



/NOENTRY

Function

The /NOENTRY switch allows the user to indicate symbols that will be ignored as definitions of library search symbols (i.e., entry points) when referenced from other links. Therefore, these symbols are not placed in LINK-10's overhead tables. For example, the user can give the /ENTRY switch to list the library search symbols in the current link. Of the symbols listed, the ones referenced by other links will appear in the INTTAB table for the current link (refer to Appendix B). If the user knows that for this execution of his program, he will not reference certain symbols, he should use the /NOENTRY switch to suppress their placement in the overhead tables.

Switch Format

/NOENTRY:symbol

/NOENTRY:(symbol,...,symbol)

Symbol is the name of the symbol in ASCII.

Category of Switch

Immediate Action Switch (refer to Paragraph 3.3.4)

Examples

```
*/ENTRY

[LNKLSS LIBRARY SEARCH SYMBOLS (ENTRY POINTS)]

        .SQRT   3456

*/NOENTRY:  .SQRT

*
```

/NOINITIAL

Function

The /NOINITIAL switch is used to clear LINK-10's initial global symbol table. This initial global symbol table consists of the .JBxxx symbols in JOBDAT. (Refer to DECsystem-10 Monitor Calls for a description of JOBDAT.) This switch is normally employed when the user is loading LINK-10 itself (in order to get the latest copy of JOBDAT), when the user wants to load a private copy of JOBDAT in order to use new values, or when the user is loading a program (for the purpose of creating a core image file) that will eventually run as an exec mode program (e.g., the monitor, diagnostics, a bootstrap loader). This switch must appear before the first file specification in the command string or else the initial LINK-10 global symbol table (JOBDAT) will be loaded. If the /NOINITIAL switch is specified, JOBDAT will be searched when the default system libraries are searched.

Switch Format

/NOINITIAL

If this switch is omitted, LINK-10's internal JOBDAT area symbols are used as the initial global symbol table.

Category of Switch

Immediate Action Switch (refer to Paragraph 3.3.4)

Examples

```
/NOINITIAL,COMMON,COMDEV,COMMOD,TOPS10/SEARCH/GO
```

Load the monitor without LINK-10's initial global symbol table.

```
/NOINITIAL,DTBOOT,EDDT/GO
```

Load the exec mode program without LINK-10's initial global symbol table.

/NOLOCAL

Function

The /NOLOCAL switch is used to load the programs without their local symbols. This is the default action.

Switch Format

/NOLOCAL

Category of Switch

File Dependent Switch (refer to Paragraph 3.3.2)

Examples

```
/LOCAL FIRST,SECOND,THIRD,FOURTH/NOLOCAL
```

Load the programs FIRST, SECOND, and THIRD with their local symbols and load the program FOURTH without its local symbols.

/NOREQUEST

Function

The /NOREQUEST switch allows the user to indicate symbols that should not be considered as references to other links and therefore should not be placed in LINK-10's overhead tables. For example, the user may decide that during a particular run of his program he does not require certain links in his overlay structure. He informs LINK-10 of this fact by specifying the names of the symbols defined in these unnecessary links, but referenced from the required links, as arguments to the /NOREQUEST switch. By eliminating the references to these links, the user causes reductions in the sizes of the overhead tables (refer to the EXTTAB table in Appendix B).

Switch Format

```
/NOREQUEST:symbol

/NOREQUEST:(symbol,...,symbol)
```

Symbol is the name of the symbol in ASCII.

Category of Switch

Immediate Action Switch (refer to Paragraph 3.3.4)

Examples

```
*/REQUEST
[LNKRER REQUEST EXTERNAL REFERENCES]
        ROUTN.
        SQRT.

*/NOREQUEST:SQRT.
*
```

The user has decided that for this particular execution of his program he does not require definition of the symbol SQRT.. Thus, to save space in the overhead tables, he tells LINK-10 to ignore the reference to SQRT..

/NOSEARCH

Function

The /NOSEARCH switch is used to turn off library search mode (i.e., to always load the entire indicated file or files whether or not the files are required). The files are not searched to determine if they are needed. This switch is normally used after a /SEARCH switch has set library search mode. This is the default action.

Switch Format

/NOSEARCH

Category of Switch

File Dependent Switch (refer to Paragraph 3.3.2)

Examples

```
PARTA,/SEARCH LIBMAC,LIBCBL,LIBFOR,/NOSEARCH PARTB,PARTC
```

The files LIBMAC, LIBCBL, and LIBFOR are searched as libraries. The files PARTA, PARTB, and PARTC are loaded in their entirety.

/NOSTART

Function

The /NOSTART switch indicates to LINK-10 to ignore all start addresses in the binary input programs. The start address for the current program is not changed.

Switch Format

/NOSTART

If this switch is omitted and more than one start address is encountered, the last one seen is used.

Category of Switch

File Dependent Switch (refer to Paragraph 3.3.2)

Examples

MAIN1,/NOSTART MAIN2,MAIN3

Start addresses are ignored in files MAIN2 and MAIN3.

/NOSYMBOL

Function

The /NOSYMBOL switch signals LINK-10 not to construct a table of the symbols used by the user's program. This switch affects the speed of loading in that LINK-10 is not required to spend time in generating a symbol table for the user. If this switch is given, the user is not able to obtain output symbol files or output map files containing symbol listings. A map file can be obtained,however, with header information only.

Switch Format

/NOSYMBOL

Category of Switch

Immediate Action Switch (refer to Paragraph 3.3.4)

Examples

/NOSYM

/NOSYSLIB

Function

The /NOSYSLIB switch is used to inhibit the searching of one or more of the system libraries upon completion of the loading process. The system libraries required by the loaded modules are usually searched at the end of the load in order to satisfy undefined global requests. These libraries are LIBOL for COBOL modules, FORLIB for FORTRAN-10 modules, LIB40 for F40 modules, and ALGLIB for ALGOL modules.

Switch Format

/NOSYSLIB:keyword

/NOSYSLIB:(keyword, . . .,keyword)

Keyword is one or more of the following:

ALGOL	to suppress the searching of ALGLIB.
BCPL	to suppress the searching of BCPLIB (not supported by DEC).
COBOL	to suppress the searching of LIBOL.
FORTRAN	to suppress the searching of FORLIB.
F40	to suppress the searching of LIB40.
NELIAC	to suppress the searching of LIBNEL (not supported by DEC).

If the keyword is omitted, the searching of all system libraries is suppressed.

Category of Switch

Delayed Action Switch (refer to Paragraph 3.3.5)

Examples

/NOSYSLIB:(ALGOL,COBOL)

Do not search ALGLIB and LIBOL.

/NOSYSLIB

Do not search any system libraries.

/NOUSERLIBRARY

Function

The /NOUSERLIBRARY switch allows the user to terminate the automatic searching of a user library. The name of the specified library is then removed from the list of libraries that are searched by LINK-10. For example, the user may have specified, with the /USERLIBRARY switch, that a particular library is to be searched each time he gives the /LINK switch. If he now decides that he does not need this library searched, he gives the /NOUSERLIBRARY switch to terminate the searching.

Switch Format

file specification/NOUSERLIBRARY

File specification is in the form dev:file.ext [directory] and specifies the device and name associated with the user library. If the specified file has not been defined as a user library, the switch is ignored. If the file specification argument is omitted, all user libraries, including ones assembled into LINK-10, are removed from the list of libraries searched.

Category of Switch

Delayed Action Switch (refer to Paragraph 3.3.5)

Examples

USERLIB/NOUSERLIBRARY

> No longer search the file USERLIB automatically at the end of each link.

/ONLY

Function

The /ONLY switch is used to load the low segment portion or the high segment portion of a two segment module. Its primary use is in generating systems that consist of multiple high segments which may share common code and symbol definitions. This switch is ignored for one segment modules.

Switch Format

file specification/ONLY:keyword

File specification is in the form dev:file.ext [directory] and specifies the device and name associated with the two segment module.

Keyword is one of the following:

BOTH	to allow both segments to be loaded. This keyword effectively turns off the switch.
HIGH	to only load code and symbols for the high segment.
LOW	to only load code and symbols for the low segment.

Category of Switch

File Dependent Switch (refer to Paragraph 3.3.2)

Examples

/ONLY:HIGH FILEA,FILEB,FILEC/ONLY:BOTH

Load only the high segment code for modules FILEA and FILEB; load code for both segments for FILEC.

/OTS

Function

The /OTS switch is used to specify the way in which the appropriate object time system is loaded and the time when it is bound to the user's program. The object time system can either be obtained from a .REL file and bound at load time or be obtained from a saved file and bound at execution time via a GETSEG UUO.

Switch Format

/OTS:keyword

Keyword is one of the following:

DEFAULT to load the object time system via a GETSEG UUO at runtime unless code already exists in the high segment and /SEGMENT: high is not set. If this is the case, a nonsharable object time system is loaded as part of the user's core image. FORTRAN, NELIAC, and ALGOL specify the high segment. This keyword is used to reset to normal conditions after specifying a /OTS switch with either the SHARABLE or NONSHARABLE keywords.

NONSHARABLE to load the object time system at load time, into the user's core image. The user's program may be in both the high and low segments, and parts of the object time system may also be in both segments.

SHARABLE to load the object time system at execution time via a GETSEG UUO. The user's program is in the low segment, and the object time system is in the high segment.

If this switch, or the value of this switch, is omitted, the default action is to bind the object time system via a GETSEG UUO at execution time unless code already exists in the high segment and /SEGMENT:HIGH is not set.

Category of Switch

Delayed Action Switch (refer to Paragraph 3.3.5)

Examples

```
FILA.REL/SYSLIB/OTS:NONSHAR
```

Load the required object time system as part of the user's core image instead of executing a GETSEG UUO at execution time.

/OVERLAY

Function

The /OVERLAY switch informs LINK-10 that the user is going to build an overlay structure for his program (refer to Chapter 5) and as such is a prerequisite for using the overlay capability. This switch causes LINK-10 to load the overlay handler, the routine responsible for ensuring that all required links are in core as needed, into the user's address space. This switch does not specify each individual link (refer to the /LINK switch).

The /OVERLAY switch also defines the characteristics of the overlay structure. In Version 2 of LINK-10, the individual links are absolute or relocatable, tree-structured, and non-writable. This means:

1. Each link has an assigned area of the user's address space and will be loaded in the same location on every call (absolute link). If the link cannot be loaded into its optimal absolute area, then its address will be relocated by the difference between the optimal and actual addresses (relocatable link).

2. Each link has only one ancestor but may have more than one successor (tree-structured link).

3. Each link is loaded in its original form; any changes that have been made to the link are destroyed once the link is overlaid (non-writable link).

In addition, the path of any link is loaded when that particular link is loaded.

This switch must be associated with the root link, which must be the first link specified in the command string. It may also be associated with a file specification, in which case LINK-10 uses that file specification as the name of the overlay file.

Any permanent file-dependent switches (e.g., /EXCLUDE, /LOCALS, /SEARCH) given by the user before he gives the /OVERLAY switch become link-permanent switches. That is, these switches automatically will be in effect at the beginning of each link, even if they had been disabled in a previous link. (Normally, permanent file-dependent switches are only in effect until modified by a subsequent switch or until the end of the command string; refer to Paragraph 3.3.2.) This method of handling permanent file-dependent switches saves the user from repeatedly typing switches that he wants to be in effect for every link.

Switch Format

file specification/OVERLAY:keyword

file specification/OVERLAY:(keyword,...,keyword)

File specification is in the form dev:file [directory] and specifies the device and name associated with the overlay file. The default specification is DSK: filename.OVL [user's default directory]. The filename is either the name of the main program or the name of the save file, if the /SAVE switch has been given by the user. The file specification argument is optional.

Keyword is one or more of the following:

ABSOLUTE to specify that the links will be absolute (default). The complement of this keyword is RELOCATABLE.

LOGFILE to output a log file of the run time messages on the user's terminal. The complement of this keyword is NOLOGFILE.

NOLOGFILE to inhibit the generation of a log file of the run time messages (default). The complement of this keyword is LOGFILE.

NONWRITABLE to specify that the links will be nonwritable (default). The complement of this switch is not implemented in Version 2 of LINK-10.

NOWARNING to suppress the output of the overlay handler's warning messages on the user's terminal. The complement of this keyword is WARNING.

PATH (LOADING) to specify that all links from the current one to the root will be loaded when the current link is loaded (default). The complement of this keyword is not implemented in Version 2 of LINK-10.

RELOCATABLE to specify that the links will be relocatable. The complement of this keyword is ABSOLUTE.

TREE (STRUCTURE) to specify that the overlay structure will be tree structured (default). The complement of this keyword is not implemented in Version 2 of LINK-10.

WARNING to output all of the overlay handler's warning messages on the user's terminal (default). The complement of this keyword is NOWARNING.

If the /OVERLAY switch is given without any keywords, the keywords ABSOLUTE, NONWRITABLE, PATH, TREE, WARNING, and NOLOGFILE are assumed. If the /OVERLAY switch is not given by the user, no overlays will be generated.

Category of Switch

Output Switch (refer to Paragraph 3.3.3). Also a required switch for specifying overlays.

Examples

```
TEST/OVERLAY,TEST/MAP=MAIN/LINK
```

Load the overlay handler, produce a map file and an overlay file both with the name TEST (i.e., TEST.MAP and TEST.OVL), and write the first overlay (MAIN) to the overlay file.

/PATCHSIZE

Function

The /PATCHSIZE switch is used to allocate space between the top of the loaded code and the bottom of the symbol table. This space is then used for new symbols defined by the user with DDT and/or for patching. Note that when the user defines symbols with DDT, each symbol will occupy two words. The space is allocated in either the high or low segment, depending upon the placement of the symbol table as specified with the /SYMSEG switch. The default is to place the symbol table in the low segment.

Switch Format

```
/PATCHSIZE:n
```

n is a decimal number representing the number of words to be allocated as patching space. An octal value can be given by preceding it with a number sign (#).. A global symbol, PAT.., is defined to be equal to the first location in the patching system.

If this switch, or the value of this switch, is omitted, the default allocation is 64 (decimal) or 100 (octal) words.

Category of Switch

Delayed Action Switch (refer to Paragraph 3.3.5)

Examples

/SYMSEG:HIGH/PATCHSIZE:200

Load the symbol table into the high segment and allocate 200 words between the loaded code and the symbol table.

/PLOT

Function

The /PLOT switch is used to generate a line drawing of the user's overlay structure. This drawing can be output on the plotter or simulated on the line printer.

Because of the plotter's limitation in the horizontal direction (i.e., in the carriage movement), it is not possible to draw an arbitrarily wide tree on the plotter paper. Thus, the user may have to divide his overlay structure into subtrees. He controls this division by specifying appropriate values as arguments to the /PLOT switch. The arguments that control the size of the diagram are LEAVES and INCHES. The value of LEAVES specifies the maximum number of links with no successors that can appear in one subtree. The value of INCHES specifies the width in inches of the desired drawing.

The values of INCHES and LEAVES also define the size of the drawing of each individual link (approximately INCHES/LEAVES wide). The user must be concerned with the values he assigns to avoid a distorted diagram. If he specifies too many LEAVES per subtree, the drawing will be distorted. If he does not specify enough LEAVES, time and paper will be wasted drawing the diagram and the diagram will be more difficult to read. The following values are recommended to generate a nondistorted drawing.

1. If the drawing is going to be output to the plotter, INCHES/LEAVES should be about 2 (e.g., INCHES=29 and LEAVES=15).

2. If the drawing is going to be simulated on the line printer, INCHES/LEAVES should be about 1.5 (e.g., INCHES=12 and LEAVES=8).

Switch Format

file specification/PLOT:(LEAVES:value, INCHES:value, STEPS:value)

File specification is in the form dev:file.ext [directory] and specifies the device and name associated with the plot. The default specification is DSK: name of main program.PLT [user's default directory].

LEAVES is the maximum number of links with no successors that will be allowed in one subtree. The default value for the plotter is 16 (decimal) and for the line printer, 8.

INCHES is the width in inches of the plot. The default value for the plotter is 29 and for the line printer, 12 (decimal). It is recommended that this value be at least one inch less than the physical width of the plotting surface.

STEPS is the number of movements per inch of the plotting device. For the plotter, the default step size is 100 (decimal) steps per inch. This argument also applies to the line printer. The plotting surface of the line printer is composed of a large number of boxes, each box being the size of a character (approximately 1/6 X 1/10 inches). During simulation to the line printer, a box is filled with a character each time the current position of the pen is on the paper and in the box. To avoid having the same box filled a number of times, it is recommended that the STEPS argument for the line printer be much smaller than it would be for the plotter, but be greater than the inverse of the dimensions of the boxes. The default step size for the line printer is 20 (decimal).

Category of Switch

Output Switch (refer to Paragraph 3.3.3)

Example

```
TEST/OVERLAY,TEST/MAP,LPT:TEST/PLOT = MAIN/LINK
```

Refer to Example 7 in Chapter 6 for the output generated by this command string.

/REQUEST

Function

The /REQUEST switch is used to type out all references to other links that obey the standard calling sequence. (If the user calls a subroutine with other than the standard calling sequence, LINK-10 cannot recognize the global symbol as a reference to a subroutine.) The references listed will normally be to links in the extended path of the current link. If the user decides that he does not need the referenced link for this particular execution of his program, he should then give the /NOREQUEST switch in order to reduce the overhead tables (refer to the EXTTAB table in Appendix B). If he does need these links, he should load the missing programs. Thus, the user can interactively satisfy requests to links before the execution of his program is terminated because of undefined references.

Switch Format

/REQUEST

Category of Switch

Immediate Action Typeout Switch (refer to Paragraph 3.3.4)

Examples

```
*/REQUEST

[LNKRER REQUEST EXTERNAL REFERENCES]
        ROUTN.
        SQRT.
```

/REQUIRE

Function

The /REQUIRE switch is used to generate global requests for the indicated symbols. Thus, this switch can be used to load library modules out of their normal loading sequence or to force the loading of modules for overlays.

The /REQUIRE switch is used to load a module by specifying one or more of its library search symbols (entry points), whereas the /INCLUDE switch is used to load a module by specifying its name. Thus, the /REQUIRE switch is useful when the user knows the function he wants loaded (e.g., SQRT), but does not know the name of the module containing that function. Like the /INCLUDE switch, the /REQUIRE switch can be used to load a module referenced by several links into a link that is common to all links referencing the module.

Switch Format

```
/REQUIRE:symbol

/REQUIRE:(symbol, . . .,symbol)
```

Symbol is the SIXBIT symbol name for which the user wants a global request generated.

Category of Switch

Immediate Action Switch (refer to Paragraph 3.3.4)

Examples

```
/REQUIRE:NAME
```

Generate a global request for the symbol called NAME.

/REWIND

Function

The /REWIND switch is used to rewind the current input or output device. The device associated with this switch must be a DECtape or magnetic tape. If the device is not a tape device, the switch is ignored.

Switch Format

/REWIND

Category of Switch

Device Switch (refer to Paragraph 3.3.1)

Examples

```
,/REWIND MTA0:,
```

/RUNCOR

Function

The /RUNCOR switch is used to specify the amount of core to be assigned to the low segment of the program when it is executed. The effect of this switch is identical to that produced when the program is run by the system run commands (R or RUN) with the given core argument.

Switch Format

/RUNCOR:n

n is a decimal number that represents the amount of core to be used as the initial core size for the program when obtained with the GET system command. An octal value can be given by preceeding it with a number sign (#). N is expressed in units of 1024 words or 512 words (a page) by following the number with K or P respectively. If K or P is omitted, K (1024 words) is assumed. If n is omitted or is less than the amount required, the number of blocks required by the core image area is assumed.

Category of Switch

Delayed Action Switch (refer to Paragraph 3.3.5)

Examples

```
/RUNCOR:50P
```

/RUNAME

Function

The /RUNAME switch is used to assign the name to the program that is to be used while the program is running. This name is stored in a job-associated table in the Monitor and is used by the SYSTAT program and the VERSION system command. This switch affects high segment programs only.

Switch Format

/RUNAME:symbol

Symbol is the name to be assigned to the program. Only the first six characters specified are used. If this switch is omitted, the default name is the name of the module with the last start address. If there is no module containing a start address, the name used is nnnLNK, where nnn is the user's job number.

Category of Switch

Delayed Action Switch (refer to Paragraph 3.3.5)

Examples

/RUNAME:PRIV,MYPROG/SSAVE

Save the file with the name MYPROG (i.e., MYPROG.SHR), but the program is run with the name PRIV.

/SAVE

Function

The /SAVE switch is used to define an output save file which will contain the core image generated by LINK-10. The core image is saved as one or two files: a low segment file and/or a high segment file. After the core image is saved on the specified output device, it can later be brought into core and executed as a non-sharable program (by using the RUN or GET system commands) without rerunning LINK-10.

Before writing low segment files (i.e., files with extensions .SAV or .LOW), LINK-10 compresses the core image by eliminating all zero blocks. High segment files are not compressed. This action is known as zero-compression and is used to save space on the storage device. The resulting zero-depressed file is, in essence, identical to the one produced by the SAVE system command.

Switch Format

file specification/SAVE:n

File specification is in the form dev:file[directory] and specifies the device and name associated with the save file. The default specification is:

DSK:name of main program [user's default directory].

User-supplied extensions are ignored and the extension given to the file depends on the number of segments saved. If there is only one segment, the extension .SAV is used. If there are two segments, the extension .LOW is used for the low segment and .HGH for the high segment.

N is a decimal number that represents the amount of core (sum of high and low segments) in which the program is later to be run. An octal value can be given by preceding it with a number sign (#). N is expressed in units of 1024 words or 512 words (a page) by following the number with K or P respectively. If K or P is omitted, K (1024 words) is assumed.

If the /SAVE is not used, a save file will not be generated. If the switch is given but the core argument is omitted, the minimum core required by the core image is used.

Category of Switch

Output Switch (refer to Paragraph 3.3.3)

Examples

```
DTA3:MYPROG/SAVE:4K=
```

Define a save file on DTA3: with the name MYPROG. The program will be run in 4K.

/SEARCH

Function

The /SEARCH switch is used to turn on library search mode (i.e., to search specified files in order to load only those modules of the file that are required to satisfy undefined global requests). The user gives this switch to search either library files that he may have created or ones that are not part of the required system libraries. The /NOSEARCH switch is used to turn off library search mode. The required system libraries are still searched unless the user has inhibited the searching with the /NOSYSLIB switch.

Switch Format

/SEARCH

Category of Switch

File Dependent Switch (refer to Paragraph 3.3.2)

Examples

```
PARTA,/SEARCH LIBMAC,LIBCBL,LIBFOR,/NOSEARCH PARTB,PARTC
```

The files LIBMAC, LIBCBL, and LIBFOR are searched as libraries. The files PARTA, PARTB, and PARTC are loaded in their entirety.

/SEGMENT

Function

The /SEGMENT switch is used to indicate to LINK-10 the segment into which to load the input modules.

Switch Format

/SEGMENT:keyword

Keyword is one of the following:

DEFAULT to follow the specifications in the program. The typical case is to load pure code into the high segment and impure code into the low segment. This keyword is used to reset to normal conditions after specifying a /SEGMENT switch with either the HIGH or LOW keywords.

LOW to load code into the low segment.

HIGH to load code into the high segment, even if the code is impure.

If this switch, or the value of the switch, is omitted, high segment code is loaded into the high segment and low segment code into the low segment. An exception to this rule is the action taken with two segment (reentrant) code produced by FORTRAN-10. The default is to load both segments into the low segment unless one of the following conditions is true:

1. Non-reentrant FOROTS was requested via the /OTS:LOW switch.
2. Code was forced into the high segment with the /SEGMENT:HIGH switch.
3. Loading of two segment code was forced with the /SEGMENT:DEFAULT switch.
4. Code currently exists in the high segment.
5. The low segment is greater than 128K.

Category of Switch

File Dependent Switch (refer to Paragraph 3.3.2)

Examples

```
/SEGMENT:LOW TESTPRG,ANSWER,ROUTIN/SEGMENT:HIGH,
```

Load the modules TESTPRG and ANSWER into the low segment and the module ROUTIN into the high segment.

/SET

Function

The /SET switch is used to set the value of a relocation counter to a specified number. Although LINK-10 will handle many relocation counters, only two relocation counters are currently implemented: the counter for the low segment (.LOW.) which begins at zero, and the counter for the high segment (.HIGH.) which begins at location 400000 or the end of the low segment, whichever is greater. Other counters can be set, but they are currently not used by LINK-10.

Switch Format

/SET:symbol:n

Symbol is the name of the relocation counter.

n is an octal number representing the value of the counter. For the first release of LINK-10, only two relocation counters can usefully be given, .LOW. and .HIGH.

Category of Switch

Immediate Action Switch (refer to Paragraph 3.3.4)

Examples

```
.SET:.LOW.:1000,/SET:.HIGH.:400000
```

/SEVERITY

Function

The /SEVERITY switch specifies to LINK-10 the level at which messages are to be considered fatal. Associated with each message is a decimal number from 0 to 31 called the severity level. With this switch, the user can specify that messages with a severity level less than or equal to a specific number are not to cause his job to be terminated. Any message with a severity level above the specified number will cause his job to abort.

Switch Format

```
/SEVERITY:n
```

n is a decimal number from 0 to 30. LINK-10 messages with a severity level above n will cause a user's job to be aborted. Even though the highest severity level is 31, the user cannot indicate that a message with this severity level is to be considered non-fatal. If this switch, or the value of the switch, is omitted, a fatal error for a timesharing job is one whose severity level is greater than 24 (decimal), and for a batch job, one whose level is greater than 16 (decimal).

Category of Switch

Delayed Action Switch (refer to Paragraph 3.3.5)

Examples

```
/SEVERITY:30
```

/SKIP

Function

The /SKIP switch is used to space forward over the specified number of input or output files. This switch is implemented for magnetic tape only and is ignored if it is given for any other device.

Switch Format

/SKIP:n

n is a decimal number representing the number of files to skip over.

Category of Switch

Device Switch (refer to Paragraph 3.3.1)

Examples

```
/SKIP:4 MTA3:
```

/SPACE

Function

The /SPACE switch is used to reserve a specific amount of core at the end of the run time representative of the current link. This additional core is used at execution time, mainly in the root link for I/O buffers and runtime tables of the object time system. If the amount of space reserved for dynamic allocation is too small, the link will not be able to be loaded at its optimal location and will have to be relocated, if possible. However, if the link was loaded as an absolute link, an allocation of too few words results in a fatal error condition. When the space allocated is larger than necessary, core will be wasted because it is not used. Since the core reserved by this switch is not actually allocated until execution time, it does not increase the size of the overlay file.

Switch Format

/SPACE:n

n is a decimal number that represents the size of the reserved area in words. An octal value can be given by preceding it with a number sign (#). If this switch, or the value of this switch, is omitted, the default allocation is 2000 (decimal) words in the root link and 0 words in the remaining links.

Category of Switch

Delayed Action Switch (refer to Paragraph 3.3.5)

Examples

```
OVERFL/OVERLAY = /SPACE:3000 MAIN/LINK
```

Load the overlay handler and give the overlay file the name OVERFL.OVL (OVERFL/OVERLAY), reserve 3000 decimal words in the root link for use during execution time (/SPACE:3000), and output the module named MAIN to the overlay file (MAIN/LINK).

/SSAVE

Function

The /SSAVE switch is used to define an output save file which will contain the core image produced by LINK-10. It is similar to the /SAVE switch except that the high segment will be sharabl- when it is brought into core and executed. The saved file produced by this switch is the same as the one produced by the SSAVE system command. Refer to the /SAVE switch.

Switch Format

```
file specification/SSAVE:n
```

Arguments are the same as for the /SAVE switch except for the following difference: when there are two segments, the extension .LOW is assumed for the low segment and .SHR for the high segment.

Category of Switch

Output Switch (refer to Paragraph 3.3.3)

Examples

DTA:SHRPRG/SSAVE,

Define a sharable save file with the name SHRPRG on the user's DECtape. The minimum core required by the core image is assigned.

/START

Function

The /START switch is used to specify the start address of the loaded program or to allow a program to specify its own start address. When a start address is specified, all subsequent start addresses are ignored. This is the default action.

Switch Format

/START:n

n is either of the following:

an octal number preceded by a number sign (#) representing the starting address of the program, or

a SIXBIT global symbol whose value is the start address. The global symbol specified must be defined.

If n is omitted, LINK-10 does not change the current start address but will accept all start addresses from the following modules (i.e., the action is to turn off a /NOSTART switch setting).

Category of Switch

File Dependent Switch (refer to Paragraph 3.3.2)

Examples

,MAINPG/START,/NOSTART PROG1,PROG2,

Use the start address in MAINPG and ignore the start addresses in PROG1 and PROG2.

/SYMBOL

Function

The /SYMBOL switch is used to specify an output symbol file which will consist of local symbols (if loaded), information stored in the local symbol table, such as module names and lengths, and global symbols sorted for DDT.

