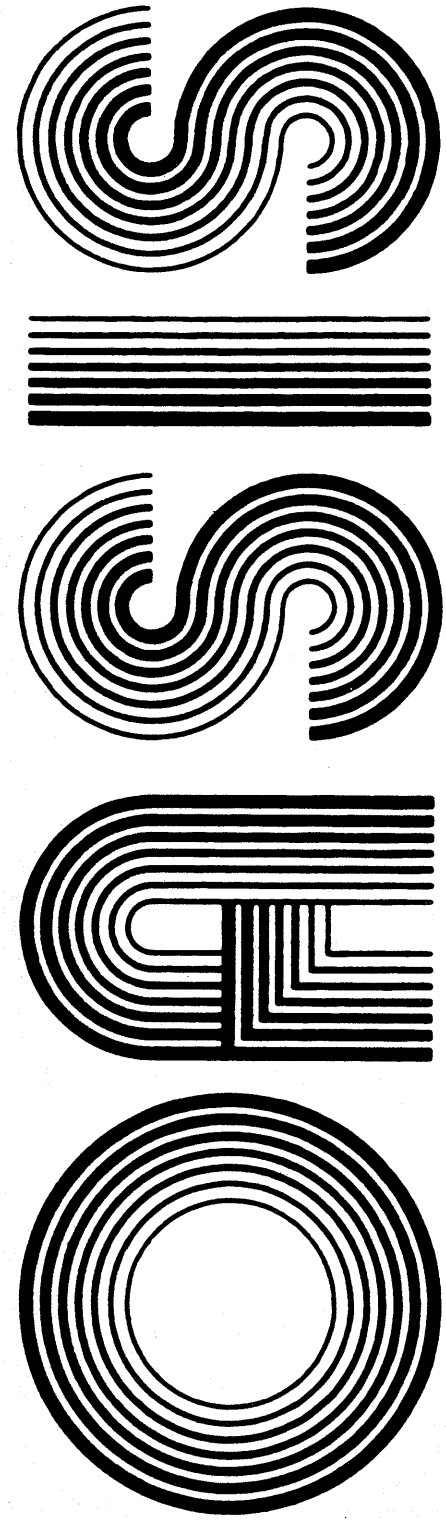
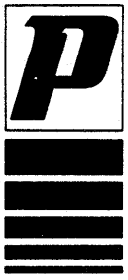


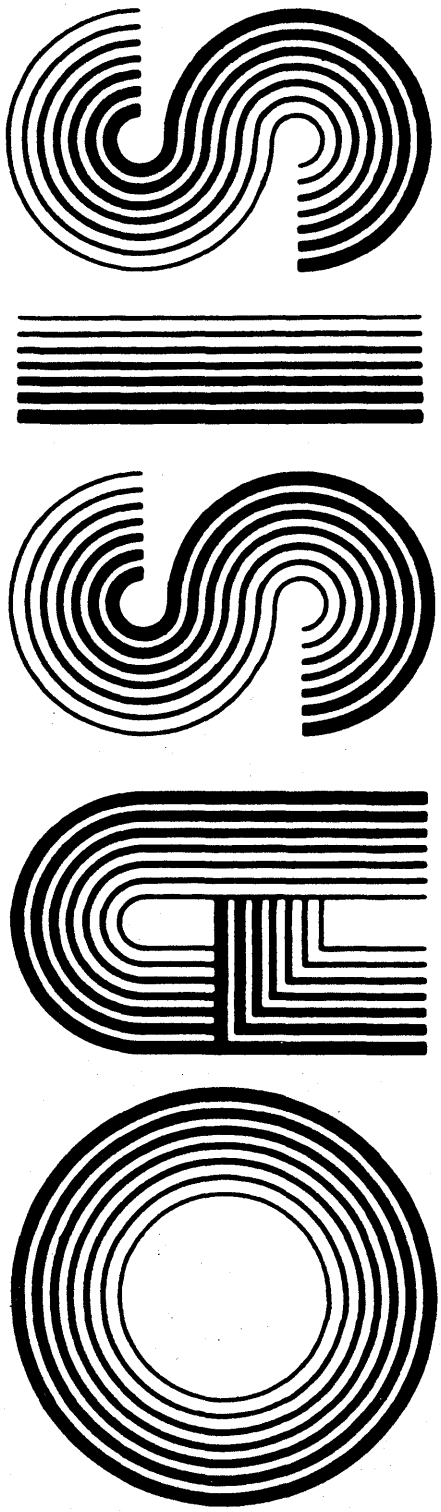
MACRO ASSEMBLER LANGUAGE REFERENCE MANUAL

OPERATING SYSTEM SOFTWARE

MAKES MICROS RUN LIKE MINIS



PHASE ONE
SYSTEMS, INC.



OPERATING SYSTEM SOFTWARE

MAKES MICROS RUN LIKE MINIS

MACRO ASSEMBLER LANGUAGE REFERENCE MANUAL

Second Edition

Revised

Documentation by: C. P. Williams
Software by: Timothy S. Williams

PHASE ONE
SYSTEMS, INC.

7700 EDGEWATER DRIVE SUITE 830
OAKLAND, CALIFORNIA 94621 USA

P R E F A C E

This manual describes the OASIS MACRO Assembler Language. It assumes the reader is familiar with computer software fundamentals and has had some exposure to assembly language programing on micro-computers. The section "Additional and Reference Material" below lists documents that may prove helpful in reviewing those areas.

The user who is unfamiliar with OASIS should first read or review those chapters of interest in the OASIS System Reference Manual to become familiar with system conventions.

Included in this manual is a chapter on "Interfacing to OASIS" which provides information about writing device drivers, assembly language subroutines that are called by a BASIC program, console class code drivers, etc.

This manual, named MACRO , like all OASIS documentation manuals, has the manual name and revision number (if applicable) in the lower, inside corner of each page of the body of the manual. In most chapters of the manual the last primary subject being discussed on a page will be identified in the lower outside corner of the page.

Additional and Referenced Material

The following manuals and publications were used in the creation of this manual and contain additional information not included in this document.

ZILOG Z80 Assembler Manual

ZILOG Z80-CPU Technical Manual

ZILOG Z80-CPU Programming Reference Card

OASIS System Reference Manual

OASIS Text Editor Reference Manual

OASIS EXEC Language Reference Manual

OASIS DEBUG Reference Manual

OASIS Diagnostic & Conversion Utilities Reference Manual

TABLE OF CONTENTS

CHAPTER 1

INTRODUCTION

The OASIS MACRO Assembler (usually refered to as the Assembler) is a symbolic assembly program for the Z80 CPU. It is a two-pass assembler (requiring the source program to be read twice to complete the assembly process) designed to run under the OASIS Operating System. It is, therefore, device independent, allowing complete user flexibility in the selection of standard input and output device options.

The Assembler performs many functions, making machine language programming easier, faster, and more efficient. Basically, the Assembler processes the programmer's source program statements by translating mnemonic operation codes to the binary codes needed for the appropriate machine instruction, relating symbols to numeric values, assigning memory addresses for program instructions and data, and preparing an output listing of the program which includes any errors encountered during the assembly.

The MACRO Assembler may be used to generate either absolute or relocatable object code from a source program file. The type of object file produced is controlled by the occurence of certain directives in the source file. Both types of object programs must be processed by the LINK command before they can be executed as programs.

The value assigned to an instruction mnemonic is the binary bit configuration recognized by the processor for that instruction. Predefined symbols are kept separately by MACRO and recognized as reserved symbols only when they are encountered in the proper context. In context other than that where their usage is predefined, the symbol will assume whatever value the user may wish to assign. For example:

```
                LD      A,0
                JP      CALL
LX:             ADD     2
CALL:           CALL    INPUT
                JP      XXXX
```

The Assembler has no problem differentiating the two CALL symbols since the one in the op-code field is predefined and the one in the label and operand fields are user-defined.

Along with relating symbols to numbers, another major function of the Assembler is to enable the programmer to reference a symbol that is defined later in the program. This is called FORWARD REFERENCING, and is resolved by the second pass of the assembly process (some directives restrict the use of forward referencing). References may be made to symbols defined in other programs (EXTERNAL REFERENCING). The values of these symbols is resolved by the linking editor (LINK).

An optional function of the MACRO Assembler is that of producing a tabulated listing of all user-defined symbols, their value and all references to them. This CROSS-REFERENCE table generation consists of recording all definitions of, and references to, user-defined symbols, sorting the references, and merging them with their values.

Another function of the MACRO Assembler is the maintenence of up to 16 PABs (Program Address Blocks) which may be used to locate data and code at assembly time. By using PABs the programmer gains the ability to write programs whose actual execution addresses are determined at load time (relocatable programs).

A final function of the MACRO Assembler is to maintain assembler macros, hence the name MACRO Assembler. A macro is a single user-defined instruction that is replaced at assembly time with one or more assembler instructions and/or directives.

1.1 Creating A Source File

An assembly language source file is created by using the system editor. Refer to the OASIS System Reference Manual for complete details on using the EDIT program.

Assembly language source files usually have a file type of ASSEMBLE. When the Editor is invoked and given a file description including a file type of ASSEMBLE, MACRO or COPY, the Editor sets some of its global commands to the values associated with an assembly source file. These values include setting LINEMODE OFF because line numbers are not normally used in the source file; setting TABSET 10 16 29 which allows for the standard format of source statements; setting CASEMODE AM.

CHAPTER 2

OASIS MACRO COMMAND

The MACRO command allows the user to translate Z80 source code and MACRO directives into machine object code. The format of the MACRO command is:

MACRO <file-desc> [(<option> ...[])]

Where:

file-desc Indicates the file description of the source file to be assembled. When the file type is omitted from this description the default file type of ASSEMBLE is used.

MACRO COMMAND Options

Options for the MACRO command include the following:

NOOBJ Indicates that no object file is to be produced.

OBJ[=fd] Indicates that an object file is to be produced. This is a default option. An fd following OBJ indicates that the object file is to be written to the disk whose directory has that label.

TYPE Indicates that the listing is to be displayed on the console terminal. Specifying this option pre-sets LIST to on.

PRINTER[n] Indicates that the listing is to be displayed on the primary printer or PRINTERn. Specifying this option pre-sets LIST to on.

DISK[=fd] Indicates that the listing is to be written to a disk file with "LISTING" as the filetype. An fd following LIST indicates that the listing file is to be written to the disk whose directory has that label. Specifying this option pre-sets LIST to on. The listing file created will be in packed format, using ANSI forms control characters.

LIST Indicates that LIST is to be pre-set to on. Any LIST directives in the source program may change this setting.

NOLIST Indicates that LIST is to be preset to off. Any LIST directives in the source program may change this setting.

SYM Indicates that the symbol table is to be included in any listing. This option may only be specified if an output device has been specified (TYPE, PRINTER, or DISK).

NOSYM Indicates that no symbol table listing is to be produced. This is a default option.

XREF Indicates that a cross-reference table is to be produced. This option is only effective when a listing device has been specified (TYPE, PRINTER, or DISK).

NOXREF Indicates that no cross-reference table is to be produced. This is a default option.

COPY Indicates that the source and object code produced from COPY files included in the assembly are to be included in any listing. This option is only effective when a listing device has been specified.

NOCOPY Indicates that the source and object code produced from COPY files included in the assembly are not to be included in the listing. This is a default option.

DATA Indicates that data defined by DC and DW directives is to be fully included in any object code listing. This option is only effective when a listing device has been specified. In addition to the DC and DW directives this option specifies that code generated by a REPT directive is also to be included in any listing.

NODATA Indicates that only the first four bytes of the data defined by DC and DW directives is to be included in any object code listing. Also, code generated by a REPT directive is not listed when this option is in effect. This is a default option.

MACRO Indicates that macro expansions are to be included in any listing. This option is only effective when a listing device has been specified.

NOMACRO Indicates that only the macro calls, not the macro expansions, are to be included in any listing produced.

IF Indicates that source code not assembled into object code due to conditional assembly and the corresponding conditional assembly pseudo op-codes are to be included in any listing produced. This option is only effective when a listing device has been specified.

NOIF Indicates that source code not assembled is to be omitted from any listing produced. This is a default option.

EXTRN Indicates that all undefined symbols are to be treated as external symbol references (16 bit) and are not to be reported as errors.

NOEXTRN Indicates that all undefined symbols are to be treated and reported as errors. This is a default option.

During the assembly process the segment names and line numbers are displayed on the console during both passes, unless the option TYPE was specified.

At the end of the assembly the following statistic information is displayed on the console:

```
OASIS MACRO version n.n (date) statistics

Source lines input:       nnnn
Object records output:    nnnn
Macro calls:              nnnn
Machine instructions:     nnnn
Symbols defined:          nnnn
Pab summary:              Name      Type Length Origin
                          aaaaaaaa aaa  nnnn   nnnnH
Assembly errors:          nn
Assembly rate:            nnnn lines per minute
```

(This page intentionally left blank)

CHAPTER 3

MACRO INSTRUCTION SYNTAX

An assembly language program consists of a sequence of statements in the assembler language. Each statement is written on one line, and terminated by a carriage return. The MACRO Assembler is a free format assembler in the sense that the various statement elements are not placed at specific numbered columns on the line. The Editor does have default tab settings for the elements but these are used only for purposes of consistency of the listing and are not required by the Assembler.

There are four elements in an assembler statement, separated from each other by specific characters. These elements are identified by their order of appearance in the statement and by the separating (delimiting) character which follows or proceeds the elements. Statements are written in the general form:

line# label: op-code operand1,operand2 ;comment

Not all of the elements are required for any specific instruction.

3.1 Line Numbers

The line number field is completely optional. The Assembler will create line numbers for the source statements if there are no line numbers on the statements. When a line number is included on the source statement it must: be the first field, use only digits, and be followed by a space character.

Line numbers may be used for some of the source statements and not others. The Assembler, when an unnumbered line is encountered, adds one to the line number used for the previous statement. This facilitates identifying the lines associated with a multi-segmented source file. The first line of each segment would be numbered by the programmer and the following lines would be unnumbered.

3.2 Labels

The label field is an optional field that may be specified with any or all of the op-codes and directives. When used the label field must be the first field in the source line (following the line number, if used).

Labels are used to reference a specific location during assembly. A label may be used on a line that is not referenced or even on a line by itself.

A label is a sequence of one or more characters terminated by a colon (:). A label must start with a letter character (local labels are an exception to this rule) and may include only letters, digits, and the dollar sign ($). No embedded spaces are allowed.

Labels longer than eight characters are tokenized internally to eight characters by taking the first four characters and the last four characters of the actual label. It is possible that this may cause a duplicate label error.

The dollar sign character ($) used as a label by itself in the operand field, is valid and indicates the current location counter.

Labels are of three types: global, local and external. A global label must be uniquely defined within a source program and may be referenced from anywhere in the program.

A local label may be duplicately defined within a source program but must be uniquely defined between two global labels, and has a value only between those two global labels. Local labels are identified by preceding the label with a period (.). All references to a local label must include the preceding period. The character following the period in a local label must be alphabetic. Macro local labels only have a value in the macro defining them. Macro local labels are identified by preceding the label with an at-sign (@). All references to a macro local label must include the preceding at sign and these references may only be from within the macro defining them.

Local labels are maintained internally in the assembly process by appending the most recent global label to the local label (macro labels are maintained by appending the macro name and macro index to the label).

External labels are labels whose value is defined outside of the source program. The values of these external labels are resolved by the Link program.

Examples:

```
        LABEL                   DONE
```

```
LST05                   OBJECT
NAME                    .OKAY
OKAY                    M0000010
NOOBJECT                .OUTPUT
.INPUT                  @LABEL
```

3.3 Op-codes

The op-code field of a source statement may only include the directives and Z80 op-codes described in this manual. An op-code is separated from a label by a colon, space, or tab. An op-code is separated from any operands by a space or tab character.

Op-codes must be spelled exactly as specified in this manual and they may not start in column one.

3.4 Operands

Operands modify the op-codes and provide the information needed by the assembler to perform the designated operation. Certain symbolic names are reserved as key words in the assembly language operand fields. These are:

1. The contents of 8 bit registers are specified by the character corresponding to the register names. The register names are A, B, C, D, E, H, L, I, R.

2. The contents of 16 bit double registers and register pairs consisting of two 8 bit registers are specified by the two characters corresponding to the register name or register pair. The names of double registers are IX, IY and SP. The names of register pairs are AF, BC, DE, and HL.

3. The contents of the auxiliary register pairs consisting of two 8 bit registers are specified by the two characters corresponding to the register pair names followed by an apostrophe. The auxiliary register pair names are AF', BC', DE', and HL'. Only the pair AF' is actually allowed as an operand, and then only in the EX AF,AF' instruction.

4. The state of the five flags is testable as follows:

FLAG	ON	OFF
Carry	C	NC
Zero	Z	NZ
Sign	M (minus)	P (positive)
Parity	PE (even)	PO (odd)
Overflow	V	NV

3.4.1 Expressions

Expressions in the operand may be simple or complex. A simple expression is an expression that includes only one term. A complex expression includes more than one term with logical, arithmetic, or relational operators joining them.

Expressions are allowed as operands whenever the symbols n, nn, or d are used in the syntax of the instruction.

Expressions are analyzed in a left to right manner with no implied hierarchy except that specified by parentheses or brackets.

Expressions wholly contained within parentheses are evaluated as an indirect address reference. Expressions that contain sub-expressions in parentheses or brackets are evaluated as indicating a hierarchy of evaluation. Parentheses and brackets are equivalent but not interchangable, that is, they must appear in pairs.

A term in an expression may be any one of the following:

label Indicates the current value of the specified label.

numeric-constant May be any unsigned numeric value less than 65536 expressed in decimal (default or terminate with D), hexadecimal (terminate with the character H), octal (terminate with the character Q or O) (Q assumes number is 16 bit octal; O assumes number is two 8 bit octal numbers), binary (terminate with the character B). All numeric constants must have a digit for the first character. If necessary a hexadecimal value may have a leading 0 such as 0FFFFH.

string-constant One or two ASCII characters enclosed within a pair of single or double quotes. (Storage definition directives DC and DW allow longer strings.)

The arithmetic operators allowed by the assembler include:

```
+  Addition or unary plus
-  Unary minus or binary subtraction (two's complement)
/  Division
*  Multiplication
```

The logical operators allowed by the assembler include:

```
.AND. Logical and, bit by bit
.OR.  Logical inclusive or, bit by bit
.XOR. Logical exclusive or, bit by bit
.NOT. Unary one's complement
.MOD. Modulo (remainder function)
.SHL. Logical shift left (vacated bits replaced by 0)
.SHR. Logical shift right (vacated bits replaced by 0)
```

The relational operators allowed by the assembler include:

```
.EQ.  Test equality, arithmetic or string - both must be same
.GT.  Test for greater than
.LT.  Test for less than
.NE.  Test for not equal to
.UGT. Test for unsigned greater than
.ULT. Test for unsigned less than
.NUL. Empty string or value.
```

The following examples represent typical expressions:

```
BASE+2100H
'A'-1
(LSTDSK)
LNKLIT+8              8 is a decimal number
256                   256 is a decimal number
.LABEL1               refers to the local label
$                     indicates the current location counter
'',
1232560               evaluated as: 0101001110101110B or 53AEH
123256Q               evaluated as: 1010011010101110B or A6AEH
10110101B+324-12H/2Q  evaluated as: 243 decimal or F3H
123+(45D-LABEL)
(123+(45D-LABEL))
(123+[45D-LABEL])
```

Further restrictions in the use of expressions are discussed in the chapter on PABs.

3.5 Comments

Comments may be included on any source line. To indicate a comment use the semi-colon character (;). All characters after the semi-colon will be ignored by the assembler except for listing purposes. A comment may start in any column.

(This page intentionally left blank)

CHAPTER 4

PROGRAM ADDRESS BLOCKS (PABS)

The concept of Program Address Blocks (PABs) may be used extensively when programming with the MACRO Assembler. A PAB is a name assigned to an address (either relative or absolute) that is referenced in a source program to define the relationship between groups of code (instructions and/or data).

The use of PABs allows the programmer to write several modules of code (each module probably performing a small, but complete, function), each module defining the instructions and data that it requires and accessing data defined in other modules, that, when linked together, form a contiguous program and data blocks.

Absolute programs must use an absolute PAB. When no PAB is defined in a program the Assembler assumes that a relocatable PAB is implied.

Normally a relocatable program would only have one or two PABs defined. One PAB would probably contain nonvolatile instructions and another PAB containing nonvolatile and volatile data to be used by the program. However, a complex program such as an operating system or compilor might use several PABs. In this complex program the PABs would be differentiated by major functions such as device drivers, logical I/O, arithmetic package, etc.

There are essentially three types of PABs.

The Absolute PAB

The absolute PAB is the Program Address Block that most assembly language programmers are familiar with. An absolute PAB is one whose base address is assigned by the programmer using the ABS directive. Symbols, instructions, and data defined using an absolute PAB can be completely resolved by the Assembler into executable machine code.