Via keywords, the user can specify that the symbol file is to be either in radix-50 representation or in triplet format. These two symbol table formats can be distinguished from each other in several ways:

1. The first word of the radix-50 symbol table is always negative. The first word of the triplet symbol table is always zero.
2. The listing of each radix-50 symbol requires two words; the first word is the symbol name in radix-50 representation, and the second word is the value.
3. The listing of each triplet symbol requires three words; the first one contains flags, the second is the symbol name in SIXBIT, and the third is the value.

This switch is useful when DDT is not loaded with the user's program because it guarantees that the symbols will be available. Note that if the user issues the /NOSYMBOL switch in the command string, he is not able to obtain the output symbol file.

Switch Format

file specification/SYMBOL:keyword

File specification is in the form dev:file[directory] and specifies the device and name associated with the symbol file. The default specification is

DSK:name of main program .SYM[user's default directory]

If there is no main program, the filename nnnLNK, where nnn is the user's job number, is used.

Keyword is one of the following:

RADIX-50 to obtain the symbols in radix-50 representation.

TRIPLET to obtain the symbols in triplet format.

If the /SYMBOL switch is not issued by the user, no output symbol file will be generated. If the keyword is omitted, RADIX-50 is assumed.

Category of Switch

Output Switch (refer to Paragraph 3.3.3)

Examples

```
DSKB:SYMFIL[20,235]/SYMBOL,
```

Define a symbol file with the name SYMFIL on the [20,235] area of DSKB:. The symbols will be output in the RADIX-50 format.

/SYMSEG

Function

The /SYMSEG switch causes symbols to be loaded with the program and indicates the segment into which the symbol table is to be placed. With this switch, the user insures that his program when loaded with DDT will run in as much core as is available without overwriting the symbol table. Loading DDT or setting the JOBDAT location .JBDDT to a non-zero value also causes the symbols to be loaded.

Switch Format

/SYMSEG:keyword

Keyword is one of the following:

DEFAULT to move the symbol table from its current position at the top of core to the first free location after the patching space. The JOBDAT location .JBFF, which points to the first free location, is adjusted to point to the first free location after the symbol table. This keyword is used to reset to the normal action after invoking the /SYMSEG switch with either the HIGH or LOW keywords.

HIGH to place the symbol table into the high segment.

LOW to place the symbol table into the low segment.

If the switch, or the value of the switch, is omitted, the symbol table is moved from its current position in the segment to the first free location in that segment. The first free location is determined after the allocation of space (default allocation is 64 decimal or 100 octal words) for patching of symbols. A global symbol, PAT.., is defined to be equal to the first location in the patching space.

Category of Switch

Delayed Action Switch (refer to Paragraph 3.3.5)

Examples

/SYMSEG:HIGH

/SYSLIB

Function

The /SYSLIB switch forces the system libraries to be searched in order to satisfy any undefined global requests. LINK-10 examines the main program first and, depending on the compiler used, searches the appropriate library (e.g., an ALGOL main program causes ALGLIB to be loaded). Then LINK-10 looks at any remaining programs and searches the relevant libraries.

A system library is not automatically searched unless its corresponding compiler-produced code has been loaded. This means that a user must explicitly request a system library when he is not loading the corresponding compiler-produced code for that library. For example, if the user is loading only MACRO-10 programs and he wants the LIB40 library searched, he must specify it in the switch format; LIB40 is not automatically searched unless F40 code has been loaded.

The normal action taken by LINK-10 is to search all required libraries at the end of the loading procedure; however, this switch without any keywords causes the libraries to be searched at the time the switch is given. If keywords are specified on the switch, the searcing of the indicated libraries occurs at the end of the loading procedure or on a subsequent /SYSLIB switch with no arguments, whichever occurs first.

Switch Format

/SYSLIB:keyword

/SYSLIB:(keyword, . . .,keyword)

Keyword is one of the following:

ALGOL	to search ALGLIB
BCPL	to search BCPLIB (not supported by DEC)
COBOL	to search LIBOL
FORTRAN	to search FORLIB

F40	to search LIB40 or FORLIB. The library searched depends upon the /FOROTS or /FORSE switch, if given, or on the default FORTRAN library, which is normally FORLIB, if neither switch is given.
NELIAC	to search LIBNEL (not supported by DEC)

If the keyword is omitted, only the libraries for which corresponding compiler-produced code has been loaded will be searched.

Category of Switch

Creates an implicit file specification (refer to Paragraph 3.3.6)

Examples

/SYSLIB

/SYSORT

Function

The /SYSORT switch is used to arrange the symbol table for output to the symbol file into the order most convenient to the user.

Switch Format

/SYSORT:keyword

Keyword is one of the following:

UNSORTED to leave the symbols in the order in which they are placed in the symbol table. This is the default.

ALPHABETICAL to arrange the symbol table in alphabetical order for each module or for each block in a block-structured module.

NUMERICAL to arrange the symbol table in numerical order for each module according to the values of the symbols.

NOTE

UNSORTED is the only keyword currently implemented. The other keywords described above are accepted but LINK-10's action is the same as that taken with the UNSORTED keyword.

Category of Switch

Delayed Action Switch (refer to Paragraph 3.3.5)

Examples

```
/SYSORT:UNSORTED
```

/TEST

Function

The /TEST switch is used to load a debugging program; thus it is similar to the /DEBUG switch except that execution is not specified. For execution of the user's program to begin, the /EXECUTE switch must be given; without /EXECUTE, the debugging program will be loaded, but execution will not occur. In addition, the /TEST switch does not cause termination of the loading; the /GO switch is required to terminate loading.

Switch Format

```
/TEST:keyword
```

Keyword is one of the following: COBDDT, COBOL, DDT, FORTRAN, MACRO, MANTIS. When a compiler or the assembler is specified, the debugging aid associated with that translator is used (e.g., if MACRO is specified, the debugging program DDT is loaded).

Category of Switch

Creates an implicit file specification (refer to Paragraph 3.3.6)

Examples

```
,MAIN1,/TEST:COBOL DATPRG,DATA,TEST/EXECUTE/GO
```

/UNDEFINED

Function

The /UNDEFINED switch is used to type all undefined global requests on the user's terminal. The user can employ this switch to determine the undefined symbols and then use the /DEFINE switch to satisfy the requests for these symbols. Thus, the user can interactively satisfy requests before LINK-10 terminates the load with undefined symbols.

Switch Format

/UNDEFINED

Category of Switch

Immediate Action Typeout Switch (refer to Paragraph 3.3.4)

Examples

```
*/UNDEF
[LNKUGS    1 UNDEFINED SYMBOL]
           NAME      400100
```

400100 is a word in the chain of fixups depending on the symbol.

/UNLOAD

Function

The /UNLOAD switch is used to rewind and unload the current input or output device. The device associated with this switch must be a DECtape or a magnetic tape; the switch is ignored for non-tape devices.

Switch Format

/UNLOAD

Category of Switch

Device Switch; however, the action of this switch is always performed after the file is processed regardless of its position in the specification (refer to Paragraph 3.3.1)

Examples

```
,/REWIND DTA3:FILNAM/UNLOAD,
```

/USERLIBRARY

Function

The /USERLIBRARY switch allows the user to specify a list of user libraries that are to be searched before the system libraries. These user libraries are placed at the front of the list of libraries searched by LINK-10. This switch is useful with the overlay facility in order to indicate that user libraries be searched automatically when the /LINK switch is given. Thus, the user does not have to include the file specifications of his user libraries in the command line for each individual link. The searching of the user libraries remains in effect until the user gives the /NOUSERLIBRARY switch.

Individual installations can assemble their own user libraries into LINK-10. If this is the case, the user libraries will be searched automatically, and the user does not need to use the /USERLIBRARY switch. However, if the user gives the /NOUSERLIBRARY switch without an argument, all user libraries, including the ones assembled into LINK-10, will be removed from the list of libraries searched.

Switch Format

file specification/USERLIBRARY:keyword

file specification/USERLIBRARY:(keyword,..., keyword)

File specification is in the form dev:file.ext [directory] and specifies the device and name associated with the user library.

Keyword is one of the following:

ALGOL	to define this user library as an ALGOL library to be searched only if ALGOL programs are loaded.
ANY	to define this user library as a library to be searched always, no matter what type of programs are loaded.
BCPL	to define this user library as a BCPL library to be searched only if BCPL programs are loaded (not supported by DEC).
COBOL	to define this user library as a COBOL library to be searched only if COBOL programs are loaded.
FORTRAN	to define this user library as a FORTRAN-10 library to be searched only if FORTRAN-10 programs are loaded.
F40	to define this user library as a F40 library to be searched only if F40 programs are loaded.
NELIAC	to define this user library as a NELIAC library to be searched only if NELIAC programs are loaded (not supported by DEC).

If this keyword is omitted the specified user library will always be searched regardless of the types of programs loaded.

Category of Switch

Delayed Action Switch (refer to Paragraph 3.3.5)

Examples

```
TEST/OVERLAY = MAIN, USERLIB/USERLIBRARY, SUBPRG/LINK
```

Load the overlay handler, produce an overlay file called TEST.OVL, write the modules MAIN and SUBPRG to the overlay file, and search the user library USRLIB before searching the system libraries. The user library will automatically be searched at the end of all following command lines unless the user gives the /NOUSERLIBRARY switch.

/VALUE

Function

The /VALUE switch allows the user to interactively type in the names of global symbols in order to find out their current values. The output given to the user consists of the requested symbol, its current value, and its status. The status can be one of: DEFINED (i.e., in the symbol table with its final value), UNKNOWN (i.e., not in the symbol table), UNDEFINED (i.e., in the symbol table as undefined), COMMON (i.e., in the symbol table and defined as COMMON).

Switch Format

```
/VALUE:symbol

/VALUE:(symbol, . . .,symbol)
```

Symbol is the name of the symbol in ASCII.

Category of Switch

Immediate Action Switch (refer to Paragraph 3.3.4)

Examples

/VALUE:(TAG1,START)

```
LNKVAL TAG1          400010    DEFINED

LNKVAL START              0    UNDEFINED
```

The symbol TAG1 is defined to be the value 400010, and the symbol START is undefined.

/VERBOSITY

Function

The /VERBOSITY switch gives the user control over the amount of text transmitted to both his terminal and his log file whenever he receives a message from LINK-10. Associated with each message is a verbosity indicating the amount of text contained in the message. A verbosity of SHORT indicates that the message consists only of a 6-letter code (e.g., LNKSTC). A message with a verbosity of MEDIUM consists of the 6-letter code and one line that explains the code (e.g., LNKSTC Symbol Table Completed). A message with a verbosity of LONG consists of the 6-letter code, the one line of explanation, plus a more detailed explanation of the message. Thus, the user can specify via this switch the amount of explanation output to his terminal and log file.

LINK-10 has the following feature to aid users receiving fatal messages (i.e., ones preceded by ?). If the user receives a fatal message but has not indicated that he wants to see the detailed explanations (i.e., verbosity LONG), he can give the CONTINUE system command after he receives the message. LINK-10 then types out the remainder of the message (if there is more information available) on the user's terminal. This additional information is not included in the user's log file nor is the job continuable after the message is output.

Switch Format

/VERBOSITY:keyword

Keyword is one of the following:

SHORT	6-letter code only.
MEDIUM	6-letter code and a one-line explanation.
LONG	6-letter code, a one-line explanation, and a detailed explanation.

The default value is MEDIUM if this switch, or the keyword to the switch, is omitted.

If the user specifies a verbosity greater than the one available for the message, the specified keyword is ignored for that message and only the available text is output. For example, if the user specifies MEDIUM as the verbosity but the message only has a 6-letter code available (i.e., SHORT), only the 6-letter code will be output because there is no additional information available for that message.

Category of Switch

Delayed Action Switch (refer to Paragraph 3.3.5)

Examples

```
/VER:SHORT
```

/VERSION

Function

The /VERSION switch is used to set a version number in the file's retrieval information block (RIB) or to change .JBVER (location 137) in the job's data area. When the switch is associated with an output specification, the version number is entered only in that file's RIB. When the switch is associated with an input specification (or no specification), the version number is entered in .JBVER and .JBHVR (location 4 in the vestigial job data area). It is also entered in the RIBs of all output file specifications unless an explicit /VERSION switch has been given for a particular output specification. If an explicit switch has been given for an output file, the setting implied by that switch is used.

Switch Format

/VERSION: major minor (edit)-modifier

Major is the major version number represented as an octal number of up to 3 digits.

Minor is the minor version number represented as one or two alphabetic characters.

Edit is the edit number represented by 6 or fewer octal digits. This number must be enclosed in parentheses, and if it is the only argument given, the entire quantity must be enclosed in double quotes to avoid conflict with repeated values (e.g., /VERSION: "(23)").

Modifier is an octal number designating the group who last modified the file (0 - DEC development, 1 - other DEC personnel, 2-7 - customer use). This number, if given, must be preceded by a hyphen.

If this switch, or the value of this switch, is omitted, the version number is the contents of location 137 (.JBVER).

Category of Switch

Delayed Action Switch when used on an input specification (refer to Paragraph 3.3.5).

Immediate Action Switch when used on an output specification (refer to Paragraph 3.3.4).

/XPN

Function

The /XPN switch is used to create or save on the disk the expanded core image file (XPN file) of the low segment, If the program has not been loaded onto the disk, this switch causes the file to be created with the name specified by the user. If the program has been loaded onto the disk, the file already exists, but with the name nnnLLC.TMP where nnn is the user's job number. Since this extension indicates a temporary file, the expanded file is normally deleted upon the completion of LINK-10's processing. Thus, in this case, the /XPN switch is used to rename the file with the .XPN extension, so that it will not be deleted.

Switch Format

file specification/XPN

File specification is in the form dev:file[directory] and specifies the device and name to be associated with the expanded core image file. The default specification is

DSK:name of main program.XPN[user's default directory]

If there is no main program, the filename nnnLNK, where nnn is the user's job number, is used.

Category of Switch

Output Switch (refer to Paragraph 3.3.3)

Example

```
DSKC:XPNFIL[20,270]/XPN
```

Save the expanded core image file on the [20,270] area of DSKC: and with the name XPNFIL.

/ZERO

Function

The /ZERO switch is used to clear the directory of the associated DECtape. The directory is always cleared before the file is written, regardless of the switch's position in the current specification. This switch is ignored for all non-DECtape devices.

Switch Format

file specification/ZERO

File specification is an output specification.

Category of Switch

Output Switch (refer to Paragraph 3.3.3)

Examples

```
DTA3:MYPROG/SAVE/ZERO
```

CHAPTER 5

LINK-10 OVERLAY CAPABILITY

Because of the size of some programs and the availability of core memory, the user may find it beneficial to be able to partition his program into segments called overlay links. When using overlays, the user can cause the system to dynamically replace currently unneeded portions of his running program with currently needed portions, thereby using less core than normally required.

Without an overlay capability, all of the modules of the user's program are simultaneously in core during execution. Thus, the amount of core required to run the user's program is the sum of all of the module's lengths. In addition, a module will always be occupying core even if it is used only a small percentage of the total run time. In an environment of unlimited resources, this method of utilizing core is the most efficient as far as execution speed is concerned because when a module is requested by a second one, it is already in core.

However, an overlay capability eliminates some of the disadvantages that arise when all of the user's program must be in core. First, the user can run a program larger than the amount of available core, thus eliminating the restriction on the maximum size of a program. Second, by dividing the program into overlays, the disadvantage of maintaining in core modules that are not currently being used disappears. This is a benefit to all users of the system in that more user jobs can be in core at the same time because of the core saved by overlaying the program. These advantages outweigh the small increase in loading and execution times that result from using the overlay capability, particularly when the system as a whole is heavily used.

5.1 USING LINK-10'S OVERLAY CAPABILITY

In order to use LINK-10's overlay capability, the user must have a good understanding of the operation of his program and the relationships among the modules in his program. He must organize his overlay structure so as to retain in core the links that contain the more commonly used modules and place the infrequently used modules in links that can overlay each other. For example, a specialized error recovery procedure would have to be in core only when the specialized error occurred. Each link should be a collection of modules that are functionally related; each should be as self-contained as possible and call other links as infrequently as possible. In particular, references to links that will cause the overlaying of existing links should be minimal.

A tree-like structure, called an overlay structure, is used to illustrate the dependencies among overlay links. In a tree structure, each link has only one immediate ancestor and may have more than one immediate successor. The link that contains the parts of the program that are always required, and thus must always remain in core during execution, is called the root link. The root link receives control at the start of execution and therefore does not have an ancestor. The remaining links branch away from the root link and are structured according to their dependencies upon each other.

Links that do not have to be in core at the same time are called independent links. For example, two modules that do not reference each other and do not pass data directly to each other are independent. Once one link is no longer needed in core, the second one can overlay it when it is brought into core.

An overlay link that receives control from, or whose data is contained in, another link is dependent on this first link. The dependent link must have the link on which it depends in core at the same time and thus cannot overlay it. All links are dependent on the root link.

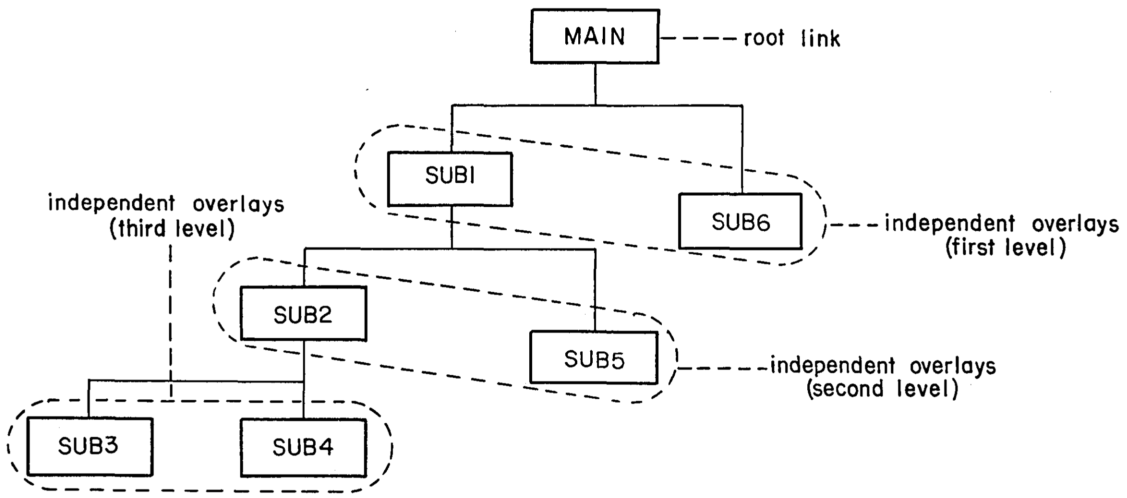
As an example, assume the user has a FORTRAN program, EXAMPL. This program consists of a main program, MAIN, and six subroutines, SUB1, SUB2, SUB3, SUB4, SUB5, and SUB6. The subroutines are related in the following ways:

1. SUB1 and SUB6 are called directly from the main program and are independent of each other.

2. SUB2 and SUB5 are called directly from SUB1 and are also independent of each other.

3. SUB3 and SUB4 are called directly from SUB2 and are independent of each other.

After analyzing these relationships, the user can draw the following tree structure to illustrate the dependencies of the subroutines.


MAIN
root link
SUB1
SUB6
independent overlays (first level)
independent overlays (third level)
SUB2
SUB5
independent overlays (second level)
SUB3
SUB4

By studying the dependencies in the diagram, the user can see that when a specific link is executed, all links between it and the root link must be in core. For example, SUB4 depends on SUB1 and SUB2; therefore, these two links must be in core for the execution of SUB4. This chain of links is called the path of the link currently being executed. The action of bringing these links into core is termed path loading. The chain of links beginning with the current link and going away from the root is called the extended path. Thus, in the previous example, the path of SUB4 is MAIN, SUB1, SUB2. There are three extended paths of SUB1:

1. SUB2, SUB3

2. SUB2, SUB4

3. SUB5

Links may communicate with other links if they lie in a common path or extended path. This communication is via references to global symbols. References from the current link to a global symbol in another link on the path are called backward references. References from the current link to a global symbol in another link on the extended path are called forward references. Since all links from the current link back to the root link must be in core, a backward reference does not cause any links to be brought into core. However, with a forward reference, the referenced link may not be in core and therefore must be brought in, possibly overlaying a link currently residing in core.

5.2 DESIGNING AN OVERLAY STRUCTURE

The first step the user takes when designing his overlay structure is to draw a tree-like diagram showing the functional relationships among the modules in his programs. The tree begins with the root link which contains the main program and which remains in core throughout execution. The remainder of the program is contained in the overlay links that support the root link.

Links that are functionally related lie in the same path. Links that can overlay each other are at the same level in different paths and thus are not functionally related.

The user should remember several points when drawing his overlay structure.

1. References that will cause overlaying of existing links should be minimized.

2. Independent links cannot reference each other; communication is by way of a common link.

3. As a general rule, calls should be forward references, and returns should be backward references.

4. If data is modified during execution, the modification is destroyed once the link is overlaid. Therefore, if data required by another link is modified, it must be returned to

the link requiring it before the link containing the changed data is overlaid.

5. Addresses or references should not be left to links that will be overlaid.

6. Modules or data areas used by several links should be explicitly loaded into a link that is common to all links using these modules or data areas. For example, a COMMON data area should be in a link just before the first link referencing it. In addition, COMMON should be positioned in such a way that it never gets reinitialized after the first call.

Tree-structured overlay systems can be one or more levels deep. The amount of core required is at least the amount needed for the longest path. The length of the longest path is not the minimum requirement, however, since special tables must be included when a program is divided into links.

As an example of designing an overlay structure, assume that the user wants to divide the following FORTRAN program, consisting of a main program and 11 subroutines, into overlay links.

```
C       MAIN PROGRAM IN ROOT LINK FOR OVERLAY
C       START WITH SINGLE PRECISION EXPONENTIATION
        TYPE 1
1       FORMAT (' INPUT SINGLE PRECISION NUMBER X=',$)
        ACCEPT 2,X
2       FORMAT (G)
        CALL SPEXP (X)
C       NOW FOR DOUBLE PRECISION
        DOUBLE PRECISION Y
        TYPE 11
11      FORMAT (' INPUT DOUBLE PRECISION NUMBER Y=',$)
        ACCEPT 2,Y
        CALL DPEXP (Y)
C       NOW FOR TRIG FUNCTIONS IN DEGREES
        TYPE 30
30      FORMAT (' INPUT ANGLE IN DEGREES T=',$
        ACCEPT 2,T
        CALL TRIG (T)
C       EXIT
        CALL EXIT
        END

        SUBROUTINE SPEXP (X)
        COMMON /X2/X2
        CALL SPEX2 (X,X2)
        TYPE 1,X,X2
1       FORMAT (' X=',G,4X,'X**2=',G)
        CALL SPEX3 (X,X3)
        TYPE 2,X,X3
2       FORMAT (' X=',G,4X,'X**3=',G)
        CALL SPEX4 (X,X4)
        TYPE 3,X,X4
3       FORMAT (' X=',G,4X,'X**4=',G)
        RETURN
        END
```

```
              SUBROUTINE SPEX2 (X,XX)
              COMMON /X2/X2
              X2=X*X
              RETURN
              END

              SUBROUTINE SPEX3 (X,X3)
              COMMON /X2/X2
              X3=X2*X
              RETURN
              END

              SUBROUTINE SPEX4 (X,X4)
              COMMON /X2/X2
              X4=X2*X2
              RETURN
              END

              SUBROUTINE DPEXP (Y)
              DOUBLE PRECISION Y,Y2,Y3,Y4
              COMMON /Y2/Y2
              CALL DPEX2 (Y,Y2)
              TYPE 1,Y,Y2
      1       FORMAT (' Y=',G,4X,'Y**2=',G)
              CALL DPEX3 (Y,Y3)
              TYPE 2,Y,Y3
      2       FORMAT (' Y=',G,4X,'Y**3=',G)
              CALL DPEX4 (Y,Y4)
              TYPE 3,Y,Y4
      3       FORMAT (' Y=',G,4X,'Y**4=',G)
              RETURN
              END

              SUBROUTINE DPEX2 (Y,YY)
              DOUBLE PRECISION Y2
              COMMON /Y2/Y2
              Y2=Y*Y
              RETURN
              END

              SUBROUTINE DPEX3 (Y,Y3)
              DOUBLE PRECISION Y2
              COMMON /Y2/Y2
              Y3=Y2*Y
              RETURN
              END

              SUBROUTINE DPEX4 (Y,Y4)
              DOUBLE PRECISION Y2
              COMMON /Y2/Y2
              Y4=Y2*Y2
              RETURN
              END

              SUBROUTINE TRIG (T)
              S1=SIND(T)
              TYPE 1,T,S1
      1       FORMAT (' SIN (',G,')=',G)
              CALL SIND2 (T,S2)
              TYPE 2,T,S2
```

```
2       FORMAT (' SIN (2*',G,')=',G)
        CALL SIND3 (T,S3)
        TYPE 3,T,S3
3       FORMAT (' SIN (3*',G,')=',G)
        RETURN
        END

        SUBROUTINE SIND2 (T,S2)
        S2=SIND(2*T)
        RETURN
        END

        SUBROUTINE SIND3 (T,S3)
        S3=SIND (3*T)
        RETURN
        END
```

The above program has three phases of execution. The first phase is single precision exponentiation; the second is double precision exponentiation; the third is trigonometric calculations of an angle. Each phase is completely independent of the other two, and once it has finished its calculations, it can be overlaid by one of the other phases. The subroutines performing the actual calculations for each phase have common subroutines that specify the FORMAT statements for the calculations.

The overlay structure for the program is shown below.

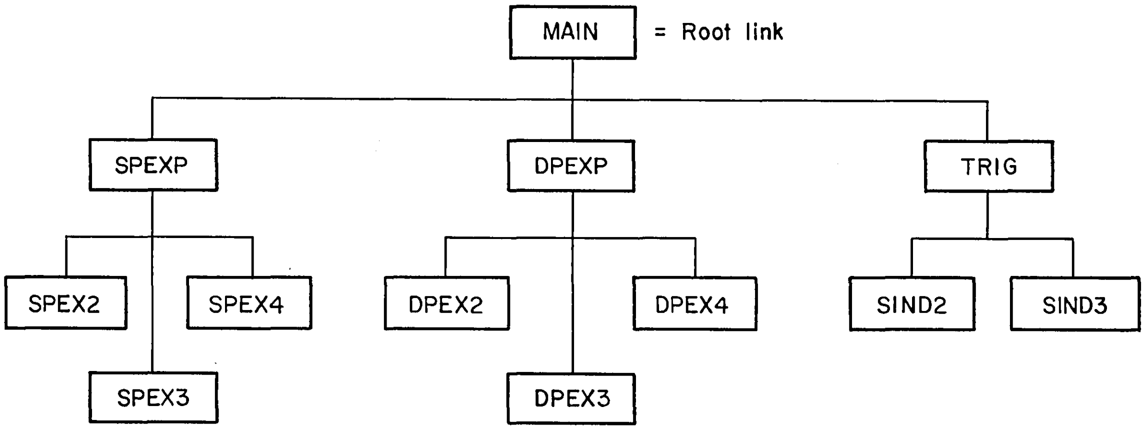


Figure 5-1 Sample Overlay Structure

5.2.1 Designing an Overlay Structure for an Existing Program

The user who has an existing program and wants to use the overlay facility without redesigning his program should follow the procedure below to determine the feasibility of this task.

1. Compile or assemble all components (subroutines) of the program.

2. Run the GLOB program (or a similar one) to determine the order of the calling sequences among the components.

3. Draw the overlay structure based on these calls. This is a static structure illustrating the dependencies among the components. The dynamic structure showing the number of calls among components can be obtained by writing a program that traces these calls, by manually proceeding through the program and counting the calls, or by loading the program and requesting a log file for analyzing.

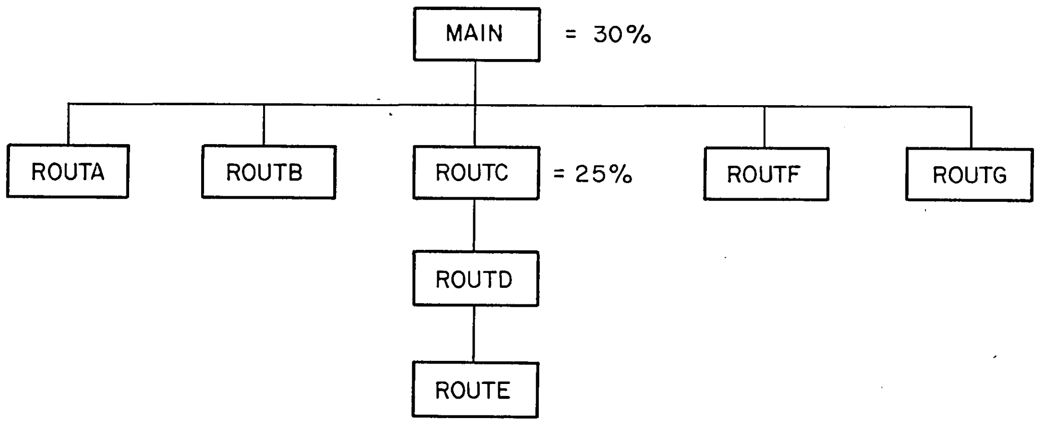
4. Load the overlay structure and request a map file. Examine the map to determine the following:

   a. The total amount of core the program takes.

   b. The percentage of the total core needed for each path of the structure. Ideally, these percentages should be about the same for each path.

   c. The number of calls causing overlaying of links already in core. These calls should be minimized, if possible, so that when links in one path have completed executing, links in a second path are called and execution is not passed back to the links in the first path.

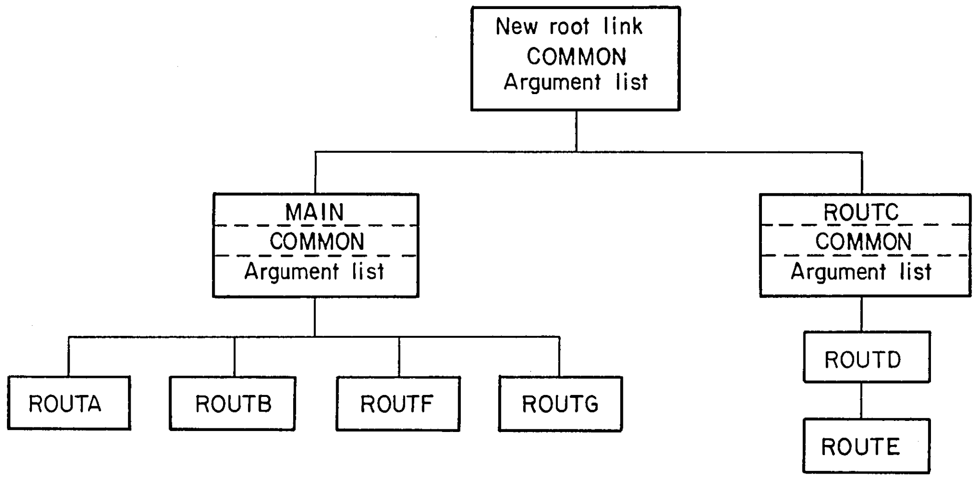
If the user finds that a large percentage of the total core required by the program (e.g., 55-60%) is in two links in the same path, he should try to equalize the sizes of the paths. For example, consider the following structure where MAIN uses 30% of the total core and ROUTC uses 25%.



One possible method for balancing the paths is to place the two links (MAIN and ROUTC) in separate paths by creating a new root link and placing the main program in a link off the root link. Now the two large links can overlay each other. To do this, two items must be feasible:

1. It must be possible to simulate the call and the passing of arguments from MAIN and ROUTC since independent overlays cannot directly call one another.

2. Any COMMON that was in MAIN must be promoted to the new link.



If the user finds that he has a large numbr of overlaying calls (i.e., calls that result in the overlaying of an existing link), he should try to combine the links that overlay each other into one link. This is reasonable when the links are relatively small or when the number of links at the same level is greater than the number of links with overlaying calls. For example, in the overlay structure shown above, if ROUTA and ROUTB are continually overlaying each other, they can, and should, be placed in one link.

5.3 SPECIFYING AN OVERLAY STRUCTURE TO LINK-10

Once the user has drawn his overlay structure, he must then specify this structure to LINK-10 with the appropriate switches on the LINK-10 command string. Three switches, /OVERLAY, /LINK, and /NODE, are required when specifying overlays.

/OVERLAY signifies that overlays are to be generated and that the overlay handler must be loaded. This switch must be included with the specification of the root link, which has to be the first link specified in the command string. The /OVERLAY switch may be associated with a file specification, in which case the file specification will be used for the overlay file. Refer to /OVERLAY in Chapter 4 for more information.

/LINK designates the end of an overlay link. When LINK-10 processes this switch, it writes the current core image to the overlay file. At this point, LINK-10 assigns the link a number. In addition, the user can assign a name to the link by giving the name as an argument to the switch. After LINK-10 processes the /LINK switch, it returns to the user for more input.

/NODE causes LINK-10 either to back up on the current path to the end of the link specified as an argument or to move to the end of the specified link in a separate path. The result of this switch is the same as if the user had issued a /LINK switch for the specified link. The recommended arguments to this switch are the following:

1. The name of the link that the user wishes to position LINK-10 after. This name is the one previously assigned by the user with the /LINK switch.

2. A negative number, -n, indicating that the user wishes to move back over the specified number of links on the path. For example, -2 backs up over two links. A zero indicates that the user wishes to position LINK-10 after the root link.

The following command sequences illustrate various ways of specifying the overlay structure in Figure 5-1. The user is giving his overlay file the name TEST and is also requesting a map file.

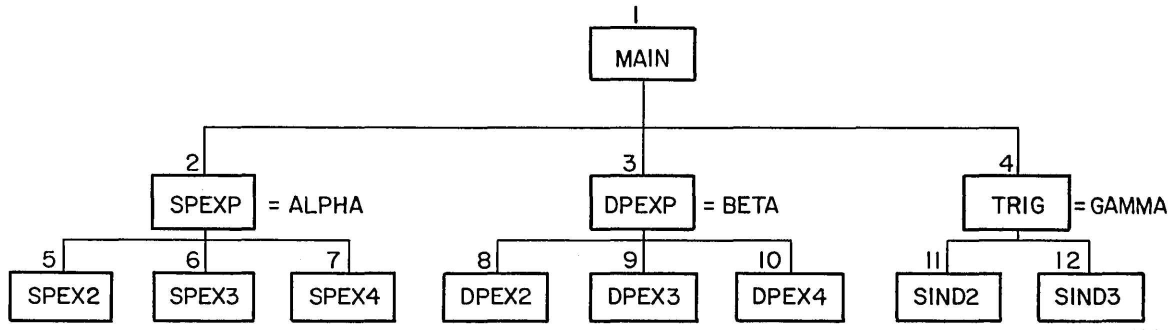
NOTE

The tabs at the beginning of the command lines are used only to illustrate the levels of the overlay structure. They do not have to be included in the command line. However, their use is recommended in command files in order to make the files easier to read.

Command Sequence 1

```
.R LINK↵

*TEST/OVERLAY,LPT:/MAP=MAIN/LINK↵
*         SPEXP/LINK:ALPHA↵
*         /NODE:0 DPEXP/LINK:BETA↵
*         /NODE:0 TRIG/LINK:GAMMA↵
*                  /NODE:ALPHA SPEX2/LINK↵
*                  /NODE:ALPHA SPEX3/LINK↵
*                  /NODE:ALPHA SPEX4/LINK↵
*                  /NODE:BETA DPEX2/LINK↵
*                  /NODE:BETA DPEX3/LINK↵
*                  /NODE:BETA DPEX4/LINK↵
*                  /NODE:GAMMA SIND2/LINK↵
*                  /NODE:GAMMA SIND3/LINK↵
*/GO↵
```

Command Sequence 1 specifies and outputs the links to the overlay file in the order shown below:

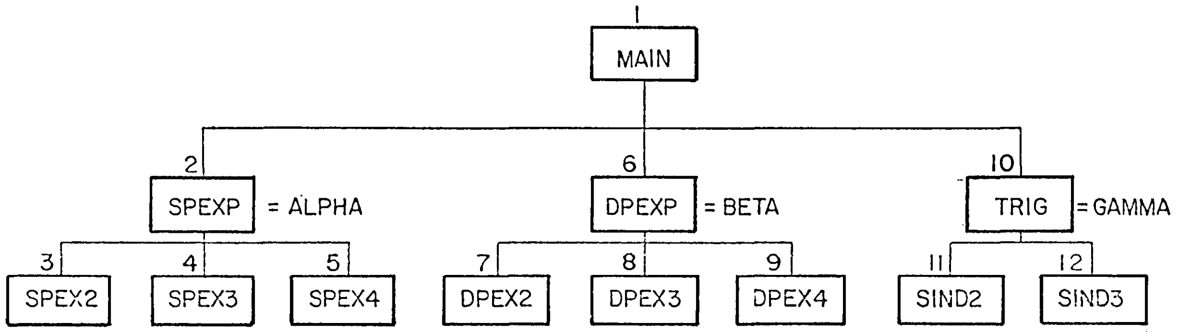


This command sequence builds the overlay structure by specifying each level completely before proceeding to the next level. The user has given names to the links in the first level (ALPHA, BETA, GAMMA) and has used these names as arguments to the /NODE switch.

Command Sequence 2

```
.R LINK↵
*TEST/OVERLAY,LPT:/MAP=MAIN/LINK↵
*         SPEXP/LINK:ALPHA↵
*                   SPEX2/LINK↵
*                   /NODE:ALPHA SPEX3/LINK↵
*                   /NODE:ALPHA SPEX4/LINK↵
*         /NODE:0 DPEXP/LINK:BETA↵
*                   DPEX2/LINK↵
*                   /NODE:BETA DPEX3/LINK↵
*                   /NODE:BETA DPEX4/LINK↵
*         /NODE:0 TRIG/LINK:GAMMA↵
*                   SIND2/LINK↵
*                   /NODE:GAMMA SIND3/GO↵
```

Command Sequence 2 specifies and outputs the links to the overlay file in the order below:



This command sequence builds the overlay structure by specifying each path completely before specifying the next path. Again, names have been given to the links in the first level and used as arguments to the /NODE switch.

Command Sequence 2 is more efficient than Command Sequence 1 since LINK-10 knows all the links back to the root. Because the links are already in core, LINK-10's task of defining global symbols is much faster.

5.4 LOADING AND EXECUTING THE OVERLAY STRUCTURE

During the loading process of the overlay structure, LINK-10 creates two files instead of the single file that it normally creates. One file is a save (.SAV) file that contains the root link, the low segment of the appropriate object time system, and the overlay handler (refer to Appendix B). This save file contains the start address of the program and remains in core throughout execution. The second file is an overlay file containing the overlay links that constitute the remainder of the program. The overlay file is a contiguous disk file and is subdivided into the actual individual links and header blocks by the internal control information that LINK-10 places in the file (refer to Paragraph B.3).

During execution, only the required portions of the program are loaded into core. When a link in the overlay file is referenced, either from the root link or a link already in core, that link is then brought into core if it is not already there. Depending on the overlay structure and the run time state of the program, the new link may be appended to the path of a current link or may replace a link that is no longer needed in core.

Links in the overlay file are not modified during the execution of the program. Each time a link is brought into core, it appears in its original from; no part of a replaced link is ever saved. Because of this, data in the form of temporary results should never be part of a link that can be overlaid.

CHAPTER 6

LINK-10 EXAMPLES

EXAMPLE 1 Loading and Executing COBOL Programs

The following files are on the user's disk area:

```
.DIRECT

FILA      CBL  1    <055>          6-FEB-73    DSKB:   [27,235]
FILB      CBL  2    <055>          6-FEB-73
FILC      CBL  1    <055>          6-FEB-73
006LNK    LOG  1    <055>         28-FEB-73
SIMPLE    MAC  1    <055>         28-FEB-73

  TOTAL OF 6 BLOCKS IN 5 FILES ON DSKB: [27,235]
```

In the command string shown below, the user is automatically compiling, loading, and executing the programs and generating a map. The /CONT:ZERO switch is passed to LINK.

```
.EXECUTE /LINK/MAP FILA,FILB,FILC%'CONT:ZERO'
COBOL:    CBS08A    [FILA.CBL]
COBOL:    CBS08B    [FILB.CBL]
COBOL:    CBS08C    [FILC.CBL]
LINK:     LOADING
[EXECUTION]
RUNNING CBS08A
RUNNING CBS08B
RUNNING CBS08C

EXIT
```

LINK-10 Examples

In the following command sequences the user is compiling the files and then directly loading and executing them through LINK-10.

```
.COM FILA,FILB,FILC
COBOL:      CBS08A     [FILA.CBL]
COBOL:      CBS08B     [FILB.CBL]
COBOL:      CBS08C     [FILC.CBL]

EXIT

.R LINK

*FILA,FILB,FILC,/MAP/CONT:ZERO/EXECUTE/GO
[EXECUTION]
RUNNING CBS08A
RUNNING CBS08B
RUNNING CBS08C

EXIT

.
```

EXAMPLE 2 Loading and Executing a MACRO Program

The user assembles the following MACRO program:

```
.COMPILE SIMPLE.MAC
MACRO: SIMPLE


EXIT

.
```

In the following command sequences, the user loads the MACRO program, interactively requests a listing of the relocation counters, library search symbols, and undefined global symbols, and then executes the program.

```
.R  LINK

*SIMPLE
*/COUNTER
RELOCATION COUNTER        INITIAL VALUE    CURRENT VALUE (OCTAL)
.LOW.                           0               140
.HIGH.                    400000           400025
*/ENTRY
NO LIBRARY SEARCH SYMBOLS (ENTRY POINTS)
*/UNDEFINE

NO UNDEFINED GLOBAL SYMBOLS
*/EXECUTE/GO
[EXECUTION]
THIS IS A VERY SIMPLE TWO-SEGMENT MACRO PROGRAM.

EXIT
```

```
.
```

EXAMPLE 3 Loading COBOL Programs and Creating a Saved File

In the following example, the user is individually loading each file and requesting a listing of undefined global symbols after each file is loaded. He also is requesting the searching of the default system libraries. After searching has been performed, the user creates a saved file and executes the core image.

```
.R LINK

*FILA/U

6 UNDEFINED GLOBAL SYMBOLS
BTRAC.     1212
TRACE.     1277
TRPD.      1214
TRPOP.     1213
CBS08B     1327
CBDDT.     1260
*FILB/U

6 UNDEFINED GLOBAL SYMBOLS
BTRAC.     1367
TRACE.     1473
TRPD.      1371
CBS08C     1615
TRPOP.     1370
CBDDT.     1454
*FILC/U

5 UNDEFINED GLOBAL SYMBOLS
BTRAC.     2052
TRACE.     2147
TRPD.      2054
TRPOP.     2053
CBDDT.     2130
*/SYSLIB/U

NO UNDEFINED GLOBAL SYMBOLS

*FILZ/SAV/EXECUTE/GO
[EXECUTION]
RUNNING CBS08A
RUNNING CBS08B
RUNNING CBS08C

EXIT

.DIR *.SAV

FILZ      SAV      5  <055>  23-APR-73      DSKC:    [27,235]

.
```

Example 4   Loading LINK-10

The Command File

```
/NOINITIAL /LOGLEVEL:1   DSK:LINK/MAP /CONT:NOABS =/RUNAME:LINK-
/HASHSIZE:1500/TEST:DDT/SYMSEG:HIGH,LNKEXO,SCAN,HELPER-
,LNKINI,/NOSTART LNKSCN,LNKOV1,LNKWLD,LNKFIO,LNKLOD,LNKHSH,LNKOLD,LNKF40-
,LNKNEW,LNKCST,LNKCOR,LNKLOG,LNKMAP,LNKOV2,LNKOVS,LNKXIT,LNKPLT,LNKSUB/S-
 ,PLTDCL,PLTUTL,PLTGLB,PLTMTH,PLTIO/GO
```

Running LINK-10 With the Disk as the Log Device

```
       LINK-10 LOG FILE        25-JUN-74
9:07:42  1   1 LIM LINK-10 INITIALIZATION
9:07:44  1   1 SNL SCANNING NEW COMMAND LINE
9:07:48  4   1 EXP EXPANDING LOW SEGMENT TO 13P
9:07:48  1   1 MOV MOVING LOW SEGMENT TO EXPAND AREA DY
9:07:49  1   1 LDS LOAD SEGMENT
9:07:49  1   1 MOV MOVING LOW SEGMENT TO EXPAND AREA DY
9:07:49  6   1 LMN LOADING MODULE UDDT
9:07:49  4   1 EXP EXPANDING LOW SEGMENT TO 17P
9:07:50  4   1 EXP EXPANDING LOW SEGMENT TO 21P
9:07:50  1   1 MOV MOVING LOW SEGMENT TO EXPAND AREA LC
9:07:50  1   1 MOV MOVING LOW SEGMENT TO EXPAND AREA LC
9:07:50  1   1 MOV MOVING LOW SEGMENT TO EXPAND AREA LC
9:07:50  6   1 LMN LOADING MODULE LNKEXO
9:07:50  6   1 LMN LOADING MODULE $SCNDC
9:07:50  6   1 LMN LOADING MODULE .SCAN
9:07:51  4   1 EXP EXPANDING LOW SEGMENT TO 25P
9:07:51  1   1 MOV MOVING LOW SEGMENT TO EXPAND AREA HC
9:07:51  1   1 MOV MOVING LOW SEGMENT TO EXPAND AREA HC
9:07:51  1   1 MOV MOVING LOW SEGMENT TO EXPAND AREA HC
9:07:51  4   1 EXP EXPANDING LOW SEGMENT TO 29P
9:07:51  1   1 MOV MOVING LOW SEGMENT TO EXPAND AREA HC
9:07:51  1   1 MOV MOVING LOW SEGMENT TO EXPAND AREA LS
9:07:52  4   1 EXP EXPANDING LOW SEGMENT TO 33P
9:07:52  1   1 MOV MOVING LOW SEGMENT TO EXPAND AREA LS
9:07:52  6   1 LMN LOADING MODULE .VERBO
9:07:52  6   1 LMN LOADING MODULE .TNEWL
9:07:52  6   1 LMN LOADING MODULE .TOUTS
9:07:52  1   1 MOV MOVING LOW SEGMENT TO EXPAND AREA HC
9:07:52  6   1 LMN LOADING MODULE .STOPB
9:07:52  6   1 LMN LOADING MODULE .CNTDT
9:07:52  4   1 EXP EXPANDING LOW SEGMENT TO 37P
9:07:52  1   1 MOV MOVING LOW SEGMENT TO EXPAND AREA LS
9:07:53  6   1 LMN LOADING MODULE .GTPUT
9:07:53  6   1 LMN LOADING MODULE .SAVE
9:07:53  6   1 LMN LOADING MODULE .HELPR
             .
             .
             .
```

```
9:07:53  6   1 LMN LOADING MODULE LINK
9:07:53  1   1 MOV MOVING LOW SEGMENT TO EXPAND AREA HC
9:07:53  1   1 MOV MOVING LOW SEGMENT TO EXPAND AREA HC
9:07:53  4   1 EXP EXPANDING LOW SEGMENT TO 41P
9:07:53  1   1 MOV MOVING LOW SEGMENT TO EXPAND AREA LS
9:07:54  6   1 LMN LOADING MODULE LNKSCN
9:07:54  1   1 MOV MOVING LOW SEGMENT TO EXPAND AREA HC
9:07:54  4   1 EXP EXPANDING LOW SEGMENT TO 45P
9:07:54  1   1 MOV MOVING LOW SEGMENT TO EXPAND AREA LS
9:07:54  6   1 LMN LOADING MODULE LNKOV1
9:07:54  1   1 MOV MOVING LOW SEGMENT TO EXPAND AREA HC
9:07:54  1   1 MOV MOVING LOW SEGMENT TO EXPAND AREA HC
9:07:55  4   1 EXP EXPANDING LOW SEGMENT TO 49P
9:07:55  1   1 MOV MOVING LOW SEGMENT TO EXPAND AREA HC
9:07:55  1   1 MOV MOVING LOW SEGMENT TO EXPAND AREA LS
             .
             .
             .
9:08:07  6   1 LMN LOADING MODULE FLOAT
9:08:07  6   1 LMN LOADING MODULE FLOAT.
9:08:07  6   1 LMN LOADING MODULE IFIX
9:08:07  6   1 LMN LOADING MODULE INT
9:08:07  6   1 LMN LOADING MODULE IFIX.
9:08:07  6   1 LMN LOADING MODULE FLT.0
9:08:07  6   1 LMN LOADING MODULE FLT.14
9:08:07  6   1 LMN LOADING MODULE IFX.0
9:08:07  6   1 LMN LOADING MODULE EXP2
9:08:07  6   1 LMN LOADING MODULE EXP
9:08:07  6   1 LMN LOADING MODULE EXP.
9:08:07  6   1 LMN LOADING MODULE ALOG
9:08:07  6   1 LMN LOADING MODULE ALOG10
9:08:07  6   1 LMN LOADING MODULE ALOG.
9:08:08  6   1 LMN LOADING MODULE SIND
9:08:08  6   1 LMN LOADING MODULE COSD
9:08:08  6   1 LMN LOADING MODULE SIN
9:08:08  6   1 LMN LOADING MODULE COS
9:08:08  6   1 LMN LOADING MODULE SIN.
9:08:08  1   1 MOV MOVING LOW SEGMENT TO EXPAND AREA LS
9:08:08  6   1 LMN LOADING MODULE LINE
9:08:08  4   1 EXP EXPANDING LOW SEGMENT TO 109P
9:08:08  1   1 MOV MOVING LOW SEGMENT TO EXPAND AREA HC
9:08:08  6   1 LMN LOADING MODULE PLOT
9:08:08  1   1 MOV MOVING LOW SEGMENT TO EXPAND AREA HC
9:08:08  1   1 MOV MOVING LOW SEGMENT TO EXPAND AREA LS
9:08:08  6   1 LMN LOADING MODULE JOBDAT
9:08:10  1   1 MPS MAP SEGMENT
9:08:13  1   1 EMS END OF MAP SEGMENT
9:08:15  1   1 EXS EXIT SEGMENT
9:08:16  1   1 SST SORTING SYMBOL TABLE
9:08:16  1   1 MOV MOVING LOW SEGMENT TO EXPAND AREA HC
9:08:16  1   1 STC SYMBOL TABLE COMPLETED
9:08:16  1   1 FIN LINK-10 FINISHED
LNKELF END OF LOG FILE]
```

```
                LINK-10 SYMBOL MAP OF   LINK    VERSION 2(210)         PAGE 1
        PRODUCED BY LINK-10 VERSION 2(205) ON 25-JUN-74 AT  9:08:11

        LOW  SEGMENT STARTS AT       0 ENDS AT    5355 LENGTH     5356 = 6P
        HIGH SEGMENT STARTS AT  400000 ENDS AT  460535 LENGTH    60536 = 49P
        274 WORDS FREE IN LOW SEGMENT, 162 WORDS FREE IN HIGH SEGMENT
        1065 GLOBAL SYMBOLS LOADED, THEREFORE MIN. HASH SIZE IS 1184
        START ADDRESS IS 407261, LOCATED IN PROGRAM LINK

                *************

UDDT    FROM SYS:DDT.REL[1,4]   CREATED ON 21-OCT-73 AT 16:21:00
        LOW  SEGMENT STARTS AT     140 ENDS AT    4557 LENGTH     4420 (OCTAL),  2320. (DECIMAL)

        DDT               140   ENTRY   RELOCATABLE            DDTEND          4560    GLOBAL  RELOCATABLE
        $1B              4431   GLOBAL  RELOCATABLE            $2B             4434    GLOBAL  RELOCATABLE
        $3B              4437   GLOBAL  RELOCATABLE            $4B             4442    GLOBAL  RELOCATABLE
        $5B              4445   GLOBAL  RELOCATABLE            $6B             4450    GLOBAL  RELOCATABLE
        $7B              4453   GLOBAL  RELOCATABLE            $8B             4456    GLOBAL  RELOCATABLE
        $I               4425   GLOBAL  RELOCATABLE            $M              4430    GLOBAL  RELOCATABLE

                *************

LNKEXO  FROM DSK:LNKEXO.REL[10,131]     CREATED BY MACRO ON 24-JUN-74 AT 13:52:00
        HIGH SEGMENT STARTS AT  400010 ENDS AT  400017 LENGTH       10 (OCTAL),     8. (DECIMAL)


                *************

$SCNDC  FROM DSK:SCAN.REL[10,131]       CREATED ON 20-MAY-74 AT  9:09:00

        ZERO LENGTH MODULE
                          .
                          .
                          .
```

```
PLOT     FROM DSK:PLTIO.REL[10,131]       CREATED ON 22-MAY-74 AT 11:39:00
         HIGH SEGMENT STARTS AT  456424 ENDS AT  460535 LENGTH     2112 (OCTAL),  1098. (DECIMAL)

         LPTOUT         460321    ENTRY    RELOCATABLE              NUMBER         460155    ENTRY    RELOCATABLE
         PLOT           456471    ENTRY    RELOCATABLE              PLOT.          456537    ENTRY    RELOCATABLE
         PLOTI          460430    ENTRY    RELOCATABLE              PLOTS          456425    ENTRY    RELOCATABLE
         SYMBOL         456661    ENTRY    RELOCATABLE              WHERE          460147    ENTRY    RELOCATABLE
         XY2CHR         460455    ENTRY    RELOCATABLE

                  *************

JOBDAT   FROM SYS:JOBDAT.REL[1,5]         CREATED BY MACRO ON 26-DEC-73 AT  9:37:00

         ZERO LENGTH MODULE

                  *************


INDEX TO LINK-10 SYMBOL MAP OF  LINK    VERSION 2(210)          PAGE 17

NAME     PAGE     NAME     PAGE     NAME     PAGE     NAME     PAGE

ALOG     15       IFX.0    14       LNKNEW    9       SIN.     16
ALOG.    15       INT      14       LNKOLD    9       SIND     15
ALOG10   15       JOBDAT   16       LNKOV1    5       UDDT      1
COS      15       LINE     16       LNKOV2   11       $SCNDC    1
COSD     15       LINK      4       LNKOVS   11       .CNTDT    3
EXP      14       LNK005   12       LNKPLT   12       .GTPUT    3
EXP.     15       LNKCOR   10       LNKPRM   12       .HELPR    4
EXP2     14       LNKCST   10       LNKSCN    5       .SAVE     4
FLOAT    13       LNKEXO    1       LNKWLD    6       .SCAN     1
FLOAT.   13       LNKF40    9       LNKXIT   12       .STOPB    3
FLT.0    14       LNKFIO    7       PLOT     16       .TNEWL    3
FLT.14   14       LNKHSH    8       PLTGLB   13       .TOUTS    3
FORMSC   13       LNKLOD    7       PLTO..   12       .TSUBS   12
IFIX     13       LNKLOG   11       PLTUTL   13       .VERBO    2
IFIX.    14       LNKMAP   11       SIN      15

[END OF LINK-10 MAP OF  LINK]
```

Example 5 Loading the Monitor

The Command File

```
/NOINITIAL /LOGLEVEL:1 /HASH:6000 RI680/SAVE ,RI680/MAP =-
/LOCALS /MAXCOR:45K COMMON.RLI,COMDEV.RLI,COMMOD.RLI-
,TOPI10/SEARCH  /PATCHSIZE:200 /GO
```