Instructions assembled in an absolute PAB can only be executed when the instructions are loaded at the address they were assembled at (unless the programmer uses position independant programming methods).

Programs that use an absolute PAB may only have the one PAB defined.

Different segments of code using the same absolute PAB name would, when linked together, form a contiguous block of code, each segment being appended to the previous.

The Relocatable PAB

The relocatable PAB is one whose base address is assigned by the program loader at load time. Symbols, instructions, and data defined using a relocatable PAB are only completely resolved when the program is loaded into memory for execution. The relocatable PAB allows the user to write, assemble, and link programs that can be executed at any address they may be loaded at.

A relocatable PAB is defined by the programmer using the REL directive. More than one relocatable PAB may be defined and used in a program. (The MACRO Assembler allows sixteen PABs per assembly, the LINK program allows 128 PABs per load module.

Different segments of code using the same relocatable PAB name would, when linked together, form a contiguous block of code, each segment being appended to the previous.

The Common Relocatable PAB

The common relocatable PAB is very similar to the relocatable PAB. Its base address is assigned by the program loader at load time and the symbols, instructions, and data defined using a common relocatable PAB are only completely resolved when the program is loaded into memory for execution.

A common relocatable PAB is defined by the programmer using the COM directive. More than one common relocatable PAB may be defined and used in a program.

The difference between a relocatable PAB and a common relocatable PAB is that when different segments of code, using the same common relocatable PAB name, are linked together the code from one segment overlays the previous segment's code.

This type of PAB is very useful for buffer definitions where several modules use the same memory area for volatile working storage. Each segment would define the layout of the buffer with the specific symbols and locations that it requires. This sounds like the same result as using the EQU directive and in fact might

produce the same results. However, when the common relocatable PABs are used no one segment would have to allocate the maximum buffer size that would be used: the Linkage editor would create the PAB as large as required by the segment that defined the largest area. Mainly, when a common relocatable PAB can be used and is called for in the design of the program, it results in a more easily coded and maintained program.

The uses of PABs is probably best explained with a few examples. Rather than invent some meaningless examples at this time it would be best to look at the programs in the appendix "Program Examples".

4.1 PAB Restrictions

Programming with PABs provides more versatility and makes the programming task more dynamic but it does carry some restrictions. These restrictions are mainly related to the use of symbols that are defined in a relocatable or common relocatable PAB.

There are a few, but important, rules to keep in mind when formulating expressions containing symbols. They are:

1. All relocatable symbols have full word (16 bit) values. This means that a relocatable symbol or expression can only be used when a 16 bit value can be used.

2. The sum or difference of a relocatable symbol and an absolute symbol is a relocatable value.

3. The difference between two relocatable symbols defined in the same PAB is an absolute value.

4. The sum, difference, product, or quotient of two absolute symbols is an absolute value.

5. The difference between two relocatable symbols defined in different PABs is an error.

6. All other operations between two relocatable symbols defined in the same PAB or in different PABs is an error.

7. All other operations between a relocatable symbol and an absolute symbol are errors.

Another restriction in relation to relocatable PABs is that the execution address is not known at assembly time. This seems obvious and of little importance except when the program listing is taken into account: the addresses listed at the left side of an assembly listing are not necessarily the execution addresses!

CHAPTER 5

MACRO DIRECTIVES & PSEUDO-OPS

The OASIS MACRO Assembler provides many directives and pseudo-ops that make programming in the Z80 assembler language easier by providing a means of assigning values to labels, allocating and initializing storage, conditional assembly, linking together several source files, incorporating source files into other files, and access to powerful system subroutines incorporated in the operating system.

ABS Directive

The ABS directive defines an absolute PAB. The ABS directive, unlike the ORG directive discussed later, does not change the location counter of the instructions following - the USING directive is responsible for that. The general format of the directive is:

<label> ABS [exp] [; comment]

Although, as indicated, the label field is required for the ABS directive the expression field is not. The label field is used by the USING directive to specify which PAB to use. The expression field, when specified, indicates the address that the PAB is to start on.

A PAB definition, such as the ABS directive, implies a USING directive following. It is not necessary for you to follow an ABS directive with a USING directive.

ALIGN Directive

The ALIGN directive can not be used when relocatable PABs have been defined.

The ALIGN directive allows the programmer to set the location counter to a user defined boundary. The general format of the directive is:

[<label>] ALIGN <exp> [;comment]

All of the terms of <exp> must have been previously defined - no forward references. <Exp> is evaluated and then the location counter is set to the value of the current location counter plus current location counter modulo <exp>. This, in effect, advances the location counter to the next <exp> boundary. For instance if the location counter is 315 and an ALIGN 256 is encountered then the location counter is set to 512.

BP Pseudo-op

The BP pseudo-op allows a break-point to be assembled into a program. The general format of the BP is:

[<label>] BP [;comment]

When assembled the BP directive occupies one byte of storage (a RST instruction). During program execution this code will cause a jump into the DEBUG program. If the DEBUG program has not been loaded then the instuction has no effect. Refer to the OASIS Dynamic Debugging Reference Manual.

COM Directive

The COM directive defines a common PAB. The general format of the directive is:

<label> COM [<exp>] [;comment]

As indicated, the label field is required for the COM directive, like all of the PAB definition directives. The <exp> field, when specified, is not used for the location of object code but only for listing purposes. A common PAB is a relocatable PAB but differs from a relocatable PAB defined by the REL directive in that the Linkage editor overlays common PABs of the same name instead of appending them. When several object files are being Linked that use common PABs each of the common PABs define the same address area, starting with relative location zero. (DS directives in a common PAB only cause previously undefined storage in the PAB to be set to zero.)

A PAB definition, such as the COM directive, implies a USING directive following. It is not necessary for you to specify a USING directive immediately following a COM directive.

COPY Directive

The COPY directive allows the programmer to specify that a sequence of code is to be found in another source file. The general format of the directive is:

[<label>] COPY <file-desc> [;comment]

The COPY directive is not a macro! No parameter replacement is allowed. When the COPY directive is encountered by the assembler the specified file is copied into memory and assembled at the current location counter as if the code were included in the source program. The copied code will be listed according to the specifications of the LIST directive.

This directive allows the programmer to easily reference frequently used sequences of code without entering the code in each program that references it.

When the <file-desc> only specifies a file name the default file type of COPY is used.

DB Directive

The DB (Define Byte) directive is a synonym of the DC (Define Constant) directive discussed next.

DC Directive

The DC directive is the most general form of the storage definition directives. The general format of the directive is:

[<label>] DC <exp list> [;comment]

Similar to the DW directive the DC directive allows the terms in the expression list to be forward references. Each expression is evaluated independently of the others. The individual expressions may be string literals (enclosed in quotes), 16 bit words (enclosed in parentheses), integer values, floating point values (decimal point specified), floating point scientific format values (decimal point and exponent specified).

The various forms of an expression are evaluated and assembled according to the following rules:

strings strings Each ASCII character in the quoted string is evaluated and the 7 bit code is generated, one per byte. If the quotes are double quotes (") the last byte will have bit position 7 set (1). If the quotes are single quotes (') the last byte is not altered.

words The expression within the parentheses is evaluated identical to the DW directive.

integers The expression is evaluated with the least significant 8 bits assembled at the current location counter. Overflow error results if the high order 8 bits are not zero or FFH.

floating point The expression is evaluated and the eight byte value is assembled at the current location counter. Floating point values are formatted using excess 128 format for the characteristic and binary coded decimal for the mantissa, consistent with the way that BASIC maintaines its numeric variables.

The value is first normalized to be a fraction less than +1, greater than -1, with no zeros to the immediate right of the decimal point, adjusting the exponent accordingly. The exponent is then added to 80H to form the first byte. The sign of the floating point number determines the value of the next nibble (four bits): 0 for positive, 8 for negative. The binary coded decimal (BCD) representation of the number follows this sign nibble creating the eight byte value with thirteen digits of precision.

DC Examples

```
Addr Obj-Code  Line *** Source Statement ***

0000 00           1          DC    0
0001 3412         2          DC    (1234H)
0003 4142534F     3          DC    'ABSOLUTE'
0007 4C555445
000B 4142534F     4          DC    "ABSOLUTE"
000F 4C5554C5
0013 00010241     5          DC    0,1,2,'A'
0016              6          DS    0FH
0025 FF00         7          DW    255
0027 83012300     8          DC    123.
002B 00000000
002F 83812300     9          DC    -123.
0033 00000000
0037 81012345    10          DC    1.234567890123
003B 67890123
003F 6D012345    11          DC    1234.5678E-23
0043 67800000
0047 7A098760    12          DC    .0000009876
004B 00000000
004F 7B012340    13          DC    .000001234
0053 00000000
0057 84012340    14          DC    .1234E+4
005B 00000000
005F 7D043210    15          DC    .4321E-3
0063 00000000
```

DS Directive

The DS directive allows the programmer to advance the location counter a specified amount, thus reserving a storage area. The general format of the directive is:

[<label>] DS <exp> [;comment]

All of the terms used in <exp> must have been previously defined - no forward references. <Exp> is evaluated and the location counter is advanced that many bytes.

DW Directive

The DW directive allows the programmer to define words of storage to be specific values. The general format of the directive is:

[<label>] DW <exp list> [;comment]

The expressions in the list are separated by commas. Each expression is evaluated independently of the other expressions in the list. The terms of the expressions may include forward references. Each expression is evaluated and assembled at the current location counter. The word is assembled with the least significant 8 bits (LSB) first followed by the most significant 8 bits (MSB). The location counter is advanced by two for each expression evaluated.

EJECT Directive

The EJECT directive indicates that a page eject is to be generated in the listing. The general format of the directive is:

EJECT [;comment]

The EJECT directive is only effective when a listing is being generated. The directive, when encountered, causes an immediate page eject to be generated in the listing. The EJECT directive itself is not listed in the listing, although it does advance the line number.

ELSE Directive

The ELSE directive allows the programmer to specify an alternate set of instructions to be assembled when the <exp> of an IF directive is evaluated to be false. The general format of the directive is:

[<label>] ELSE [;comment]

The ELSE directive is an extension of a prior IF (or ELSEIF) directive and therefore the ELSE directive may only be used between an IF and ENDIF ENDIF directive or between an ELSEIF and ENDIF directive.

When the <exp> of an IF or ELSEIF directive is evaluated to be false the assembler searches forward for an ELSE (or ELSEIF) directive. The instructions following the ELSE directive are then assembled. When the <exp> is evaluated to be true the instructions following the ELSE directive are not assembled.

ELSEIF Directive

The ELSEIF directive provides "case" statement conditional assembly capability. The general format of the directive is:

[<label>] ELSEIF <exp> [;comment]

When used, the ELSEIF directive must be between an IF, ELSEIF or ELSE directive and an ELSE, ELSEIF, or ENDIF directive. All terms in the <exp> must have been previously defined.

Only one ELSE statement is allowed per IF statement but there may be several ELSEIF statements following an IF statement.

During the analysis of an IF - ELSEIF...ELSEIF - ENDIF statement group assembly of source statements is suppressed until a true condition is detected for one of the IF, ELSEIF, or ELSE statements. When this occurs the statements are assembled until an ELSE, ELSEIF, or ENDIF statement is encountered--then the statements are skipped until the matching ENDIF is encountered.

Examples

```
LABEL1:  EQU     1
LABEL2:  EQU     0
LABEL3:  EQU     LABEL2*LABEL1
LABEL4:  EQU     LABEL2.AND.LABEL3
         IF      LABEL1
                                  This code will be assembled
         ELSEIF  LABEL2
                                  This code will not be assembled
         ELSE
                                  This code will be assembled
         ENDIF
         IF      LABEL3
                                  This code will not be assembled
         ENDIF
         IF      LABEL4
                                  This code will not be assembled
         ELSE
                                  This code will be assembled
         ENDIF
                                  This code will be assembled
```

END Directive

The END directive specifies the physical end of the source code. In addition this directive may specify the entry point address. The general format of the directive is:

[<label>] END [<exp>] [;comment]

It is not necessary to terminate the source program with the END directive, however, it is recommended and when used, it will be the last line of code analyzed.

When the <exp> is specified it indicates the address to be used for the entry point. That is the address at which execution will begin when the program is executed.

ENDIF Directive

The ENDIF directive is required to terminate the instructions that are to be conditionally assembled. The general format of the directive is:

[<label>] ENDIF [;comment]

Every IF directive must have a matching ENDIF directive.

ENDM Directive

The ENDM directive indicates the physical end of a macro prototype definition. The general format of the directive is:

ENDM [;comment]

The usage of this directive is explained in the chapter on Macros.

ENTER Directive

The ENTER directive is identical to the VALUE directive except that the <exp> is entered from the keyboard during pass one of assembly. The general format of the directive is:

<label> ENTER [<quoted string prompt>] [;comment]

When the ENTER directive is encountered during pass one of the assembly the <quoted string prompt> is displayed on the console. If the <quoted string prompt> is omitted the <label> name is displayed for prompting purposes. At this time the operator enters the expression to be assigned to <label>.

The ENTER directive must have a label. When the ENTER directive is encountered by the assembler during pass one the operator is allowed to enter the value (this value may be in the form of an expression using literal and previously defined labels. The label being defined with the ENTER directive may have been previously defined and used.

Examples

```
DEBUG:    ENTER  'Is this a debugging assembly? (Y/N)'
LABEL1:   ENTER  'Please type the value of LABEL1'
          .
          .
          IF     DEBUG.EQ.'Y'
          .
          .
          ENDIF
```

ENTRY Directive

The ENTRY directive allows you to specify that a label, defined in the current assembly, is an external reference (EXTRN) of another assembly. The general format of the directive is:

ENTRY <label>[,<label>]... [;comment]

The list of labels may be forward references to labels defined later in the assembly but the labels must be defined at some time during the current assembly. This directive is the logical inverse of the EXTRN directive.

The ENTRY directive would be used in a module of source code that defines a label(s) whose value will be needed in another module(s) that is not to be assembled with this one but will be LINKed with the current module.

For more explanation of the use of this directive and the EXTRN directive see the OASIS LINK Editor Reference Manual.

EQU Directive

The EQU directive allows the programmer to assign a value to a label. The general format of the directive is:

<label> EQU <exp> [;comment]

The EQU directive must have a label. All terms in <exp> must have been previously defined - no forward references are allowed.

When the EQU directive is encountered by the assembler <exp> is evaluated and assigned to <label>.

A label that has been equated with the EQU directive may not have been defined by any other directive or instruction in the program.

ERR Directive

The ERR directive is used to display an error message during the assembly process. Normally this would be used in conjunction with the conditional directives when an invalid condition has been detected. The general format of the directive is:

ERR 'message' [;comment]

When the ERR directive is encounted the message is displayed on the console along with the line number and the error message is included in any listing file being generated. This directive does not cause the assembly process to be cancelled but it will cause the return code to be set to a non-zero value. This return code can be displayed when the RDYMSG has been set ON and it can be tested by an EXEC program.

EX Pseudo-ops

The EX pseudo-op provides a convenient method of expressing some frequently used register exchanges with the Z80 registers.

MACRO Pseudo-op		Equivalent Z80 Instruction	
EXA		EX	AF,AF'
EX	AF,AF	EX	AF,AF'
EX	HL,DE	EX	DE,HL
EX	BCDEHL,BCDEHL'	EXX	

As can be seen, the pseudo-ops are more versatile in their use and would be very meaningful for the programmer who is unfamiliar with the Z80 exchange instructions.

EXITM Directive

The EXITM directive is used in a macro prototype, usually in conjunction with the conditional directives, to skip to the ENDM directive. The general format of the directive is:

EXITM [;comment]

The EXITM directive is discussed in the chapter on Macros.

EXTRN Directive

The EXTRN directive allows you to specify that a label is defined externally to the current assembly. The general format of the directive is:

EXTRN [<label>[,<label>]...] [;comment]

The list of labels specified in the operand field cannot include any labels defined during the current assembly, either before or after this directive.

Omitting a label specification indicates that all undefined label references in the program are to be treated as externally defined.

For more information regarding the use of this directive and the ENTRY directive see the OASIS LINK Editor Reference Manual.

IF Directive

The IF directive allows the programmer to include code that is assembled only when an expression is true. The general format of the directive is:

[<label>] IF <exp> [;comment]

All terms referenced in <exp> must have been defined previously in the program. No forward references are allowed.

The <exp> is evaluated and, if true, the instructions following are assembled. When the value of the <exp> is false the instructions following, up to the next ELSE, ELSEIF, or ENDIF, are not assembled.

LD Pseudo-ops

The LD pseudo-op provides a convenient method of performing some frequently used double register loads that are not available in the Z80 instruction set. The general format of the pseudo-op is:

[<label>] LD <rr>,<rr> [;comment]

[<label>] LD <rr'>,(<ii+d>) [;comment]

[<label>] LD (<ii+d>),<rr'> [;comment]

[<label>] LD <rr'>,(HL) [;comment]

Where:

rr Is any of the double register pairs: BC, DE, HL, IX, or IY.

rr' Is any of the double register pairs: BC, DE, or HL.

ii Is either of the index register pairs: IX or IY.

d Is a signed displacement value.

The LD pseudo-op is the same op-code as the Z80 LD instruction except in its permissible syntax. The LD pseudo-op generates the corresponding instructions to perform the desired load. For example- the pseudo-instruction: LD HL,DE will generate the Z80 instructions: LD H,D and LD L,E.

LINK Directive

The LINK directive provides a means of segmenting the source program into more workable units. The general format of the directive is:

LINK <file-desc> [;comment]

When the LINK directive is encountered by the assembler the specified file is used for the next line of source code. Obviously the LINK directive should be the last line of code in the current file as any code following the LINK directive will be ignored.

When the <file-desc> only specifies a file name the file type used in the OASIS MACRO command is used - that command had a default file type of ASSEMBLE.

LIST Directive

The LIST directive specifies how (and if) the assembler is to list the source program. The general format of the directive is:

LIST [<option list>] [;comment]

The LIST directive is only effective when one of the listing output options was specified in the OASIS MACRO command. The LIST directive may be used more than once in a source program to change the listing options. Similar to the USING and ORG directives, when the option list is specified the current list options are pushed onto an 8 level, internal LIST stack. When the option list is omitted the previous list options are popped from this LIST stack.

The options that may be specified include:

ON Indicates that a listing is to be created.

OFF Indicates that no listing file is to be created.

COPY Indicates that code found in a "COPY" file is to be included in the listing.

NOCOPY Indicates that code found in a "COPY" file is not to be included in the listing. This option does not affect the object program generated.

IF Indicates that source code not assembled due to conditional assembly is included in the listing.

NOIF Indicates that source code not assembled due to conditional assembly is not included in the listing.

DATA Indicates that all data generated by the storage definition directives is to be included in the listing.

NODATA Indicates that only the first four bytes of data generated by each storage definition directive is to be included in the listing.

MACRO Indicates that macro expansions are to be included in the listing.

NOMACRO Indicates that macro expansions are not to be included in the listing.

The options specified in the CSI MACRO command initially set the various list options, however (assuming a listing output device was specified) the LIST directive may override these options.

MACLIB Directive

The MACLIB directive allows the programmer to specify that a file of macro definitions is to be located and remembered. The general format of the directive is:

[<label>] MACLIB <file name>[.<file type>][:<file disk>][;comment]

When the MACLIB directive is encountered by the assembler the specified file (default file type of MACLIB) is located. The macro definitions contained in the file are noted and the macros may be used by the program just as if the macro were defined by the program.

No listing of the MACLIB file will be produced. The MACLIB file may only contain macro definitions.

MACRO Directive

The MACRO Directive specifies that the code following (up to and including the ENDM directive) is a macro prototype definition. The general format of the directive is:

MACRO [;comment]

The MACRO directive, along with the other macro related directives, is discussed in the chapter on Macros.

ORG Directive

The ORG directive allows the programmer to change the value of the location counter. This location counter is used to determine the address at which to assemble the next instruction. The general format of the directive is:

[<label>] ORG [<exp>] [;comment]

The ORG directive always specifies that the location counter is to be changed. When the ORG directive is encountered in an ABS PAB the expression specifying the new location counter is absolute. When the ORG directive is encountered in a REL or COM PAB the expression specifying the new location counter must be a relocatable expression.

All of the terms in <exp> must have been previously defined - no forward references are allowed. When the ORG directive is encountered <exp> is evaluated and assigned to the location counter and <label>, when specified.

When <exp> is specified with the ORG directive the current location counter is placed on an internal 8 level ORG stack. When <exp> is omitted the previous

element on the internal ORG stack is popped off.

This feature allows the programmer to place the code defining the working storage near the code referencing this storage even though in fact the address of the working storage may be any place in memory.