The Log File

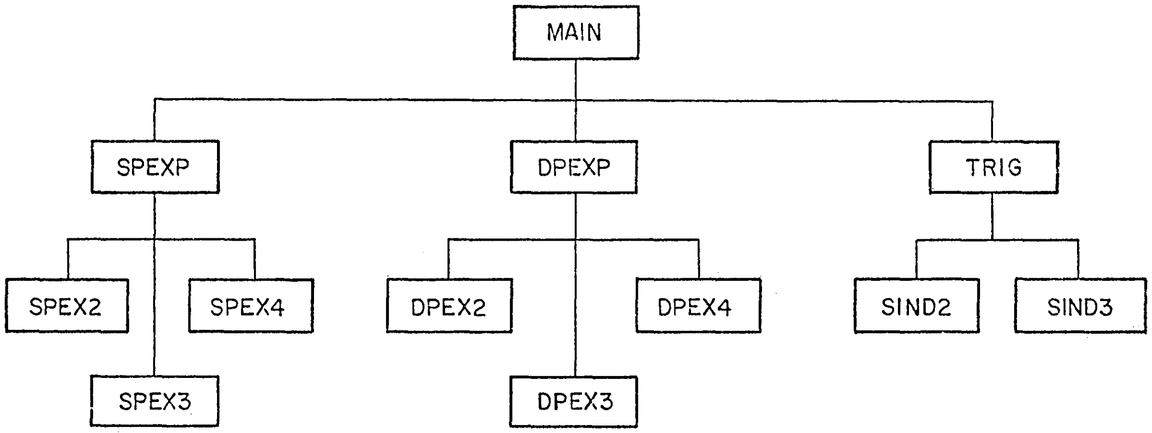
```
          LINK-10 LOG file        25-Jun-74
9:20:23  1   1 LIM LINK-10 initialization
9:20:24  1   1 SNL Scanning new command line
9:20:27  1   1 LDS LOAD segment
9:20:27  4   1 EXP Expanding low segment to 13P
9:20:27  1   1 MOV Moving low segment to expand area DY
9:20:28  6   1 LMN Loading module COMMON
9:20:28  4   1 EXP Expanding low segment to 17P
9:20:28  1   1 MOV Moving low segment to expand area LC
9:20:28  1   1 MOV Moving low segment to expand area LC
9:20:28  4   1 EXP Expanding low segment to 29P
9:20:28  4   1 EXP Expanding low segment to 33P
9:20:28  1   1 MOV Moving low segment to expand area LC
9:20:29  4   1 EXP Expanding low segment to 37P
9:20:29  1   1 MOV Moving low segment to expand area LC
9:20:29  1   1 MOV Moving low segment to expand area LC
9:20:30  4   1 EXP Expanding low segment to 41P
9:20:30  1   1 MOV Moving low segment to expand area LS
9:20:30  4   1 EXP Expanding low segment to 45P
9:20:30  1   1 MOV Moving low segment to expand area LS
9:20:31  4   1 EXP Expanding low segment to 49P
9:20:31  1   1 MOV Moving low segment to expand area LS
9:20:32  4   1 EXP Expanding low segment to 53P
9:20:32  1   1 MOV Moving low segment to expand area LS
9:20:32  4   1 EXP Expanding low segment to 57P
9:20:32  1   1 MOV Moving low segment to expand area LS
9:20:33  4   1 EXP Expanding low segment to 61P
9:20:33  1   1 MOV Moving low segment to expand area LS
9:20:34  4   1 EXP Expanding low segment to 65P
9:20:34  1   1 MOV Moving low segment to expand area LS
9:20:35  6   1 LMN Loading module COMDEV
9:20:35  1   1 MOV Moving low segment to expand area LC
9:20:35  1   1 MOV Moving low segment to expand area LC
9:20:35  4   1 EXP Expanding low segment to 69P
9:20:35  1   1 MOV Moving low segment to expand area LS
9:20:36  4   1 EXP Expanding low segment to 73P
9:20:36  1   1 MOV Moving low segment to expand area LS
9:20:38  6   1 LMN Loading module COMMOD
9:20:38  4   1 EXP Expanding low segment to 77P
9:20:38  1   1 MOV Moving low segment to expand area LC
9:20:38  1   1 MOV Moving low segment to expand area LC
                 .
                 .
                 .
```

```
 9:21:34  1   1 MOV Moving low segment to expand area LS
 9:21:34  1   1 MOV Moving low segment to expand area LS
 9:21:34  1   1 MOV Moving low segment to expand area GS
 9:21:34  1   1 MOV Moving low segment to expand area LS
 9:21:34  1   1 MOV Moving low segment to expand area LS
 9:21:34  1   1 MOV Moving low segment to expand area LS
 9:21:34  1   1 MOV Moving low segment to expand area LS
 9:21:35  1   1 MOV Moving low segment to expand area LS
 9:21:35  1   1 MOV Moving low segment to expand area LS
 9:21:35  6   1 LMN Loading module SYSCHK
 9:21:35  1   1 MOV Moving low segment to expand area LS
 9:21:35  1   1 MOV Moving low segment to expand area LC
 9:21:35  1   1 MOV Moving low segment to expand area LC
 9:21:35  1   1 MOV Moving low segment to expand area LC
 9:21:35  1   1 MOV Moving low segment to expand area LC
 9:21:35  1   1 MOV Moving low segment to expand area LC
 9:21:35  1   1 MOV Moving low segment to expand area LS
 9:21:35  1   1 MOV Moving low segment to expand area LS
 9:21:35  1   1 MOV Moving low segment to expand area LS
 9:21:35  1   1 MOV Moving low segment to expand area LS
 9:21:35  1   1 MOV Moving low segment to expand area LS
 9:21:36  1   1 MOV Moving low segment to expand area LS
 9:21:36  1   1 MOV Moving low segment to expand area LS
 9:21:36  1   1 MOV Moving low segment to expand area FX
 9:21:36  6   1 LMN Loading module ONCMOD
 9:21:36  1   1 MOV Moving low segment to expand area LC
 9:21:36  1   1 MOV Moving low segment to expand area LC
 9:21:36  1   1 MOV Moving low segment to expand area LC
 9:21:36  1   1 MOV Moving low segment to expand area LC
 9:21:37  1   1 MOV Moving low segment to expand area LC
 9:21:37  1   1 MOV Moving low segment to expand area LC
 9:21:37  1   1 MOV Moving low segment to expand area LC
 9:21:37  1   1 MOV Moving low segment to expand area LC
 9:21:37  1   1 MOV Moving low segment to expand area LS
 9:21:37  1   1 MOV Moving low segment to expand area LS
 9:21:37  1   1 MOV Moving low segment to expand area LS
 9:21:37  1   1 MOV Moving low segment to expand area LS
 9:21:37  1   1 MOV Moving low segment to expand area GS
 9:21:38  1   1 MOV Moving low segment to expand area LS
 9:21:38  1   1 MOV Moving low segment to expand area GS
 9:21:38  6   1 LMN Loading module REFSTR
 9:21:39  6   1 LMN Loading module ONCE
 9:21:46  1   1 FCF Final core fixups
 9:21:56  1   1 MPS MAP segment
 9:21:57  1   1 MOV Moving low segment to expand area LS
 9:22:30  1   1 EMS End of MAP segment
 9:22:38  1   1 EXS EXIT segment
 9:22:38  1   1 SST Sorting symbol table
 9:22:47  1   1 STC Symbol table completed
 9:22:48  1   1 CSF Creating SAV file
 9:23:16  1   1 FIN LINK-10 finished
[LNKELF END OF LOG FILE]
```

```
                LINK-10 symbol map of   RI680   version 507(10671)            page 1
        Produced by LINK-10 version 2(205) on 25-Jun-74 at  9:21:57

        Low  segment starts at       0 ends at  157160 length   157161 = 112P
        399 words free in Low segment
        4984 Global symbols loaded, therefore min. hash size is 5538
        Start address is  11244, located in program COMMON

                *************

COMMON  from DSK:COMMON.RLI[10,131]     created on 17-Jun-74 at 15:14:00
        Low  segment starts at      140 ends at   14474 length    14335 (octal),  6365. (decimal)

        A                  0    Global  Absolute     Suppressed  A0.NOC          77000    Global  Absolute     Suppressed
        A00CLH             0    Global  Absolute     Suppressed  A00CVN              0    Global  Absolute     Suppressed
        A00DLN            77    Global  Absolute     Suppressed  A00MCO          10671    Global  Absolute     Suppressed
        A00MVN           507    Global  Absolute     Suppressed  A00SVN              0    Global  Absolute     Suppressed
        A00VER         50677    Global  Absolute     Suppressed  A00WHO              0    Global  Absolute     Suppressed
        A1070S             0    Global  Absolute     Suppressed  ABSTAB            410    Global  Absolute
        ADRPT1         11734    Global  Absolute                 ADRPT2          11736    Global  Absolute
        ADRPT3         11740    Global  Absolute                 AL                  1    Global  Absolute     Suppressed
        ALLJSP         11526    Global  Absolute     Suppressed  ANYRUN          11524    Global  Absolute     Suppressed
        AP0BCK         13437    Global  Absolute                 AP0CHL          12431    Global  Absolute     Suppressed
        AP0CHN             3    Global  Absolute     Suppressed  AP0INT          13433    Global  Absolute
        AP0JEN         12453    Global  Absolute     Suppressed  AP0NUL         123733    Global  Absolute     Suppressed
        AP0PDP         12512    Global  Absolute     Suppressed  AP0RET          12446    Global  Absolute     Suppressed
        AP0RST        323733    Global  Absolute     Suppressed  AP0SAC          12472    Global  Absolute     Suppressed
        AP0SAV         12433    Global  Absolute     Suppressed  APR0SN           1002    Global  Absolute     Suppressed
        APR1SN             0    Global  Absolute     Suppressed  APRSN            1002    Global  Absolute     Suppressed
        APRSTS         11266    Global  Absolute                 ARFLAG          11506    Global  Absolute
        ASSCON        400000    Global  Absolute     Suppressed  ASSPRG         200000    Global  Absolute     Suppressed
        AUAVAL         14210    Global  Absolute                 AUQ                 4    Global  Absolute     Suppressed
        AUUSER         14224    Global  Absolute                 AVALTB          14210    Global  Absolute
        AVTBMQ         14204    Global  Absolute     Suppressed  BATMAX          10266    Global  Absolute
        BATMIN         10267    Global  Absolute                 BATNUM          10272    Global  Absolute
                                  .
                                  .
                                  .
                LINK-10 symbol map of   RI680   version 507(10671)            page 51
ONCMOD
        S..ERD        143170    Global  Relocatable Suppressed  S..ERM         144406    Global  Relocatable Suppressed
        S..ERS        143232    Global  Relocatable Suppressed  S..EWR         143162    Global  Relocatable Suppressed
        S..IDC        144645    Global  Relocatable Suppressed  S..JDJ         147104    Global  Relocatable Suppressed
        S..NMC        143745    Global  Relocatable Suppressed  S..NNU         143253    Global  Relocatable Suppressed
        S..NR4        145026    Global  Relocatable Suppressed  S..NRS         143240    Global  Relocatable Suppressed
                                  .
                                  .
                                  .
        S..UIF         146745     Global  Relocatable Suppressed  SCONMS         147604     Global  Relocatable
        SETKON         142745     Global  Relocatable             SHRTGO         142742     Global  Relocatable
        SHRTID         142657     Global  Relocatable             SHRTPM         142645     Global  Relocatable
        SHRTRF         142643     Global  Relocatable             SHRTST         142611     Global  Relocatable
        SHUTUP         143204     Global  Relocatable             SOPOUT         147572     Global  Relocatable
        SPUNAM         147566     Global  Relocatable             SVMOUT         147624     Global  Relocatable
        SVOSET         147555     Global  Relocatable             TEST22         143665     Global  Relocatable
        VONCMD            627     Global  Absolute    Suppressed  WRTRUN         150103     Global  Relocatable

                **************

REFSTR  from DSK:TOPI10.REL[10,131]      created on 17-Jun-74 at 16:30:00
        Low  segment starts at  152075 ends at  154220 length     2124 (octal),  1108. (decimal)

        CHKBIT         153175     Global  Relocatable             RB1UN              11     Global  Absolute    Suppressed
        RBLUN               5     Global  Absolute    Suppressed  REFSTR         152075     Entry   Relocatable
        S..CAS         153655     Global  Relocatable Suppressed  S..CIO         154026     Global  Relocatable Suppressed
        S..ERB         153126     Global  Relocatable Suppressed  S..ERH         152126     Global  Relocatable Suppressed
        S..ERP         153671     Global  Relocatable Suppressed  S..EWB         154034     Global  Relocatable Suppressed
        S..EWH         153070     Global  Relocatable Suppressed  S..HBE         153037     Global  Relocatable Suppressed
        S..NMU         152506     Global  Relocatable Suppressed  S..NSR         153511     Global  Relocatable Suppressed
        S..NSS         152307     Global  Relocatable Suppressed  S..TMR         153662     Global  Relocatable Suppressed
        S..ZBC         152133     Global  Relocatable Suppressed  SCNBAT         153133     Global  Relocatable
        VREFST             71     Global  Absolute    Suppressed

                **************

        Index to LINK-10 symbol map of  RI680   version 507(10671)          page 52

        Name    Page    Name    Page    Name    Page    Name    Page

        CDRSRX  32      DTASRN  37      LPTSER  40      REFSTR  51
        CLOCK1  32      EDDT    50      METCON  40      REMDLX  42
        COMCON  34      EJBDAT  28      MSGSER  40      RTTRP   43
        COMDEV  16      ERRCON  37      MTXSER  41      SCHED1  43
        COMMOD  19      FHXKON  32      ONCE    51      SCNSER  44
        COMMON   1      FILFND  28      ONCMOD  50      SEGCON  46
        CORE1   35      FILIO   29      PATCH   49      SWPSER  47
        D76INT  37      FILUUO  30      PLTSER  41      SYSCHK  50
        DATMAN  36      FSXKON  32      PSISER  41      SYSINI  49
        DL0INT  36      IPCSER  38      PTPSER  42      TMPUUO  47
        DL1INT  37      KILOCK  39      PTRSER  42      UUOCON  47
        DPXKON  31      KISER   39      PTYSER  42

        [End of LINK-10 map of  RI680]
```

Example 6 Using the Overlay Capability

The user has the following overlay structure:



One command file to build the above structure is:

```
TEST/OVERLAY,LPT:/MAP= MAIN/LINK
        SPEXP/LINK
                SPEX2/LINK
                /NODE:-1 SPEX3/LINK
                /NODE:-1 SPEX4/LINK
        /NODE:-2 DPEXP/LINK
                DPEX2/LINK
                /NODE:-1 DPEX3/LINK
                /NODE:-1 DPEX4/LINK
        /NODE:-2 TRIG/LINK
                SIND2/LINK
                /NODE:-1 SIND3/GO
```

The user then loads and executes his program.

```
.R LINK

*@TEST.CCL

EXIT

.RU TEST
INPUT SINGLE PRECISION NUMBER X=2.0
X=  2.000000          X**2=   4.000000
X=  2.000000          X**3=   8.000000
X=  2.000000          X**4=   16.00000
INPUT DOUBLE PRECISION NUMBER Y=3.0
Y=  0.3000000000000000000D+01     Y**2=  0.9000000000000000000D+01
Y=  0.3000000000000000000D+01     Y**3=  0.2700000000000000000D+02
Y=  0.3000000000000000000D+01     Y**4=  0.8100000000000000000D+02
INPUT ANGLE IN DEGREES T=30.0
SIN (    30.00000    ) = 0.5000000
SIN (2*    30.00000    ) = 0.8660254
SIN (3*    30.00000    ) = 1.000000

END OF EXECUTION
CPU TIME: 0.32 ELAPSED TIME: 57.90
EXIT
```

Below is a partial map file of the program

```
                LINK-10 symbol map of   MAIN            page 1
        Produced by LINK-10 version 2(210) on 26-Jun-74 at 10:03:37

        Overlay no.     0        name    ROOT
        Low  segment starts at       0 ends at    3650 length     3651 =   2K
        Control Block address is   3621, length     30 (octal), 24. (decimal)
        87 words free in Low segment
        76 Global symbols loaded, therefore min. hash size is 85
        Start address is    175, located in program MAIN.

                *************

JOBDAT-INITIAL-SYMBOLS

        Zero length module

                *************

MAIN.   from DSK:MAIN.REL[10,131]       created by FORTRAN-10 /KI10 on 25-Jun-74 at  9:37:00
        Low  segment starts at     140 ends at     174 length        35 (octal),    29. (decimal)
        High segment starts at     175 ends at     323 length       127 (octal),    87. (decimal)

        FOROT%         400010    Global  Absolute

                *************

OVRLAY  from SYS:OVRLAY.REL[1,5]        created by MACRO on 24-Jun-74 at  1:25:00
        Low  segment starts at    2771 ends at    3533 length       543 (octal),   355. (decimal)
        High segment starts at     324 ends at    2737 length      2414 (octal),  1292. (decimal)

        GETOV.          1301    Entry   Relocatable             INIOV.          1267    Entry   Relocatable
        LOGOV.          2064    Entry   Relocatable             REMOV.          1320    Entry   Relocatable
        RUNOV.          1342    Entry   Relocatable             .OVRLA          2772    Entry   Relocatable
        .OVRLO          2777    Global  Relocatable             .OVRLU          1641    Entry   Relocatable
        .OVRWA          2776    Global  Relocatable
```

```
          *************

FORINI  from SYS:FORLIB.REL[1,5]        created on 25-Jun-74 at 10:51:00
        Low  segment starts at    3534 ends at    3605 length       52 (octal),    42. (decimal)

        ALCHN.          400034   Global  Absolute                 ALCOR.          400032   Global  Absolute
        CLOSE.          400013   Global  Absolute                 DEC.            400022   Global  Absolute
        DECHN.          400035   Global  Absolute                 DECOR.          400033   Global  Absolute
        ENC.            400021   Global  Absolute                 EXIT.           400031   Global  Absolute
        FIN.            400026   Global  Absolute                 FIND.           400030   Global  Absolute
        FORER.            3574   Global  Relocatable              FUNCT.          400037   Global  Absolute
        IN.             400015   Global  Absolute                 IOLST.          400025   Global  Absolute
        MTOP.           400027   Global  Absolute                 NLI.            400023   Global  Absolute
        NLO.            400024   Global  Absolute                 OPEN.           400012   Global  Absolute
        OUT.            400016   Global  Absolute                 RELEA.          400014   Global  Absolute
        RESET.            3534   Entry   Relocatable              RTB.            400017   Global  Absolute
        TRACE.          400036   Global  Absolute                 WTB.            400020   Global  Absolute

          *************

        index to overlay numbers of MAIN                page 15

        overlay Page    overlay Page    overlay Page    overlay Page

        #0       3      #3       6      #6       9      #9       12
        #1       4      #4       7      #7       10     #10      13
        #2       5      #5       8      #8       11     #11      14

        index to overlay names of MAIN

        Name     Page

        ROOT      3

        [End of LINK-10 map of  MAIN]
```

Suppose the user removes subroutine SPEX4 from his overlay structure:

```
        /L/OVERLAY,LPT:/MAP=MAIN/T /LINK
                SPEXP/LINK
                        SPEX2/LINK
                        /NODE:-1 SPEX3/LINK    The user removed SPEX4.
                /NODE:-2 DPEXP/LINK
                        DPEX2/LINK
                        /NODE:-1 DPEX3/LINK
                        /NODE:-1 DPEX4/LINK
                /NODE:-1 TRIG/LINK
                        SIND2/LINK
                        /RESET:-1 SIND3/GO
```

He now loads and runs his program.

```
        .R LINK

        *@TEST
        %LNKUSC UNDEFINED SUBROUTINE SPEX4 IN LINK NUMBER 1
```

LINK-10 notifies the user that the subroutine is missing.

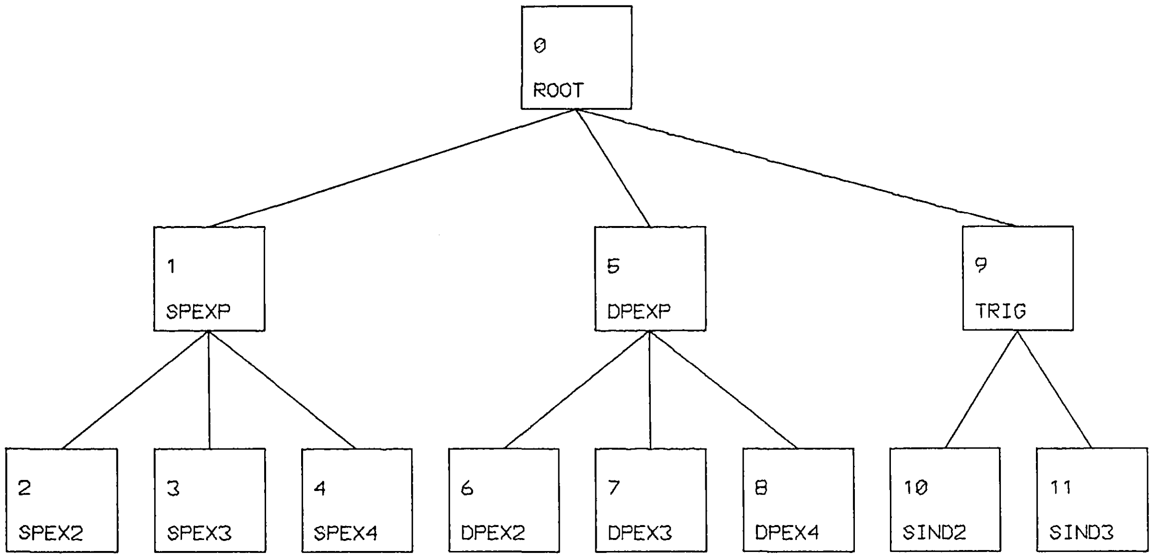
```
        EXIT

        .RU TEST

        INPUT SINGLE PRECISION NUMBER X=1.0
        X=  1.000000         X**2=  1.000000
        X=  1.000000         X**3=  1.000000
        %OVLUSC UNDEFINED SUBROUTINE SPEX4 CALLED FROM 017516

        INPUT DOUBLE PRECISION NUMBER Y=2.0
        Y=  0.2000000000000000D+01     Y**2=  0.4000000000000000D+01
        Y=  0.2000000000000000D+01     Y**3=  0.8000000000000000D+01
        Y=  0.2000000000000000D+01     Y**4=  0.1600000000000000D+02
        INPUT ANGLE IN DEGREES T=30.0
        SIN (   30.00000   ) = 0.5000000
        SIN (2*  30.00000   ) = 0.86660254
        SIN (3*  30.00000   ) = 1.000000

        END OF EXECUTION
        CPU TIME: 0.54 ELAPSED TIME: 1:30.57
        EXIT

        .
```

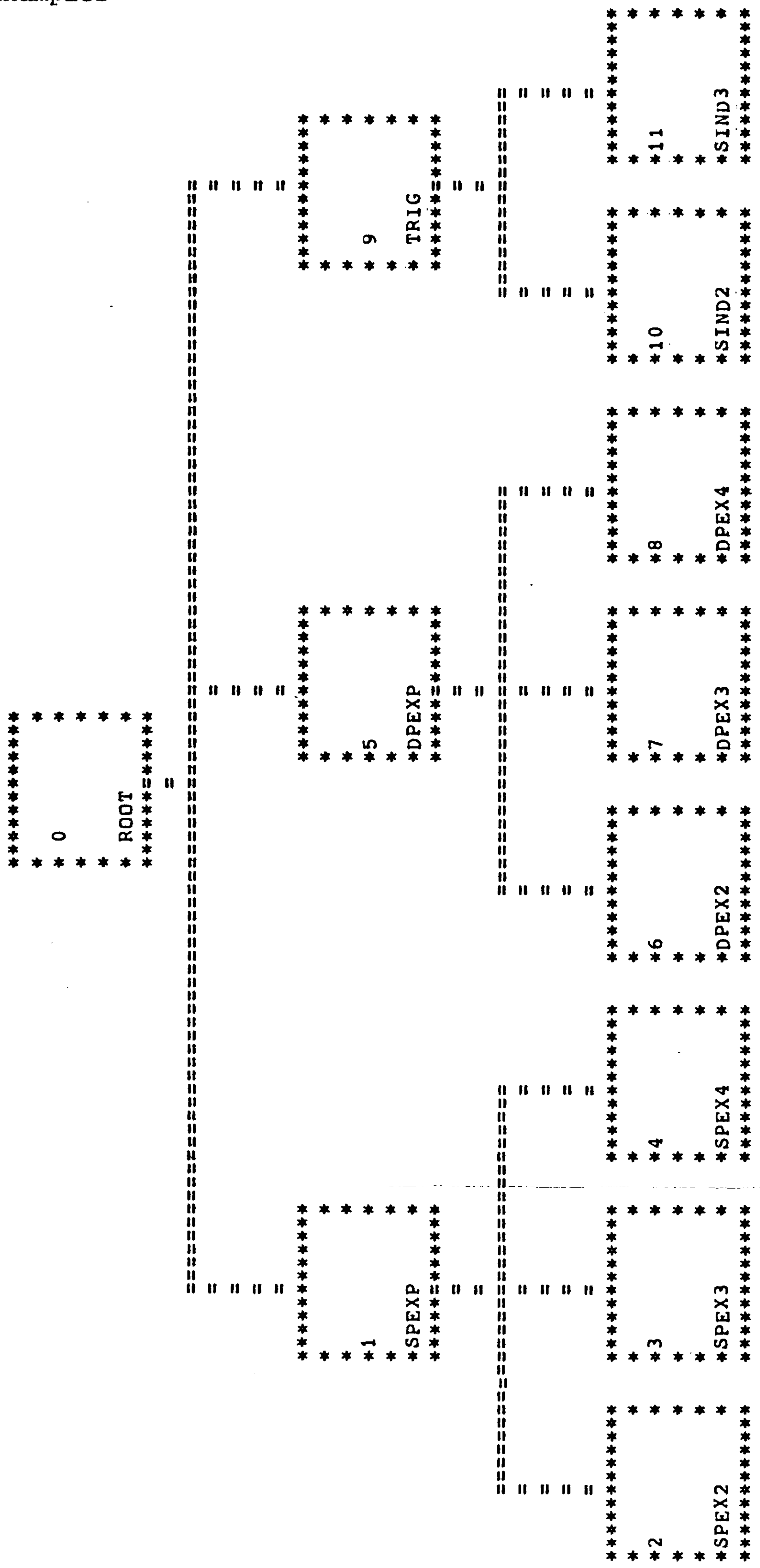
Example 7 Obtaining a Diagram of an Overlay Structure

The following command file produces on the line printer a line drawing of the overlay structure in Example 6. Plotter output can be obtained by substituting device PLT: for device LPT: in the first line of the command file.

```
    TEST/OVERLAY,TEST/MAP,LPT:TEST/PLOT = MAIN/LINK
            SPEXP/LINK:SPEXP
                    SPEX2/LINK:SPEX2
                    /NODE:-1 SPEX3/LINK:SPEX3
                    /NODE:-1 SPEX4/LINK:SPEX4
            /NODE:-2 DPEXP/LINK:DPEXP
                    DPEX2/LINK:DPEX2
                    /NODE:-1 DPEX3/LINK:DPEX3
                    /NODE:-1 DPEX4/LINK:DPEX4
            /NODE:-2 TRIG/LINK:TRIG
                    SIND2/LINK:SIND2
                    /NODE:-1 SIND3/LINK:SIND3
    /GO
```

Both the plotter and line printer drawings are shown below.




0
ROOT
1
SPEXP
5
DPEXP
9
TRIG
2
SPEX2
3
SPEX3
4
SPEX4
6
DPEX2
7
DPEX3
8
DPEX4
10
SIND2
11
SIND3

APPENDIX A

LINK ITEM TYPES

Input to LINK-10 is in the form of relocatable binary (.REL) files. Each .REL file is composed of link items of varying lengths. Each link item contains a specific type of information for LINK-10. The first word of these items is a header word containing, in the left half, an octal code for the item type and, in the right half, usually the number of words in the item. For item types 0-37, the count of words does not include overhead words (i.e., relocation words); for item types 1000-1777, the count does include these words. The format of the remaining words depends upon the individual link item. The link items are as follows:

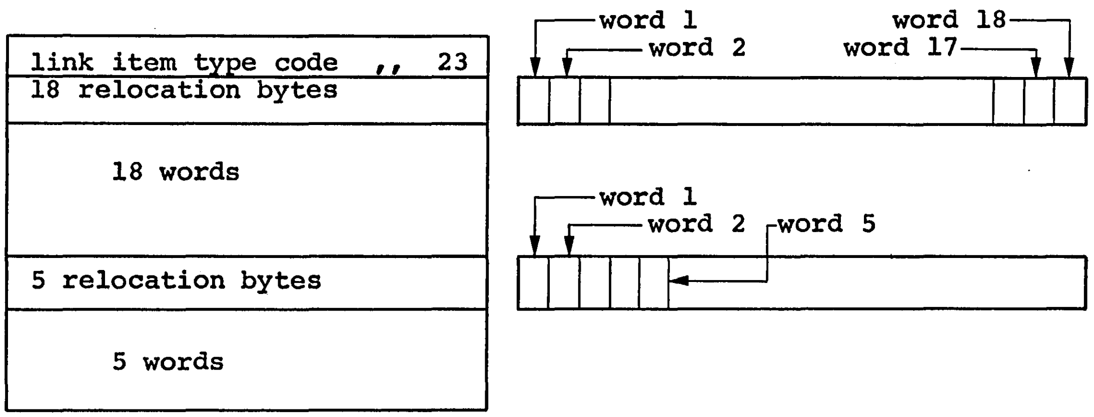
Link Item Type	Use
0-37	Reserved for DEC
40-77	Reserved for customers
100-377	Reserved for DEC
400	FORTRAN-IV (F40) marker block
401	FORTRAN-IV (F40) with FORDDT information
402-777	Reserved for customers
1000-1777	Reserved for DEC (not used in the first release of LINK-10)
2000-3777	Reserved for customers
4000-777777	Reserved to avoid conflict with ASCII text

A.1 LINK ITEM TYPES 0-37

Link items in this range are the LOADER program block types and all have an identical format. The first word of the item, the header word, contains the item type in the left half and the count of data words in the right half. Following the header word is a relocation word containing up to 18 2-bit bytes which specify the relocation bits for the 18 words or less that follow. The relocation bits are left-justified and have the following meanings:

Byte Value	Meaning
0	Do not relocate
1	Relocate right half of word
2	Relocate left half of word
3	Relocate both halves of word

Following the relocation word are up to 18 words of the item. If there are more than 18 words in the item, there is another word of relocation bytes for the next 18 words. The relocation words are not included in the count of data words appearing in the left half of the header word. Thus, an item with a word count of 23 decimal would be as follows:



A.1.1 Link Item Type 0

This item type is ignored by LINK-10 and therefore can be used to store information not required by it. Totally null words look like this item type.

A.1.2 Link Item Type 1 CODE

This item type contains code and data. The first data word specifies the beginning address into which the item is to be loaded. The remaining words of the item are loaded into contiguous locations starting at that address. All words, including the load address, are relocated as specified by the relocation bytes.

If bit 0 of the first data word is 1, the word is assumed to be a Radix-50 symbol. The load address is then the value of this symbol plus the next word. Thus, in this case, there is one less actual data word than is indicated by the count in the header word.

A.1.3 Link Item Type 2 SYMBOLS

This item type consists of symbols, with each symbol occupying two words. The first word of each symbol contains 4 bits of code (bits 0-3) and 32 bits of the Radix-50 representation of the symbol (bits 4-35). Unless stated otherwise, the second word is the value of the symbol.

The code bits are as follows:

00	This symbol is a program name. It is entered into the symbol table by a link item type 6, not a item type 2. The right half of the second word contains the relocation constant for the program, and the left half contains the number of words of symbol table space used by that program. However, for the last program loaded, the left half of this word is zero. (This code should never happen.)
04	This symbol is a global definition. Its value is available to other programs. Two global symbols with the same name but different values cause an error message.
10	This symbol is a local symbol and is not loaded unless the user requests the loading of local symbols. Local symbols of the same name can occur in different modules without causng an error, even though the values may be different.
14	This symbol is a block name and is used by translators that are block structured. The second word is the block level and is placed in the symbol table with no additional processing. This symbol is not loaded unless the user requests loading of local symbols.
24	This symbol is a global symbol which will have the right half of its value fixed up to satisfy a global request symbol.
44	(1)Same as code 04, with the addition that the global symbol is suppressed to DDT typeout, or (2) This symbol is a global symbol which will have the left half of its value fixed up to satisfy a global request symbol.
50	Same as code 10, with the addition that the local symbol is suppressed to DDT typeout.
60	This symbol is a global request.

If bit 0 of the second word in the pair is 0, then bits 18-35 contain the address of the first word in a chain of requests for the global. In each request, the right half of the second word contains the address of the next request. The chain is terminated when the right half of the second word contains zero.

If bit 0 of the second word in the pair is 1, the request involves additive global processing. When bit 2 of this word is 0, bits 18-35 contain an address of a word of code. The right half of the value of the symbol requested is added to the left or right half of this word of code according to the following rule:

If bit 1 of the second word in the pair is 1, the add is to the left half.
If bit 1 of the second word is 0, the add is to the right half.

The result is stored back into the word of code. (Note that there is no full word add; that result must be accomplished by a left and a right add.)

When bit 2 of the second word is 1, bits 3-35 contain the Radix-50 representation of a second symbol, whose value depends upon the global being requested. The second symbol must be the last symbol defined before the global request or else it will be treated as a local symbol and no action will occur, unless local symbols are being loaded. When the value of the requested global is determined, it is added to the right half of the value of the second symbol if bit 1 of the second word is 0, or to the left half if bit 1 is 1. Since the actual value of the symbol is not determined until the definition of the global upon which it depends, the code bits of the symbol indicate that the value of the symbol will change and cannot be used to satisfy bepudcps until the symbol is fully defined.

64 (1) This symbol is a global symbol which will have both the left and right halves of its value fixed up to satisfy a global request symbol, or
(2) Same as code 24, with the addition that the global symbol is suppressed to DDT txpanut.

Symbols are placed into the symbol table in the order in which they are seen by LINK-10. However, DDT expects to see them in the following order. For nonblock-structured programs, the order is:

```
 ____________________
| program name       |  higher core location
|--------------------|
| global and local   |
| symbols for that   |
|    program         |
|____________________| lower core location
```

For a block-structured program setup as

```
┌─Begin b1 (same as program name)
│┌-begin b2
│└-end b2
│ ┌-begin b3
│ │┌-begin b4
│ │└-end b4
│ └-end b3
└─End b1
```

the order is:

program name (b1)
block name b2
symbols for block b2
block name b4
symbols for block b4
block name b3
symbols for block b3
block name b1
symbols for block b1

A.1.4 Link Item Type 3 HISEG

This item type indicates to LINK-10 that code is to be loaded into the high segment. This item type has either one or two data words. The right half of the first data word is the initial address in the high segment (usually 400000). When the left half of the data word is zero, subsequent CODE items are assumed to have been produced by the HISEG pseudo-op in MACRO-10. This means that the addresses are relative to zero but are to be placed into the high segment. When the left half of the first data word is negative (i.e., greater than the right half) , subsequent CODE items have been generated by the TWOSEG pseudo-op in MACRO-10. This requires that addresses greater than the right half be placed into the high segment and addresses less than the right half be placed into the low segment. The left half is interpreted as the high segment break (i.e., the first free location after the high segment) with the maximum length of the high segment being the difference between the left and right halves of the word. One-pass translators that cannot determine the high segment break should set the left half of the data word equal to the right half.

If there is a second data word (e.g., as in FORTRAN-10), the right half of this word is the low segment origin (usually 0) and the left half is the low segment program break.

A.1.5 Link Item Type 4 ENTRY

This item type is the entry item and must be the first item in a .REL file if the .REL file is to be loaded in a library search. It consists of a list of Radix-50 symbols which are separated every 18 words by a relocation word of zeroes. When LINK-10 is in library search mode, each global symbol in the list is checked against the undefined global requests for the load. If one or more matches occur, the following module is loaded. If a match does not occur, the module is ignored. If LINK-10 is not in library search mode, this checking of undefined global requests is not performed.

The entry items are stored. If the module is not loaded, these items are ignored. If the module is loaded, the entry items are scanned again and the entry point bit is turned on for the corresponding symbol in the symbol table.

A.1.6 LINK Item Type 5 END

This item type is the end item and is the last link item in the .REL file. It contains two words whose meanings depend on whether the file contains two segments or one. If the file has two segments, the first word is the high segment break and the second word is the low segment break. If the file has only one segment, the first word is the first free location above the program (this word is relocatable) and the second word is the highest absolute address seen, if higher than location 137.

A.1.7 Link Item Type 6 NAME

This item is the name item and must appear before any type 2 link item (SYMBOL), The item has one or two data words. The first word is the program name in Radix-50 symbol format. The second word, if it appears, contains in bits 6-17 a code for the translator that produced the binary file, and in the right half the length of blank COMMON. (FORTRAN programs use both named and blank COMMON. COBOL uses blank COMMON to indicate the length of LIBOL's static area. Thus, the length has meaning for FORTRAN and COBOL programs.) The octal codes (bits 6-17) for the various translators are as follows:

Octal Code	Translator
0	UNKNOWN
1	F40
2	COBOL
3	ALGOL-60
4	NELIAC
5	PL/1
6	BLISS-10
7	SAIL
10	FORTRAN-10
11	MACRO
12	FAIL

Bits 0-5 of the second word indicate the processor on which the program will execute. If the value of these bits is 0, the program will execute on either processor; if the value is 1, the program will execute only on the KA10 processor; and if the value is 2, the program will execute only on the KI10 processor. Remaining values are reserved for the future.

A.1.8 Link Item Type 7 START ADDRESS

This item type contains in the right half of the data word the address at which execution of the program is to begin. The start address for a relocatable program may be relocated by means of the relocation bits. The last link item of this type encountered by LINK-10 is the one used, unless LINK-10 is ignoring start addresses (indicated by the user via switches). If the program is not to specify a start address, no item of this type should be included.

A.1.9 Link Item Type 10 INTERNAL REQUEST

This item type is provided for one-pass language translators when internal symbols are used before they are defined. The item type consists of a series of data words where each word represents one request. Each data word has a value in the right half and a pointer to the last request in the chain of requests for that value in the left half. Each quantity may be relocatable. The symbols are chained in a manner similar to the global requests which have bit 0 in the second word of each pair equal to zero (i.e., the value is substituted in the right half of each location in the chain). However, if a data word is -1, then the next data word indicates a chained request to the left half of the word specified rather than the right half.

A.1.10 Link Item Type 11 POLISH

This item type is provided for Polish fixups involving arithmetic and logical operations on relocatable or externally-defined quantities. Each item contains only one Polish string. The data words in each item are a series of half-words consisting of operators and operands followed by store operators and store addresses. The operators and operands are as follows:

0	The next half word is an operand.
1	The next two half-words form a 36-bit operand.
2	The next two half-words form a Radix-50 symbol which is a global request. The operand is the value of the global.
3	Add.
4	Subtract.
5	Multiply.
6	Divide.
7	Logical AND.
10	Logical OR.
11	Left shift.
12	Logical XOR.
13	One's complement (not).
14	Two's complement (negative).

The store operators are as follows:

<u>18 bit value</u>

-1	Right half chained fixup (777777).
-2	Left half chained fixup (777776).
-3	Full word chained fixup (777775). The entire word pointed to is replaced and the old right half points to the next full word.

The half word following the store operator is used as the address of the first element in the chain.

A.1.11 Link Item Type 12 LINK

Data words in this item type occur in pairs. The first word of the pair is a link number and the second word is an address. There are 20 (octal) links numbered from 1 to 20. When LINK-10 is initialized, the value of each link is set to zero. Each time a specific link is seen, the current value of the link is stored in the address specified by the second word of the word pair, and the specified address becomes the new value of the link. If the number of the link seen is negative, the address is saved as the end of the link . At the end of loading, the current value for each link is stored in the address indicated by the end of each link. If the end of the link is 0, no storing is done.

A.1.12 Link Item Type 13 LVAR

This item type is used in LVAR fixups and is not currently handled by LINK-10. It is not supported by DEC and is not needed because the TWOSEG pseudo-op is superior. The first data word is the location of a variable area in the low segment. The second data word is the length of the area needed. The low segment relocation counter is incremented by the area needed. Data words after the first two data words occur in pairs. If bit 2 of the first word of the pair is zero, then the second word contains, in its left half, the address of a fixup chain, and in the right half, the relative location in the variable area to use for this fixup. The chaining occurs with the right half of the words if bit 0 of the first word is 0; otherwise, chaining occurs with the left half of the words.

If bit 2 of the first word of the pair is one, then the pair is used to make a symbol table fixup. The right half of the first word is the value of the fixup. The second word is the Radix-50 representation for the symbol.

A.1.13 Link Item Type 14 INDEX

This item type is produced by FUDGE2 to identify an index to LINK-10. The index is a list of all entry points (Link item type 4) in a library .REL file with pointers to the beginning of the individual modules. The index is 200 octal words long and if there are more entries in the library than will fit in 200 words, other item types 14 are created to contain the remainder of the entries. Each index is divided into sub-items of various lengths. The sub-items do not include the relocation word normally found in entry items of a library. Each sub-item has a header word with the word count in the right half and the link item type 4 in the left half. Following this header is the list of Radix-50 entry symbols. After the list of entries, there is a pointer to the individual module within the library file. The right half of the pointer is the block number of the module, and the left half is the word count within the block for the start of the module. The last word of the index item type contains a -1 in the left half to signal the end of the index item and the block number of the next index item in the right half. If LINK-10 is not in library search mode, index items are ignored.

A.1.14 Link Item Type 15 ALGOL

This item type is the special ALGOL OWN item. The first data word is the length of the OWN area to be allocated in the low segment. The remaining words are chained with the right half of the OWN fixups.

A.1.15 Link Item Type 16 REQUEST LOAD

This item type is produced by the SAIL compiler and is used to request the loading of programs. Thus, a .REL file can request libraries and other files to be loaded, thereby keeping the command string to LINK-10 simple. LINK-10 maintains a table for the names of libraries to be loaded and another table for the names of standard relocatable binary files to be loaded. When a new file is requested by link item type 16 or 17, LINK-10 searches the appropriate table to verify that the file has not already been specified. If it has not been specified, an entry is made in the appropriate table. After all files in the LINK-10 command string have been loaded, the files specified in the two tables are loaded. The relocatable binary files are loaded first; the libraries are loaded last.

The data words in this link item type appear in triplets. The first word contains the filename in SIXBIT (the extension of .REL is assumed). The second word is the UFD number in binary, and the third word is the SIXBIT name of the device containing the file.

A.1.16 Link Item Type 17 REQUEST LIBRARY

This item type is the same as item type 16 except that the specified files are loaded only if they are needed to satisfy global requests. That is, the files are loaded in library search mode. The data words are identical to those in item type 16.

A.1.17 Link Item Type 20 COMMON ALLOCATION

This item type is used to allocate named COMMON areas. The relocation word must be present, but the bits should be zero. The data words are grouped in pairs, where the first word contains the Radix-50 symbol for the name of the COMMON area and the second word contains the length of the area required by this program.

This item type causes LINK-10 to search for the specified COMMON area to determine if it has been previously loaded. If it has, the length given in this item type must be less than or equal to the length already allocated. Thus, the first program that defines a COMMON area also defines the maximum size of that COMMON area. No subsequent program can expand this particular area, although COMMON areas of different names can be defined.

If the specified COMMON area has not been loaded, the symbol name is given the current low segment relocation value, and the length of the area is added to the low segment relocation counter.

A.1.18 Link Item Type 21 SPARSE DATA

This item type is used to load data into arrays when link item type 1 is inefficient for this purpose. The data words are grouped in sub-items and each sub-item is treated in the same manner as link item type 1. The first word of each sub-item contains in the left half a count of the number of data words in the sub-item, and in the right half the beginning address into which the data words are to be loaded. The remaining words of each sub-item are the data words.

If bit 0 of the first word of a sub-item is 1, the first word is assumed to be a Radix-50 symbol. The left half of the second word is the count of data words and the right half contains an offset. The load address is then the value of the symbol plus the offset.

A.1.19 Link Item Types 22-36

These item types are not yet defined and return an error message if used.

A.1.20 Link Item Type 37 DEBUG

This item type is used for the debugging symbol table for COBDDT (the COBOL debugging program). If debugging is requested in local symbol mode, the data from this item type is loaded in the same manner as the data from link item type 1. If local symbols are not required, this item type is ignored.

A.2 Link Item Type 400 FORTRAN (F40)

This item type is output by the old one-pass FORTRAN-IV complier (F40). It does not contain a word count, relocation words, or data words. It contains only the one word indicating the item type code.

A.3 Link tem Type 401 FORTRAN (F40)

This item type is similar to link item type 400 and in addition it indicates that the file contains FORDDT debugging information.

A.4 Link Item Types 1000-1777

Link items in this range do not have identical formats. There is a general pattern in that the first word of each item contains an item type number in the left half and a word count in the right half. However, unlike link item types 0-37, the word count of item types 1000-1777 is a count of all following words including overhead words (relocation words). The structure of the relocation words depends upon the link item; there may be any number of relocation bits from 1 to 18 per half or full word. Link items that do not need relocation do not have relocation words. These item types are not currently used.

LINK-10 Item Types

A.4.1 Link Item Type 1000

This item type is ignored by LINK-10 and thus can be used to store information not required by it.

A.4.2 Link Item Type 1001 ENTRY

This item type is the simple entry item and consists of a list of SIXBIT symbols. Each data word contains one left-adjusted symbol which can be a maximum of six characters in length. There are no relocation words, thus distinguishing this item type from item type 4. However, the two item types are used in the same manner.

A.4.3 Link Item Type 1002 LONG ENTRY

This item type contains one extended symbol (i.e., the symbol contains more than six characters) in SIXBIT, which is tested to determine if it is required as an entry point. This link item type is used in the same manner as link item type 1001.

A.4.4 Link Item Type 1003 NAME

This item type contains information about the file and the translator that produced it. The information in this item is stored in the symbol table and can be output on a map listing.

The data words occur in triplets. The left half of the first word of each triplet contains flag bits for that triplet and the right half is unused. The first triplet of data (the primary triplet) contains the program name in SIXBIT in the second word. This program name is taken from the TITLE statement in a MACRO-10 program. If the program name is longer than six characters, one or more triplets follow containing the remaining characters of the name. Triplets following the program name are identified by the flag bits in the first word of each triplet. The triplet after the name triplets contains the low segment relocation counter in the second word and the high segment relocation counter in the third word. The next triplet has, in the second word, the SIXBIT name of the translator that produced the file and in the third word, the version number of the translator. This version number is taken from location 137. The following triplet contains the compilation date and time obtained from the LOOKUP UUO block in the second word, and in the third word, a default code for the translator used, in case LINK-10 could not determine the translator from the information in the previous triplet. The default translator codes are listed in Paragraph A.1.7. The next triplet contains in the second word, the name of the device on which the source file is stored, and in the third word, the SIXBIT filename of the source file. The information in the next triplet is the source filename extension in the second word and the name of the UFD containing the source file in the third word. The next triplet contains sub-file directory information. The following triplet contains the version number of the source file as obtained by the translator that processed the file. The information in the last triplet is interpreted as ASCII text and is stored in the format in which it is given.

More than one NAME link item may be seen per module for programs made from several source files. The program and compiler name triplets must be the same in the the NAME link items, but the source filename and any remaining triplets can be different.

A.4.5 Link Item Type 1004 RELOCATION

This item type consists of groups of words (usually pairs) without any relocation words. The first data word of the item type contains the total number of relocation groups in the item in order that sufficient space can be allocated. The first word of each relocation group has a relocation level in the left half and the count of the number of words in the relocation counter name in the right half. The remaining words in each group are the relocation counters. The relocation level is the position in the table of relocation counters, such that for any word needing relocation, the value of the relocation byte will receive the correct constant for addition.

If a relocation counter is not yet defined (or a complex Polish expression not yet resolved), it must be placed in the undefined table, and its slot in the relocation tables is marked as undefined. All code referring to the undefined counter is stored in the fixup area or on the disk. In other words, if the location into which code is to be loaded is not yet defined, all the code under the relocation counter must be placed in the fixup table or on the disk. Link item type 1004 can appear anywhere and must be used whenever a new relocation counter is used. The standard name for the low segment relocation counter is .LOW. and the standard for the high segment counter is ..HIGH. These counters normally occupy positions 1 and 2 in the table of relocation counters.

A.4.6 Link Item Type 1005

This item type is undefined and reserved for future definition.

A.4.7 Link Item Type 1006 START

This item type contains the start addresses for the program. It consists of a relocation word with 4-bit bytes for full word relocation, followed by the list of relocatable start addresses in order of their use. These addresses are used or ignored depending on the switches given by the user. Currently, only one start address per program is recognized.

A.4.8 Link Item Type 1007 START

This item type is used for additional start addresses or external symbolic start addresses. The link item is divided into groups of words for each start address. The first word of each group contains flag bits in the left half and the count of the number of words in the group in the right half. Currently, bit 0 is the only flag bit. If this bit is 1, a Polish expression follows; if it is 0, a symbol follows. This item type does not include relocation words.

A.4.9 Link Item Types 1010-1017 CODE

The link items in the range 1010-1017 are similar except for the size of the relocation byte. The most general case uses 18 bits per half word, but this method consumes too much space for simple programs. Item type 1010 has a byte size of 2 bits, thereby allowing three relocation counters and absolute code. Relocation occurs only on the right half of the word and is positive; the left half is considered absolute. Since in most programs the code consists of constants in the left half (op-codes, indexes, ACs) and relocatable addresses or constants in the right half, this item type should be sufficient for most programs.

Item type 1011 also has 2-bit bytes but has relocation for the left half as well as the right half of the word. This item type allows three relocation counters plus absolute code. Link item type 1011 is used mainly for table generation.

Item type 1012 allows relocation only for the right half of the word (similar to item type 1010) but has a byte size of 4 bits, giving allowances for 15 relocation counters.

Item type 1013 allows relocation for both the left and right halves of the word (similar to item type 1011) but uses a 4-bit byte size.

Item types 1014-1016 are reserved for future use.

Item type 1017 has 18 bits of relocation per half word.

A.4.10 Link Item Types 1020-1027 SYMBOL

All symbols are in triplet format. The link items in the range 1020-1027 differ only in the size of the relocation byte. This byte is the same as the byte size for the corresponding CODE item. For example, symbol type 1020 and code type 1010 use 2-bit bytes, symbol type 1022 and code type 1012 use 4-bit bytes, and so forth. The relocation word applies only to the third word of the triplet (the symbol value). Thus, for example, in the case of symbol type 1020, each relocation word is followed by up to 18 triplets rather than 18 words.

A.4.11 Link Item Type 1030 POLISH

This item type is provided for Polish fixups and consists of operators and operands, including store operators and store operands in pre-fixup form. Each item contains only one Polish string, but may contain many different store pointers. Operators are stored one per half word, and symbols are stored in contiguous half words. Store pointers are in the form of either an address in a halfword or a byte pointer in a full word. Associated with store pointers are store operators that shift the value to the correct field and store operator. The store operator may also point to a symbol that is to be stored in the symbol table.

The operators and operands are as follows:

0	The next half word is an operand.
1	The next two half words form a 36-bit operand.
2	The next two half words form a 36-bit symbol which is a global request. The operand is the value of the global.
3	The next half word is the count of half words in an extended symbol. The subsequent half words are the symbol.
4	The next half word is a numeric relocation counter for the program.
5	The next two half words are a symbolic relocation counter.
6	The next half word is a count of the number of half words in an extended symbolic relocation counter. The following halfwords are the relocation counter.
7	The next two half words are a byte pointer to code already loaded.
10-77	Reserved for future use.
100	Add
101	Subtract
102	Multiply
103	Divide
104	Logical AND
105	Logical OR
106	Left Shift (LSH)
107	Logical XOR
110	One's complement (not)
111	Two's complement (negate)
112	Get contents (MOVE)
113	Reserved for future use

The store operators are as follows:

<u>18 Bit Value</u>

-1	Right half chained fixup (777777).
-2	Left half chained fixup (777776).
-3	Full word chained fixup (777775).
-4	The next two half words are a byte pointer (777774).
-5	The next two half words are an instruction plus an address (ANDM,XORM) (777773).
-6	The next two half words are a symbol and the value is stored in the half words (777772).
-7	The next half word is the count of the number of

	half words in an extended symbol. The half words following are the extended symbol and the value is stored in these half words (777771).
-10	The next half word is a numeric relocation counter (777770).
-11	The next two half words are a symbolic relocation counter (777767).
-12	The next half word is a count of the number of half words in an extended symbolic relocation counter. The following half words are the counter (777766).
-13	Reserved for future use.

The store operators obtain their arguments from a stack; the first word is usually the value and the second is the memory address. Addresses can be built using other Polish operators. For chained fixups, the half word preceding the store operator is used as the address of the first element in the chain.

A.4.12 Link Item Type 1031 POLISH

This item type is similar to item type 1030 except that Polish notation in post-fixup form is used. The operators and operands are the same.

A.4.13 Link Item Types 1032-1033

These item types are reserved for future use.

A.4.14 Link Item Types 1034-1037 CONDITIONAL

There are three kinds of conditonal loading item types: the Begin conditional, the End conditional, and the Else conditional. The Begin conditional has a unique number assigned by the translator which is matched with the unique number in the End and Else conditionals. It also contains a conditional operand and operator. The End conditional cancels the conditional loading, updates the relocation counters, and generates the next implicit relocation counter, if it is not explicitly defined by the user, so that following code can be loaded. The Else conditional is the inverse of the condition in the Begin conditional in that code is loaded if the condition is false. The three kinds of condition items can be nested.

A.4.14.1 The Begin Conditional - Link Item Type 1034 - This item type has four relocation bits per half word thereby allowing 15 possible relocation counters. The first data word contains the unique conditional number. If a number is not specified, zero is assumed and LINK-10 matches the Begin with the first End or Else conditional at that level. The second data word contains the conditional operator in the left half and the conditional operand in the right half. The remaining words contain the rest of the operand.

The conditional operators are coded as follows:

0	null
1	if zero
2	if greater than zero
3	if greater than or equal to zero
4	if less than zero
5	if less than or equal to zero
6	if not equal to zero
7	if defined
10	if not defined
11	if global
12	if local

The operand is either a symbol or a Polish expression. If the operand cannot be evaluated, the words are stored on the disk. The operands are:

100	The next two half words contain a SIXBIT symbol.
101	The next half word is a count of the number of half words in an extended symbol. The following words contain the SIXBIT symbol.
102	A pre-fixup Polish expression follows (refer to Paragraph A.4.11).
103	A post-fixup Polish expression follows (refer to Paragraph A.4.12).

If the condition is met, all code up to an End or Else conditional is loaded. When the condition is not met, the code is not loaded.

A.4.14.2 The Begin Conditional - Link Item Type 1035 - This item type is similar to Link Item Type 1034 except that it has half word relocation per half word.

A.4.14.3 The Else Conditional - Link Item Type 1036 - This item type contains no relocation words and has one data word containing a unique number matching the one in the Begin conditional. If the condition in the Begin conditional is true, the code in the current Else conditional to its matching End conditional or to the next matching Else conditional is ignored. If the condition is not true, the code is loaded.

A.4.14.4 The End Conditional - Link Item Type 1037 - This item type also has no relocation words. The first data word is a unique number matching the one in the Begin conditional. If the condition in the Begin conditional is false and no Else conditional is seen, the End conditional is ignored. However, if code was loaded, the End conditional is read. The item type contains one data word for each relocation counter used in the same order as specified in the last relocation setting link item. The data words are the highest value of the relocation counter used in the conditionally-loaded code. These values are added to the current values, and to the accumulation of such values, until the final END item type of the REL file.

A.4.15 Link Item Type 1040 END

This link item marks the end of a link module. It does not contain relocation words but does contain a list of all relocation counters used and their final values. Any conditional code that was loaded plus other overhead items, such as the ALGOL item, are added to the final values. The resulting values are then added to the current values of the relocation counters to obtain the value for the next module. The beginning and ending addresses are stored in the symbol table in order that DDT has the range of the program and that they can be output in a map listing.

A.4.16 Link Item Type 1041 Special FORTRAN-10 Block

This link item defines a call to a special once-only routine that is to be executed by LINK-10 after all code has been loaded.

A.4.17 Link Item Type 1042 Program Request

This link item requests the loading of .REL files required for this program. It is similar to link item type 16; however, there are no relocation words. This item replaces the need for library searches and is useful when loading real and dummy routines because it specifies filenames rather than modules names.

The data appears in groups of four or more words. Each group contains the following words:

Name of the device in SIXBIT containing the file.

Name of the file in SIXBIT.

Extension of the file in SIXBIT in the left half, and the length of the directory in the right half.

UFD in octal.

Remaining words in the group are sub-file directory names in SIXBIT.

The requests are stored until the end of loading and are loaded before the default libraries and requested libraries (link item type 1043). Any number of files can be requested.

A.4.18 Link Item Type 1043 Library Request

This item type requests the searching of libraries, either in search mode for all unresolved entries or for particular modules. The data is identical to that in item type 1042.

A.4.19 Link Item Types 1044-1047

These item types are reserved for future use.

A.4.20 Link Item Type 1050 Global Data

This item type contains data that is common to many programs (i.e., constants, argument lists, literals in MARCO-10 language). The global data item consists of two other link items: the relocation setting item (type 1004) and a code item (types 1010-1017). The initial global data item has no relocation words. The first data word is the header of the relocation item and only the relocation actually used should appear in this word; all other entires should be zero. The next data words are the data for the relocation item. Following these data words is a code item with relocation bits and data which may be relocatable or absolute. LINK-10 collects all the global data blocks, compares them, and keeps only one copy of those with the same data and relocation. The global data items are loaded at the end of loading or immediately after a /DATA switch is seen. These items should reduce the size of loaded programs because of pooling of literals.

A.4.21 Link Item Types Greater Than 3777 ASCIZ

This item type is recognized by the first 7-bit byte of the item being in the range 40 through 172, inclusively (i.e., an ASCIZ character). There is no word count in the item, and termination of the item occurs with a null byte. ASCIZ items are generated by translators and contain ASCIZ commands similar to those typed on the user's terminal. Thus, they act like an indirect command file. One use of ASCIZ items is to embed the overlay structure in the file to simplify the maintenance of large overlay programs. Any switches in ASCIZ items that are not associated with a file specification are considered part of the file specification currently being processed. For example, if the user has the following command line

```
DSK:COMMAN.REL,FILEA.REL
```

and embedded in COMMAN.REL are the ASCIZ items

```
/LOCAL,SYS:SPEDDT.REL
```

the user's command line is effectively

```
DSK:COMMAN.REL/LOCAL,SYS:SPEDDT.REL,DSK:FILE.REL
```

APPENDIX B

OVERLAY HANDLER

The routine that determines when overlaying is to occur is the overlay handler. It initiates overlays during execution of the program if a module in core references a module that is not in core. (No overlays occur if the module refers to another module already in core.) It is responsible for checking forward references to insure that all required links are in core when needed. The overlay handler resides on device SYS: as a REL file and is moved into the root link of the user's overlay structure when the user gives the /OVERLAY switch.

The overlay handler consists of self-modifying code and data plus two 128-word buffer areas. One area, IDXBFR, holds a 128-word section of the link number index table. This allows 256 links to be referenced directly at any given time. The second area, INBFR, contains the preamble and relocation tables, if required, of the individual links.

Overlays can be initiated in one of two ways, either explicitly by calling an overlay handler subroutine with a link name as an argument or implicitly as the result of a global reference which calls a subprogram outside the current overlay. The explicit call gives the user complete control over the core image and allows him to specify exact paths when an implicit call might prove ambiguous due to the same subroutine being in different links. However, it does require explicit calls to be included in the source language program, and these calls must obey the standard calling sequence (see below). In particular, the user is responsible both for the calling of the overlay handler and of the overlay structure. Most programs do not need to use the explicit call; instead they should let LINK-10 define all external references by default. Implicit calls to links require no special calls since LINK-10 generates all those required. However, this method does require the user to build the overlay structure.