For example:

```
Addr Obj-Code  Line *** Source Statement ***

                      1 MAIN:    ABS
4000                  2          ORG    4000H
4000           320090 3          LD     (LABEL1),A
4003           E3     4          EX     (SP),HL
4004           7E     5          LD     A,(HL)
4005           23     6          INC    HL
4006           E3     7          EX     (SP),HL
4007           FE45   8          CP     VALUE2
4009           3805   9          JR     C,LABEL2
400B           3A0090 10         LD     A,(LABEL1)
400E           37     11         SCF
400F           C9     12         RET
9000                  13         ORG    9000
9000           0000   14 LABEL1: DC     (0)
9002           00     15 LABEL3: DC     0
4010                  16         ORG
4010                  17 LABEL2:
```

REL Directive

The REL directive is used to define the relocatable PAB. The general format of the directive is:

[<label>] REL [<exp>] [;comment]

Unlike the ABS directive, the label field is not required when there is only one REL PAB in a program. When the label field is omitted the PAB will be assigned the name of the program. When the label field is specified it is used by the USING directive to specify which PAB to use for assembling code. The <exp> field, when used, specifies an address relative to the load address of the program that the PAB is to start on for listing purposes only. Obviously, since this defines a relocatable PAB, the actual addresses used during execution time may be different.

A PAB definition, such as the REL directive, implies a USING directive following. It is not necessary for you to specify a USING directive immediately following a REL directive.

REPT Directive

The REPT directive allows you to duplicate a line of source code several times without coding several times. The general format of the directive is:

REPT [<exp>] [;comment]

When the REPT directive is encountered by the Assembler the next sequential line of code will be duplicated the number of times specified by <exp>. <exp> must be in the range of 1 - 65535. No forward referencing is allowed.

The line that follows the REPT directive cannot have a label in the label field as that label would be duplicated along with the rest of the code. This, of course, would cause a duplicate label error.

The listing of the duplicated lines of code is controlled by the DATA/NODATA option of the LIST directive.

SC Pseudo-op

The SC allows the assembly language programmer to utilize various portions of the operating system. The general format of a System Call is:

[<label>] SC <exp> [;comment]

The <exp> specifies which system routine control is to be transferred to. Although <exp> may have a value between 0 and 255 the actual number of system routines implemented is less. Reference to a system call number not implemented will cause system call number 0 to be executed. SC 0 will cause control to return to the

OASIS operating system.

When assembled the SC occupies two bytes of storage.

The system routines implemented and the requirements for usage are discussed in the chapter on System Calls.

SUBT Directive

The SUBT directive allows the programmer to specify a sub-heading to be printed on each page. The general format of the directive is:

SUBT <quoted string> [;comment]

The <quoted string> replaces the second heading line message at the top of each subsequent page of the listing.

TITLE Directive

The TITLE directive allows the programmer to specify the heading to be printed at the top of each page in the listing. The general format of the directive is:

TITLE <quoted string> [;comment]

The TITLE directive is only effective when a listing is being generated. When the TITLE directive is encountered by the assembler the heading for the next page of the listing is changed to be the <quoted string> (exlusive of the delimiting quotes) and a page eject is generated in the listing. The TITLE directive itself is not listed in the listing, however the line number is incremented.

USING Directive

The USING directive is used in conjuntion with the ABS, COM or REL directives to specify the PAB that instructions following belong to. The general format of the directive is:

USING [<label>] [;comment]

The USING directive can not have a label. The label specified in the operand portion of the directive must be of a previously defined PAB (no forward references). When label is used in the operand position the current "USING PAB" is pushed onto an 8 level USING stack. When <label> is omitted the last "USING PAB" is popped from this USING stack.

When a PAB is defined by the ABS, COM, or REL directive a USING directive is implied. There is no need for you to follow a PAB definition with a USING directive unless you wish to specify some code "using" a different PAB than the one just defined. This implied USING performs a push onto the USING stack just as if you had specified the USING directive yourself. In fact, when you specify the USING directive following a PAB definition there will be two pushes onto the USING stack.

VALUE Directive

The VALUE directive is similar to the EQU directive with the added ability of redefining a previously defined label in the program. The general format of the directive is:

<label> VALUE <exp> [;comment]

The VALUE directive must have a label. All terms in <exp> must have been previously defined - no forward references are allowed.

CHAPTER 6

MACROS

Macros are predefined sections of source code which may be used to facilitate the coding of commonly used procedures. Macro source code is modified by the MACRO Assembler to include labels and expressions passed as arguments by the main body of source statements. Macro definitions are called "Macro Prototypes" and are saved for later access by the MACRO Assembler.

The OASIS MACRO Assembler allows macro prototypes to be defined either within a source file (must be defined before referenced), in an external macro source file (file type of MACRO, one per file), in an external macro library file (file type MACLIB, one or more per file), or in a COPY file that was copied before the macro was referenced.

6.1 Preparing Macro Prototypes

Macro prototypes must be defined in the following format:

```
            MACRO  [;comment]
[&<label>]  name   [&<symbol>[(<default>)]][,&<symbol>[(<default>)]]...
  one or more assembly language statements and macro directives
            ENDM
```

Each prototype must start with the MACRO directive and end with the ENDM directive.

The second statement of each prototype is called a "Macro Prototype Header" and defines the name of the macro and any labels and symbols that may be replaced during assembly. The name may be any 1 to 8 character symbol that is not already predefined by the MACRO Assembler (Z80 op-codes and MACRO directives). All arguments shown in brackets are optional and may be omitted if not needed.

Notice that the label and symbols are preceded by the ampersand character. This is also true of the assembly statements within a macro. The ampersand character always precedes a substitution label or symbol.

Labels and symbols shown in the prototype header define items in the statements that follow that may be replaced at assembly time. Following each symbol in the header a default expression may be defined. The default will be used if a macro reference in the source program fails to supply a replacement expression for the preceding symbol. Spaces or commas may be used to separate the times in the list.

More than one macro may be defined in a program.

6.2 Macro Calls

Code from a macro prototype is included in assemblies by the means of "macro calls". The general form of macro calls is:

[<label>] name [<exp>[,<exp>]...] [;comment]

The name used in the instruction field will be assumed to be a macro name if it is not a recognizable MACRO Assembler instruction mnemonic or directive. The label and expression arguments in brackets are optional. Arguments defined in the expression field are positional and must be defined in the same order as related symbols in the macro's prototype header (except keywords).

Notice that a macro call does not use the ampersand character.

There is a purposeful similarity between the format of a macro call and macro prototype header. They are closely related and determine the final code that will be included in the assembly.

```
Header: [&<label>] name [&<sym>[(<def>)][,&<sym>[(<def>)]...]]
Call:   [<label>]  name [<expression>   [,<expression>]...]
```

The label for the call will replace the occurrences of the header label in prototype code during expansion. The first expression in the call will replace the first header symbol in the prototype code, the second expression will replace the second symbol, and so forth.

Arguments may be omitted in each list of macro call expressions by coding only the trailing comma to indicate the missing expression. Trailing commas after the last expression included in a list are not required.

The rules for substitution are:

Macro Call	Prototype Header	Action
Label	No label	Label is defined normally before expanded macro code is processed.
Label	Label	Call label substituted in expanded macro code.
No label	No label	No change.
No label	Label	Prototype label is omitted.
Symbol	No symbol	Call symbol ignored.
Symbol	Symbol	Call symbol substituted for occurrences in macro code.
No symbol	Symbol-no default	Header symbol disappears in expanded code.
No symbol	Symbol-default	Default substituted for occurrences in macro code.

Expansion example:

Macro prototype:

```
            MACRO
&LABEL:     CLEAR   &FIELD,&SIZE(80)
                    ; Clear &FIELD to zeros for length &SIZE
&LABEL:     LD      B,&SIZE                 ; Get field length
            LD      HL,&FIELD               ; Point to &FIELD
LOOP:       LD      (HL),0                  ; Set byte to zero
            INC     HL                      ; Point next
            DJNZ    LOOP                    ; Repeat till done
            ENDM
```

Macro Call:

```
LOOP:   CLEAR   BUFFER
```

Expansion:

```
                    ; Clear BUFFER to zeros for length 80
LOOP:       LD      B,80                    ; Get field length
            LD      HL,BUFFER               ; Point to BUFFER
LOOP:       LD      (HL),0                  ; Set byte to zero
            INC     HL                      ; Point next
            DJNZ    LOOP                    ; Repeat till done
```

In the above example the symbols &LABEL and &FIELD in the prototype have been replaced by "LOOP" and "BUFFER" provided by the macro call. The symbol "SIZE" did not have a replacement expression in the macro call so the default "80" was substituted.

6.3 Macro Keywords

The MACRO Assembler provides an alternate format for prototype headers and macro calls to allow easier implementation of macros with long symbol lists. This alternate format uses the keyword feature.

As described above the symbols in a prototype header and a macro call are positional, meaning that a one to one match is made between the first symbol defined in the header and the first position of the call, the second symbol defined in the header and the second position of the call, etc.

When the keyword feature is used the symbols are no longer positionally defined and called. This is important when a long list of symbols and defaults are defined in a header but only a few are used in the call.

A symbol is defined as a keyword in a macro call by using the symbol with an equal sign (=) followed by the value.

Example:

Macro Prototype:

```
          MACRO
&LABEL:   TEST   &A(1),&B(2),&C,&D(256),&E(0),&F(5),&G(1)
&LABEL:   DC     &A,&B
          DC     &C
          DS     &D
          DC     &E,&F,&G
          ENDM
```

Macro Call:

```
VALUE:    TEST   ,5,5,G=128
```

Expansion:

```
VALUE:    DC     1,5
          DC     5
          DS     256
          DC     0,5,128
```

6.4 Labels

Labels within a macro are of three types: global, local, and macro local. The global label within a macro functions the same as it does outside of a macro: it can be referenced from anywhere in a program. A global label defined within a macro is different from a global label defined outside of a macro in that the definition of the global label does not affect local labels.

The local label defined within a macro functions the same as it does outside of a macro: it can only be referenced from locations between two global labels (global labels defined outside of the macro.

The macro local label is a label that has a value only when reference from within the macro defining it. A macro local label is a label whose first character is a @.

6.5 Concatenation

The concatenation character, vertical bar (¦) is used in inner macro calls and macro prototype expressions to separate a macro symbol from a literal that is to be concatenated to the replaced value of the symbol. Macro symbols may be concatenated by merely concatenating the symbol references in the prototype.

Example:

Macro prototype:

```
          MACRO
          MSG       &AAA,&BBB
MSG&AAA:  DC        &BBB¦LOC,&BBB¦SIZE
          DC        'ERROR IN PHASE DCT&AAA'
          DC        (&BBB&AAA)
          ENDM
```

Macro Call and Expansion

```
          MSG       024,PHS4

MSG024:   DC        PHS4LOC,PHS4SIZE
          DC        'ERROR IN PHASE DCT024'
          DC        (PHS4024)
```

In order to include the vertical bar character as part of a macro or macro call you must duplicate it: ¦¦

6.6 Macro Substrings

Substrings of macro variables can be used by specifying the starting and ending character positions of the variable, within parenthesis, immediately following the variable name. For example: &NAME(3,5) indicates the substring of the value of the variable &NAME from position three through position five (three characters). Any time a variable name is used followed by a left parenthesis character the assembler will try to substing the variable. When the left parenthesis character is used and

substringing is not desired you must use the concatenation character described above.

6.7 Macro Nesting

The OASIS MACRO Assembler allows the nesting of macro calls within macro calls up to eight levels deep. Macro Local labels cannot be passed as arguments to inner macros. Local labels may be passed as arguments to inner macros but this usage may be restricted by the definition of global labels (same as non-macro code). The passage of global labels and other arguments is unrestricted.

6.8 Macro Reserved Variables

Within a macro prototype or macro call there are four reserved variables available to the user. These variables allow you to access the current date and time, the program name, and the current macro index value. If these variables are to be used as labels then they should be concatenated with other characters to generate unique labels. The variables are as follows:

```
&DATE    current date in mm/dd/yy format
&TIME    current time in hh:mm:ss format
&PROG    current source program name
&INDEX   current macro call index number
```

6.9 Macro Comments

Comments may be included in a macro prototype in the same manner as comments in the main program. Macro symbols may be included as part of a comment and these will be expanded.

A comment may be included in a macro prototype that is not to be expanded or even listed in any listing file created. This type of comment (macro comment) is indicated by pairing the comment delimiter (;;).

6.10 Macro Example

```
          MACRO                   ; Create FCB
&LABEL:   FCB     &CHANNNEL,&MODE,&BUFFER
          IF      .NUL.&LABEL     ; Asm only if &LABEL is empty
          ERR     'Label field required for FCB'
          EXITM
          ENDIF
          IF      &CHANNEL.LT.0.OR.&CHANNEL.GT.16
          ERR     'ACB channel number out of range'
          EXITM
          ENDIF
&LABEL:   DC      &CHANNEL
          IF      .NUL.&MODE
          ERR     'Access mode required'
          EXITM
          ELSE                    ;; Test the access mode specified
          IF      '&MODE(1,3)'.EQ.'INP'
          DC      90H
          ELSEIF  '&MODE(1,1)'.EQ.'O'
          DC      88H
          ELSEIF  '&MODE(1,1)'.EQ.'D'
          DC      40H
          ELSEIF  '&MODE(1,3)'.EQ.'IND'
          DC      20H
          ELSE
          ERR     'Access mode undefined'
          EXITM
          ENDIF
          ENDIF
          IF      '&BUFFER'.EQ.''
          DC      (@BUFF)
@BUFF:    DS      255
          ELSE
          DC      (&BUFFER)
          ENDIF
          ENDM
```

CHAPTER 7

SYSTEM CALLS

This chapter describes all of the system calls implemented in this version of the MACRO Assembler. They are described because they do exist and are available for use, not because they should be used by the programmer. In fact, some of these system calls should not be used: 10, 11, 27, 28, 50, and 51. These system calls are related to physical disk I/O and, if used indiscreetly, may destroy the resident operating system or the contents of a disk or disks. Any consequential damages caused by the use of these specific system calls are the responsibility of the user.

7.1 Documentation Conventions

This chapter describes the syntax and operation of the system calls available to the programmer using the OASIS MACRO Assembler. Each system call is presented in the same format:

1. System call heading, centered on the page.
2. Function of the system call.
3. Input parameters. This area defines all of the parameters that are required to be defined before the system call is invoked.
4. Output parameters. This area defines any parameters that are returned to the calling program.
5. Description. A general descriptive text of the function of the system call.
6. Other system calls used. This area specifies if any other system calls are used to perform the function and what they are.
7. Other registers altered. Any registers that may be changed by the system call, excluding those specified as output parameters, are listed in this area.
8. Example. A specific example of the calling sequence and result of the system call is given. An example is not given if the system call is obvious or trivial.

System control blocks are referenced frequently through this chapter. Refer to the appendix on System Control Blocks for information regarding the content and format of each of the control blocks.

SC 0 QUIT

Function: Reload the Command String Interpreter - restart.

Input parameters:

Reg A - Return Code

Output parameters: none

Description:

The Command String Interpreter is reloaded and control is passed to the CSI. This system call is generally used when an assembly program is finished its execution and control is to return to the operating system.

Certain statuses and switches are reset by this system call: ESC,Q and ESC,S are reset; DET and QET are reset; the stack pointer is reset to top of memory; any TEBs owned by this partition are cleared; all ACBs are closed; all known resources locked by this partition are released; and all files and records locked by this partition are released.

The value in the A register is the return code. This return code is displayed if RDYMSG is set ON and is accessible by the EXEC language.

Other system calls used: SYSIN (6), SYSOUT (7), MOUNT (9), RD1 (10), GETSCR (48), RD (50), SYSDISP (52), TIMER (53), GETMEM (55), PUTQET (57), PUTDET (74), GETACB (77), NOTONLY (85), UNEXCLUS (90), GETWORK (91), COMPARE (93)

Other registers altered: all (control returns to operating system)

Example Calling Sequence:

```
LD      A,16        ; Return code
SC      0           ; Re-load CSI & exit
END
```

SC 1 KEYIN

Function: Accept a line of input from the console keyboard.

Input parameters:

Reg B - Max line length to accept
Reg DE - Address of buffer to store line

Output parameters:

Reg A - Actual line length accepted

Description:

Up to B characters are accepted from the console input device (CONIN). All characters will be echoed to the console output device, dependent upon the controls set in the console control byte. Entry is terminated by entry of B characters or a carriage return. (The console control byte may specify that any control character terminates input.) When the input is terminated a carriage return, line feed is echoed to the console output device.

If the input is not terminated by a carriage return (B characters entered) then a carriage return is appended to the end of the character string in the buffer. For this reason the buffer length should be B+1.

Note: When there is information available from the EXEC stack this system call will retrieve characters from that stack and echo it to the console if the stack display switch is in effect.

Other system calls used: CONIN (4), CONOUT (5), CRLF (18), GETSCR (48)

Other registers altered: C, D, E, H, L

Example Calling Sequence:

```
                LD      B,64            ; Length
                LD      DE,AREA         ; Input buffer
                SC      1               ; Get line from console
                .
                .
                .
        AREA:   DS      65              ; Buffer
```

SC 2 DISPLAY

Function: Display characters on console output device.

Input parameters:

Reg DE - Address of first character to output

Output parameters:

Reg DE - Address of last char output plus one

Description:

Characters from the buffer addressed by register pair DE are displayed on the console output device. A null character (00) terminates output to the console and returns from the system call.

A carriage return will be displayed as a carriage return, line feed and the system call will be exited. A line feed will be displayed as a carriage return, line feed, output continues. An HT character (09H) will be displayed as the proper number of spaces according to the Tab Set Block (TSB). All other editing is done by the CONOUT system call on a character by character basis.

Other system calls used: CONOUT (5), CRLF (18)

Other registers altered: A

Example Calling Sequence:

```
                LD      DE,MSG          ; Point to message string
                SC      2               ; Display on console
                .
                .
                .
        MSG:    DC      'Any old thing',0DH
```

SC 3 CONST

Function: Get status of console input device.

Input parameters: none

Output parameters:

Flag Z - set if no character ready; reset otherwise

Description:

The console input device is queried: the zero flag (Z) is reset if at least one character is available for input, the zero flag is set if no characters are available.

Other system calls used: GETSCR (48), DEVST (62)

Other registers altered: A

Example Calling Sequence:

```
                SC      3               ; Test console ready
                JR      Z,NOTRDY        ; Jump if no char ready
```

SC 4 CONIN

Function: Accept one character from the console input device.

Input parameters: none

Output parameters:

Reg A - contains character input

Description:

One character is accepted from the console input device. Characters accepted from the console device or EXEC stack are edited according to the set values for UP, DOWN, etc, and the console class code, if any. The underscore character is always translated to a RUBOUT character by this system call. Return from this system call is performed only after a character is accepted. The character will be echoed to the console output device with editing performed according to the switches set for upper/lower case, rubout, graphic display, etc. This system call never echos control characters (values < 32 or > 128).

Note: When there is information available from the EXEC stack this system call will retrieve a character from that stack and echo it to the console if the stack display switch is in effect.

Other system calls used: CONOUT (5), GETSCR (48), GETMEM (55), PUTMEM (56), DEVIN (63)

Other registers altered: none

Example Calling Sequence:

```
SC      4               ; Read & echo char from console
```

SC 5 CONOUT

Function: Display one character on console output device.

Input parameters:

Reg C - character to be displayed

Output parameters: none

Description:

The character contained in register C is displayed on the console output device (CONOUT) with editing performed according to the console control byte: graphics, printer echo, etc. Output to the console is suppressed if there is EXEC stack data present and the NOSTACK option is in effect. When the character is displayed on the console the current cursor location in the nucleus is maintained and auto new line is simulated if the character is to be displayed past the end of the attached line length.

Other system calls used: SYSOUT (7), PRTOUT (8)

Other registers altered: A

Example Calling Sequence:

```
LD      C,'?'           ; Load a question mark
SC      5               ; Display on console
```

SC 6 SYSIN

Function: Accept one character from console.

Input parameters: none

Output parameters:

Reg A - contains character input

Description:

One character is accepted from the console input device. Return from this system call is performed only after a character is accepted. The character will always be echoed to the console output device (status of Console Echo-key ignored) with editing performed according to the switches set for upper/lower case, rubout, graphic display, etc. The character will never be echoed to the printer device (status of Printer Echo-key ignored). This system call never echos control characters (values < 32 or > 128). In other respects this system call performs the same editing as the CONIN system call.

The status of the EXEC stack and the stack display switch is ignored by this system call (character is always accepted from CONIN and displayed on CONOUT).

Other system calls used: SYSOUT (7), GETSCR (48)

Other registers altered: none

Example Calling Sequence:

```
SC      6               ; Get char from CONIN
```

SC 7 SYSOUT

Function: Display one character on console output device.

Input parameters:

Reg C - character to be output

Output parameters: none

Description:

The character contained in register C is diaplayed on the console output device (CONOUT) with editing performed according to the console control byte: graphics, etc. The status of the Console Echo-key and the Printer Echo-key is ignored.

The status of the EXEC stack and the stack display switch is ignored (character is always displayed on the CONOUT).

Other system calls used: CRLF (18), DEVOUT (64)

Other registers altered: A

Example Calling Sequence:

```
LD      C,12H           ; Load DC2 char
SC      7               ; Output to console
```

SC 8 PRTOUT

Function: Output one character to Printer 1.