The overlay handler has several entry points, some of which are available to user programs via explicit calls. The user program can use any of the entry points whose first letter is not a period. The entry points whose first letter is a period are reserved for the system. All calls to the overlay handler must use the following calling sequence:

```
MOVEI 16, address of argument list
PUSHJ 17, entry point name
```

B.1 OVERLAY HANDLER SUBROUTINES

The overlay handler subroutines are called from a FORTRAN program when the user includes a statement of the form

```
     CALL xxxOVL    (arg1, arg2, ..., argn)
```

where xxx are the first three letters of the subroutine.

arg1...argn are either file specifications or link names. File specifications are ASCII strings consisting of a device, file.ext, and directory name. Link names are either names in ASCII or integer numbers.

The following subroutines are available to the user program.

CALL INIOVL (file specification)

The initialization routine is used to specify the location of the overlay file if the load time specification is incorrect. The argument list is:

```
     -1,,0
     code,, file specification
```

CALL GETOVL (name1, name2, ..., namen)

This subroutine is used to change the core image by inputting the specified links and their path. It is useful for prefetching an extended path when the choice may otherwise be ambiguous. Since the user returns to the next instruction after the calling instruction, the link called and its path must not overlay the calling link. Any attempt to do so results in a run time error. The argument list is

```
          -n,, 0
          code,, name1
          code,, name2
             .
             .
             .
          code,, namen
```

CALL RUNOVL (name)

This subroutine changes the core image by loading the specified link into core and transferring control to the start address of the link. Since a return is not required, any link except the root link can be overlaid. However, a runtime error occurs if there is no start address in the specified link. Normally a start address is in the main program, but FORTRAN main programs must reside in the root link. To use the RUNOVL subroutine, but to avoid having a main program in a link other than the root, the user has two options:

1. He can use FORTRAN subroutines in the links other than the root and, to specify a start address, give the /START

switch to LINK-10 with the name of the subroutine as an argument.

2. He can write small dummy MACRO main programs since MACRO main programs can appear in links other than the root.

The argument list is

```
-1,, 0
code,, name
```

CALL REMOVL (name1, name2, ..., namen)

This subroutine removes the specified links from the core image. This action is essentially the reverse of path loading on the extended path of the link. The current link cannot be removed. This subroutine is used to reduce the core image size in order to obtain better response. The argument list is

```
-n,, 0
code,, name1
code,, name2
    .
    .
    .
code,, namen
```

CALL LOGOVL (file specification)

This subroutine is used to specify an output log file specification for runtime messages and to cause LINK-10 to output them. The format of the messages include the elasped run time since the first call to the overlay handler. A 0 argument list closes the log file and turns off the feature to output run time log file messages. The argument list is

```
-1,, 0
code,, file specification
```

The device code for the user's terminal is TTY.

B.2 OVERLAY HANDLER MESSAGES

The overlay handler messages can be recognized by the first three letters, OVL, of the six-letter code. (Load time messages have LNK as the first three letters and are described in Appendix E.) All messages except log file information are output to the user's terminal.

The column labeled SEVERITY indicates the severity level associated with each message. The severity level is the point at which LINK-10 considers a message to be fatal and is controlled by the user with the /SEVERITY switch. Refer to the /SEVERITY switch in Chapter 4 and to Appendix E for additional information on severity levels.

LINK-10 OVERLAY HANDLER

CODE	SEVERITY	MEANING
ACF	%W or %F	ABSOLUTE CORE REQUEST FAILED, FUNCT. RETURN STATUS (xxx) Relocation will be required because the link cannot be loaded at its optimal address. The error is fatal if the link was loaded with /OVERLAY:ABSOLUTE; otherwise the error is a warning message. The status is one of the following: 2 - CORE ALREADY ALLOCATED 3 - ILLEGAL ARGUMENT TO FUNCT. MODULE
AOC	%F	ATTEMPT TO OVERLAY CALLER FROM LINK $\begin{Bmatrix}\text{NUMBER}\\\text{NAME}\end{Bmatrix}\begin{Bmatrix}\text{number}\\\text{name}\end{Bmatrix}$ The named link attempted to replace the link from which it was called. Dependent links cannot overlay each other. The user must redefine his overlay structure.
ARC	%F	ATTEMPT TO REMOVE CALLER FROM LINK $\begin{Bmatrix}\text{NUMBER}\\\text{NAME}\end{Bmatrix}\begin{Bmatrix}\text{number}\\\text{name}\end{Bmatrix}$ The named link attempted to remove the link from which it was called. This message occurs when the user calls the REMOVL subroutine and the routine tries to remove the current link.
ARL	%W	AMBIGUOUS REQUEST IN LINE [number] FOR [symbol], USING LINK [number] More than one successor link satisfies a call from an ancestor link. Since none of the successor links are in core and all their paths are equal, the overlay handler randomly picked the named link.
CDL	%F	CANNOT DELETE LINK $\begin{Bmatrix}\text{NUMBER}\\\text{NAME}\end{Bmatrix}\begin{Bmatrix}\text{number}\\\text{name}\end{Bmatrix}$, FUNCT. RETURN STATUS (xxx) This is an internal LINK-10 error and is not expected to occur. If it does, please notify your Software Specialist or send a Software Performance Report (SPR) to DEC. Status is one of the following: 1 - CORE ALREADY DEALLOCATED 3 - ILLEGAL ARGUMENT TO FUNCT. MODULE

LINK-10 OVERLAY HANDLER

CGC	%F	CANNOT GET CORE FROM OTS, FUNCT. RETURN STATUS (xxx)	The system does not have enough free core to load the link. The status (3-ILLEGAL ARGUMENT) is returned from the object time system.
CNA	%F	I/O CHANNEL NOT AVAILABLE, CHANNEL 0 USED	The specific I/O channels are not available from the object time system.
DLN	%I	DELETING LINK $\left\{\begin{array}{l}\text{NUMBER}\\\text{NAME}\end{array}\right\}\left\{\begin{array}{l}\text{number}\\\text{name}\end{array}\right\}$ AFTER time	A log file message indicating that the link has been removed from the user's address space. The time is the incremental runtime time since the first call to the overlay handler.
DOE	%F	DEVICE OPEN ERROR FOR [file specification]	The OPEN UUO failed for the log file device. The device could be in use for another user.
IAT	%F	ILLEGAL ARGUMENT TYPE ON CALL TO [subroutine]	The user gave an invalid argument when explicitly calling the named overlay handler subroutine.
IEO	%F	INPUT ERROR FOR OVERLAY FILE, STATUS (xxxxxx)	An error occurred when reading from the overlay file. The file is closed at the end of the last data that was successfully input. The status is represented by the right half of the file status word. Refer to DECsystem-10 Monitor Calls for the explanation of the file status bits.
ILN	%F	ILLEGAL LINK NUMBER [number]	The user gave an invalid link name or number when calling an overlay handler subroutine.
IMP	%F	IMPOSSIBLE ERROR CONDITION AT PC= [number]	An internal error caused by error returns from UUOs that should not occur. This message is output instead of the usual HALT message.
IVN	%W	INCONSISTENT VERSION NUMBERS	The overlay file (.OVL) was not created at the same time as the save file (.SAV). Thus, the two files may not be compatible.

NRT	%F	NO RELOCATION TABLES FOR LINK $\begin{Bmatrix}\text{NUMBER}\\ \text{NAME}\end{Bmatrix}$ The link was loaded as an absolute link and therefore cannot be relocated.
NSA	%F	NO START ADDRESS FOR LINK $\begin{Bmatrix}\text{NUMBER}\\ \text{NAME}\end{Bmatrix}\begin{Bmatrix}\text{number}\\ \text{name}\end{Bmatrix}$ The start address is zero because the user failed to load a module that contains a start address. This message occurs when the user calls the subroutine RUNOVL and it finds no start address for the link.
NYA	%F	SUBROUTINE [subroutine] NOT YET AVAILABLE The user has called an overlay handler subroutine that is not yet implemented. The unimplemented subroutines are SAVOVL, CLROVL, and TMPOVL.
OEO	%F	OUTPUT ERROR FOR OVERLAY FILE, STATUS (xxxxxx) An error occurred when writing to the overlay file. The file is closed at the end of the last data that was successfully output. The status is represented by the right half of the file status word. Refer to DECsystem-10 Monitor Calls for the explanation of the file status bits.
RLL	%I	RELOCATING LINK $\begin{Bmatrix}\text{number}\\ \text{name}\end{Bmatrix}$ AT [location] A log file message indicating that the named relocatable link has been loaded into the user's address space.
RLN	%I	READING IN LINK $\begin{Bmatrix}\text{NUMBER}\\ \text{NAME}\end{Bmatrix}\begin{Bmatrix}\text{number}\\ \text{name}\end{Bmatrix}$ AFTER [time] A log file message indicating that the named link has been loaded into the user's address space. The time is the incremental run time since the first call to the overlay handler.
USC	%W	UNDEFINED SUBROUTINE [name] CALLED FROM [pc] A reference to the named subroutine has occured at the specified program counter location. Since the subroutine is required for execution, the user should load the module in which it is contained.

B.3 OVERLAY FILE

In addition to creating the conventional SAV format file, LINK-10 creates an overlay file containing the entire overlay structure, including the root link. However, the root link cannot be accessed from this file; it is accessed from the SAV file. The overlay file resides on disk and is about twice the size of the total core images of all the links contained in it. Links in the overlay file are brought into core during execution as they are required by links already in core.

The first block of the overlay file is the directory block, which has pointers to all links in the overlay structure. The contents of the directory is as follows:

Word 1	The left half is 0 (reserved for the future). The right half is the number of words in this directory block.
Word 2	The number of regions in the oVerlay structure. For Version 2 of LINK-10, this word is 0.
Word 3	The version number of the corresponding save file.
Word 4	The left half is the negative of the number of links. The right half is the pointer to the block containing the link number table.
Word 5	The left half is the negative of the number of names. The right half is the pointer to the block containing the link name table.
Word 6	The left half is the negative of the number of entries. The right half is the pointer to the block containing the entry name table.

The remainder of the directory block and all blocks up to the block containing the link number table are reserved for the future. The link number table would normally be block 2.

B.3.1 Link Number Table

The link number table, usually the second block of the overlay file, consists of half-word entries, each of which points to the preamble block of a specific link. This table is usually all that is required to locate a desired link. The half-word entries are arranged in ascending numerical order starting with the root link, e.g.,

```
pointer to link 0,, pointer to link 1
pointer to link 2,, pointer to link 3
etc.
```

The last block of the table contains zeroes for all nonexistent links.

B.3.2 Link Name Table

The link name table consists of word groups. The left half of the first word contains the number of words required for the name and the right half contains the link number. The remaining words in the group contain the SIXBIT name of the link.

B.3.3 Entry Name Table

The entry name table consists of the SIXBIT entry name followed by pointers to a list of the links that contain the entry name. If there is only one link that contains the entry name, then that link's number is in the right half of the word following the entry name, and the left half of that word is zero. Thus, the format of entries in this table is either

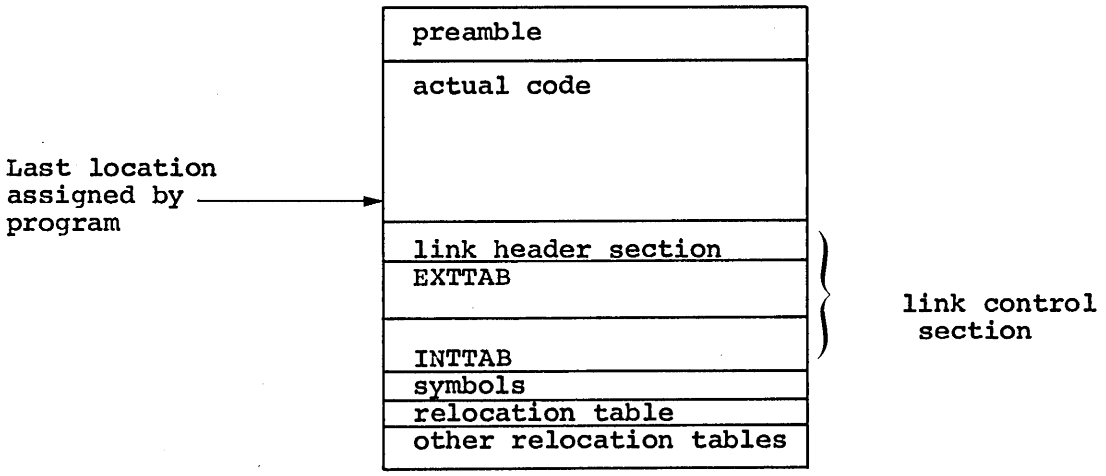
```
          name
          0,, link number
```

or

```
          name
          -n,,[link 1
               link 2
                 .
                 .
                 .
               link n]
```

B.4 INDIVIDUAL LINKS IN THE OVERLAY FILE

Each link area has the following format:



B.4.1 PREAMBLE

Although the preamble is not used during execution of the user's program, it is read by the overlay handler into its own area before the actual code is read. The preamble has the following entries:

Word 1	LH=0 (reserved for the future) RH= length of preamble
Word 2	LH=0 (reserved for the future) RH= region number (0 in Version 2 of LINK-10)
Word 3	LH=0 (reserved for the future) RH= link number
Word 4	Link name
Word 5	Pointer to list of links bound to this link starting with the root.
Word 6	Pointer to list of links bound to this link starting with link furthest from root.
Word 7	Pointer to list of links equivalent to this link (future)
Word 10	Address of link control section
Word 11	Future
Word 12	Absolute address at which this link was loaded
Word 13	Length of the link
Word 14	Block number of the start of the actual code
Word 15	Block number of the start of the symbols (future)
Word 16	Block number of the start of the relocation table for this link
Word 17	Block number of the start of the relocation tables for bound links
Word 20	Block number for global symbols in triplet format (unused)
Word 21	Block number for Radix-50 symbols
Word 22	Block number for the relocation of RADIX-50 symbols

B.4.2 Actual Code

This section contains the loaded code plus the link control section. (For Version 2 of LINK-10, it also contains the symbol table, if requested.) The code is read into core with a single dump mode read. When the code is read into the address at which it was loaded, the only action is to connect the link into the overlay structure of the existing links. If it is not read into the address at which it was loaded, relocation has to be performed.

The link control section follows the last location assigned by the program. It contains the link header section, EXTTAB, INTTAB, and for Version 2 of LINK-10, the symbols.

The link header section has the following format:

Word 1	LH=0 (reserved for the future)
	RH= Number of words, including this one, in the header
Word 2	LH=0 (reserved for the future)
	RH= Number of the region (0 in Version 2 of LINK-10)
Word 3	LH=0 (reserved for the future)
	RH= Number of the link
Word 4	SIXBIT name of the link if the user has assigned one
Word 5	LH= Pointer toward the root to the preceeding link
	RH= Pointer forward to the next link in the path
Word 6	Pointer to the symbols for this link (0 if symbols are not loaded)
Word 7	LH=0 (reserved for the future)
	RH= Start address of the link if one was supplied
Word 10	LH= Length of the core required to load the link. This includes actual code, symbols, and the link control section.
	RH= First address in link
Word 11	LH= The negative of the number of items in EXTTAB
	RH= The address of the first item in EXTTAB
Word 12	LH= The negative of the number of items in INTTAB
	RH=The address of the first item in INTTAB
Word 13	Pointer to the DDT symbol table on disk (future)
	LH=Negative count of the RADIX-50 symbols
	RH=Disk block number of the start of the symbols
Word 14	The offset if the link had to be relocated.

The remaining items in the link header section are reserved for the future.

EXTTAB contains references to routines that are referenced by this link but are defined in other links. INTTAB contains references to routines defined in this link, but referenced from other links.

The EXTTAB table has a slightly different format depending on whether the subroutine exists or is undefined. If a call is made to an existing subroutine the EXTTAB entry contains the following four words:

Word 1	JSP 1, .OVRLA
Word 2	FLAGS ,, INTTAB ADDRESS
Word 3	LINK # ,, THIS HEADER ADDRESS
Word 4	BACKWARDS PTR ,, FORWARD PTR

If a call is made to an undefined subroutine, the EXTTAB entry contains the following words:

Word 1	JSP 1, .OVRLU
WORD 2	0 ,, 0
WORD 3	0 ,, THIS HEADER ADDRESS
Word 4	SUBROUTINE NAME

Each entry in the INTTAB table, if defined, has the words:

Word 1	FLAGS ,, ADDRESS
Word 2	0 ,, FORWARD POINTER

B.4.3 Relocation Tables

All relocatable addresses are stored as absolute addresses on disk. If all previous links have been loaded into their optimal location, no relocation is performed and the relocation constant is zero. However, when some of the links have been relocated, the overlay handler must relocate all references to these links by adding to or subtracting from the absolute address to obtain the actual address.

The relocation table for this link consists of 2-bit bytes, one bit for each half word in the code section. If the bit is 0, the corresponding half word is absolute. If the bit is 1, the half word is relocatable.

The relocation table to other links on the path has word groups for each link back to the root link. Each word group has the following format:

```
          Word 1 = The number of words (n) following for this link.

          Word 2 = LH- the link number
                   RH- the absolute address the link should have  been
                   loaded into.

          Word 3-Word n-1 = relocation words
```

The relocation words have the form:

```
          LH= 9 * 2-bit bytes
          RH= address of 1st word in the current link
```

APPENDIX C

FUNCT. SUBROUTINE

In order for the overlay handler to have facilities for performing I/O, core management, and error message handling, each DEC-supplied object time system has a general-purpose subroutine (FUNCT.) to serve as an interface for these facilities. The subroutine has one entry point FUNCT. and is called by the calling sequence

```
          MOVEI 16, ARGLIST
          PUSHJ 17, FUNCT.
```

The general form of the argument list is as follows:

```
             -arg count,, 0
     list:   type,, [function]
             type,, [error code]
             type,, [status]
             type,, [arg1]
             type,, [arg2]
                  .
                  .
                  .
             type,, [argN]
```

where type is the FORTRAN argument types.

function is one of the required functions described below.

error code is the 3-letter mnemonic output by the object time system after the ?, %, or [.

status is undefined on the call and set on the return with one of the values below:

-1	Function not implemented
0	Successful return
1,...,n	Specific error message

Function 0 (ILL)

This function is illegal. The argument block is ignored, and the function always returns a status of -1.

FUNCT. SUBROUTINE

Function 1 (GAD)

This function gets core from a specific address. The arguments are

arg1	address at which to allocate core
arg2	size of core to allocate

The returned statuses are

0	core allocated (arg1 and arg2-unchanged)
1	not enough core available in system (arg1 and arg2-unchanged)
2	cannot allocate core at specified address (arg1 and arg2-unchanged)
3	illegal arguments (i.e., address+size is greater than 256K) (arg1 and arg2-unchanged)

Function 2 (COR)

This function gets core from any address. The arguments are

arg1	undefined
arg2	size of core to allocate

The returned statuses are

0	core allocated (arg2-unchanged, arg1-beginning address of the allocated core)
1	not enough core available in system (arg2-unchanged)
3	illegal argument (i.e., size is greater than 256K)

Function 3 (RAD)

This function returns core at the specified address. The arguments are

arg1	address of core to be returned
arg2	size of core to be returned

The returned statuses are

0	core deallocated
1	core cannot be deallocated
3	illegal argument (i.e., both the address and the size are greater than 256K)

Function 4 (GCH)

This function gets an I/O channel. The argument is

arg1	undefined

The returned statuses are

0	I/O channel allocated (arg1-channel number)
1	no I/O channels available

Function 5 (RCH)

This function returns an I/O channel. The argument is

arg1	I/O channel number to be returned

The returned statuses are

0	channel returned
1	invalid channel number

Function 6 (GOT)

This function gets core from the object time system list. The arguments are

arg1	address at which to allocate core
arg2	size of core to allocate

The returned statuses are

0	core allocate (arg1 and arg2-unchanged)
1	not enough core available in system (arg1 and arg2-unchanged)
2	cannot allocate core at specified address (arg1 and arg2-unchanged)
3	illegal arguments

This function differs from function 1 in that if the object time system has two free core lists, then function 1 is used to allocate space for links, and this function is used to allocate space for I/O buffers. Function 1 uses the free core list for LINK-10, and function 6 uses the list for the object time system.

Function 7 (ROT)

This function returns core to the object time system. The arguments are

arg1	address of core to be returned
arg2	size of core to be returned

The returned statuses are

0	core deallocated
1	core cannot be deallocated
3	illegal argument

Function 8 (RNT)

This function returns the initial runtime from the object time system. The argument is

arg1	undefined

The returned status is

0	always (arg1-runtime from the object time system)

This function is used only if the user desires a log file.

Function 9 (IFS)

This function returns the initial runtime file specification from the object time system. The specification is obtained from accumulators 0, 7, and 11 after the initial RUN command. The arguments are

arg1,...,arg3	undefined

The returned status is

0	always (arg1-device from accumulator 11, arg2-filename from accumulator 0, and arg3-directory from accumulator 7)

This function tells the overlay handler which file to read after the initial RUN command.

Function 10 (CBC)

This function cuts back core if possible and is used to reduce the size of the user job. There are no arguments. The returned status is

0	always

APPENDIX D

MIXFOR FEATURE

Normally, it is not possible to load a mixture of FORTRAN-10 and F40 programs. However, if both the FMXFOR feature test switch is on and the user has given the /MIXFOR switch, he can load any combination of FORTRAN subroutines with either a FORTRAN-10 or a F40 main program.

D.1 SWITCHES

Two switches are available to the user in order that he can load a mixture of FORTRAN programs. The /MIXFOR switch informs LINK-10 that a combination of FORTRAN-10 and F40 programs will be loaded together. It must appear in the command string before any FORTRAN programs are loaded. This switch is a delayed action switch (refer to Paragraph 3.3.5) and has no arguments.

The /NOMIXFOR switch specifies that the user does not want to load a combination of FORTRAN-10 and F40 programs. Since this is the default case, this switch is needed only when the installation has made the default setting of FMXFOR equal to -1 (i.e., prepare for loading a combination of FORTRAN programs unless the user specifies otherwise). The /NOMIXFOR switch is also a delayed action switch (refer to Paragraph 3.3.5) and must appear in the command string before any FORTRAN programs are loaded.

D.2 DESCRIPTION OF SOFTWARE

In order to load a combination of FORTRAN programs, the MIXFOR subroutine must be included in the FORTRAN library FORLIB. When the FMXFOR feature test switch in LINK-10 is 0, LINK-10 does not reference the MIXFOR subroutine and does not change any code. When the FMXFOR switch is +1, LINK-10 references the MIXFOR subroutine and changes code if the user gives the /MIXFOR switch. When the FMXFOR switch is -1, LINK-10 always references the MIXFOR subroutine and changes the code, unless the user gives the /NOMIXFOR switch. (The setting for the FMXFOR switch in Version 2 of LINK-10 is -1.)

MIXFOR Feature

To implement the MIXFOR feature, LINK-10 has modifcations to recognize either type of FORTRAN subroutine and change its code in the following ways:

1. The ENTRY points are remembered and the global fixups are not done when the global definitions are seen.

2. After loading the subroutine, LINK-10 appends the following words of code for each entry point.

   ```
   CAIA
   PUSHJ 17, .MXFOR##
   PUSHJ 17, .SAV15##
   JRST  entry point instruction
   ```

   where the entry point instruction is the instruction of the entry point as defined by the compiler, and the entry point address is the address of the corresponging CAIA instruction.

After it appends the four words of code, LINK-10 performs the global fixups and then examines the loaded code for the return instructions.

LINK-10 makes different changes to the return instructions depending on whether the subroutine was compiled by FORTRAN-10 or F40. If the subroutine was compiled by FORTRAN-10, LINK-10 searches for the multiple return instruction HRRM 1,0(17) and replaces it with a HRRM 1,-2(17) instruction. (Single return instructions are not changed.) The POPJ instruction following the HRRM instruction causes a return to .SAV15## or .MXFOR## depending on the caller, which then restores the stack and returns to the correct location.

When the subroutine has been compiled by F40, LINK-10 changes both the single return and multiple return instructions. The single return instruction JRA 16,n(16) is replaced by a POPJ 17, instruction, and the multiple return instruction JRA 16,@-1(16) is replaced by SOJA 16, .JRA 16##.

If LINK-10 cannot find the return instructions, the following warning message is output and the fixups are not done:

```
%LNKFSF   FORTRAN SUBROUTINE xxxxxx NOT IN
          EXPECTED FORM, MIXFOR FIXUP NOT DONE
```

This message is not expected to occur. If it does, please notify your Software Specialist or send a Software Performance Report (SPR) to DEC.

At the end of loading, LINK-10 generates a request for the symbol FORSE if a FORTRAN-10 main program and at least one F40 subroutine were loaded. This request causes the FORJAK routine in FORLIB to be loaded in case F40 subroutines perform I/O using F40 UUO's. In addition, the MIXFOR routine, which contains the entry points .MXFOR, .SAV15, and .JRA16, is loaded during the library search of FORLIB.

APPENDIX E

LINK-10 MESSAGES

The following table of LINK-10 messages consists of four columns: CODE, LVL, SEV, and MESSAGE. The leftmost column (CODE) contains a code, which represents a terse, abbreviated form of the message. This code, when output to the user, is actually six letters. However,since the first three letters are always LNK, only the last three unique letters of the code are shown in the manual. The user can indicate, via the /VERBOSITY:SHORT switch, that he desires only the 6-letter code to be output whenever he receives a LINK-10 message. Refer to the /VERBOSITY switch in Chapter 4 for additional information.

The second column of each message (LVL) indicates the message level associated with that message. The message level is the factor that determines if the message is to be output. Normally, informative messages are suppressed to the user's terminal and all messages are output to the log file, if the user has designated one. However, the user can override this action with the /ERRORLEVEL and /LOGLEVEL switches. These switches accept a decimal number and indicate to LINK-10 that messages with a message level less than or equal to the specified number are not to be output to the user's terminal (/ERRORLEVEL) or to his log file (/LOGLEVEL). Messages with a message level greater than the specified number will be output. The two switches are independent if the user's log file is not being output to his terminal. That is, he can have one set of messages printed on his terminal and another set listed in his log file. When the device for the log file is the user's terminal, only one set of messages is output. This set is the one generated by the lower argument in either the /ERRORLEVEL or /LOGLEVEL switch.

There are currently representations for three message levels:

%I	informative, message levels 1-9
%W	warning, message levels 10-30
%F	fatal, message level 31

Note that the messages with an asterisk (*) for the message level cannot be suppressed. These messages are output only to the user's terminal. Refer to the /ERRORLEVEL and /LOGLEVEL switches in Chapter 4 for additional information.

The third column (SEV) contains the severity level associated with each message. The severity level is the point at which LINK-10 considers a message to be fatal (i.e., one which will terminate the load). The predefined LINK-10 severity levels can be overridden by the user via the /SEVERITY switch. This switch accepts a decimal number and indicates to LINK-10 that messages with a severity level less than or equal to the specified number are not to be considered fatal. Messages with a severity level greater than the specified number will cause the load to be terminated. (Note that messages with a severity level of 31 are always fatal and that the user cannot override the action taken with these messages.) If the user does not give a /SEVERITY switch, or does not give an argument to the switch, a severity level of 24 is considered fatal for a timesharing job and a severity level of 16 is considered fatal for a batch job.

Currently the representations for the severity levels are as follows:

%I	severity level 1. The message is enclosed in square brackets (informative).
%W	severity level 10. The message is preceded by a percent sign (warning).
%E	severity level 30. The message is preceded by a percent sign and followed by a line requesting the user to re-edit the current file specification, if he wishes. This option is available only to a timesharing user (editing).
%F	severity level 31. The message is preceded by a question mark (fatal).

Refer to the /SEVERITY switch in Chapter 4 for additional information.

The rightmost column (MESSAGE) contains a more detailed explanation of the message than the one appearing in the CODE column. This message, along with the six-letter code, is normally output. However, the user can override this action with the /VERBOSITY switch. Refer to the /VERBOSITY switch in Chapter 4 for further information.

CODE	LVL	SEV	MESSAGE
ARL	%W	%W	AMBIGUOUS REQUEST IN LINK [number] FOR [symbol] DEFINED IN LINKS [number , ..., number] More than one successor link satisfies a call from an ancestor link. At run time, the link in core, or the one with the longest path in core, will be used to satisfy the call. No message will be given. However, if none of the successor links are in core, the overlay handler picks one with the longest path in core. If all paths are equal, the overlay handler picks one at random and gives a warning message to the user. To avoid this situation, the user should promote, to a common link, the module containing the called subroutine.
AMP	%W	%W	ALGOL MAIN PROGRAM NOT LOADED The user has loaded ALGOL procedures without a main program. Execution will be terminated because of missing start address and undefined symbols.
ANC	%F	%F	ADDRESS NOT IN CORE (1) LINK-10 expected a particular user address to be in core, but it is not there. This is a LINK-10 internal error.
AZW	%F	%F	ALLOCATING ZERO WORDS (1) LINK-10's space allocator was called with a request for zero words. This is an internal error in LINK-10.
B4R	%W	%W	BAD F40 PRODUCED REL FILE FOR [name] Either the compiler produced incorrect code or the file was modified so that the code is no longer valid. The REL file may contain tables longer than 2↑18 words or tables known to contain word pairs but that actually have an odd length. Although this message is not fatal, it is usually followed by a fatal one.