Input parameters:

Reg C - character to be output

Output parameters: none

Description:

If Printer 1 is not attached then this system call is exited. If the printer is attached then the character in the C register is output to that device along with any editing or options specified in the attachment of

that device.

Other system calls used: DEVOUT (64)

Other registers altered: A

Example Calling Sequence:

```
        LD      C,0CH           ; Form feed
        SC      8               ; Output to PRINTER1
```

SC 9 MOUNT

Function: Allow change of diskette on a specified drive.

Input parameters:

Reg B - logical drive code (0 - 7) = (S - G)

Output parameters: none

Description:

Internal switches are set to indicate that the next read or write to this disk must first read the diskette ID. If the drive code in the B register specifies a drive that is not attached or is invalid then nothing is done by this system call.

Other system calls used: GETUCB (21)

Other registers altered: A

Example Calling Sequence:

```
        LD      B,1             ; Drive code for A
        SC      9               ; Perform mount on A
```

SC 10 RD1

Function: Read one sector from a diskette.

Input parameters:

Reg B - logical drive code (0 - 7) = (S - G)
Reg DE - sector address, relative to 0
Reg HL - buffer address

Output parameters: none

Description:

Specified drive is selected, if legal, and the indicated sector is read into the location specified by the HL register pair. If the drive or sector is illegal or an error is detected during the read no error status is returned--disk errors are reported to the operator for handling (see SC 74).

This system call, when used in a multi-user environment, checks the Sector Lock Table (SLT) and waits if the requested sector is locked by another partition.

Caution: Use of this system call is not advised.

Other system calls used: RD (50)

Other registers altered: A, C

Example Calling Sequence:

```
                LD      B,0             ; Drive S
                LD      DE,1            ; Sector 1
                LD      HL,BUFFER       ; Memory address
                SC      10              ; Read a sector
                .
                .
                .
        BUFFER: DS      256
```

SC 11 WR1

Function: Write one sector to a disk.

Input parameters:

```
Reg B  - logical drive code (0 - 7) = (S - G)
Reg DE - sector number, relative to 0
Reg HL - buffer address
```

Output parameters: none

Description:

The specified drive, if legal, is selected and the data at the location indicated by register pair HL is written to the specified sector. If the drive or sector number is illegal or an error is detected during the write operation no error status is returned--disk errors are reporated to the operator for handling (see SC 74).

This system call, when used in a multi-user environment, checks the Sector Lock Table (SLT) and waits if the requested sector is locked by another partition.

Caution: Use of this system call is not advised.

Other system calls used: WR (51)

Other registers altered: A, C

Example Calling Sequence:

```
                LD      B,1             ; Drive A
                LD      DE,(SECT)       ; Sector address
                LD      HL,DMA          ; Memory address
                SC      11              ; Write a sector
                .
                .
                .
        SECT:   DC      (112)           ; Must be 16 bit word
        DMA:    DS      256
```

SC 12 GETVER

Function: Return nucleus version number.

Input parameters: none

Output parameters:

```
REG H  - Binary Coded Decimal version number
REG L  - Alphabetic version suffix
```

Description:

This system call returns the system version number in the HL register pair. The version number of the nucleus is always in the form of nna where nn is the version number and 'a' is the version suffix letter (i.e.: 54F, 50B, or 55). The version suffix may be blank. The 'nn' portion of the version number is returned in the H register in BCD format (i.e., when version is 54F the H register will contain 54H). The 'a' suffix portion

is returned in the L register as an ASCII character (i.e., when version is 54F the L register will contain 46H).

Other system calls used: none

Other register altered: none

SC 13 WRFDIR

Function: Write file directory entry.

Input parameters:

Reg B - Logical drive code (0 - 7) = (S - G)
Reg DE - Address of DEB

Output parameters:

Flag C - Set if error; reset otherwise
Flag Z - Reset if error; set otherwise

Description:

The directory entry addressed by the DE register pair is written to the directory of the drive addressed by the B register. The directory entry block (DEB) must be completely filled in (all 32 bytes). If the directory is full or if the directory entry is a duplicate of an entry already on file the carry flag is set and the zero flag is reset; otherwise the carry flag is reset and the zero flag is set.

The user is advised to not use this system call to create directory entries. When files are created using the other appropriate system calls the directory entry is automatically created.

Other system calls used: WR1 (11), LOOKUP (20), GETSCR (48), ONEONLY (84), NONTONLY (85), GETWORK (91)

Other registers altered: A

SC 14 HEXI

Function: Convert hexadecimal number to 16 bit binary.

Input parameters:

Reg DE - Address of hex string

Output parameters:

Reg DE - Address of byte following string
Reg HL - Binary result
Flag C - Set if overflow; reset otherwise

Description:

The string of characters addressed by the DE register pair is converted to a binary value, conversion stopping on the first non-hexadecimal digit. The resultant value is placed in the HL register pair, the DE register pair is adjusted to point to the character following the last hexadecimal digit or trailing 'H'. The system call is exited.

Other system calls used: none

Other registers altered: A

Example Calling Sequence:

```
        LD      DE,AREAH        ; Point ASCII hex
        SC      14              ; Convert to binary
        .
        .
        .
AREAH:  DC      'ABCDH'         ; Hex value
```

SC 15 DECI

Function: Convert decimal number to 16 bit binary.

Input parameters:

Reg DE - Address of decimal string

Output parameters:

Reg DE - Address of byte following
Reg HL - Result
Flag C - Set if overflow; reset otherwise

Description:

The decimal string of characters addressed by the DE register pair is converted to an unsigned binary integer value and placed in the HL register pair. Conversion stops when a non-numeric character is encountered. The DE register pair is adjusted to point to the first character following the digits or trailing 'D' character. The system call is exited.

Other system calls used: none

Other registers altered: A

Example Calling Sequence:

```
        LD      DE,AREAD        ; Point ASCII Decimal
        SC      15              ; Convert to binary
        .
        .
        .
AREAD:  DC      '12345'         ; Decimal value
```

SC 16 HEXO

Function: Convert 8 bit value to hexadecimal characters.

Input parameters:

Reg B - Byte to be converted
Reg DE - Address of storage area

Output parameters:

Reg DE - Address of next location following

Description:

The 8 bit value in the B register is converted to the two hexadecimal character equivalent. These two characters are placed in the storage area addressed by the DE register pair. The DE register pair is adjusted to point to the location following the second character. The system call is exited.

Other system calls used: none

Other registers altered: A

Example Calling Sequence:

```
                LD      B,(HL)          ; Get byte to convert
                LD      DE,AREAH        ; Conversion area
                SC      16              ; Convert binary to hex
                .
                .
                .
        AREAH:  DS      2               ; Conversion area
```

SC 17 DECO

Function: Convert 16 bit unsigned value to decimal string.

Input parameters:

Reg DE - Address of storage area
Reg HL - Value to be converted

Output parameters:

Reg DE - Address of location following

Description:

The 16 bit value in the HL register pair is converted to the ASCII character decimal equivalent (leading zeros are suppressed). The resultant string is placed in the storage area addressed by the register pair DE and the register pair DE is adjusted to point to the following location. The system call is exited.

Other system calls used: none

Other registers altered: A, B, C, H, L

Example Calling Sequence:

```
                LD      DE,AREA         ; Work area
                LD      HL,(NUMBER)     ; Get number
                SC      17              ; Convert to decimal
                LD      A,0DH           ; Get a CR
                LD      (DE),A          ; Mark end
                .
                .
                .
        AREA:   DS      6
        NUMBER: DC      256
```

SC 18 CRLF

Function: Display carriage return, line feed on console.

Input parameters: none

Output parameters: none

Description:

A carriage return and a line feed character are displayed on the console output device.

Other system calls used: CONOUT (5)

Other registers altered: none

Example Calling Sequence:

```
                SC      18              ; Display CR/LF
```

SC 19 MSEC

Function: Wait specified number of milliseconds

Input parameters:

Reg A - Number of milliseconds

Output parameters: none

Description:

The number of milliseconds indicated by the contents of the A register are "waited". An instruction sequence is performed that requires exactly one millisecond to execute. The content of the A register is then decremented. If the A register is not zero then the loop is executed again. If the A register is zero then control is returned to the instruction following the system call.

Note: If the A register contains a zero upon entry then 256 msec will elapse before control is returned. Any interrupts that occur while this routine is executing will cause minor inaccuracies in the actual elapsed time.

Other system calls used: none

Other registers altered: A

Example Calling Sequence:

```
        LD      A,10            ; Get count
        SC      19              ; Wait for 10 msec
                                ; Wait for 1 second
        LD      A,232           ; Initial value
        SC      19              ; Wait 232 msec
        SC      19              ; Wait 256 msec
        SC      19              ; Wait 256 msec
        SC      19              ; Wait 256 msec
```

SC 20 LOOKUP

Function: Locate directory entry of specified file.

Input parameters:

Reg DE - Address of DCB
Reg HL - Address of 256 byte work area

Output parameters:

If found-
Flag Z - Set
Flag C - Set
Reg A - 0
Reg B - Logical drive number (0 - 7) = (S - G)
Reg DE - Sector address of directory block.
Reg HL - Address within work area of entry

If not found-
Flag Z - Reset
Flag C - Reset if directory not full
Set if directory full
Reg A - 01 if directory not full
FF if directory full

Description:

The specified file description is searched for in the directory of the drive indicated. If the directory entry for the file is found then the relevant information is placed in the indicated registers and the system call is exited.

If the directory entry for the file is not found then the relevant information is placed in the indicated registers and the system call is

exited. In this situation the calling program should create a directory entry for the file at the location within the work area and write the work area to disk using the WRFDIR (13) system call.

This method of creating file entries is not intended to be used for general purpose file creation - the system utilities provide this ability with proven safety. Be very carefull if you do use this system call!

Other system calls used: RD1 (10), DIV (38), GETSCR (48), TSTDEV (58), GETUSER (101)

Other registers altered: C

Example Calling sequence:

```
        LD      DE,FNFTFD       ; Point DCB
        LD      HL,WORK         ; Point work area
        SC      20              ; Directory lookup
        JP      NZ,NOFND        ; Branch if not found
        .
        .
        .
WORK:   DS      256
FDFTFD: DC      1,'TEST    ','FILE    ' ; TEST.FILE:A
```

SC 21 GETUCB

Function: Get address of UCB (Unit Control Block).

Input parameters:

Reg B - Logical device number

Output parameters:

Reg HL - Address of UCB for physical device
Reg C - Physical device number
Flag C - set if no attachment

Description:

The logical device indicated is tested for an attachment to a physical device. If no attachment then the carry flag is set and the system call is exited. If the device is attached then the address of the Unit Control Block is placed in the HL register and the physical device number that the logical device is attached to is placed in the C register.

Other system calls used: TSTDEV (58)

Other registers altered: A

Example Calling sequence:

```
        LD      B,9             ; Log device number
        SC      21              ; Point UCB of CONOUT
        LD      DE,10           ; Displacement to delay
        ADD     HL,DE           ; Point delay value
        LD      (HL),0          ; Reset to zero
```

SC 22 LOAD

Function: Load a program.

Input parameters:

Reg HL - Load address
Reg DE - Address of DCB

Output parameters:

```
Reg A  - Return code:
         01 relocatable program loaded
         02 absolute program loaded
         04 program not found
         05 absolute program - load address different
         06 insufficient memory
Reg B  - Drive code that file was found on
Flag C - reset if program loaded successfully
         set if program not loaded
```

Description:

The program specified by the directory control block pointed to by the DE register pair is loaded into memory at the load address referenced by the HL register pair.

Other system calls used: RD1 (10), LOOKUP (20), GETSCR (48), RD (50), GETWORK (91)

Other registers altered: none

Example Calling sequence:

```
            LD      DE,SUBRNAME   ; Point to name
            LD      HL,SUBR       ; Memory address
            SC      22            ; Load it
            CALL    SUBR          ; Execute the program
            .
            .
            .
SUBRNAME:   DC      0,'USER    ','PROGRAM ' ; USER.PROGRAM:S
SUBR:       EQU     $             ; Load here
```

SC 23 PRINT

Function: Output a line to printer 1

Input parameters:

Reg DE - Address of line to print

Output parameters: none

Description:

The characters in the buffer addressed by the register pair DE are transmitted to printer 1 until a carriage return or null is encountered. Carriage returns and line feed characters are printed as a carriage return, line feed sequence. Other editing is performed according to the options associated with the attached printer.

Other system calls used: PRTOUT (8)

Other registers altered: A, C

Example Calling sequence:

```
            LD      DE,LINE       ; Point to message
            SC      23            ; Output to PRINTER1
            .
            .
            .
LINE:       DC      'Now is the time',10,'for all etc.',13
```

SC 24 ASSIGN

Function: Store ACB (Assign Control Block)

Input parameters:

```
Reg B  - ACB number (0 - 16)
Reg DE - Address of formatted ACB
```

Output paramters:

```
Reg A  - Set to 255 if error
Flag C - Set if error; reset otherwise
```

Description:

The ACB number is verified to be in the range 0-16, if not the value 255 is placed in the A register and the system call is exited. The formatted ACB referenced by the DE register pair is placed in the specified ACB. The A register is set to zero and the system call is exited.

Other system calls used: GETACB (77)

Other registers altered: C, H, L

Example Calling sequence:

```
        LD      B,6             ; Channel 6
        LD      DE,ACB          ; Point to my copy of ACB
        SC      24              ; Store assign control block
        .
        .
        .
ACB:    DC      1,'FILENAME','FILETYPE',1
```

SC 25 ADRV

Function: Convert logical drive code to logical drive number.

Input paramters:

```
Reg B - Logical drive code (S - G, *)
```

Output parameters:

```
Reg A - Logical drive number (0 - 7, 255)
Flag C - Set if error.
```

Description:

The drive code (alphabetic) is converted into a number in the range of 0 thru 7. If the drive code is an asterisk (*) the number is 255.

Other system calls used: GETLUB (87)

Other registers altered: none

Example Calling sequence:

```
        LD      B,'A'           ; Load drive code
        SC      25              ; Convert to number
```

SC 26 BDRV

Function: Convert logical drive number to logical drive code.

Input parameters:

```
Reg B - Logical drive number (0 - 7, 255)
```

Output parameters:

```
Reg A - Logical drive code (S - G, *)
```

Description:

The logical drive number is converted to the external logical drive code (alphabetic).

Other system calls used: TSTDEV (58)

Other registers altered: none

Example Calling sequence:

```
        LD      A,(FD)      ; Get logical drive number
        LD      B,A         ; Move to B
        SC      26          ; Convert to drive code
        .
        .
        .
FD:     DC      1
```

SC 27 ALLOC

Function: Allocate disk space.

Input paramters:

Reg B - Logical drive number (0 - 7) = (S - G)
Reg DE - Number of 1K disk blocks to allocate

Output parameters:

Reg HL - Sector address of first block.
Reg A - 00 if space allocated
FF if disk full or write protected
Flag Z - Set if space allocated
reset if disk full for write protected
Flag C - Set if space allocated
Reset if disk full or write protected

Description:

The specified disk allocation map is searched for a contiguous block of unallocated disk space equal to the number of disk blocks desired. If insufficient space is available the Z flag is reset. If space is available the Z flag is set, the allocation map is updated and written to the disk, and the first sector address of the allocated disk space is loaded into the HL register pair.

Caution: Use of this system call is not advised.

Other system calls used: RD1 (10), WR1 (11), TSTDEV (58), ONEONLY (84), GETWORK (91), CALLOC (99)

Other registers altered: none

Example Calling sequence:

```
        LD      B,0         ; Drive S
        LD      DE,1        ; One block
        SC      27          ; Allocate
        JP      NZ,FULL     ; Branch if full
        LD      (SECT),HL   ; Else save sector address
```

SC 28 DEALL

Function: Deallocate disk space

Input parameters:

Reg B - Logical disk drive number (0 - 7) = (S - G)
Reg DE - Number of 1K blocks to deallocate
Reg HL - Starting sector number

Output parameters:

```
Flag Z - Status:
         set - okay
         reset - error
```

Description:

The specified disk allocation map is searched for the indicated allocated space. If the indicated space is not already allocated the Z flag is reset and the system call is exited. Otherwise the allocation map is updated and written to disk; the Z flag is set and the system call is exited.

Caution: Use of this system call is not advised.

Other system calls used: RD1 (10), WR1 (11), GETUCB (21), TSTDEV (58), ONEONLY (84), NOTONLY (85), GETWORK (91)

Other registers altered: H, L

Example Calling sequence:

```
        LD      B,0             ; Drive S
        LD      DE,1            ; 1K bytes
        LD      HL,(SECT)       ; Sector address
        SC      28              ; Return to avail status
```

SC 29 ERASE

Function: Erase logical file from a disk.

Input parameters:

```
Reg DE - Address of DCB
```

Output parameters:

```
Reg A  - Return Code:
         00 Successful
         FF File protected
Flag Z - Status:
         set - okay
         reset - error
Flag C - reset if successful
         set if file or disk protected
```

Description:

The directory for the specified disk drive is searched for a match with the file description. When a match is found the file disk space is deallocated, the directory entry is placed in a delete status and the directory block is updated on disk.

Other system calls used: RD1 (10), WR1 (11), LOOKUP (20), GETUCB (21) DEALLOC (28), GETWORK (91), GETUSER (101)

Other registers altered: none

Example Calling sequence:

```
        LD      DE,FN           ; Point to DCB
        SC      29              ; Erase file if it exists
        .
        .
        .
FN:     DC      1,'TEST    ','FILE    '
```

SC 30 FETCH

Function: Load program into memory, execute and return to CSI.

Input parameters:

```
Reg B  - Logical drive code
Reg DE - Directory entry pointer
```

Output parameters: none

Description:

The eventual return address is replaced with the address of the boot loader; system call 22 is executed with control returned to the boot loader upon completion of the program execution.

Other system calls used: RD1 (10), LOAD (22), GETSCR (48), RD (50), GETMEM (55), TSTESCC (69), GETWORK (91), ERRQUIT (97)

Other registers altered: B, C

Example Calling Sequence:

```
        LD      DE,DCB          ; Point to DCB
        LD      HL,WORK         ; Point work space
        SC      20              ; Get directory entry
        EX      DE,HL           ; DE points directory
        LD      A,(DCB)         ; Point to drive
        LD      B,A             ;
        SC      30              ; Load & execute
        .
        .
DCB:    DC      1,'MYPROG  ','COMMAND '
WORK:   DS      256
```

SC 31 RENAME

Function: Rename a logical disk file.

Input parameters:

```
Reg DE - Address of DCB
Reg HL - Address of new DCB
```

Output parameters:

```
Flag Z - Status:
         Set if successful
         Reset if error
Reg A  - Return code:
         00 if okay
         04 if old file not found
         08 if new file description exists
         0A Protected file or disk
```

Description:

The new drive code is set equal to the old drive code. The directory for the specified disk is searched for the old file description. If the directory entry cannot be found then the A register is set to 04 and the system call is exited. If the file is found then the directory is searched for the new file description. If the directory entry is found then the A register is set to 08 and the system call is exited.

If the old file description does exist and the new file description doesn't exist then the old file entry is placed in delete status, the directory block is updated, the new file entry is created (duplicating the attributes of the old file), and the directory block is updated. The system call is exited.

Other system calls used: WR1 (11), WRFDIR (13), LOOKUP (20), GETUCB (21), GETWORK (91), GETUSER (101)

Other registers altered: H, L

Example Calling Sequence:

```
                LD      DE,OLD          ; Point to old name
                LD      HL,NEW          ; Point to new name
                SC      31              ; Rename it
                JR      Z,OKAY          ; Error?
        ERROR:  .
                .
                .
        OLD:    DC      1,'OLD     ','FILE    '
        NEW:    DC      1,'NEW     ','DESCRIPT'
```

SC 32 OPEN

Function: Open a logical file.

Input parameters:

Reg DE - Address of FCB

Output parameters:

```
Reg A  - Return code:
         00 Successful
         01 Already open
         04 Invalid file definition
         08 Invalid file number
         0A File protected
         10 Disk full
         20 Directory full
         40 File not found
Reg B  - Device assigned to file
Flag Z - Status:
         set - okay (Reg A = 0)
         reset - error (Reg A <> 0)
```

Description:

The file specified by the FCB is opened in the mode indicated with the appropriate return code set if the open is unable to be accomplished. Register B is set to the logical drive code that a new sequential file was opened to if the drive was not specified explicitly in the ACB.

This system call checks the File Lock Table (FLT) and waits if the file is locked by another partition. When the file is not locked by another partition or is released by that partition this system call will lock the file if specified by the FCB.

Other system calls used: RD1 (10), WR1 (11), WRFDIR (13), LOOKUP (20), GETUCB (21), ALLOC (27), DEALL (28), ERASE (29), DATEPACK (46), TSTDEV (58), DEVOUT (64), GETWORK (91), GETUSER (101)

Other registers altered: C, H, L

Example Calling Sequence:

```
                LD      B,16            ; Assign I/O ch 16
                LD      DE,ACB16
                SC      24
                LD      DE,FCB1         ; Point to FCB
                SC      32              ; Open the file
                JR      NZ,ERROR        ; BRIF error
                .
                .
                .
        FCB1:   DC      16              ; ACB = 16
                DC      10001100B       ; Seq, append
                DC      (BUFF1)         ; I/O buffer
        BUFF1:  DS      256
        ACB16:  DC      1,'REPORT  ','LISTING '
                DC      1
```

SC 33 CLOSE

Function: Close a logical file.

Input parameters:

```
Reg DE - Address of FCB
```

Output parameters:

```
Reg A  - Return code
         00 Successful
         08 Invalid file number
         10 Disk full
Flag Z - Status:
         set - okay (Reg A = 0)
         reset - error (Reg A <> 0)
```

Description:

The specified file is logically and physically closed with the appropriate return code set. Closing a file involves the updating of the disk file with the data in the I/O buffer; updating the directory entry for the file; flagging the ACB as closed.

When the file being closed is a console file a CR, LF is output to the console. When the file being closed is a printer file a CR, LF, US is output.

This system call unlocks the file and all related sectors from the FLT and SLT.

Other system calls used: WR1 (11), LOOKUP (20), DATEPACK (46), DEVOUT (64), ONEONLY (84), NOTONLY (85), GETWORK (91)

Other registers altered: B, C, H, L

Example Calling Sequence:

```
                                ; Using current assign
        LD      DE,FCB1         ; Open FCB1
        SC      33
        JR      NZ,ERROR        ; BRIF error
        .
        .
        .
FCB1:   DC      16
        DC      10001000B       ; Seq, output
        DC      (BUFF1)         ; I/O buffer
BUFF1:  DS      256
```

SC 34 RDSEQ

Function: Get a logical record from a sequential file.

Input parameters:

```
Reg DE - Address of FCB
Reg HL - Address of record area
```

Output parameters:

```
Reg AF - Return code
         00 Successful
         01 End of File
         08 Invalid file number
         FF File not open
Flag Z - Status:
         set - okay (Reg A = 0)
         reset - error (Reg A <> 0)
```

Description:

The ACB is validated for: open, sequential, and input. The A register is set to 255 if ACB invalid. The ACB is tested for an EOF condition and the appropriate return code is set if true and the system call is exited. If everything is okay the next record is passed to the record buffer addressed by the HL register pair with file input performed as required. ASCII sequential file records are always terminated with a carriage return character (0DH).

This system call, like all logical record input/output system calls, maintains the Sector Lock Table (SLT) according to the FCB.

Other system calls used: INPUT (1), RD1 (10), DEVIN (63)

Other registers altered: B, C

Example Calling Sequence:

```
            LD      DE,FCB1         ; Get record from file
            LD      HL,BUFF         ; Put in BUFF buffer
            SC      34              ; Do it
            JR      NZ,CHKERR       ; Analyze error routine
            .
            .
            .
FCB1:       DC      10              ; I/O ch 10
            DC      10010000B       ; Seq input
            DC      (BUFF1)         ; I/O buffer
BUFF1:      DS      256
BUFF:       DS      128             ; Max rec length = 128
```

SC 35 WRSEQ

Function: Write a logical record to a sequential file.

Input parameters:

Reg DE - Address of FCB
Reg HL - Address of record

Output parameters:

Reg AF - Return code
00 Successful
08 Invalid file number
10 Disk full
FF File not open, etc.
Flag Z - Status:
set - okay (Reg A = 0)
reset - error (Reg A <> 0)

Description:

The ACB is validated: open, sequential, and output or append. The appropriate return code is set when invalid and the sysem call is exited. The record is transferred to the file buffer and physical output is performed as required. When the file is a disk file and the file requires more allocation to perform the physical output then the file is expanded.

When the FCB is for PRINTER1, PRINTER2, PRINTER3, or PRINTER4 logical device, the output record is assumed to contain an ANSI forms control character as the first character of each record.

This system call, like all logical record input/output system calls, maintains the Sector Lock Table (SLT) according to the FCB.

Note: Be sure that the record addressed by the HL register pair contains a carriage return character (0DH) as the terminating character.

Other system calls used: CONOUT (5), WR1 (11), ALLOC (27), WAIT (49), DEVOUT (64)

Other registers altered: B, C

Example Calling Sequence:

```
                LD      DE,FCB2         ; Write seq record
                LD      HL,BUFF         ; From BUFF buffer
                SC      35
                JR      Z,OKAY          ; Skip if okay
                CP      10H             ; Check for disk full
                JR      Z,DFULL         ; BRIF full
                                        ;  else ignore error
        OKAY:   .
                .
                .
        FCB2:   DC      2               ; I/O channel 2
                DC      10001000B       ; Seq output
                DC      (BUFF2)         ; I/O buffer
        BUFF2:  DS      256
        BUFF:   DS      128
```

SC 36 GETDATE

Function: Get formatted date.

Input parameters:

Reg DE - Address for storage

Output parameters:

Reg DE - Address of byte following formatted date.

Description:

The packed system date is unpacked and placed in the storage location addressed by the DE register pair. The format of the resulting date string is determined by the currently set date format (see the "SET COMMAND", DATEFORM option in the OASIS System Reference Manual). The DE register pair is adjusted to point to the byte following the last character of the date string.

Other system calls used: DATEOUT (106)

Other registers altered: A

Example Calling Sequence:

```
                LD      DE,WORK         ; Point to work area
                SC      36              ; Get system date
                LD      A,13            ; Get CR
                LD      (DE),A          ; Mark end
                LD      DE,MSG          ; Point to beginning of message
                SC      2               ; Display on console
                .
                .
                .
        MSG:    DC      'The current date is '
        WORK:   DS      9
```

SC 37 GETTIME

Function: Get formatted time.

Input parameters:

Reg DE - Address of storage

Output parameters:

Reg DE - address of byte following formatted time

Description:

The current packed system time is unpacked and placed in the storage location addressed by the DE register pair. The colon character is used to separate the hours, minutes, and seconds. The DE register pair is adjusted and the system call is exited.

Other system calls used: HEXO (16)

Other registers altered: A

Example Calling Sequence:

```
                LD      DE,WORK         ; Point to work area
                SC      37              ; Get system time
                LD      A,13            ; Get CR
                LD      (DE),A          ; Mark end
                LD      DE,MSG          ; Point to message
                SC      2               ; Display on console
                .
                .
                .
        MSG:    DC      'The current time is '
        WORK:   DS      9
```

SC 38 DIV

Function: 16 Bit, binary, unsigned divide.

Input parameters:

Reg DE - Divisor
Reg HL - Dividend

Output parameters:

Reg DE - Remainder
Reg HL - Quotient
Flag C - Set if divide by zero; reset otherwise

Description:

The divisor is tested. If zero the HL register pair is set to zero, the carry flag is set and the system call is exited. The value in the HL register pair is divided by the value in the DE register pair. The result is placed in the HL register pair and any remainder is placed in the DE register pair.

Other system calls used: none

Other registers altered: A

Example Calling Sequence:

```
                LD      DE,(VALUE1)     ; Divide value1
                LD      HL,(VALUE2)     ; into value2
                SC      38
                JR      C,DIVZERO       ; Divide by zero err?
                .
                .
        VALUE1: DS      2
        VALUE2: DS      2
```

SC 39 MUL

Function: 16 bit, unsigned, integer multiply.

Input parameters:

Reg DE - Multiplier
Reg HL - Multiplicand

Output parameters:

```
Reg HL - Product
Flag C - Set if overflow; reset otherwise
```

Description:

The value in the HL register pair is multiplied by the value in the DE register pair. The result is placed in the HL register pair. If overflow occurs (more than 16 bits of product) the carry flag is set. The sytem call is exited.

Other system calls used: none

Other registers altered: A

Example Calling Sequence:

```
        LD      DE,(VALUE1)     ; Multiply value1
        LD      HL,(VALUE2)     ; by value2
        SC      39
        JR      C,OVERFLO       ; BRIF error
        .
        .
        .
VALUE1: DC      (3)
VALUE2: DC      (12345)
```

SC 40 RDDIR

Function: Read logical record from a direct disk file.

Input parameters:

```
Reg BC - Record number
Reg DE - Address of FCB
Reg HL - Address of record storage area
```

Output parameters:

```
Reg A  - Return code
         00 Successful
         08 Invalid ACB number
         80 Invalid record number
         FF File not open, etc.
Flag Z - Status:
         set - okay (Reg A = 0)
         reset - error (Reg A <> 0)
```

Description:

The required I/O overlay is loaded, if necessary. The ACB is tested for an open, direct file and the appropriate return code is set if invalid. The record number and the file's filesize are compared. If the record is outside of the filesize the appropriate return code is set. The record is transferred from the file buffer with physical input performed as required.

This system call, like all logical record input/output system calls, maintains the Sector Lock Table (SLT) according to the FCB.

Other system calls used: RD1 (10)

Other registers altered: none

Example Calling Sequence:

```
                LD      HL,(RECNUM)     ; Get record number
                LD      B,H             ; Copy to BC reg
                LD      C,L             ;
                LD      HL,BUFF         ; Point to record buffer
                LD      DE,FCB1         ; Point to FCB, ch 1
                SC      40              ; Get the record
                JR      NZ,RDERR        ; Jump on error
                .
                .
      RECNUM:   DS      2               ; Current record number
      FCB1:     DC      1,01011000B     ; Direct I/O with record lock
                DW      IOBUFF1         ; I/O buffer addr
      BUFF:     DS      32              ; Record buffer
      BUFF1:    DS      256             ; I/O Buffer
```

SC 41 WRDIR

Function: Write a logical record to a direct disk file.

Input parameters:

```
Reg BC - Record number
Reg DE - Address of FCB
Reg HL - Address of record to be written
```

Output parameters:

```
Reg A  - Return code
         00 Successful
         08 Invalid ACB number
         0A Protected file
         80 Invalid record number
         FF File not open
Flag Z - Status:
         set - okay (Reg A = 0)
         reset - error (Reg A <> 0)
```

Description:

The required I/O overlay is loaded, if necessary. The ACB is tested for an open, direct file and the appropriate return code is set if invalid. The file's filesize is compared to the record number specified and the appropriate return code is set if the record number is invalid. The record is transferred to the file buffer with physical output performed as required.

This system call, like all logical record input/output system calls, maintains the Sector Lock Table (SLT) according to the FCB.

Note: The record will be truncated or padded with zeros as necessary to make the record the length specified for the file's DEB.

Other system calls used: RD1 (10), WR1 (11)

Other registers altered: none

Example Calling Sequence:

```
                LD      HL,(RECNUM)     ; Get record number
                LD      B,H             ; Copy to BC reg
                LD      C,L             ;
                LD      HL,BUFF         ; Point to record storage
                LD      DE,FCB1         ; Point to FCB, ch 1
                SC      41              ; Write it
                JR      NZ,WRERR        ; Jump on error
                .
                .
      RECNUM:   DS      2               ; Record to be accessed
      FCB1:     DC      1,01011000B     ; Ch 1, direct I/O with record lock
                DW      BUFF1           ; I/O buffer address
      BUFF1:    DS      256             ; I/O buffer
      BUFF:     DS      32              ; Record buffer
```

SC 42 NUMBER

Function: Convert numeric string (hex or dec) to 16 bit value.

Input parameters:

Reg DE - Address of character string

Output parameters:

Reg DE - Address of character following
Reg HL - Result
Flag C - Set if overflow; reset otherwise

Description:

The string of characters is examined and the number base is determined. The appropriate conversion routine is used to produce the equivalent 16 bit value in the HL register pair.

Other system calls used: DECI (15), HEXI (14)

Other registers altered: A

Example Calling Sequence:

```
        LD      DE,INPUT        ; Point to number string
        SC      42              ; Convert it
        JR      C,CONERR        ; Jump on overflow
        LD      (NUMB),HL       ; Save value
        .
        .
INPUT:  DC      '12345D'        ; Number to convert
NUMB:   DS      2               ; Value
```

SC 43 RDIX

Function: Read a logical record from an indexed disk file.

Input parameters:

Reg BC - Address of key
Reg DE - Address of FCB
Reg HL - Address of record storage area

Output parameters:

Reg A - Return code
- 00 Successful
- 01 Record not found
- 08 Invalid ACB number
- FF File not open

Flag Z - Status:
- set - okay (Reg A = 0)
- reset - error (Reg A <> 0)

Description:

The required I/O overlay is loaded, if necessary. The ACB is tested for an open, indexed file and the appropriate return code is set. The record key is searched for in the file. If the record key is found the record is transferred to the record address specified in the HL register pair and the return code is set. If the record key is not found the return code is set and the relative record number of the next record that would logically collate after the specified key is saved in the ACB.

This system call, like all logical record input/output system calls, maintains the Sector Lock Table (SLT) according to the FCB.

Other system calls used: RD1 (10), ONEONLY (84), NOTONLY (85), GETWORK (91)

Other registers altered: AF', BC', DE', HL'

Example Calling Sequence:

```
                LD      HL,KEY          ; Point to key string
                LD      B,H             ; Copy to BC reg
                LD      C,L             ;
                LD      HL,BUFF         ; Point to input buffer
                LD      DE,FCB1         ; FCB for ch 1
                SC      43              ; Read the record
                JR      NZ,NOFIND       ; Jump if record not found
                .
                .
        FCB1:   DC      1,00111000B     ; Ch 1, Indexed I/O with record lock
                DW      BUFF1           ; I/O buffer address
        BUFF1:  DS      256             ; I/O buffer
        KEY:    DS      10              ; Key of 10 characters
        BUFF:   DS      122             ; Rec of 122 characters
```

SC 44 RDNIX

Function: Read the next logically sequential record of indexed file.

Input parameters:

```
Reg BC - Address of key storage area
Reg DE - Address of FCB
Reg HL - Address of record storage area
```

Output parameters:

```
Reg A  - Return code
         00 Successful
         01 End of file
         08 Invalid ACB number
         FF File not open
Flag Z - Status:
         set - okay (Reg A = 0)
         reset - error (Reg A <> 0)
```

Description:

The required I/O overlay is loaded, if necessary. The ACB is tested for an open, indexed file and the appropriate return code is set. Using the relative record number in the ACB indicating the disk address of the next logically sequential record in the file, the record and key are read into the file buffer and transferred to the key and record storage areas specified by the BC and HL register pairs. The following logically sequential record is located and the relative record number is saved in the ACB. The return code is cleared and the system call is exited.

This system call, like all logical record input/output system calls, maintains the Sector Lock Table (SLT) according to the FCB.

Other system calls used: RD1 (10), DIV (38), RDIX (43), ONEONLY (84), NOTONLY (85), GETWORK (91)

Other registers altered: AF', BC', DE', HL'

Example Calling Sequence:

```
                LD      HL,KEY          ; Point to key string
                LD      B,H             ; Copy to BC reg
                LD      C,L             ;
                LD      HL,BUFF         ; Point to input buffer
                LD      DE,FCB1         ; FCB for ch 1
                SC      44              ; Read the next record
                JR      NZ,NOFIND       ; Jump if record not found
                .
                .
        FCB1:   DC      1,00110000B     ; Ch 1, Indexed Input
                DW      BUFF1           ; I/O buffer address
        BUFF1:  DS      256             ; I/O buffer
        KEY:    DS      10              ; Key of 10 characters
        BUFF:   DS      122             ; Rec of 122 characters
```

SC 45 WRIX

Function: Write a logical record to an indexed disk file.

Input parameters:

```
Reg BC - Address of key
Reg DE - Address of FCB
Reg HL - Address of record
```

Output parameters:

```
Reg A  - Return code
         00 Successful
         0A Protected file
         10 File full - record not written
         FF File not open
Flag Z - Status:
         set - okay (Reg A = 0)
         reset - error (Reg A <> 0)
```

Description:

The required I/O overlay is loaded, if necessary. The ACB is tested for an open, indexed file and the appropriate return code is set. The file is searched for a current record with the same key. If a record does exist the record is overwritten with the new record the return code is cleared and the system call is exited. If a record does not exist a location for the new record is found and the record is written to the file. The return code is cleared and the system call is exited. If no space is available for the new record the return code is set to 10H and the system call is exited. No attempt is made to write the record to the file in this situation.

This system call, like all logical record input/output system calls, maintains the Sector Lock Table (SLT) according to the FCB.

Other system calls used: RD1 (10), WR1 (11), DIV (38), ONEONLY (84), NOTONLY (85), GETWORK (91)

Other registers altered: AF', BC', DE', HL'

Example Calling Sequence:

```
        LD      HL,KEY          ; Point to key string
        LD      B,H             ; Copy to BC reg
        LD      C,L             ;
        LD      HL,BUFF         ; Point to input buffer
        LD      DE,FCB1         ; FCB for ch 1
        SC      45              ; Write the record
        JR      NZ,ERR          ; Jump if error
        .
FCB1:   DC      1,00101000B     ; Ch 1, Indexed output
        DW      BUFF1           ; I/O buffer address
BUFF1:  DS      256             ; I/O buffer
KEY:    DS      10              ; Key of 10 characters
BUFF:   DS      122             ; Rec of 122 characters
```

SC 46 DATEPACK

Function: Pack system date and time into 24 bit value.

Input parameters:

```
Reg DE - Address of storage area
```

Output parameters:

```
Reg DE - Address of location following
         3 byte storage area -

           4 bits of month (1 - 12)
           5 bits of day (1 - 31)
           4 bits of year (year - 1977)
           5 bits of hour (0 - 24)
           6 bits of minute (0 - 59)
```

Description:

The system date and system time are converted, formatted, and packed into a 24 bit (3 byte) format. The result is placed in the location addressed by the DE register pair and the DE register pair is adjusted.

This system call is normally only used for converting the date and time for use in a file's directory entry, although it can be used for other purposes. There is no corresponding unpack system call.

Other system calls used: none

Other registers altered: A, B, C

Example Calling Sequence:

```
        LD      DE,DIR+25       ; Point to storage
        SC      46              ; Get date and time
        .
        .
DIR:    DS      32              ; Directory entry buffer
```

SC 47 LABEL

Function: Find disk with specific label.

Input parameters:

```
Reg DE - Address of 8 character label
```

Output parameters:

```
Reg A  - Logical drive number (0 - 7) = (S - G)
Flag C - Set if not mounted; reset otherwise
```

Description:

The disks mounted in the attached disk drives are interrogated for a match with the specified disk label. The drive code of the first match found is placed in the A register. If no match is found the carry flag is set.

Other system calls used: RD1 (10), GETUCB (21), GETLUB (87), GETWORK (91), COMPARE (93)

Other registers altered: none

Example Calling Sequence:

```
        LD      DE,LABEL        ; Point to desired label
        SC      47              ; Find disk with label
        JR      C,ERR           ; Check if found
        LD      (DRIVE),A       ; Save drive number
        .
        .
        .
LABEL:  DC      'WORK    '
DRIVE:  DS      1
```

SC 48 GETSCR

Function: Get base address of your System Communication Region.

Input parameters: none

Output parameters:

Reg IY - SCR address

Description:

The first address of your SCR is placed in the IY index register and the system call is exited.

Other system calls used: none

Other registers altered: none

Example Calling Sequence:

```
SC      48              ; Get SCR base
LD      (BASE),IY       ; Save base address
```

SC 49 WAIT

Function: Wait for operator to release current console page.

Input parameters: none

Output parameters: none

Description:

The Console Screen Wait-key status is tested and, if disabled, the system call is exited. When the Console Screen Wait-key is enabled the page pause prompt character (^) is displayed at the lower left hand corner of the console output device (CONOUT) (unless the console terminal class is 0) and processing is suspended until the operator types a key to indicate that the page may be released. At this time a CR is displayed on the console and control is returned to the calling program.

Other system calls used: CONOUT (5), SYSOUT (7), GETSCR (48), GETPL (59), DEVIN (63)

Other registers altered: A

Example Calling Sequence:

```
.                       ; Code to output 'page'
.                       ; of information
.
SC      49              ; Wait at bottom if enabled
```

SC 50 RD

Function: Read multiple sectors of a disk.

Input parameters:

Reg B - Logical drive number (0 - 7) = (S - G)
Reg C - Number of sectors to read
Reg DE - First sector address.
Reg HL - Storage address

Output parameters: none

Description:

The specified drive is selected, if legal, and the sector specified by the contents of the DE register pair is read into the location indicated by the HL register pair. The sector count is decremented, the DE register pair is incremented, the HL register pair is adjusted, and, if the count is greater than zero the next sector is read.

If any errors are reported by the disk driver this system call passes control to the user DET if any or reports them to the operator on the console screen and awaits a reply.

This system call, when used in a multi-user environment, checks the Sector Lock Table (SLT) and waits if the requested sector is locked by another partition.

Caution: Use of this system call is not advised.