(1) This message is not expected to occur. If it does, please notify your Software Specialist or send a Software Performance Report (SPR) to DEC.

CEF	%F	%F	CORE EXPANSION FAILED All attempts to obtain more core, including writing files onto disk, have failed. The program is too big for available user core, probably because of too many global symbols. A future version of LINK-10 will overflow global symbols to the disk. However, there will always be a minimum size below which LINK-10 will not operate.
CLF	%I	%I	CLOSING LOG FILE, CONTINUING ON [file specification] This message occurs when the user changes the device on which the log file is being written. The log file is closed on the first device and the remainder of the file is written on the second device.
CMF	%F	%F	COBOL MODULE MUST BE LOADED FIRST The COBOL-produced file must be the first file loaded when loading COBOL modules. COBDDT, the COBOL debugging program, or any other modules, such as a MACRO routine, cannot be the first file in the command string. The user should begin loading again and place the COBOL main program or routine as the first file in the command string.
CNW	%F	%F	CODE NOT YET WRITTEN AT [label] (1) The user attempted a feature that is not yet implemented. This is an internal error in LINK-10.
CSF	%I	%I	CREATING SAV FILE LINK-10 is generating the requested save file by running the core image through a zero compressor routine in order to produce a SAV format file.
DEB	*	%I	[name] EXECUTION The loading process is complete and the named debugging program (e.g., DDT, COBDDT) has begun execution.

(1) This message is not expected to occur. If it does, please notify your Software Specialist or send a Software Performance Report (SPR) to DEC.

DLT	*	%F	EXECUTION DELETED A program was prevented from being executed because of errors detected during translating or loading or because of no start address. Loading is performed but LINK-10 exits to the monitor. Messages output previous to this one indicate the reasons for failure.
DNS	%I	%I	DEVICE NOT SPECIFIED FOR /switch A device switch, such as /REWIND or /BACKSPACE, has been given, but there is no device to be associated with it. The switch is ignored. This occurs when the user does not give a device name in the specification containing the switch or has not specified a device name in the current line. (Remember that devices are cleared at the end of the line.) LINK-10's default device DSK does not apply to device switches nor does a device specified in a /DEFAULT switch apply. The user should respecify the command line and include the appropriate device name with the switch.
DRC	%W	%W	DECREASING RELOCATION COUNTER [symbol] FROM [value] TO [value] The user is reducing the size of an already defined relocation counter via the /SET switch. The new value is accepted. The user should be extremely careful when he does this because code previously loaded under the old relocation counter may be overwritten. This practice of reducing counters is dangerous unless the user knows exactly where modules are loaded.
DSC	%F	%F	DATA STORE IN COMMON [symbol] NOT IN LINK NUMBER [number] FOR [module] IN [file specification] The user has a DATA statement in FORTRAN which sets up a COMMON area, but the COMMON area is in another link closer to the root. The user should set up the COMMON area in the link in which it is first defined.
DSL	%F	%F	DATA STORE TO LOCATION [address] NOT IN LINK [number] FOR [module] IN [file specification] The user has a data store to an absolutely-defined location that is not in the specified link (e.g., the user is storing data in JOBDAT). The user should move the module to the root link.

DSO	%F	%F	DATA STATEMENT OVERFLOW (1) Incorrect code has been generated by the F40 compiler.
DUZ	%F	%F	DECREASING UNDEFINED SYMBOL COUNT BELOW ZERO (1) On an internal check of the counter for undefined symbols, LINK-10 determined that the counter was negative. This is an internal error.
EID	%F	%F	ERROR ON INPUT DEVICE STATUS (xxxxxx) FOR [file specification] A read error has occurred on the input device. Use of the device is terminated and the file is released. The status is represented by the right half of the file status word. Refer to DECsystem-10 Monitor Calls for the explanation of the file status bits.
ELF	%I	%I	END OF LOG FILE Notification that the LINK-10 module LNKLOG has completed the writing of the log file. The file is now closed.
$\begin{Bmatrix}\text{ELC}\\\text{EHC}\\\text{ELS}\\\text{EFX}\\\text{EGS}\end{Bmatrix}$	%F	%F	ERROR CREATING OVERFLOW FILE FOR AREA $\begin{Bmatrix}\text{LC}\\\text{HC}\\\text{LS}\\\text{FX}\\\text{GS}\end{Bmatrix}$ LINK-10 could not make the named file on the disk (LC=user's low segment code, HC=user's high segment code, LS=local symbol table, FX=fixup area, and GS=global symbol table). The user could be over quota, or the disk could be full or have errors.
EOV	%F	%F	ERROR CREATING OVERLAY FILE FOR [file specification] LINK-10 could not create the overlay file on the disk. The user could be over quota, or the disk could be full or have errors.

---

(1) This message is not expected to occur. If it does, please notify your Software Specialist or send a Software performance Report (SPR) to DEC.

EMS	%I	%I	END OF MAP SEGMENT Notification that the LINK-10 module LNKMAP has completed the writing of the map file. The map is now closed.
ESN	%F	%F	EXTENDED SYMBOL NOT EXPECTED (1) The code to handle symbols longer than six characters has not been completed. This code will be available in a future release.
EXP	%I-4	%I	EXPANDING LOW SEGMENT TO [n] K LINK-10 needs more core and is expanding to the specified amount. In future loads of the same programs, the user can run LINK-10 more efficiently by requesting this amount of core at the beginning of the load with the /CORE switch.
EXS	%I	%I	EXIT SEGMENT LINK-10 is entering the completion stages of the loading process. These stages include the creation of save and symbol files and, if required, the execution of the core image.

FCD	%F	%F	FORTRAN CONFUSED ABOUT DATA STATEMENTS (1)
			
			Incorrect code was generated by the F40 compiler for a data statement in the form
			`DATA A(I),I=1,4/1,2,3,4/`
			as opposed to a data statement in the form
			`DATA (A(I),I=1,4)/1,2,3,4/`

FCF	%I	%I	FINAL CODE FIXUPS LINK-10 is now reading the low and/or high segment overflow files backwards in order to do all remaining code fixups. This process may cause considerable disk overhead. Note that the message occurs only if the load was too large to fit entirely in core.

(1) This message is not expected to occur. If it does, please notify your Software Specialist or send a Software Performance Report (SPR) to DEC.

FIA	%F	%F	CANNOT MIX KI10 AND KA10 FORTRAN-10 COMPILED CODE The FORTRAN-10 compiler generates different output for the KA10 and the KI10 processors (e.g., double precision code) and the user cannot load this mixture. He should decide which processor he wants to use and then recompile the appropriate programs.
FIN	%I	%I	LINK-10 FINISHED LINK-10 has completed its task of loading the user's program and other required programs. Control is either returned to the monitor or given to the user's program for execution.
FON	%F	%F	CANNOT MIX F40 AND FORTRAN-10 COMPILED CODE Output from the F40 and FORTRAN-10 compilers cannot be used together in the same load. The user should decide which compiler he wants and then recompile the appropriate program with that compiler.(1)
FOV	%F	%F	CANNOT OVERLAY F40 COMPILED CODE FOR [file specification] Output from the F40 compiler cannot be used with the overlay facility. The user should recompile his program with the FORTRAN-10 compiler.
{FEE FRE}	%F	%F	{ENTER RENAME} ERROR (0) ILLEGAL FILENAME FOR [file specification] One of the following conditions occurred: 1. The filename given was illegal. 2. When updating a file, the filename given did not match the file to be updated. 3. The RENAME UUO following a LOOKUP UUO failed.

(1) If the feature test switch FMXFOR is on and the user has given the /MIXFOR switch, FORTRAN-10 and F40 compiled subroutines can be loaded together and this message is not valid. For additional information, refer to Appendix D.

$\left\{\begin{matrix}\text{FLE}\\\text{GSE}\end{matrix}\right\}$	%F	%E	$\left\{\begin{matrix}\text{LOOKUP}\\\text{GETSEG}\end{matrix}\right\}$	ERROR (0) FILE WAS NOT FOUND
				The file requested by the user was not found. The user should respecify the correct filename.
$\left\{\begin{matrix}\text{FEE}\\\text{FLE}\\\text{FRE}\\\text{GSE}\end{matrix}\right\}$	%F	%E	$\left\{\begin{matrix}\text{ENTER}\\\text{LOOKUP}\\\text{RENAME}\\\text{GETSEG}\end{matrix}\right\}$	ERROR (1) NO DIRECTORY FOR PROJECT-PROGRAMMER NUMBER FOR [file specification]
				The UFD does not exist on the named file structure, or the project-programmer number given was incorrect.
$\left\{\begin{matrix}\text{FEE}\\\text{FLE}\\\text{FRE}\\\text{GSE}\end{matrix}\right\}$	%F	%E	$\left\{\begin{matrix}\text{ENTER}\\\text{LOOKUP}\\\text{RENAME}\\\text{GETSEG}\end{matrix}\right\}$	ERROR (2) PROTECTION FAILURE FOR [file specification]
				The user does not have the correct privileges to access the named file.
FRE	%F	%E		ENTER ERROR (2) DIRECTORY FULL
				The directory on the DECtape has no room for the file.
$\left\{\begin{matrix}\text{FEE}\\\text{FLE}\\\text{FRE}\\\text{GSE}\end{matrix}\right\}$	%F	%F	$\left\{\begin{matrix}\text{ENTER}\\\text{LOOKUP}\\\text{RENAME}\\\text{GETSEG}\end{matrix}\right\}$	ERROR (3) FILE WAS BEING MODIFIED FOR [file specification]
				Another user is currently modifying the named file. The user should try accessing the file later.
$\left\{\begin{matrix}\text{FEE}\\\text{FLE}\\\text{FRE}\\\text{GSE}\end{matrix}\right\}$	%F	%F	$\left\{\begin{matrix}\text{ENTER}\\\text{LOOKUP}\\\text{RENAME}\\\text{GETSEG}\end{matrix}\right\}$	ERROR (4) RENAME FILENAME ALREADY EXISTS FOR [file specification] (1)
				The specified filename already exists, or a different filename was given on the ENTER UUO following a LOOKUP UUO.

(1) This message is not expected to occur. If it does, please notify your Software Specialist or send a Software Performance Report (SPR) TO DEC.

FEE FLE FRE GSE	%F	%F	ENTER LOOKUP RENAME GETSEG	ERROR (5) ILLEGAL SEQUENCE OF UUOS FOR [file specification] (1)

The user specified an illegal sequence of monitor calls, UUOs, (e.g., a RENAME without a preceding LOOKUP or ENTER, or a LOOKUP after an ENTER).

FEE FLE FRE GSE	%F	%F	ENTER LOOKUP RENAME GETSEG	ERROR (6) BAD UFD OR BAD RIB FOR [file specification] (1)

One of the following conditions occurred:

1. Transmission, device, or data error occurred while attempting to read the UFD or RIB.
2. A hardware-detected device or data error was detected while reading the UFD RIB or UFD data block.
3. A software-detected data inconsistency error was detected while reading the UFD RIB or file RIB.

FEE FLE FRE GSE	%F	%F	ENTER LOOKUP RENAME GETSEG	ERROR (7) NOT A SAV FILE FOR [file specification] (1)

The named file is not a core image file. This message can never occur and is included only for completeness of the LOOKUP, ENTER, and RENAME error codes.

FEE FLE FRE GSE	%F	%F	ENTER LOOKUP RENAME GETSEG	ERROR (10) NOT ENOUGH CORE FOR [file specification] (1)

The system cannot supply enough core to use as buffers or to read in a program. This message can never occur and is included only for completeness of the LOOKUP, ENTER, and RENAME error codes.

---

(1) This message is not expected to occur. If it does, please notify your Software Specialist or send a Software Performance Report (SPR) to DEC.

```
FEE              ENTER
FLE   %F   %F    LOOKUP   ERROR (11) DEVICE NOT AVAILABLE FOR
FRE              RENAME   [file specification] (1)
GSE              GETSEG
```

The device indicated by the user is currently not available. This message can never occur and is included only for completeness of the LOOKUP, ENTER and RENAME error codes.

```
FEE              ENTER
FLE   %F   %F    LOOKUP   ERROR (12) NO SUCH DEVICE FOR
FRE              RENAME   [file specification] (1)
GSE              GETSEG
```

The device specified by the user does not exist. This message can never occur and is included only for completeness of the LOOKUP, ENTER, and RENAME error codes.

```
FEE              ENTER
FLE   %F   %F    LOOKUP   ERROR (13) NOT TWO RELOC REG
FRE              RENAME   CAPABILITY FOR [file specification]
GSE              GETSEG   (1)
```

The machine does not have a two-register relocation capability. This message can never occur and is included only for completeness of the LOOKUP, ENTER and RENAME error codes.

```
FEE              ENTER
FLE   %F   %F    LOOKUP   ERROR (14) NO ROOM OR QUOTA
FRE              RENAME   EXCEEDED FOR [file specification]
GSE              GETSEG
```

There is no room on the file structure for the named file, or the user's quota on the file structure would be exceeded if the file were placed on the structure.

```
FEE              ENTER
FLE   %F   %F    LOOKUP   ERROR (15) WRITE LOCK ERROR
FRE              RENAME   FOR [file specification]
GSE              GETSEG
```

The user cannot write on the specified device because it is write-locked.

(1) This message is not expected to occur. If it does, please notify your Software Specialist or send a Software Performance Report (SPR) to DEC.

FEE FLE FRE GSE	%F	%F	ENTER LOOKUP RENAME GETSEG	ERROR (16) NOT ENOUGH MONITOR TABLE SPACE FOR [file specification]

There is not enough table space in the monitor's (FILSER) 4-word blocks for the specified file. The user should try running the job at a later time.

FEE FLE FRE GSE	%W	%W	ENTER LOOKUP RENAME GETSEG	ERROR (17) PARTIAL ALLOCATION ONLY FOR [file specification]

Because of the user's quota or the available space on the device, the total number of blocks requested could not be allocated and a partial allocation was given.

FEE FLE FRE GSE	%F	%F	ENTER LOOKUP RENAME GETSEG	ERROR (20) BLOCK NOT FREE ON ALLOCATION FOR [file specification] (1)

The block required by LINK-10 is not available for allocation. This message can never occur and is included only for completeness of the LOOKUP, ENTER, and RENAME error codes.

FEE FLE FRE GSE	%F	%F	ENTER LOOKUP RENAME GETSEG	ERROR (21) CAN'T SUPERSEDE (ENTER) AN EXISTING DIRECTORY FOR [file specification] (1)

The user attempted to supersede an existing directory. This message can never occur and is included only for completeness of the LOOKUP, ENTER, and RENAME error codes.

FEE FLE FRE GSE	%F	%F	ENTER LOOKUP RENAME GETSEG	ERROR (22) CAN'T DELETE (RENAME) A NON-EMPTY DIRECTORY FOR [file specification] (1)

The user attempted to delete a directory that was not empty. This message can never occur and is included only for completeness of the LOOKUP, ENTER, and RENAME error codes.

(1) This message is not expected to occur. If it does, please notify your Software Specialist or send a Software Performance Report (SPR) to DEC.

```
(FEE )                (ENTER )
)FLE (    %F   %F     )LOOKUP(  ERROR (23) SFD NOT FOUND FOR
)FRE (                )RENAME(  [file specification]
(GSE )                (GETSEG)
```

The required sub-file directory in the specified path was not found.

```
(FEE )                (ENTER )
)FLE (    %F   %F     )LOOKUP(  ERROR (24) SEARCH LIST EMPTY FOR
)FRE (                )RENAME(  [file specification]
(GSE )                (GETSEG)
```

A LOOKUP and ENTER UUO was performed on generic device DSK and the search list is empty.

```
(FEE )                (ENTER )
)FLE (    %F   %F     )LOOKUP(  ERROR (25) SFD NEST LEVEL TOO
)FRE (                )RENAME(  DEEP FOR [file specification] (1)
(GSE )                (GETSEG)
```

An attempt was made to create a subfile directory nested deeper than the maximum level allowed. This message can never occur and is included only for completeness of the LOOKUP, ENTER, and RENAME error codes.

```
(FEE )                (ENTER )
)FLE (    %F   %F     )LOOKUP(  ERROR (26) NO-CREATE ON FOR ALL
)FRE (                )RENAME(  SEARCH LIST FOR [file specification]
(GSE )                (GETSEG)
```

No file structure in the job's search list has both the no-create bit and the write-lock bit equal to zero and has the UFD or SFD specified by the default or explicit path.

```
(FEE )                (ENTER )
)FLE (    %F   %F     )LOOKUP(  ERROR (27) SEGMENT NOT ON SWAP
)FRE (                )RENAME(  SPACE FOR [file specification] (1)
(GSE )                (GETSEG)
```

A GETSEG UUO was issued from a locked low segment to a high segment which is not a dormant, active, or idle segment. This message can never occur and is included only for completeness of the LOOKUP, ENTER, and RENAME error codes.

---

(1) This message is not expected to occur. If it does, please notify your Software Specialist or send a Software Performance Report (SPR) to DEC.

FEE FLE FRE GSE	%F	%F	ENTER LOOKUP RENAME GETSEG	ERROR (30) CAN'T UPDATE FILE (1) A LOOKUP and ENTER UUO was given to update a file, but the file cannot be updated for some reason (e.g., another user is superseding it or the file was deleted between the time of the LOOKUP and the ENTER).
GSE	%W	%W		GETSEG ERROR (31) LOW SEGMENT OVERLAPS HIGH SEGMENT (1) The end of the low segment is above the beginning of the high segment.
FEE FLE FRE GSE	%F	%F	ENTER LOOKUP RENAME GETSEG	ERROR (nn) UNKNOWN CAUSE FOR [file specification] (1) This message indicates that a LOOKUP, ENTER, or RENAME error occurred which was larger in number than the errors LINK-10 knows about.
FSF	%W	%W		FORTRAN SUBROUTINE [name] NOT IN EXPECTED FORM, MIXFOR FIXUP NOT DONE (1) LINK-10 cannot find the return instructions in the F40 compiled subroutine.
FSI	%W	%W		FORTRAN-10 REQUIRES FOROTS,/FORSE SWITCH IGNORED The user gave a /FORSE switch while loading FORTRAN-10 compiled code.
HSL	%F	%F		ATTEMPT TO SET HIGH SEGMENT ORIGIN TOO LOW The user is trying to set the beginning of the high segment below the end of the last page of the low segment. The user can either specify a /SET:.HIGH. switch or in the case of MACRO-10, reassemble the module. (Note that the setting of the beginning of the high segment below 400000 will fail on all KI10 monitors previous to 5.07 and on all KA10 monitors.)

(1) This message is not expected to occur. If it does, please notify your Software Specialist or send a Software Performance Report (SPR) to DEC.

HSO	%W	%W	ATTEMPT TO CHANGE HIGH SEGMENT ORIGIN FROM [value] TO [value]
			The user is attempting to change the starting address of the high segment. The specified value is ignored. The cause may be that the user gave a /SET:.HIGH.: value switch which does not agree with the first LINK item type 3. The user should recompile the incorrect files or use the correct value on the /SET:.HIGH. switch.
HTL	%F	%F	SYMBOL HASH TABLE TOO LARGE (1)
			The user has more global symbols than can fit in the maximum hash table (about 25K in size) LINK-10 can generate. Possible action is to increase the maximum allowable size of the hash table.
$\left\{\begin{array}{l}\text{I4D}\\ \text{I4S}\\ \text{I4T}\end{array}\right\}$	%F	%F	ILLEGAL F40 $\left\{\begin{array}{l}\text{DATA CODE}\\ \text{SUB-BLOCK}\\ \text{TABLE ENTRY}\end{array}\right\}$ (xxxxxx) (1)
			Incorrect code was produced by the F40 compiler.
IBC	%F	%F	ATTEMPT TO INCREASE SIZE OF BLANK COMMON
			An attempt was made to expand the blank COMMON area. Once a COMMON area is defined, the size cannot be expanded. The user should load the module with the largest blank COMMON area first or specify the larger area with the /COMMON switch before loading either module.
ICI	%F	%F	INSUFFICIENT CORE TO INITIALIZE LINK-10
			There is not enough core in the system to initialize LINK-10.
IDM	%F	%E	ILLEGAL DATA MODE FOR DEVICE
			The data mode specified for a device is illegal, such as dump mode for the terminal (e.g., TTY:/SAVE). The user should respecify the correct device.

(1) This message is not expected to occur. If it does, please notify your Software Specialist or send a Software Performance Report (SPR) to DEC.

IFD	%F	%F	INIT FAILURE FOR DEVICE [dev] The OPEN or INIT UUO failed for the specified device. The device could be in use by another user.
$\left\{\begin{matrix}\text{ILC}\\\text{IHC}\\\text{ILS}\\\text{IFX}\\\text{IGS}\end{matrix}\right\}$	%F	%F	ERROR INPUTTING AREA $\left\{\begin{matrix}\text{LC}\\\text{HC}\\\text{LS}\\\text{FX}\\\text{GS}\end{matrix}\right\}$ - STATUS (xxxxxx) An error occurred while reading in the named area (LC=user's low segment code, HC=user's high segment code, LS=local symbol table, FX=fixup area, and GS=global symbol table). The status is represented by the right half of the file status word. Refer to DECsystem-10 Monitor Calls for the explanation of the file status bits.
ILI	%F	%F	ILLEGAL LINK ITEM TYPE (xxxxxx) ON [file specification] The input file either was generated by a translator that LINK-10 does not recognize (e.g., a non-supported translator) or is not in proper binary format (e.g., is an ASCII or SAV file).
IMA	%I	%I	INCREMENTAL MAPS NOT YET AVAILABLE The INCREMENTAL keyword for the /MAP switch is not implemented. The switch is ignored.
INS	%F	%F	I/O DATA BLOCK NOT SET UP (1) LINK-10 attempted to do I/O (LOOKUP, ENTER UUOs) for a channel that has not been set up. This is an internal LINK-10 error.
IOV	%F	%F	INPUT ERROR FOR OVERLAY FILE, STATUS (xxxxxx) An error occurred when reading the overlay file. The status is represented by the right half of the file status word. Refer to the DECsystem-10 Monitor Calls for the explanation of the file status bits.

(1) This message is not expected to occur. If it does, please notify your Software Specialist or send a Software Performance Report (SPR) to DEC.

IPO	%F	%F	INVALID POLISH OPERATOR (1) An incorrect link item type 11 was seen. This is an internal LINK-10 error.
ISD	%F	%F	INCONSISTENT SYMBOL DEFINITION FOR [symbol] An already-defined symbol has been given a second "partial" definition. The user should examine the usage of the named symbol.
ISO	%F	%F	INCORRECT STORE OPERATOR (1) An incorrect link item type 11 was seen. This is an internal LINK-10 error.
ISP	%F	%F	INCORRECT SYMBOL POINTER (1) The current symbol pointer does not point to a valid symbol triplet. This can occur if an extended symbol does not terminate properly. This is an internal LINK-10 error.
IST	%F	%F	INCONSISTENCY IN SWITCH TABLE (1) An internal error occurred in the switch tables built by the SCAN module.
ITT	%W	%W	ILLEGAL TYPE 12 IN LINK NUMBER [number] IN MODULE [name] A number other than 1 through 20 was used in a link item type 12.
IUU	*	%F	ILLEGAL USER UUO AT PC [value] (1) This is an internal LINK-10 error.
IVC	%F	%F	INDEX VALIDATION CHECK FAILED AT [address] (1) The range checking of LINK-10's internal tables and arrays failed. The address output is the point in the appropriate LINK-10 segment at which this occurred.

(1) This message is not expected to occur. If it does, please notify your Software Specialist or send a Software Performance Report (SPR) to DEC.

LDS	%I	%I	LOAD SEGMENT Indication that the LINK-10 module LNKLOD has started its processing.
LII	%W	%I	LIBRARY INDEX INCONSISTENT, CONTINUING The index (link item type 14) on a FUDGE library file is not correct. The file will be searched as if the index were absent.
LIM	%I	%I	LINK-10 INITIALIZATION LINK-10 has begun its processing of the user's input.
LIT	%F	%F	LINK ITEM TYPE (xxxxxx) TOO SHORT FOR [file specification] An error occurred in the named link item. This could result from incorrect output generated by a translator (e.g., no argument is seen on an END block when one is required). The user should retranslate the module.
LMN	%I-6	%I	LOADING MODULE [name] LINK-10 is in the process of loading the named module.
LNA	%W	%W	LINK [name] ALREADY ASSIGNED The user has previously assigned the specified name to another link. This attempt is ignored. The user should specify a different name if he wants one associated with the link.
LNC	%F	%F	LINK NUMBER [number] NOT IN CORE (1) The named link could not be found in core.
LNL	%W	%W	LINK NUMBER [number] NOT LOADED The indicated link has not yet been loaded. This can happen if the user specifies link numbers, instead of link names, as arguments

(1) This message is not expected to occur. If it does, please notify your Software Specialist or send a Software Performance Report (SPR) to DEC.

			to the /NODE switch and then forgets the numbers. The /NODE switch is ignored. The use of link numbers as arguments is not recommended.
LNN	%W	%W	LINK [name] NOT ASSIGNED The user specified a name of a link on the /NODE switch and LINK-10 has not yet loaded a link with that name. The /NODE switch is ignored.
LSS	*	%I	LIBRARY SEARCH SYMBOLS (ENTRY POINTS) This is the response to the /ENTRY switch.
MDS	%W	%W	MULTIPLY-DEFINED GLOBAL SYMBOL [symbol] IN MODULE [name] DEFINED VALUE = [value], THIS VALUE = [value] The user has given an existing global symbol a value different from its original one. The second occurrence of the global symbol is in the named module. The currently defined value is used. The user should change the name of the symbol or reassemble one of the files with the correct parameters.
MNS	%I	%I	MAP SORTING NOT YET IMPLEMENTED Alphabetic and numeric sorting of the map file is not yet implemented. The symbols appear in the order in which they were placed in the symbol table.
MOV	%I	%I	MOVING LOW SEGMENT TO EXPAND AREA [area] This message indicates that LINK-10 is making inefficient use of core. In future loads of the same programs, the user should allocate more core to LINK-10 at the beginning of the load. Area is one of the following: LC=user's low segment code, HC=user's high segment code, LS=local symbol table, FX=fixup area, GS=global symbol table, and DY= dynamic data area.
MPS	%I	%I	MAP SEGMENT Indication that the LINK-10 module LNKMAP has begun to write a map file.

MRN	%I	%I	MULTIPLE REGIONS NOT YET IMPLEMENTED Overlay structures consisting of more than one region are not yet supported.
MSS	%W	%W	MAXCOR SET TOO SMALL, INCREASING TO nK The current value of MAXCOR is too small for LINK-10 to operate. In future loads of this program, the user can save LINK-10 time by setting MAXCOR to this new expanded size at the beginning of the load.
MTB	%W	%W	MAXCOR TOO BIG,nK USED The user attempted to set MAXCOR to a value so large that the low segment would be greater than the start of the high segment. The value of n is usually 128K.
MTS	%W	%W	MAXCOR TOO SMALL, AT LEAST nK IS REQUIRED The user specified the /MAXCOR switch with an argument that is below the minimum size LINK-10 requires as its low segment. The switch is ignored. The minimum size is dependent upon the code already loaded. The user should respecify the switch.
NCL	%W	%W	NOT ENOUGH CORE TO LOAD JOB, SAVED AS [file specification] The user's program was too large to load into core. Thus, LINK-10 created a saved file on disk and cleared user core. The user can perform a GET or RUN operation on the program to load it into core. If the core image is still too big, the user can either employ a bigger machine or obtain a larger core limit (e.g., increase CORMAX).
NCX	%W	%I	NOT ENOUGH CORE TO LOAD AND EXECUTE JOB, WILL RUN FROM [file specification] The user's program was too large to load into core and LINK-10 created a saved file on disk. It automatically executes the program by performing a RUN UUO. However, the saved file remains on disk and the user must delete it, if he wishes.
NEB	%W	%W	NO END BLOCK SEEN FOR [module] The end block (type 5) has not been seen for the named module. This can happen if two name blocks (type 6) are seen without an

			intervening end block, or if the end of the file was seen before the end block. Although this message is not fatal, usually fatal errors follow.
NED	%F	%E	NON-EXISTENT DEVICE [dev]: The user has specified a device that does not exist in the system. The user can re-edit the input files to correct the device name or type control-C to abort the load.
NSA	*	%I	NO START ADDRESS The start or reenter address is zero because the user failed to specify a start address either in the END statement of the source program or with the /START switch.
NYI	%W	%W	NOT YET IMPLEMENTED - /switch The user issued a switch that is not implemented in this version of LINK-10.
$\left\{\begin{matrix}\text{OLC}\\\text{OHC}\\\text{OLS}\\\text{OFX}\\\text{OGS}\end{matrix}\right\}$	%F	%F	ERROR OUTPUTTING AREA $\left\{\begin{matrix}\text{LC}\\\text{HC}\\\text{LS}\\\text{FX}\\\text{GS}\end{matrix}\right\}$ -STATUS (xxxxxx) An error occurred while writing out the named area (LC=user's low segment code, HC=user's high segment code, LS=local symbol table, FX=fixup area, and GS=global symbol table). The status is represented by the right half of the file status word. Refer to DECsystem-10 Monitor Calls for the explanation of the file status bits.
$\left\{\begin{matrix}\text{OEL}\\\text{OEM}\\\text{OES}\\\text{OEX}\end{matrix}\right\}$	%W	%W	OUTPUT ERROR ON $\left\{\begin{matrix}\text{LOG}\\\text{MAP}\\\text{SYMBOL}\\\text{XPN}\end{matrix}\right\}$ FILE. FILE CLOSED. JOB CONTINUING - STATUS [xxxxxx] An error has occurred on the output file. The output file is closed at the end of the last data that was successfully output. The status is represented by the right half of the file status word. Refer to DECsystem-10 Monitor Calls for the explanation of the file status bits.