Other system calls used: QUIT (0), SYSIN (6), SYSOUT (7), HEXO (16), DECO (17), GETUCB (21), BDRV (26), DIV (38), SYSDISP (52), SNU (79), ONEONLY (84), NOTONLY (85), GETWORK (91), CONESC (102)

Other registers altered: A, C

Example Calling Sequence:

```
            LD      B,0             ; Drive S
            LD      DE,256          ; Starting at sector 256
            LD      C,16            ; For 16 sectors
            LD      HL,BUFFER       ; Read into buffer
            SC      50              ; Read the sectors
            .
            .
BUFFER:
            REPT    16              ; Buffer for 16 sectors
            DS      256             ;
```

SC 51 WR

Function: Write multiple sectors to disk.

Input parameters:

Reg B - Logical drive number (0 - 7) = (S - G)
Reg C - Sector count
Reg DE - First sector address
Reg HL - Address of data to be written

Output parameters: none

Description:

The specified drive is selected, if legal. The data stored at the location referenced by the HL register pair is written to the sector specified by the DE register pair. The DE register pair is incremented, the HL register pair is adjusted, and the sector count in decremented. If the sector count is not zero then the next sector is written.

If any errors are reported by the disk driver this system call passes control to the user DET if any or reports them to the operator on the console screen and awaits a reply.

This system call, when used in a multi-user environment, checks the Sector Lock Table (SLT) and waits if the requested sector is locked by another partition.

Caution: Use of this system call is not advised.

Other system calls used: QUIT (0), SYSIN (6), SYSOUT (7), HEXO (16), DECO (17), GETUCB (21), BDRV (26), DIV (38), SYSDISP (52), SNU (79), ONEONLY (84), NOTONLY (85), GETWORK (91), CONESC (102)

Other registers altered: A, C

Example Calling Sequence:

```
        LD      B,0             ; Drive S
        LD      DE,256          ; Starting at sector 256
        LD      C,16            ; For 16 sectors
        LD      HL,BUFFER       ; Write from buffer
        SC      51              ; Write the sectors
        .
        .
BUFFER:
        REPT    16              ; Buffer for 16 sectors
        DS      256             ;
```

SC 52 SYSDISP

Function: Display characters on console output device.

Input parameters:

Reg DE - Address of first character to output

Output parameters:

Reg DE - Address of last character output plus one

Description:

Characters from the buffer addressed by register pair DE are displayed on the console output device. A null character (00) terminates output to the console and returns from the system call.

A carriage return will be displayed as a carriage return, line feed and the system call will be exited. A line feed will be displayed as a carriage return, line feed, output continues. An HT character (09H) will be displayed as the proper number of spaces according to the Tab Set Block (TSB).

This system call, unlike SC 2 (DISPLAY) will always display the characters on the console and never echo them to the printer (the status of Console Echo-key and Printer Echo-key is ignored).

Other system calls used: DISPLAY (2), SYSOUT (7)

Other registers altered: A

Example Calling Sequence:

```
        LD      DE,MSG          ; Point to message string
        SC      52              ; Display on console
        .
        .
        .
MSG:    DC      'This is a message',13
```

SC 53 TIMER

Function: Set up for a clocked interrupt (event)

Input parameters:

Reg DE - Number of "ticks"
Reg HL - Address of TEB

Output parameters: none

Description:

This system call initiates a Timer Event. The contents of the DE register pair are stored in the TEB (Timer Event Block) specified by the contents of the HL register pair. The required links are made to other TEBs and control is returned to the instruction following the system call.

When the number of "ticks" specified by the DE register pair have elapsed the interrupt service routine is executed. The service routine must physically follow and be continguous to the TEB. Upon entry interrupts are enabled.

It is the responsibility of the interrupt service routine to save any and all registers used and to execute a RET when service is complete (not a RETI).

The TEB should in no way be modified by the user until the interrupt service routine has been entered. Any changes to this TEB or any other TEB still in process will cause the operating system to act erratically, at best.

The length of time for a "tick" is dependent upon the system. Refer to the Supplemental documentation supplied with the OASIS System Reference Manual for the specific length of time for a "tick" on your machine.

Other system calls used: GETBYTE (104), PUTBYTE (105)

Other registers altered: none

Example Calling Sequence:

```
            LD      DE,60           ;Set up for timed interrupt
            LD      HL,LABEL1
            SC      53              ;Start the clock
            .
            .
            .
LABEL1:     DS      6               ; TEB for above-must be 6 bytes
            .                       ;Code for interrupt service
            .                       ;must follow the TEB
            .
            RET                     ;Resume normal processing
```

SC 54 EXCMD

Function: Execute a command.

Input parameters:

Reg DE - Address of CSI command text

Output parameters: none

Description:

The Command String Interpreter is loaded and the command, with options, specified by the DE register is executed. The command is translated to upper case before interpretation. Upon completion of the command the system call is exited back to the CSI level.

When the first character of the string of characters addressed by the DE register pair is a '>' the string will be displayed on the user's console before it is executed.

Other system calls used: ?????

Other registers altered: all (No Return)

Example Calling Sequence:

```
            LD      DE,COMMAND      ; Point to command string
            SC      54              ; Transfer control
COMMAND:    DC      'ERASE *.BACKUP:A (NOQUERY NOTYPE)',13
            END
```

SC 55 GETMEM

Function: Get stored memory size.

Input parameters: none

Output parameters:

Reg HL - Address of 'end of memory'

Description:

The currently stored value of the address of the end of memory is placed in the HL register pair and the system call is exited. This value may not be the actual address of the physical end of memory determined when the system was first IPL'd. The value is the currently saved address. This address can be changed by system call 56.

Other system calls used: GETSCR (48)

Other registers altered: none

Example Calling Sequence:

```
SC      55              ; Get current EOM
LD      (EOM),HL        ; Save current EOM
LD      DE,-1000
ADD     HL,DE           ; Compute new EOM
SC      56              ; Protect it
```

SC 56 PUTMEM

Function: Store memory size.

Input parameters:

Reg HL - Address of end of memory

Output parameters: none

Description:

The value in the HL register pair updates the currently stored value of the address of the end of memory. This system call is the logical inverse of system call 55.

Other system calls used: GETSCR (48)

Other registers altered: none

Example Calling Sequence: see SC 55 (GETMEM)

SC 57 PUTQET

Function: Set quit error trap (System Cancel-key).

Input parameters:

Reg HL - Address of break routine

Output parameters: none

Description:

The value in the HL register is loaded into the quit error trap vector and the system call is exited. This routine addressed by HL will be given control whenever the System Cancel-key is typed. An address of zero (0000) in the HL register pair indicates that the user QET is to be disabled.

An example of the use of this system call is the BASIC interpreter. The BASIC interpreter sets the quit error trap to execute a routine that closes all open files before exiting.

Other system calls used: GETSCR (48)

Other registers altered: none

Example Calling Sequence:

```
        LD      HL,QETSERVC     ; Point to service routine
        SC      57              ; Set trap
        .
        .
QETSERVC:                       ; Routine to handle
                                ; System Cancel-key entry
```

SC 58 TSTDEV

Function: Test device attachment.

Input parameters:

Reg B - Logical device number

Output parameters:

Reg A - Physical device number
Flag Z - Set if not attached; reset otherwise
Flag C - Set if not attached; reset otherwise

Description:

The specified device is tested for attachment. If the device is attached the physical device number that it is attached to is placed in the A register, the Z flag is reset and the system call is exited. If the device is not attached to anything then the A register is set to FF, the Z flag is set and the system call is exited.

Other system calls used: GETLUB (87)

Other registers altered: none

Example Calling Sequence:

```
        LD      B,16            ; Point to COMM1 device
        SC      58              ; Test if attached
        JR      Z,NOCOMM        ; Jump if not
        .
        .
```

SC 59 GETPL

Function: Get console/printer page and line parameters.

Input parameters:

Reg B - Logical device number

Output parameters:

Reg B - Line length
Reg C - Page length
Reg A - Class code

Description:

The device number specified in the B register is validated to determine if it is the console or one of the printer devices. If the device number is invalid the system call is exited. If the device number is valid then the ATTACHed line and page size parameters are loaded into the B and C register, respectively and the class code is loaded into the A register.

If the specified device is not attached then zero values are returned in the registers.

Other system calls used: GETUCB (21)

Other registers altered: none

Example Calling Sequence:

```
        LD      B,9             ; Point to CONOUT device
        SC      59              ; Get parameters
        LD      (CLASS),A       ; Save class code
        LD      A,B             ;
        LD      (LINE),A        ; Save line length
        LD      A,C             ;
        LD      (PAGE),A        ; Save page length
        .
        .
```

SC 60 DELIX

Function: Delete record from indexed file.

Input parameters:

```
Reg BC - Address of key
Reg DE - Address of FCB
Reg HL - Address of record storage area
```

Output parameters:

```
Reg A  - Return code
         00 Successful
         08 Invalid ACB number
         FF File not open
Flag Z - Status:
         set - okay (Reg A = 0)
         reset - error (Reg A <> 0)
```

Description:

The required I/O overlay is loaded, if necessary. The ACB is tested for an open, indexed file and the appropriate return code is set. The record key is searched for in the file. If the record key is found the record is transferred to the record address specified in the HL register pair, the record key buffer is modified to indicate that the record is deleted (first character changed to 0FFH value) and the record is written back. The record linkages are updated to reflect the deleted record.

If the record key is not found the relative record number of the next record that would logically collate after the specified key is saved in the ACB.

This system call, like all logical record input/output system calls, maintains the Sector Lock Table (SLT) according to the FCB. If any of the sectors needed for the search and deletion of the record are locked by another partition this system call will wait for the sector to be released.

Other system calls used: RD1 (10), WR1 (11), DIV (39), RDIX (43), ONEONLY (84), NOTONLY (85), GETWORK (91)

Other registers altered: none

Example Calling Sequence:

```
                LD      HL,KEY          ; Point to record key
                LD      B,H             ; Copy to BC reg
                LD      C,L             ;
                LD      HL,REC          ; Point to record buffer
                LD      DE,FCB1         ; Point to channel 1 file
                SC      60              ; Delete the record
                JR      NZ,DELERR       ; Jump on error
                .
                .
FCB1:           DC      1,00111000B     ; Indexed, ch 1 with record lock
                DC      BUFFER          ; I/O buffer address
BUFFER:         DS      256             ;
KEY:            DS      32              ; Key is 32 character long
REC:            DS      32              ; Record is 32 character long
```

SC 61 DEVINIT

Function: Initialize a device driver.

Input parameters:

Reg B - Logical device number

Output parameters: none

Description:

The physical device driver attached to the logical device specified in the B register is entered at its initialization entry point. The actual process of initialization is device dependent. However, when the device number is 12-15 (PRINTERs) the UCB is initialized for current line, last character, and side.

The address of the UCB associated with this device is loaded into the IY register and passed to the device driver along with the B register.

Note: This system call is used by the ATTACH command when a device is first attached and should not be used by user programs.

Other system calls used: GETUCB (21), CONESC (78)

Other registers altered: all

Example Calling Sequence:

```
                LD      B,17            ; Point to COMM2 device
                SC      61              ; Init driver
                .
                .
```

SC 62 DEVST

Function: Get status of device driver.

Input parameters:

Reg B - Logical device number

Output parameters:

Flag Z - Set if input character not ready; reset otherwise
Flag C - Set if ready for output; reset otherwise

Description:

The attachment of the specified device is tested. If the device is not attached the system call is exited. If the device is attached the status of the physical device attached to the logical device specified in the B register is returned in the Z flag.

The address of the UCB associated with this device is loaded into the IY register and passed to the device driver along with the B register.

If the device driver is user written (see chapter on Interfacing to OASIS) the status of the device is dependent upon the device driver subroutine accessed by entry point 1.

Other system calls used: GETUCB (21), CONESC (78)

Other registers altered: A

Example Calling Sequence:

```
        LD      B,17            ; Point to COMM2 device
        SC      62              ; Get driver status
        .
        .
```

SC 63 DEVIN

Function: Get input of device driver.

Input parameters:

Reg B - Logical device number

Output parameters:

Reg A - Character input

Description:

The attachment of the specified device is tested. If no device is attached the system call is exited. If a device is attached the physical device driver attached to the logical device specified in the B register is entered at the input entry point. OASIS physical device drivers will not return to the caller until a character is ready. Use system call 62 to test if a character is ready.

The address of the UCB associated with this device is loaded into the IY register and passed to the device driver along with the B register.

Other system calls used: GETUCB (21), CONESC (78)

Other registers altered: none

Example Calling Sequence:

```
        LD      B,17            ; Point to COMM2 device
        SC      63              ; Get device input
        .
        .
```

SC 64 DEVOUT

Function: Put output to device driver.

Input parameters:

Reg B - Logical device number
Reg C - Character to be output

Output parameters: none

Description:

The attachment of the specified device is tested. If not attached the system call is exited. If attached the physical device driver attached to the logical device specified in the B register is given the character in the C register. The communication of the character to the device is dependent upon the specific device driver.

The address of the UCB associated with this device is loaded into the IY register and passed to the device driver along with the B register.

This system call performs special processing when the device is the console or one of the printers. When the device is the console any LF and/or FF delay specified in the device attachment is performed when the character output is a CR or LF (LF delay) or FF (FF delay). In addition, this system call handles any character delay specified by the operator with the Console Display-fast and Console Display-slow keys.

When the device is the primary printer (PRINTER1) and the spooler is active the character is passed to the spooler, not the device driver.

When the device is the primary printer and the spooler is not active or when the device is one of the secondary printers (PRINTER2-PRINTER4) special processing may occur if the character output is:

CR If last character was not CR or the printer is not performing ALF then a CR is output and any LF delay specified is performed; if the last character was a CR and the printer is performing ALF then an LF is output with any LF delay; otherwise the charcter is ignored.

LF Maintains line count; suppresses output of the LF when the previous character was a CR and the printer is performing automatic line feeds; performs any LF delay specified.

FF Maintains page side and line count; if printer is incapable of form feeds will simulate with proper number of CR, LF to advance printer to top of form; performs any FF delay specified.

US Translates to FF and processes as such.

Other system calls used: SYSOUT (7), GETUCB (21), DELAY (76)

Other registers altered: A

Example Calling Sequence:

```
        LD      B,17        ; Point to COMM2 device
        LD      C,A         ; Get character to output
        SC      64          ; Output char to device
        .
        .
```

SC 66 GETLAB

Function: Get disk label of a drive.

Input parameters:

Reg B - Logical drive number (0 - 7) = (S - G)
Reg DE - Address of storage area (8 bytes)

Output parameters: none

Description:

The drive code is tested for validity: if greater than 7 then the system call is exited. The specified drive's UCB is tested to determine if the disk label must be read from the disk - if so then the label is read. The disk label is transferred to the storage area addressed by the DE register pair and the system call is exited.

Other system calls used: GETUCB (21)

Other registers altered: A

Example Calling Sequence:

```
        LD      B,0             ; Point to system disk
        LD      DE,LABEL        ;
        SC      66              ; Get disk label
        .
        .
LABEL:  DC      '       ',0
```

SC 67 PUTDEV

Function: Store device driver address.

Input parameters:

Reg B - Physical device number
Reg HL - Address of device driver

Output parameters: none

Description:

The device number is verified to be in the range 8-32, if not the system call is exited. The address specified is loaded into the device table, overlaying any current device address in that location of the table. An address of zero (0000) in the HL register pair indicates that the specified device has been unloaded.

This system call is normally only used by the ATTACH command. It will be a lot easier for the user to allow that command to set the driver address as all of the other related house-keeping is performed by the command at that time. This system call might be used by the user for a program that uses a device in a manner different from all other programs and has its own driver for the device embedded in its code.

Other system calls used: none

Other registers altered: A, D, E, H, L

Example Calling Sequence:

```
        LD      B,17            ; Point to COMM2
        LD      HL,ENTRY        ; Point to device driver
        SC      67              ; Set driver address
        .
        .
```

SC 68 DEVUNINIT

Function: De-initialize a device driver.

Input parameters:

Reg B - Logical device number

Output parameters: none

Description:

The attachment of the specified device is tested. If not attached the system call is exited. If attached the physical device driver attached to the logical device specifed in the B register is entered at the de-initialize entry point.

The address of the UCB associated with this device is loaded into the IY register and passed to the device driver along with the B register.

Upon return from the un-init routine of the driver the associated terminal class code file is unloaded from memory (if currently at top of memory) and the device driver is unloaded from memory (if currently at top of memory).

Note: This system call is used by the ATTACH command when a device is detached and should not be used by user programs.

Other system calls used: GETUCB (21), GETMEM (55), PUTMEM (56), CONESC (78)

Other registers altered: can be all

Example Calling Sequence:

```
LD      B,17        ; Point to COMM2 device
SC      68          ; Un-init driver
.
.
```

SC 69 TSTESCC

Function: Test if Program Cancel-key entered.

Input parameters: none

Output parameters:

Flag Z - Status
Set = Not entered
Reset = Entered

Description:

The system control flag is tested to determine if the Program Cancel-key has been entered. The Program Cancel-key is defined in the System Reference Manual. If the Program Cancel-key has been entered then the Z flag is set and the A register contains a non-zero value. The control flag is cleared by this test process. If the key has not been entered then the Z flag is reset and the A register is set to zero.

The status of the control flag is also cleared by System Call 30 and by the CSI.

The Program Cancel-key is only used by OASIS language products such as the BASIC interpreter, Text Editor, and the Debugger. It would be consistent to use it in user programs that are iterative and/or interactive in function.

Other system calls used: CONST (3), GETSCR (48)

Other registers altered: A

Example Calling Sequence:

```
SC      69          ; Test program cancel
JR      NZ,NOCAN    ; Jump if not
.
.
```

SC 70 EXCMDR

Function: Execute a program and return.

Input parameters:

Reg HL - Return address
Reg DE - Address of command string buffer

Output parameters: none

Description:

This is the system call used by the system programs BASIC and EDIT when a CSI sub-command is executed. The DE register contains the address of a work area which is the CSI command string along with any options desired, terminated by a CR (13).

When this system call is executed high memory is set to the address in the

HL register, the CSI is loaded and it interprets the command in the work area specified by the DE register pair. This command may be any valid command (including an EXEC) that can fit in the memory available with the exceptions of: DEBUG and ATTACH when the device being ATTACHed is not currently attached to a logical device. These exceptions are due to the fact that those commands would normally cause a program to be loaded into high memory and "protected" at that location.

After the command has completed its execution control returns to the current high memory location.

Execution of this system call will disable any and all timer tasks whose TEB location is not included in the "protected" memory area, and a disk error trap set up by SETDET (SC 74).

Other system calls used: EXCMD (54)

Other registers altered: all (unknown)

Example Calling Sequence: not recommended for use by end user.

SC 71 BUFFI

Function: Get character from buffer.

Input parameters:

```
Reg HL - Address of buffer prefix
         Prefix:  Byte 0 = buffer length
                       1 = current size
                       2 = current location
         Prefix followed by buffer storage.
```

Output parameters:

```
Reg A  - Next character from buffer
Flag C - Set if buffer empty
```

Description:

This system call gets the next character ready for output from a FIFO buffer, probably loaded by system call 72 (BUFFO). The two system calls should be used in conjunction with each other to assist you in maintaining a FIFO stack of up to 256 byte length.

This routine and the BUFFO routine are designed to be operated by interrupt service routines although they could be used for normal processing.

Other system calls used: none

Other registers altered: none

Example Calling Sequence:

```
            LD      HL,BUFFER     ; Point to buffer
            SC      71            ; Get a byte
            .
            .
BUFFER:     DC      128           ; Buffer length
            DC      0             ; Currently used
            DC      0             ; Current byte
            DS      128           ;
```

SC 72 BUFFO

Function: Add character to buffer.

Input parameters:

```
Reg A  - character to be added to buffer
Reg HL - address of buffer prefix
         Prefix:  Byte 0 = buffer length
                       1 = current size
                       2 = current location
         Prefix followed by buffer storage.
```

Output parameters: none

Description:

This system call adds one character to a FIFO buffer maintaining the buffer pointers, etc. This routine should be used in conjunction with the BUFFI system call and is designed to be the buffer management for an interrupt service routine, although it could be used for normal programming.

When there is no room in the buffer for the character to be added the routine "hangs" until space becomes available. If the characters are not being removed by an interrupt routine the routine will continue in a two-instruction loop.

Other system calls used: none

Other registers altered: none

Example Calling Sequence:

```
            LD      HL,BUFFER       ; Point to buffer
            SC      72              ; Put a byte
            .
            .
BUFFER:     DC      128             ; Buffer length
            DC      0               ; Currently used
            DC      0               ; Current byte
            DS      128             ;
```

SC 73 PUTCON

Function: Get/set console control byte.

Input parameters:

```
Reg B - Enable mask
Reg C - Disable mask
```

Output parameters:

```
Reg A - Result
```

Description:

The console control byte is a bit-mapped byte controlling the console display and keyboard. The byte in the B register is logically ORed with the control byte and the byte in the C register is logically 1's complemented and ANDed with the control byte. The resulting control byte status is returned in the A register. If the B and C registers contain zero then the control byte is not changed and the system call merely returns the status of the control byte.

The bit-mapping of the control byte is as follows:

Bit	Function
7	Echo, on/off. When this bit set then all non-control characters typed on CONIN are displayed on CONOUT, after conversion due to the status of the other bits in this control byte.
6	Fold to upper. When this bit is set then all lowercase characters typed on CONIN are converted to uppercase.

5 Fold to lower. When this bit is set and bit 6 is off then all characters typed on CONIN are converted to their inverse casemode (only letter characters are affected).

Bits 5 and 6 function as a unit:

6	5	Function
OFF	OFF	No translation
ON	X	Translate to upper
OFF	ON	Translate to inverse

4 CTRL stop. When this bit is set then entry of any control character (value less than 32) will terminate the input.

3 CTRL delete. When this bit is set then all control characters typed on CONIN are ignored (except BS (8), TAB (9), CR (13), and CAN (24)).

2 CTRL graphic. When this bit is set and bit 7 is set then all control characters typed on CONIN are displayed on CONOUT in their graphic equivalent (an up arror (^) followed by the character equal to the control character + 64).

1 Not used.

0 Stack. Indicates EXEC stacked data available. This bit is not changeable by the system call.

Other system calls used: GETSCR (48)

Other registers altered: none

Example Calling Sequence:

```
; The following instructions will set the console
; control byte to perform the following:
;       set echo on
;       no case translation
;       accept and display CTRL char in graphics
;
LD      B,10000100B     ; Enable mask
LD      C,01111010B     ; Disable mask
SC      73              ; Set console control
.
.
```

SC 74 PUTDET

Function: Trap disk errors before message displayed.

Input parameters:

Reg HL - address of user error routine

Output parameters: none (see description)

Description:

This system call does not have any output parameters upon return to the calling program; however, when a disk error does occur certain registers do have defined values:

```
Reg B  - disk drive number
Reg DE - relative sector number
Reg HL - memory location of disk buffer
Reg A  - disk error code
         1 = Disk not ready
         2 = Disk write protected
         3 = Disk not initialized
         4 = Data CRC error
         5 = Invalid parameters
         6 = Disk label changed
         7 = Sector not found
         8 = Track not found
         9 = Address (sector/track header) CRC error
```

When the disk error occurs control is transferred to the address specified in the HL register pair. After your routine has done its processing and is ready to return control to OASIS the A register should be set to one of the following values:

```
                  00 Ignore error
01 -              FE Retry operation (no change)
                  FF Quit - return to CSI
```

To disable your disk error routine then use this system call with the HL register containing 0. (Your routine will automatically be disabled when the CSI is loaded.)

An example of the use of this system call is the VERIFY command. That command performs disk readability diagnostics and therefore needs to gain control when a disk error occurs.

Other system calls used: GETSCR (48)

Other registers altered: none (see description)

Example Calling Sequence:

```
LD      HL,DISKERR    ; Point to error routine
SC      74            ; Inform OS
.
.
```

SC 75 NEWSYS

Function: Change system disk.

Input parameters:

Reg B - new physical drive number (0 - 7)

Output parameters: none

Description:

This system call performs the same operation as the ATTACH command when the system disk is to be changed. Register B is loaded with the new physical drive number of the system disk. When the system call is executed the current system disk is accessed to read in any necessary overlays, a message is displayed to the operator asking for the new system disk to be mounted in the specified drive. (No message is displayed if the new system disk is in a different drive then old system disk). After the operator loads the disk and responds to the message the new system disk is accessed, the necessary SYSTEM files (NUCLEUS, CSI, EXECLANG, EXEC1, and ERRMSG) are located and control returns to the CSI.

The new system disk must contain a SYSTEM.NUCLEUS of the same version as the current system disk. The results will be unpredictable if the version is different.

Other system calls used: QUIT (0), CONIN (4), SYSOUT (7), MOUNT (9), RD1 (10), WR1 (11), LOOKUP (20), GETUCB (21), GETSCR (48), RD (50), SYSDISP (52), DEVST (62), DEVIN (63), PUTDET (74), DELAY (76), GETLUB (87), GETWORK (91), ERRQUIT (97)

Other registers altered: none

Example Calling Sequence:

```
        LD      B,0             ; Point to drive 0
        SC      75              ; Change system disk
        .
        .
```

SC 76 DELAY

Function: Delay processing for specified period of time.

Input parameters:

```
Reg A - formated delay time.
        Bit 7,6 - Unit of measure
                  00 = 1/1000 (millisecond)
                  01 = 1/100 second
                  10 = 1/10 second
                  11 = 1 second
        Bit 5-0 - count (1 - 63)
```

Output parameters: none

Description:

This is a general purpose processing delay routine. It was developed for the timing delay required by serial I/O devices but can be used for any purpose. When the system call is executed the formated delay factor in the A register is decoded into milliseconds and a TEB is initiated for the specified time. Then the system call waits for the TEB to be exhausted before returning control to the calling program.

Although you have access to the TEB syscall and MSEC this is a much easier and straight-forward method of long delays (up to a minute).

Processing of your program is suspended for the specified length of time but all interrupt service routines are still enabled.

Other system calls used: MSEC (53)

Other registers altered: none

Example Calling Sequence:

```
        LD      A,(DELAY)       ; Set up for delay
        SC      76              ; Delay processing
        .
        .
DELAY:  DC      11000101B       ; 5 second interval
```

SC 77 GETACB

Function: Point to Assign Control Block entry.

Input parameters:

```
Reg B  - ACB number (0 - 16)
```

Output parameters:

```
Reg HL - Address of ACB
```

Description:

The address of any assigned Assign Control Block for the number specified by the contents of the B register is returned in the HL register pair. This ACB is not the ACB address used in system call 24 but the internal copy of that ACB.

Other system calls used: none

Other registers altered: A

Example Calling Sequence: not recommended for use by end user.

SC 78 CONESC

Function: Analyze escape sequence and execute if system defined.

Input parameters:

Reg A - Second character of escape sequence

Output parameters:

Reg A - Status:
00 System handled
unchanged = undefined

Description:

This system call first changes the character in the A register to its uppercase equivalent and checks it against the defined system escape keys (A, B, C, D, I, O, P, Q, S, W,], and ^). When a match is found the appropriate action is taken and control is returned to the calling program with the A register cleared and the Z flag set. If a match is not found the Z flag is reset and the A register is left as is (folded to uppercase).

This system call is used by the SYSTEM.CLASSnn files to cause the system to act on a system defined escape sequence. When an escape character is detected the next character received is loaded into the A register and this system call is executed.

This system call could be used by a program to force a system defined function such as toggling the printer echo feature, etc. Merely load the A register with the character corresponding to the second character of the escape sequence that would be used to invoke the function from the keyboard. For a listing of these functions and character see the OASIS System Reference Manual, "System Control Keys".

Other system calls used: CONST (3), SYSIN (6), PRTOUT (8), CRLF (18), GETUCB (21), GETSCR (48), SYSDISP (52), TSTDEV (58), DELAY (76), SNU (79), GETWORK (91)

Other registers altered: none (may not return if A reg contains a 'Q' or 'I')

Example Calling Sequence:

```
LD      A,'P'           ; Toggle the PRT echo
SC      78              ;
.
.
```

SC 79 SNU

Function: Select next user.

Input parameters: none

Output parameters: none

Description:

The next active user partition is selected and control of the system transfers to it.

Although this system call is used by all other system calls that are waiting for action (input/output operations) you should use it in any code that is performing a wait without a system call. (The next user will be selected automatically when your time slice elapses but the performance of the system will be enhanced if you can give up control instead of just looping.)

When your user partition is activated again your program will continue execution at the instruction after this system call.

Note: On single user system this system call returns immediately.

Other system calls used: none

Other registers altered: AF', BC', DE', HL'

Example Calling Sequence:

```
        SC      79              ; Select next user
```

SC 80 GETBASE

Function: Get monitor (NUCLEUS) location.

Input parameters: none

Output parameters:

Reg IY - Monitor address

Description:

The first address of the SYSTEM.NUCLEUS is placed in the IY index register and the system call is exited.

Other system clls used: none

Other registers altered: none

Example Calling Sequence:

```
        SC      80              ; Get NUCLEUS base
        LD      (BASE),IY       ; Save
        .
        .
```

SC 81 GETMFG

Function: Get manufacturer number of system.

Input parameters: none

Output parameters:

Reg A - Manufacturer number

Description:

Each computer manufacturer that supports the OASIS operating system is assigned a unique value. This value can be accessed with this system call and used to determine if the manufacturer is the same as required by the program requesting it (some programs may use hardware dependant code). By using this system call a program can determine what type of computer it is running on.

Other system calls used: none

Other registers altered: none

Example Calling Sequence:

```
        SC      81              ; Get MFG number
        LD      (MFG),A         ; Save
```

SC 82 GETPIN

Function: Get your user partition number.

Input parameters: none

Output parameters:

Reg A - Your user partition identification number (PIN)

Description:

Your user partition identification number is return in the A register.

Note: On single user systems this system call will always return a 0.

Other system calls used: none

Other registers altered: none

Example Calling Sequence:

```
        SC      82              ; Get PIN
```

SC 83 UNLOCK

Function: Release a file record for another partition's use.

Input parameters:

Reg BC - Address of key, indexed files or
Record number, direct files
Reg DE - Address of FCB

Output parameters: none

Description:

The sectors of the record currently locked in the file referenced by the FCB are unlocked, allowing other users to access it. If the record is not currently locked or the system is a single-user system then nothing is performed except the return from the system call.

Other system calls used: none

Other registers altered: none

Example Calling Sequence:

```
        LD      BC,(RECNUM)     ; Get record number
        LD      DE,FCB1)        ; Point to FCB, ch 1
        SC      83              ; Unlock the record
        .
        .
        .
RECNUM: DS      2               ; Current record number
FCB1:   DC      1,01011000B     ; Direct I/O
        DW      IOBUFF1         ; I/O buffer address
```

SC 84 ONEONLY

Function: To indicate that your partition has exclusive use of a function/resource.

Input parameters:

Reg HL - Address of semaphore

Output parameters: none

Description:

The byte addressed by the HL registers is tested to determine if another user has exclusive control of it. If no other user has control then the byte is flagged to indicate that you have control and the system call is exited. If another user does have control then the next user is selected; upon return to your partition the byte is tested again, etc.

The byte addressed by the HL registers must be in true global memory

(non-bank selectable).

Note: On a single user system this system call returns immediately.

Other system calls used: SNU (79)

Other registers altered: none

Example Calling Sequence:

```
        LD      HL,USERFLAG     ; Point to your user communication flag
        SC      84              ; Get exclusive use of flag
        .
        .
        .
        LD      HL,USERFLAG     ; Point to your user communication flag
        SC      85              ; Release exclusive use of flag
```

SC 85 NOTONLY

Function: To release exclusive use of a function/resource.

Input parameters:

Reg HL - Address of semaphore

Output parameter: none

Description:

The byte addressed by the HL registers is tested to determine if another user has exclusive control of it. If your partition has exclusive control of the byte then that control is released. If your partition does not have exclusive control of the byte then the system call is exited with no action taken.

The byte addressed by the HL registers must be in true global memory (non-bank selectable).

Note: On a single user system this system call returns immediately.

Other system calls used: none

Other registers altered: none

Example Calling Sequence:

```
        LD      HL,USERFLAG     ; Point to your user communication flag
        SC      84              ; Get exclusive use of flag
        .
        .
        .
        LD      HL,USERFLAG     ; Point to your user communication flag
        SC      85              ; Release exclusive use of flag
```

SC 86 ACTIVATE

Function: To activate another, specific partition to execute some code.

Input parameters:

Reg A - Partition number to activate
Reg HL - Address to start execution at

Output parameters: none

Description:

This system call is used by the system and the multi-user commands START, STOP, FORCE, and MSG to cause another partition to become active and execute some code.

It is advised that the end user does not use this system call.

Other system calls used: none

Other registers altered: none

SC 87 GETLUB

Function: Get base address of LUB table.

Input parameters: none

Output parameters:

Reg IY - Base address of LUB table

Description:

This system call is used in some system commands. The user should not use it.

Other system calls used: GETSCR (48)

Other registers altered: A

SC 88 MSG

Function: Send a message to another user's console.

Input parameters:

Reg A - Partition number to send message to
Reg DE - Address of message to send

Output parameters: none

Description:

This system call is not intended for general usage.

The message addressed by the DE register pair is displayed on the user's console owned by the partition specified in the A register. If the partition is invalid, or inactive the system call will return immediately. If the destination's message switch is set off the message will still be sent.

Note: On a single user system this system call returns immediately.

Other system calls used: CONOUT (5), SNU (79), ONEONLY (84), NOTONLY (85), ACTIVATE (86)

Other registers altered: none

SC 89 EXCLUSIVE

Function: To gain exclusive control of key system tables, etc.

Input parameters: none

Output parameters: none

Description:

Certain critical system tables are locked so that other partitions cannot access them, thus allowing your program to alter them in some way without damage to other user's processes.

The system tables locked by this system call include: PCB table, schedule table, mailbox file, etc.

Note: On a single user system this system call returns immediately.

Other system calls used: ONEONLY (84)

Other registers altered: none

Example Calling Sequence:

```
        SC      89          ; Get exclusive use of system tables
        .
        .
        .
        SC      90          ; Release exclusive use of system tables
```

SC 90 UNEXCLUSIVE

Function: Release exclusive control of system tables.

Input parameters: none

Output parameters: none

Description:

The critical system tables locked by SC 89 are released for other user's use.

The system tables released by this system call include: PCB table, schedule table, mailbox file, etc.

Note: On single user systems this system call returns immediately.

Other system calls used: NOTONLY (85)

Other registers altered: none

Example Calling Sequence:

```
        SC      89          ; Get exclusive use of system tables
        .
        .
        .
        SC      90          ; Release exclusive use of system tables
```

SC 91 GETWORK

Function: Get base address of your SCR work area.

Input parameters: none

Output parameters:

Reg HL - Address of 256 byte SCR work area

Description:

The first address of the start of the 256 byte work buffer used by your partition's System Communication Region is return in the HL register pair.

Other system calls used: GETSCR (48)

Other registers altered: none

SC 92 GETPRIV

Function: Get the current privilege level of user.

Input parameters: none

Output parameters:

Reg A - Privilege level of user

Description:

The current privilege level of the user is returned in the A register.

Other system calls used: GETSCR (48)

Other registers altered: none

Example Calling Sequence:

```
SC      92              ; Get privilege level
CP      3               ; Compare with 3
JR      NC,OKAY         ; BRIF less
SC      0               ; Else exit
```

SC 93 COMPARE

Function: Perform string comparison.

Input parameters:

Reg BC - Length
Reg DE - Address of string 1
Reg HL - Address of string 2

Output parameters:

When string 1 = string 2:

Reg BC - 00
Reg DE - Address of byte following string 1
Reg HL - Address of byte following string 2
Flag Z - Set
Flag C - Reset

When string 1 <> string 2:

Reg BC - Count of bytes remaining
Reg DE - Address of string 1 byte not equal
Reg HL - Address of string 2 byte not equal
Flag Z - Reset
Flag C - Set if string 2 > string 1; reset otherwise

Description:

The string of characters addressed by the DE register is compared with the string of characters addressed by the HL register for the number of characters specified by the BC register. If the two sequences of characters exactly equal each other then the Z flag is set and the C flag is reset. If the two strings do not equal each other then the Z flag is reset and the C flag is set if the second string is greater in value than the first string.

Other system calls used: none

Other registers altered: A

Example Calling Sequence:

```
                LD      A,(STRING1)     ; Get length
                LD      C,A             ; Copy to C reg
                LD      B,0             ;
                LD      DE,(STRING1+1)  ; Point to string
                LD      HL,(STRING2+1)  ; Point to string
                SC      93              ; Compare strings
                JR      Z,.MATCH        ; BRIF equal
                .
                .
                .
        STRING1: DC     5,'ABCDE'
        STRING2: DC     5,'ABCde'
```

SC 94 RDBIN

Function: Get binary data stream from sequential file.

Input parameters:

```
Reg B  - Byte count to get
Reg HL - Storage area
Reg DE - Address of FCB
```

Output parameters:

```
Reg A  - Return code
         00 Successful
         01 End of file
         08 Invalid file number
         FF File not open
Flag Z - Status:
         set - okay (Reg A = 0)
         reset - error (Reg A <> 0)
```

Description:

The required I/O overlay is loaded, if necessary. The ACB is validated: open, sequential, and input. The A register is set to 255 if ACB invalid. The ACB is tested for an EOF condition and the appropriate return code is set if true and the system call is exited. If everything is okay the number of bytes indicated is read in from the file and transferred to the buffer designated by the HL register pair.

This system call, like all logical record input/output system calls, maintains the Sector Lock Table (SLT) according to the FCB.

Other system calls used: KEYIN (1), RD1 (10), DEVIN (63)

Other registers altered: B, C

Example Calling Sequence:

```
                LD      B,25            ; Get next 25 bytes from file
                LD      DE,FCB1         ; Point to file on ch 1
                LD      HL,BUFF         ; Put in BUFF buffer
                SC      94              ;
                JR      NZ,CHKERR       ; Jump if read error
                .
                .
        FCB1:   DC      1,10010000B     ; Sequential input, ch 1
                DW      BUFF1           ; I/O buffer
        BUFF1:  DS      256             ;
        BUFF:   DS      25              ; Input buffer
```

SC 95 WRBIN

Function: Put binary data stream to sequential file.

Input parameters:

```
Reg B  - Byte count to write
Reg DE - Address of FCB
Reg HL - Address of data to write
```

Output parameters:

```
Reg A  - Return code
         00 Successful
         08 Invalid file number
         10 Disk full
         FF File not open
Flag Z - Status:
         set - okay (Reg A = 0)
         reset - error (Reg A <> 0)
```

Description:

The required I/O overlay is loaded, if necessary. The ACB is validated: open, sequential, and output or append. The appropriate return code is set when invalid and the system call is exited. The number of bytes specified in the B register are writen to the file buffer and physical output is performed as required. When the file is a disk file and the file requires more allocation to perform the physical output then the file is expanded.

This system call, like all logical record input/output system calls, maintains the Sector Lock Table (SLT) according to the FCB.

Other system calls used: DISPLAY (2), WR1 (11), ALLOC (27), DEVOUT (64)

Other registers altered: B, C

Example Calling Sequence:

```
                LD      B,25            ; Write 25 bytes to file
                LD      DE,FCB1         ; On ch 1
                LD      HL,BUFF         ; From buffer BUFF
                SC      95              ;
                JR      NZ,CHKERR       ; Jump on error
                .
                .
        FCM1:   DC      1,10001000B     ; Ch 1, seq
                DW      BUFF1           ;
        BUFF1:  DS      256             ; I/O buffer
        BUFF:   DS      25              ; Data buffer
```

SC 96 ERRDIS

Function: Display error message on console

Input parameters:

```
Reg DE - Tokenized parameter list
Reg HL - Error number
```

Output parameters: none

Description:

This system call is used by all system programs to display error and standard information messages kept in the SYSTEM.ERRMSG file (see System Reference Manual).

The DE register pair need only be loaded with the address of the tokenized parameter list if the message contains parameter replacement codes. The tokenized parameter list is a list of parameters in ASCII, each parmeter eight (8) bytes in length with no delimiting characters. Use trailing spaces if the parameter is not eight characters.

Other system calls used: CONOUT (5), RD1 (10), CRLF (18), GETSCR (48), GETWORK (91)

Other registers altered: none

Example Calling Sequence:

```
        LD      DE,PARAM        ; Point to parameters
        LD      HL,47           ; Display message # 47
        SC      96              ;
        .
        .
PARAM:  DC      '123    HELLO   '
```

SC 97 ERRQUIT

Function: Display error message and re-boot.

Input parameters:

```
Reg DE - Address of parameter list
Reg HL - Message number
Reg A  - Return code
```

Output parameters: none

Description:

This system call is identical to system call 96 (ERRDIS) except that control does not return to the calling program. After the message is displayed control will return to the CSI with the return code set to the value in the A register.

Other system calls used: QUIT (0), ERRDIS (96)

Other registers altered: all (no return)

Example Calling Sequence:

```
        LD      HL,23           ; Message # 23
        LD      A,4             ; Return code = 4
        SC      97              ;
        .
        .
```

SC 98 OVERLAY

Function: Program overlay load (for system use only).

Input parameters:

```
Reg A  - Directory type (1 = relocatable, 2 = absolute)
Reg B  - Drive code
Reg DE - Starting disk address of program
Reg HL - Address of overlay list:
         0-1 Memory address to load into
         1-3 Length to load, in bytes
         4   Number of sectors to load
         5-6 Sector number, relative to program start
```

Output parameters: none

Description:

The overlay segment of your program indicated by the input parameters is loaded into memory at the address indicated. This system call always performs the overlay, even if it is the same overlay as is already in memory. Therefore, it is the responsibility of your program to test whether the overlay is needed.

The drive code and starting sector number of your program used in the input registers B and DE respectively are available when your program is first invoked by the CSI. For more information refer to the chapter "Interfacing to OASIS" in this manual.