OFN	%F	%F	OLD FORTRAN (F40) MODULE NOT AVAILABLE The standard released version of LINK-10 includes the LNKF40 module that loads F40 code. However, the installation has removed it by loading a dummy version of LNKF40 and thus LINK-10 is unable to handle F40 compiler output. The user should request his installation to load a version of LINK-10 with the real LNKF40 module.
OHN	%F	%F	OVERLAY HANDLER NOT LOADED (1) The internal symbols in the overlay handler could not be referenced. This is either an internal error or a user error if the user supplied his own overlay handler.
OMN	%F	%F	OBSOLETE MONITOR WILL NOT SUPPORT LINK-10 LINK-10 requires a monitor that contains the DEVSIZ UUO.
OOV	%F	%F	OUTPUT ERROR FOR OVERLAY FILE-STATUS (xxxxxx) An error has occurred while writing the overlay file. The status is represented by the right half of the file status word. Refer to DECsystem-10 Monitor Calls for the explanation of the file status bits.
OS2	%I	%I	OVERLAY SEGMENT PHASE 2 Indication that the LINK-10 module LNKOV2 has begun its second phase of writing the overlay file.
PBI	%W	%W	PROGRAM BREAK [address] INVALID IN [module] FOR [file specification] The last address allocated by the specified module is greater than 256K. The user should modify the modules of his load list to reduce the program size to less than 256K. This error condition is usually caused by the user dimensioning arrays too large.

(1) This message is not expected to occur. If it does, please notify your Software Specialist or send a Software Performance Report (SPR) to DEC.

$\left\{\begin{array}{l}\text{PLC}\\ \text{PHC}\\ \text{PLS}\\ \text{PFX}\\ \text{PGS}\end{array}\right\}$	%I	%I	AREA $\left\{\begin{array}{l}\text{LC}\\ \text{HC}\\ \text{LS}\\ \text{FX}\\ \text{GS}\end{array}\right\}$ OVERFLOWING TO DSK The job is too large to fit into the allowed core and the named area is being moved to disk (LC=user low segment code, HC=user high segment code, LS=local symbol table, FX=fixup area, and GS=global symbol table).
PSF	%F	%F	POLISH SYMBOL FIXUPS NOT YET IMPLEMENTED The requested feature is not yet available.
RCF	%F	%F	RELOCATION COUNTER TABLE FULL The relocation counter table is a fixed length and cannot be expanded in the current version of LINK-10. This restriction will be eliminated in a future release.
RED	%I	%I	REDUCING LOW SEGMENT TO [n] K LINK-10's internal tables have been deleted and core has been reclaimed. This message occurs near the end of loading.
RER	%I	%I	REQUEST EXTERNAL REFERENCES This is the response to the /REQUEST switch.
RGS	%I	%I	REHASHING GLOBAL SYMBOL TABLE FROM [old size] TO [new size] LINK-10 is expanding the global symbol table either to the next prime number as requested by the user (via /HASHSIZE) or to its next expansion of about 50%. In future loads of this program, the user can save LINK-10 time by setting the hash table to this new expanded size at the beginning of the load.
RLC	*	%I	RELOC.CTR. [initial value] [current value] (octal) This is the response to the /COUNTER switch.
RME	*	%F	REMAP ERROR (1) The REMAP UUO failed.

(1) This message is not expected to occur. If it does, please notify your Software Specialist or send a Software Performance Report to DEC.

RPR	%F	%F	RESET PAST ROOT NOT ALLOWED The user attempted to move LINK-10 backwards from its current position on the path to a position beyond the root link. For example, if LINK-10 is positioned after the fourth link in a path, the largest negative number the user can specify as an argument to the /NODE switch is -3.
RUC	%F	%F	RETURNING UNAVAILABLE CORE(1) LINK-10's space allocator received some words that did not fit into the area to which they were to be returned. This is an internal error in LINK-10.
SIF	%F	%F	SYMBOL INSERT FAILURE, NON-ZERO HOLE FOUND (1) An internal LINK-10 error. LINK-10's hashing algorithm failed. A symbol already exists in the location in which LINK-10 needs to place the new symbol. The error may disappear if the user loads the files in a different order.
SFU	%I	%I	SYMBOL TABLE FOULED UP (1) An internal LINK-10 inconsistency. LINK-10 cannot locate the TITLE triplets in order to store the lengths of the control sections. The loading process continues. Any maps requested by the user will not contain the lengths of the control sections.
SNC	%F	%F	SYMBOL [symbol] ALREADY DEFINED, BUT NOT AS COMMON The user has defined a non-COMMON symbol with the same name as a COMMON symbol. The user should decide which symbol definition he wants. If he uses the COMMON definition, the COMMON area should be loaded first.

(1) This message is not expected to occur. If it does, please notify your Software Specialist or send a Software Performance Report (SPR) to DEC.

SNL	%I	%I	SCANNING NEW COMMAND LINE LINK-10 has completed the scanning and processing of the current command line and is ready to accept the input on the next line.
SNP	%W	%W	SUBROUTINE [name] IN LINK NUMBER [number] NOT ON PATH FOR CALL FROM LINK NUMBER [number] The named subroutine is not in a successor on the same path as the calling link, but is in another path. The user should reconstruct his overlay structure and place the subroutine on the correct path. Otherwise, a call to an undefined subroutine will occur at run time.
SOE	%F	%F	SAVE FILE OUTPUT ERROR - STATUS (xxxxxx) An error has occurred on the save file. The file is closed at the end of the last data that was successfully output. The status is represented by the right half of the file status word. Refer to DECsystem-10 Monitor Calls for the explanation of the file status bits.
SSN	%I	%I	SYMBOL TABLE SORTING NOT YET IMPLEMENTED Alphabetic and numeric sorting of the symbol table is not yet implemented. The symbols appear in the order in which they were placed in the symbol table.
SST	%I	%I	SORTING SYMBOL TABLE LINK-10 is arranging the symbol table in the order specified by the user via the /SYSORT switch, and if required, is converting the symbols from the new to old format as indicated on the /SYMSEG, /SYMBOL, or /DEBUG switch.
STC	%I	%I	SYMBOL TABLE COMPLETED The symbol table has been sorted and moved according to the user's request via the /SYMSEG, /SYMBOL, or /DEBUG switch.
T13	%F	%F	LVAR (TYPE 13) CODE NOT IMPLEMENTED LINK item type 13 (LVAR) is not implemented in LINK-10 nor supported by DEC. The TWOSEG pseudo-op in the MACRO-10 language should be used.

TDS	%W	%W	TOO LATE TO DELETE INITIAL SYMBOLS The /NOINITIAL switch was placed in the command string after the first file specification. Because this switch was not first in the command string, LINK-10's initial symbol table was loaded.
TEC	%F	%F	TRYING TO EXPAND COMMON An attempt was made to expand a COMMON area. The largest occurrence of the COMMON area of a given name must be linked first. Once defined, the size cannot be expanded although new COMMON areas of different names can be defined. The user should load the largest occurrence first.
TSO	%F	%F	CANNOT LOAD TWO SEGMENT MODULE INTO ONE SEGMENT The user attempted to force two segments into one segment via the /SEGMENT switch. However, the binary file dos not contain the necessary information (i.e., the length of the high segment) in LINK item type 3. This situation is usually caused by a one-pass compiler (e.g.,ALGOL).
TTF	%W	%W	TOO MANY TITLES FOUND (1) An internal LINK-10 ERROR. WHEN LINK-10 produces the index for the map it has found more program names than actually exist. The symbol table is in error.
UGS	*	*	UNDEFINED GLOBAL SYMBOLS This message can occur for two reasons. If it is the response to the /UNDEFINED switch, the severity level is %I. If it occurs at the end of loading, the message and severity levels are %F.
URC	%I	%I	UNKNOWN RADIX-50 SYMBOL CODE Bits 0-3 of the first word of the link item contain an unknown symbol code. Either the translator is generating incorrect code or the binary file is bad. The user should recompile the file.

(1) This message is not expected to occur. If it does, please notify your Software Specialist or send a Software Performance Report to DEC.

USA	%W	%W	UNDEFINED STARTING ADDRESS The user has given a global symbol as the start address and the symbol is currently undefined. The user should load the module that defines the symbol.
USC	%W	%W	UNDEFINED SUBROUTINE [name] CALLED IN LINK NUMBER [number] A reference to the named subroutine has occurred in the specified link, and LINK-10 has not yet loaded the referenced subroutine. If this subroutine is required for execution, the user should reload and include the required modules on the path on which they were referenced.
VAL	*	%I	[symbol] [value] [status] This is the response to the /VALUE switch.
XCT	*	%I	[name] EXECUTION The loading process is complete and the user's program has begun execution.

APPENDIX F

LOADER AND LINK-10 DIFFERENCES

This appendix is intended as an aid for users who have been employing the LOADER program and who are now converting to the LINK-10 program. Both programs are linking loaders. Both have the same basic functions of loading and relocating user's object code modules and resolving references among the modules. But LINK-10 is not just an updated version of LOADER. It is a completely new, more sophisticated, and more flexible piece of software. This appendix itemizes the differences between the two programs in order to facilitate conversion to LINK-10.

LOADER	LINK-10
The default output device is TTY.	The default output device is DSK.
The default name of the MAP file is MAP.MAP.	The default name of the MAP file is the name of the last program with a start address. If there is no program with a start address, the default name is nnnLNK.MAP, where nnn is the user's job number.
Command files are specified in the form * file @ The default extension of the command file is .TMP.	Command files are specified in the form * @ file The default extension of the command file is .CCL.
Input and output specifications are separated by a back-arrow (←). Thus, an output file is defined as being on the left side of the back-arrow.	Input and output specifications may be separated by an equals sign (=), but this is not required. An output file is specified by giving a file specification followed by an output switch.

The only output file produced by LOADER is a map file.

LINK-10 can be instructed to produce map, save, log, symbol, and XPN files.

Exit conditions are /G, altmode, and ↑Z.

The only exit condition is /GO.

Line terminators (e.g. <carriage return, line feed>) are treated in the same way as commas (i.e., they terminate the specification). File dependent switches remain in effect until overridden by a subsequent switch or until the end of the load. The most recently specified source device remains the default until a new device is specified or until the end of the load. Defaults carry across lines.

LINK-10 has a line oriented scanner. All file-dependent switches are turned off at the end of the line to which they belong. The most recently specified source device remains the default until a new device is specified or until the end of a line is reached. Standard defaults are restored at the beginning of each line. In general, it is best to place all the commands for loading a program on a single line. A hyphen is used as the line continuation character.

To load local symbols for FILE1 and FILE2 and then load DDT, the following sequence could be used:

```
*/S
*FILE1,FILE2
*/W/D$
```

To load mcql symbols for FILE1 and FILE2 and then to load DDT, the following sequence is used:

```
*/LOCALS FILE1,FILE2,
*/TEST /GO
```

Note that if the /LOCALS switch had appeared on a line by itself, it would have had no effect.

To search FILEA and FILEB in library search mode, the sequence:

```
*/L
* FILEA,FILEB
```

could be used.

To search FILEA and FILEB in library search mode, the sequence is:

```
*/SEARCH FILEA,FILEB
```

The sequence

```
*/SEARCH
*FILEA,FILEB
```

does not cause FILEA and FILEB to be searched. Instead, they are loaded in their entirety.

When performing a search of the default libraries at the end of the load, LOADER makes one pass through all required libraries. In addition, LIB40 is always searched.	LINK-10 performs multiple passes through all required libraries until no undefined symbols remain or until no additional routines have been loaded. In addition, LIB40 is not automatically searched unless it is required by an F40 program. Thus, when loading MACRO programs which utilize routines in LIB40, the user must explicitly request that LIB40 be searched. Also, JOBDAT.REL is not searched unless the /NOINITIAL switch is used. LINK-10 automatically initializes its global symbol table to include JOBDAT symbols.
The /D and /T switches load with local symbols. This mode remains in effect until it is turned off with the /W switch, and remains off until another switch which loads local symbols is given.	The /TEST and /DEBUG switches instruct LINK-10 to load all subsequent files with their local symbols. The /NOLOCAL switch can be used to suppress the loading of local symbols. However, since the /NOLOCAL switch is file dependent, it is cleared at the end of the line and load with local symbols mode is reinstated.
If there is no code in the low segment, LOADER will not save the symbols.	If there is no code in the low segment, LINK-10 will save the symbols only if .JBDDT is non-zero or user gave the /SYMSEG switch.

The following table lists each LOADER switch and the LINK-10 switch which performs the nearest equivalent action. Note that there is not always a one-to-one correspondence between the action performed by the LOADER switch and by the LINK-10 switch. Refer to Chapter 4 for the complete descriptions of the LINK-10 switches.

LOADER and LINK-10 Differences

LOADER	LINK-10
/A	/CONTENT:ZERO
/B	/SYMSEG:LOW
/1B	/SYMSEG:HIGH
/nnnnB	/PATCHSIZE:nnnn
/C	No equivalent switch. LINK-10 does not support the old CHAIN facility.
/D	/TEST:DDT or /TEST:MACRO
/E	/EXECUTE
/F	/SYSLIB
/1F	/FORSE
/2F	/FOROTS
/G	/GO
/nnnG	/START:nnn
/H	/SEGMENT:LOW
/1H	/SEGMENT:HIGH
/nnnnH	/SET:.HIGH.:nnnn
/-H	/SEGMENT:DEFAULT
/I	/NOSTART
/J	/START
/nK	/RUNCOR:n
/-K	No equivalent switch. Use /RUNCOR.
/L	/SEARCH
/M	/MAP:END
/1M	/MAP:END/CONTENT:LOCALS
/N	/NOSEARCH
/nnnO	/SET:.LOW.:nnn
/P	/NOSYSLIB
/Q	/SYSLIB at the end of the command string.

/R	No equivalent switch. LINK-10 does not support the old CHAIN facility.
/S	/LOCALS
/T	/DEBUG:DDT or /DEBUG:MACRO
/U	/UNDEFINED
/V	/OTS:HIGH
/-V	/OTS:LOW
/W	/NOLOCALS
/X	/CONTENT:NOZERO
/Y	/REWIND
/Z	/RUN:LINK

GLOSSARY

Absolute Virtual Address

A fixed location in user virtual address space which cannot be relocated by the software. However, it can still be translated to a physical address by the hardware. For example, the high-speed accumulators on the DECsystem-10 occupy locations 0 through 17 (octal) in the user's virtual address space. All modules that reference the accumulators must reference these locations. Thus the addresses 0 through 17 (octal) are absolute virtual addresses.

Absolute Module

A module whose program counters are set to absolute addresses only.

Absolute Overlay

A link that is assigned a fixed location in user virtual address space. It must be loaded into that location on every call.

Address Mapping

The assignment of user virtual address space to the physical address space in computer memory. This is automatically performed by the DECsystem-10 monitor and is completely invisible to user programs.

Assemble

To prepare a machine-language module from a symbolic-language module by substituting the actual numeric operation codes for symbolic operation codes, and the absolute or relocatable addresses for symbolic addresses.

Assembler

A program which accepts symbolic assembly code and translates it into machine instructions. MACRO-10 is the standard DECsystem-10 assembler supplied by DEC.

Backward Reference

A reference to a global symbol that is not in the current link, but is in a link on the path from the current link back to the root link.

Base Address

An address used as a basis for computing the value of some other address. This computation is usually of the form

final address = base address (+ or -) offset.

Bound Backwards

The requirement that for any link, all other links bound to that link are on the same path to the root link.

Bound Path

The required path to be loaded when a particular link is loaded into the user's virtual address space. In other words, path loading will be performed on links on the bound path.

Call Reference

A reference to another link via the standard calling sequence

```
MOVEI 16,ARGLIST
PUSHJ 17,ADR
```

Clear

To erase the contents of a location, a block of memory, or a mass storage device by replacing the contents with blanks or zeroes.

COMMON Area

A section in a program's address space which is set aside for common use by many modules. COMMON is usually set up by modules written in the FORTRAN language. It is used by independently-compiled modules to share the same data locations.

Conflicting Lateral Reference

A lateral reference to a link that occupies either all or a portion of the address space of the current link.

Control Section

A unit of code (instructions and/or data) that is considered an entity and that can be relocated separately at load time without destroying the logic of the program. Control is passed properly from one Control Section to another regardless of their relative positions in user virtual address space. A Control Section is identified by a relocation counter and thus is the smallest unit of code that can be relocated separately.

Current Link

The link pointed to by the program counter.

Default Directory

The directory in which the Monitor searches when a directory specification has not been given by the user. Typically, this is the UFD (User-file directory) corresponding to the user's logged-in project-programmer number but it may another UFD or a SFD (sub-file directory).

Directory

A file which contains the names and pointers to other files on the device. The MFD, UFDs, and SFDs are directory files. The MFD is the directory containing all the UFDs. The UFD is the directory containing the files existing in a given project-programmer number area. The SFD is a directory pointed to by a UFD or a higher-level SFD. The SFDs exist as files under the UFD.

Executable Reference

A reference that causes a memory reference or PC transfer to another link when the instruction at the location referenced is executed (e.g., MOVE 1,ADR). Call references are a subset.

Extended Path

One of the many paths of the links that occupy non-conflicting address spaces beginning with the current link and going away from the root.

External Symbol

A global symbol which is referenced in one module but defined in another module. The EXTERN statement in MACRO-10 is used to declare a symbol external. A subroutine name referenced in a CALL statement in a FORTRAN module is automatically declared external.

File

An ordered collection of characters or 36-bit words containing computer instructions and/or data. A file is stored on a device, such as disk or magnetic tape, and can be of any length, limited only by the available space on the device and the user's maximum space allotment on that device.

File Specification

A list of identifiers which uniquely specify a particular file. A complete file specification consists of: the name of the device on which the file is stored, the name of the file including its extension, and the name of the directory in which the file is contained.

Forward Reference

A reference to a global symbol that is in a link on the path beginning with the current link and going away from the root (i.e., is on the extended path).

FUDGE2

A system utility program used to update libraries containing one or more relocatable binary modules and to manipulate modules within these libraries.

GET

To transfer a saved program from a file into core memory using a loading program or the Monitor. The GET command places a program into memory. The RUN command performs the same operation and, in addition, starts the program. The GET operation differs from the LOAD operation (refer to LOAD).

GLOB

A system utility program used to read collections of relocatable binary modules which have been loaded together (from both library files and separate files) in order to generate an alphabetical cross-referenced list of all the global symbols encountered. When a program is composed of many modules which communicate via global symbols, it is useful to have an alphabetical list of all global symbols with the names of the modules in which they are defined and referenced.

Global Request

A request to LINK-10 to link a global symbol to a module.

Global Symbol

A symbol that is accessible to modules other than the one in which it is defined. The value of a global symbol is placed in LINK-10's global symbol table when the module containing the symbol definition is loaded.

High Segment

That portion of the user's addressing space, usually beginning at relative location 400000, which generally is used to contain pure code that can be shared by other users. This segment is usually write-protected in order to protect its contents. The user can place information into a high segment with the TWOSEG pseudo-op in MACRO-10. Higher-level languages, such as COBOL and FORTRAN, also have provisions for loading pure code in the high segment.

Initialize

To set counters, switches, or addresses to zero or other starting values at prescribed points in the execution of a computer routine, particulary in preparation for reexecution of a sequence of code.

Internal Symbol

A global symbol located in the module in which it is defined. In a MACRO-10 program, a symbol is declared internal with the INTERN or ENTRY pseudo-op. These pseudo-ops generate a global definition which is used to satisfy all global requests for the symbol. In FORTRAN programs, internal symbols are generated to match the names of SUBROUTINEs, FUNTIONs, and ENTRYs. An internal symbol is similar to a library search symbol; however, it will not cause a module to be linked in search mode.

Job Data Area (JOBDAT)

The first 140 octal locations of a user's virtual address space. This area provides storage for certain data items used by both the Monitor and the user's program. Refer to the DECsystem-10 Monitor Calls Manual.

Label

A symbolic name used to identify a statement or an item of data in a program.

Lateral Reference

A reference to a global symbol in a link that is not on the path or on an extended path of the current link.

Library

A file containing one or more relocatable binary modules which may be loaded in Library Search Mode. FUDGE2 is a system utility program which enables users to merge and edit a collection of relocatable binary modules into a library file. PIP can also be used to merge relocatable binary modules into a library, but it has no facilities for editing libraries.

Library Search Mode

The mode in which a module (one of many in a library) is loaded only if one or more of its declared entry points satisfy an unresolved global request.

Library Search Symbol (Entry Symbol)

A list of symbols that are matched against unresolved symbols in order to load the appropriate modules. This list is used only in library search mode. A library search symbol is defined by an ENTRY statement in MACRO-10 and BLISS-10 and a SUBROUTINE, FUNCTION, or ENTRY statement in FORTRAN.

Link

1. To combine independently-translated modules into one module in which all relocation of addresses has been performed relative to that module and all external references to symbols have been resolved based on the definition of internal symbols.

2. A contiguous section of user virtual address space. Also known as an overlay.

Link Name

The (optional) name assigned by the user to a link. This name can be any number of SIXBIT characters; however; six or less characters are recommended.

Link Number

An arbitrary number of 18 bits assigned by LINK-10 to each link.

Linker

A program that combines many input modules into a single module for loading purposes. Thus, it allows for independent compilations of modules. Typically, it satisfies global references and may combine control sections.

Linking Loader

A program that provides automatic loading, relocation, and linking of compiler and assembler generated object modules.

Load

To produce a core image and/or a saved file from one or more relocatable binary files (REL files) by transforming relocatable addresses to absolute addresses. This operation is not to be confused with the GET operation, which initializes a core image from a saved file (refer to GET).

Local Symbol

A symbol known only to the module in which it is defined. Because it is not accessible to other modules, the same symbol name with different values can appear in more than one module. These modules can be loaded and executed together without conflict. Local symbols are primarily used when debugging modules; symbol conflicts between different modules are resolved by mechanisms in the debugging program.

Low Segment

The segment of user virtual address space beginning at zero. It contains the Job Data Area and I/O buffers. The length of the low segment is stored in location .JBREL of the Job Data Area. When writing two-segment programs, it is advisable to place data locations and impure code in the low segment.

Main Program

The module containing the address at which object program execution normally begins. Usually, the main program exercises control over the operations performed and calls subroutines to perform specific functions.

Module

The smallest entity that can be loaded by LINK-10. It is composed of a collection of control sections. In MACRO-10, the code between the TITLE and END statements represents a module. In FORTRAN, the code between the first statement and the END statement is a module. In COBOL, the code between the IDENTIFICATION DIVISION statement and the last statement is a module.

Module Origin

The first location occupied by the module in user virtual address space.

Non-automatic Overlay

Each link is controlled exclusively by source level code, as in CALL CHAIN (arg,arg2). The user is responsible both for the call to the overlay handler and for the overlay structure.

Non-executable Reference

A reference to a location in another link that is not directly executable, for example,

```
JRST @TABLE(AC)
```

where TABLE is

```
TABLE:EXP ADR,ADR1,ADR2
```

Object Module

The primary output of an assembler or compiler, which can be linked with other object modules and loaded into a runnable program. This output is composed of the relocatable machine language code for the translated module (i.e., link items), relocation information, and the corresponding symbol table listing the definition and use of symbols within the module.

Object Time System

The collection of modules that supports the compiled code for a particular language in order to perform various utility functions. This collection usually includes I/O and trap-handling routines.

Offset

The number of locations or bytes relative to the base of an array, string, or block. For example, the number of locations relative to zero that a Control Section must be moved before it can be executed.

Operating System

The collection of programs that administer the operation of the computing system by scheduling and controlling the operation of user and system programs, performing I/O and various utility functions, and allocating resources for efficient use of the hardware.

Overlay

1. The technique of repeatedly modifying the user's virtual address space by replacing one or more links. When one link is no longer needed in storage, another link can replace all or part of it.
2. Refer to Link(2.).

Overlay Handler

The routine responsible for ensuring that all required links are in core when needed.

Path

The address space occupied by all links beginning with the current link and going back to the root link.

Path loading

The requirement that the path from a link be loaded whenever a particular link is loaded into the address space.

Physical Address Space

A set of separate memory locations where information can actually be stored (i.e., core memory) for the purpose of program execution.

Program

A collection of routines which have been linked and loaded to produce a saved file or a core image. These routines typically consist of a main program and a set of subroutines, some of which may have come from a library.

Promote

To move a data area from its current link into a link closer to the root link. This promotion is often used for COMMON areas.

Pure Code

Code which is never modified in the process of execution. Therefore, it is possible to let many users share the same copy of a program.

Read Only Link

A link in which changes are not preserved. The original copy of the link is loaded each time the link is called.

REL File

A file containing one or more relocatable object modules. These object modules are composed of li items (refer to Appendix A).

Relocatable Address

An address within a module that is specified as an offset from the first location in that module.

Relocatable Control Section

A control section whose addresses have been specified relative to zero. Thus, the control section can be placed into any area of core memory for execution.

Relocatable Overlay

A link that is not assigned a fixed location in user virtual address space, and thus it may be loaded in any unoccupied location. All required relocation is done at execution time.

Relocation Counter

1. The number assigned by LINK-10 as the beginning address of a Control Section. This number is assigned in the process of loading specific Control Sections into a saved file or a core image and is transformed from a relocatable quantity to an absolute quantity.

2. The address counter that is used during the assembly of relocatable code.

Relocation Factor

The contents of the relocation counter for a control section. This number is added to every relocatable reference within the Control Section. The relocation factor is determined from the relocatable base address for the control section (usually 0 and 400000) and the actual address in user virtual address space at which the module is being loaded.

Root Link

The code that must always be in the user's virtual address space. In addition to containing part of the user's program, it contains the overlay handler.

Routine

A set of instructions and data for performing one or more specific functions.

Segment

An absolute Control Section.

Source Language Program

The original, untranslated version of a program written in a high level language (e.g., FORTAN, COBOL, MACRO). A translator (assembler, compiler, or interpreter) is used to perform the mechanics of tranlating the source program into a machine language program that can be run on the computer. Source programs, when translated, produce object modules as their primary output. A program may exist as a source program, an object module, and a runnable core image.

Symbol

Any identifier (composed of SIXBIT characters) used to represent a value that may or may not be known at the time of its original use in a source language program. Symbol appear in source language statements as labels, addresses, operators, and operands.

Symbol Binding

To resolve references in one module to symbols which are defined (i.e., are assigned a value) in another module.

Symbol Table

A table containing entries and binary values for each symbol defined or used within a module.

Translate

To compile or assemble a source program into a machine language program, usually in the form of a (relocatable) object module.

Tree Structure

The method of arranging links such that each link has only one immediate ancestor but may have more than one successor. However, the root link has no ancestor.

User Virtual Address Space

A set of memory addresses within the range of 0 to 256K words. These addresses are mapped into physical core addresses by the paging or relocation-protection hardware when a program is executed. On a KA10 processor, the range of addresses is limited by the amount of physical core available to a given user.

User's Program

All of the code running is a user virtual address space.

Zero Length Module

A module containing symbol definitions but no instruction or data words (e.g., JOBDAT). Note that the word "length" in this context refers to the program length of the module after loading.

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READER'S COMMENTS

NOTE: This form is for document comments only. Problems with software should be reported on a Software Problem Report (SPR) form (see the HOW TO OBTAIN SOFTWARE INFORMATION page).

Did you find errors in this manual? If so, specify by page.

Did you find this manual understandable, usable, and well-organized? Please make suggestions for improvement.

Is there sufficient documentation on associated system programs required for use of the software described in this manual? If not, what material is missing and where should it be placed?

Please indicate the type of user/reader that you most nearly represent.

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