When the overlay is relocatable the sector count of the overlay must include the relocation table.

Other system calls used: RD1 (10), GETSCR (48), RD (50), GETWORK (91)

Other registers altered: none

Example Calling Sequence:

```
            LD      A,(OVERLAY)     ; Get current overlay number
            CP      1               ; Test if already loaded
            JR      Z,OVERLAY+1     ; BRIF is
            LD      A,1             ; Segment is relocatable
            LD      B,(PRGDRIVE)    ; Drive code of program
            LD      DE,(PRDSECT)    ; Starting sector of program
            LD      HL,SEG1TABLE    ; Overlay table 1
            SC      98              ; Get overlay
            JR      OVERLAY+1       ; Continue in overlay
            .
            .
            .
SEG1TAB:    DC      (OVERLAY)       ; Address of overlay region
            DC      (OVEREND-OVERLAY+1) ; Overlay region length
            DC      4               ; Sector count, including rel table
            DC      23              ; Relative sector # of segment
```

SC 99 CALLOC

Function: Conditional allocation.

Input parameters:

```
Reg B  - Logical drive code (0 - 7) = (S - G)
Reg DE - Maximum desired blocks of allocation
Reg HL - Minimum desired blocks of allocation
```

Output parameters:

```
Reg A  - 00 successful; FF unsuccessful
Reg DE - Actual number of blocks allocated
Reg HL - Sector number of first block allocated
Flag Z - Set if able to allocate minimum; reset otherwise
Flag C - Set if error; reset if okay
```

Description:

The disk is tested for its largest contiguous area available. If this area is smaller in size than that requested for the minimum allocation the Z flag will be reset and the system call exited. If this area is at least the size of the minimum allocation requested space will be allocated, up to the maximum space requested. The return registers are set to reflect the amount and location of the space actually allocated.

Other system calls used: RD1 (10), WR1 (11), TSTDEV (58), ONEONLY (84), GETWORK (91)

Other registers altered: A

Example Calling Sequence:

```
            LD      B,1             ; Point to A drive
            LD      DE,20           ; Maximum of 20 blocks
            LD      HL,4            ; Minimum of 4 blocks
            SC      99              ; Allocate space
            JR      NZ,NOSPACE      ; Insufficient space
            LD      (SIZE),DE       ; Save actual alloc size
            LD      (SECT),HL       ; Save first sect number
            .
            .
            .
```

SC 100 DISPATCH

Function: Perform table lookup.

Input parameters:

```
Reg DE - Address of string to lookup
Reg HL - Address of start of table
         Table: Minimum spelling
                Match string
                Related address
```

Output parameters:

```
Reg HL - Related address if match found
Flag Z - Set if match found
         reset otherwise
```

Description:

The table designated by the HL register pair is searched for a match with the string addressed by the DE register pair. If a match is found the Z flag is set and the HL register pair is loaded with the third field in the matching table entry. If no match is found the Z flag is reset and the HL register pair is undefined.

The string addressed by the DE register pair and the strings in the table are of variable length. The string to look up is terminated by a non-alphanumeric non dollar sign character. The last character of the strings in the table is marked with the parity bit (bit 7 on). This is automatically performed by the assembler when the double quote mark is used (see DC directive).

The end of the table is marked with a binary zero entry.

Other system calls used: none

Other registers altered: A, B, C

Example Calling Sequence:

```
            LD      DE,STRING       ; Point to string
            LD      HL,TABLE        ; Point to table
            SC      100             ; Lookup
            JR      NZ,NOTFOUND     ; BRIF not found
            JP      (HL)            ; Else branch to related address
            .
            .
            .
STRING:     DC      'THIS IS A STRING',0
TABLE:      DC      1               ; Minimum spelling
            DC      "FILELIST"      ; Match string
            DC      (FILELIST)      ; Related routine
            DC      4,"FILT8080",(FILT8080)
            DC      2,"FORCE",(FORCE)
            DC      10,"THIS IS A STRING",(EXIT)
            DC      0               ; End of table
```

SC 101 GETUSER

Function: Get the current user account number.

Input parameters: none

Output parameters:

```
Reg A  - User account number id
```

Description:

The user id number currently logged onto this partition is returned in the A register. The user id number is the number used by the system to distinguish different owning accounts. The system accounts have an id number of zero; user accounts have an id number in the range 1 - 254.

Other system calls used: GETSCR (48)

Other Registers altered: none

Example Calling Sequence:

```
SC      101             ; Get user id
LD      (CUR$USER),A    ; Save it
.
.
.
```

SC 102 CHARIN

Function: Perform console input character translate and escape sequence actions.

Input parameters:

Reg A - Character input
Reg IY - Address of UCB

Output parameters:

Reg A - Character to be used
Flag C - Set if character to be ignored by driver
reset otherwise

Description:

This system call provides a simple and consistent method for a device driver to make sure that the OASIS system console escape sequences are handled properly. It is advised that all user written device drivers that accept input from a device and that might be attached as a console device use this system call for each character that is input. (The driver should check to see if it is the console first to improve performance.)

This system call tests to see if the device is the conole input device. If not then the system call is exited with the carry flag reset. When the device is the console the system call checks to see if there is a SYSTEM.CLASSnn file loaded--if so then the character is passed to that routine. If not then the character is checked to see if it is part of an escape sequence. When the character is part of an escape sequence from the console input device the appropriate action is taken and the carry flag is set before the system call is exited.

Other system calls used: GETSCR (48), CONESC (78)

Other registers altered: A

For an example see the appendix on programing examples.

SC 103 PUTVECT

Function: To insert an interrupt vector address into the system table.

Input parameters:

Reg A - Relative vector number
Reg DE - Vector transfer address

Output parameters: none

Description:

This system call is used to inform the operating system where an interrupt service routine is located at. It is mandatory that this system call be used for this purpose in a multiuser, multi-memory bank system and it should be used in all other types of systems for convenience and consistency.

The relative vector number in the A register is a number in the range of 2 - 6 (mode 0), 0 - 7 (mode 1) or 0 - 127 (mode 2), corresponding to the desired priority of the interrupt (mode 1) or the vector number that the interrupting device will give to the system when it interrupts (mode 0 or 2). The interrupt service routines for the three modes of interrupts are similar except the mode 1 service routine must first poll its device to

determine if it was the device causing the interrupt; if not then the routine performs a return without enabling interrupts (the system will call the next routine in the vector table). The relative vector number for mode 1 determines the "priority" or sequence that the service routine will be called when an interrupt occurs.

The vector transfer address in the DE register pair is the address of the interrupt service routine for the vector number in the A register. When the system has multiple memory banks available to it the operating system will keep track of which bank that particular address is in.

Other system calls used: none

Other registers altered: none

Example Calling Sequence:

```
LD      A,2             ; Vector number 2
LD      DE,INT          ; Input interrupt
SC      103             ; Put vector
```

SC 104 GETBYTE

Function: Transfer byte(s) from another partition space.

Input parameters:

```
Reg A  - Partition identification number of partition to get from
Reg BC - Count of bytes to get
Reg DE - Address of buffer to transfer bytes to (your partition)
Reg HL - Address of buffer to transfer bytes from (his partition)
```

Output parameters:

```
Reg BC - 0
Reg DE - Address following bytes transferred (your partition)
Reg HL - Address following bytes transferred (his partition)
         Interrupts are disabled
```

Description:

This system call functions similar to an LDIR instruction in a single user system.

In a multi-user system this system call allows you to transfer a character or string of characters from another partition to your partition, even though that other partition may be in different bank of memory.

Note: Upon return from this system call interrupts have been disabled. It is your responsibility to re-enable them if they should be on.

Other system calls used: none

Other registers altered: none

Example Calling Sequence:

```
LD      A,2             ; From partition two
LD      HL,5000H        ; From his location 5000
LD      DE,4F00H        ; To my location 4F00
LD      BC,20H          ; For 32 bytes
SC      104             ; Transfer
EI                      ; Enable interrupts
```

SC 105 PUTBYTE

Function: Transfer byte(s) to another partition space.

Input parameters:

```
Reg A  - Partition identification number of partition to put to
Reg BC - Count of bytes to put
Reg DE - Address of buffer to transfer bytes to (his partition)
Reg HL - Address of buffer to transfer bytes from (your partition)
```

Output parameters:

```
Reg BC - 0
Reg DE - Address following bytes transferred (his partition)
Reg HL - Address following bytes transferred (your partition)
         Interrupts are disabled
```

Description:

This system call functions similar to an LDIR instruction in a single user system.

In a multi-user system this system call allows you to transfer a character or string of characters to another partition from your partition, even though that other partition may be in different bank of memory.

Note: Upon return from this system call interrupts have been disabled. It is your responsibility to re-enable them if they should be on.

Other system calls used: none

Other registers altered: none

Example Calling Sequence:

```
LD      A,2             ; To partition two
LD      HL,5000H        ; From my location 5000
LD      DE,4F00H        ; To his location 4F00
LD      BC,20H          ; For 32 bytes
SC      105             ; Transfer
EI                      ; Enable interrupts
```

SC 106 DATEOUT

Function: Translate a packed BCD date to string format.

Input parameters:

```
Reg C  - Month number (BCD)
Reg H  - Day number (BCD)
Reg L  - Year number (BCD)
Reg DE - Storage area
```

Output parameters:

```
Reg DE - End of formatted date plus one
```

Description:

The date specified by the C, H, and L registers is converted and formatted according to the currently set DATEFORM.

Note: This system call does not validate the date input.

Other system calls used: HEXO (16), GETSCR (48)

Other registers altered: none

Example Calling Sequence:

```
LD      C,03            ; Month 3 - March
LD      H,22            ; Day 22
LD      L,93            ; Year 1993
LD      DE,BUFFR        ; Storage area
SC      106             ; Convert to string form
```

SC 107 WAITINT

Function: Deactivate current partition until interrupt occurs.

Input parameters: none

Output parameters: none

Description:

This system call is similar to system call 79 (SNU) in that the next user partition is activated. Unlike SC 79 this system call informs the operating system that the current partition is not to be activated again until an interrupt occurs that needs this partition to be serviced.

This system call allows greater throughput for a multi-user system in that any partition using it that is waiting for an event to happen (i.e., waiting for the operator to type another key) will not waste a lot of CPU time merely determining that it is still waiting.

When this system call is used (as it is in all OASIS supplied device drivers) control will return to the instruction following the call when any interrupt occurs from a device attached to this partition. However, the interrupting device may not be the event that was required by your partition. Therefore upon return to your program you should re-check the status of the device that you were waiting for.

Other system call used: SNU (79)

Other registers altered: none

Example Calling Sequence:

```
IN:     CALL    STATUS      ; Check status of device
        JR      NZ,IN1      ; Skip if ready
        SC      107         ; Else deactivate
        JR      IN          ; Re-check status
IN1:
```

SC 108 FINDPGM

Function: Return address of a loaded, re-entrant program.

Input parameters:

Reg DE - Address of program name desired (8 characters)

Output parameters:

Flag Z - Set if found
Reset otherwise
Reg HL - Address of program if found

Description:

This system call searches the Re-entrant Program Table (RPB) for a match with the program name specified by the DE register pair. If the program is found in the table the starting address is loaded into the HL register pair, the Z flag is set and the system call exited.

When the program name specified by the DE register pair is not found in the RPB the Z flag is reset and the system call is exited.

Other system calls used: COMPARE (93)

Other registers altered: none

Example Calling Sequence:

```
        LD      DE,NAME         ; Point to program name
        SC      108             ; Find program
        JR      NZ,LOADIT       ; BRIF not found
        JP      (HL)            ; Else branch to loaded program

NAME:   DC      'BASIC   '
```

SC 109 PUTTOD

Function: Pass system time of day to user supplied time of day routine.

Input parameters: none

Output parameters: none

Description:

The currently set system time of day is passed to a user supplied routine that will initialize a time of day clock.

Other system calls used: none

Other Registers altered: none

SC 110 PUTDAY

Function: Pass system date to user supplied date routine.

Input parameters: none

Output parameters: none

Description:

The currently set system date is passed to a user supplied routine that will initialize a calendar/clock.

Other system calls used: none

Other Registers altered: none

CHAPTER 8

Z80 CPU OVERVIEW

8.1 Addressing modes

Most of the Z80 instructions operate on data stored in internal CPU registers, external memory or in the I/O ports. Addressing refers to how the address of this data is generated in each instruction. This section gives a brief summary of the types of addressing used in the Z80.

Immediate - In this mode of addressing the byte following the op-code in memory contains the actual operand. Examples of this type of instruction would be to load the accumulator with a constant, where the constant is the byte immediatlely following the op-code.

```
LD A,25
```

Immediate Extended - This mode is merely an extension of immediate addressing in that the two bytes following the OP code are the operand. Examples of this type of instruction would be to load the HL register pair with 16 bits of data.

```
LD HL,LABEL
```

Modified Page Zero Addressing - The Z80 has a special single byte call instruction to any of 8 locations in page zero of memory. This instruction (referred to as a restart) sets the Program Counter (PC) to an effective address in page zero. The value of this instruction is that it allows a single byte to specify a complete 16 bit address where commonly called subroutines are located, thus saving memory space.

```
RST 38
```

Relative Addressing - Relative addressing uses one byte of data following the op-code to specify a displacement from the existing program to which a program jump can occur. This displacement is a signed two's complement number that is added to the address of the op-code of the following instruction.

```
JR LABEL
```

The value of relative addressing is that it allows jumps to nearby locations while only requiring two bytes of memory space. For most progams, relative jumps are by far the most prevalent type of jump due to the proximity of related program segments. The signed displacement can range between +127 and -128. Another advantage is that it allows for relocatable code.

Extended Addressing - Extended addressing provides for two bytes (16 bits) of address to be included in the instruction. This data can be an address to which a program can jump or it can be an address where an operand is located. Extended addressing is required for jumps with a displacement greater than 127.

```
LD HL,(LABEL)
```

When extended addressing is used to specify the source or destination address of an operand, the notation (nn) is used to indicate the content of memory at nn, where nn is the 16 bit address specified in the instruction. This means that the two bytes of address nn are used as a pointer to a memory location. The use of the parentheses always means that the value enclosed within them is used as a pointer to a memory location. For example, (1200) refers to the contents of memory at location 1200.

Indexed Addressing - In this type of addressing the byte of data following the op-code contains a displacement which is added to one of the two index registers (the op-code specifies which index register is used) to form a pointer to memory. The contents of the index register are not altered by this operation. An example of an indexed instruction would be to load the contents of the memory location (Index Register + displacement) into the accumulator. The displacement is a signed two's complement number. Indexed addressing greatly simplifies programs using tables of data since the index register can point to the start of any table. Two index registers are provided since very often operations require two or more tables. Indexed addressing also allows for relocatable code.

```
LD HL,(IX+3)
```

To indicate indexed addressing the notation: (IX+d) or (IY+d) is used. Here d

is the displacement specified after the OP code. The parentheses indicate that this value is used as a pointer to external memory.

Register Addressing - Many of the Z80 op-codes contain bits of information that specify which CPU register is to be used for an operation. An example of register addressing would be to load the data from register B into register C.

```
LD A,B
```

Implied Addressing - Implied addressing refers to operations where the op-code automatically implies one or more CPU reigisters as containing the operands. An example is the set of arithmetic operations where the accumulator is always implied to be the destination of the results.

```
ADD C
```

Register Indirect Addressing - This type of addressing specifies a 16 bit CPU register pair (such as HL) to be used as a pointer to any location in memory. This type of instruction is very powerful and it is used in a wide range of applications. The symbol (HL) specifies that the contents of the HL register are to be used as a pointer to a memory location.

```
LD A,(HL)
```

Bit Addressing - The Z80 contains a large number of bit set, reset and test instructions. These instructions allow any memory location or CPU register to be specified for a bit operation through one of three previous addressing modes (register, register indirect and indexed) while three bits in the op-code specify which of the eight bits is to be manipulated.

```
SET 3,D
```

Many instructions include more than one operand (such as arithmetic instructions or loads). In these cases, two types of addressing modes may be employed.

```
BIT 7,(IX)
```

8.2 Registers

The Z80 CPU contains 208 bits of Read/Write static memory that are accesible to the programmer. This memory is configured into eighteen 8 bit registers and four 16 bit registers.

General Purpose Registers

There are two matched sets of general purpose registers, each set containing six 8 bit registers that may be used individually as 8 bit registers (B, C, D, E, H, L) or as 16 bit register pairs by the programmer. One set is called BC, DE, and HL while the complementary set is called BC', DE', and HL'. At any one time the programmer can select only one set of registers to work with, althrough a single exchange command exchanges the contents of the entire set. In systems where fast interrupt response is reguired, one set of general purpose registers and an accumlator/flag register may be reserved for handling this very fast routine. Only a simple exchange command need be executed to go between the routines.

Accumulator and Flag Registers

The CPU includes two independent 8 bit accumulators (A and A') and associated 8 bit flag registers (F and F'). The accumulator holds the results of 8 bit arithmetic or logical operations while the flag register indicates specific conditions for 8 or 16 bit operations, such as indicating whether or not the result of an operation is equal to zero. The programmer selects the accumulator and flag pair that he wishes to use with a single exchange instruction so that he may easily work with the contents of either pair.

Special Purpose Registers

1. **Program Counter (PC).** The Program Counter holds the 16 bit address of the current instruction being fetched from memory. The PC is automatically incremented after its contents have been transferred to the address lines. When a program jump occurs the new value is placed in the PC, overriding the incrementer.

2. **Stack Pointer (SP).** The stack pointer holds the 16 bit address of the current top of a stack located anywhere in external system RAM memory. The external stack memory is organized as a last-in, first-out (LIFO) file. Data can be

pushed onto the stack from specific CPU registers or popped off of the stack into specific CPU registers through the execution of PUSH and POP instructions. The data popped from the stack is always the last data pushed onto it. The stack allows simple implementation of multiple level interrupts, unlimited subroutine nesting and simplification of many types of data manipulation.

3. **Two Index Registers (IX and IY).** The two independent index registers hold a 16 bit base address that is used in indexed addressing modes. In this mode, an index register is used as a base to point to a region in memory from which data is to be stored or retrieved. An additional byte is included in indexed instructions to specify a displacement from this base. This displacement is specified as a two's complement signed integer. This mode of addressing greatly simplifies many types of programs, especially where tables of data are used.

4. **Interrupt Page Address Register (I).** The Z80 CPU can be operated in a mode where an indirect call to any memory location can be achieved in response to an interrupt. The I Register is used for this purpose to store the high order 8 bits of the indirect address while the interrupting device provides the lower 8 bits of the address. This feature allows interrupt routines to be dynamically located anywhere in memory with absolute minimal access time to the routine.

   Caution: The Interrupt Page Address Register is used extensively by the OASIS Operating System. Any change to this register will cause unpredictable and probably disastrous results.

5. **Memory Refresh Register (R).** The Z80 CPU contains a memory refresh counter to enable dynamic memories to be used with the same ease as static memories. This 7 bit register is automatically incremented after each instruction fetch. The data in the refresh counter is sent out on the lower portion of the address bus along with a refresh control signal while the CPU is decoding and executing the fetched instruction. This mode of refresh is totally transparent to the programmer and does not slow down the CPU operation. The programmer can load the R register for testing purposes, but this register is normally not used by the programmer.

8.3 Flags

The flag register (F and F') supplies information to the user regarding the status of the CPU at any given time. The bit positions for each flag is shown below:

7	6	5	4	3	2	1	0
S	Z	X	H	X	P/V	N	C

Where:

S = Sign flag
Z = Zero flag
H = Half-Carry flag
P/V = Parity /Overflow flag
N = Add/Subract flag
C = Carry flag
X = Not used

Each of the two CPU flag registers contains 6 bits of status information which are set or reset by CPU operations. Four of these bits are testable (C,P/V,Z and S) for use with conditional jump, call or return instructions. Two flags are not testable (H,N) and are used for BCD arithmetic.

Carry Flag (C)

The carry flag is sometimes referred to by the symbol CY.

The carry bit is set or reset depending on the operation being performed. For ADD instructions that generate a carry and SUBTRACT instructions that generate no borrow, the carry flag will be set. The carry flag is reset by an ADD that does not generate a carry and a SUBTRACT that generates a borrow. Also the DAA instruction will set the carry flag if the conditions for making the decimal adjustment are met.

For instructions RLA, RRA, RLS and RRS, the carry bit is used as a link between the LSB and MSB for any register or memory location. During instrucitons RLCA, RLC s and SLA s, the carry contains the last value shifted out of bit 7 of any register or memory location. During instructions RRCA, RRC s, SRA s and SRL s the carry contains the last value shifted out of bit 0 of any register or memory location.

For the logical instructions AND s, OR s and XOR s, the carry will be reset.

The carry flag can also be set (SCF) and complemented (CCF).

Add/Subtract Flag (N)

This flag is used by the decimal adjust accumulator instruction (DAA) to distinguish between ADD and SUBTRACT instructions. For all add instructions, N will be set to 0. For all subtract instructions N will be set to 1.

Parity/Overflow Flag (P/V)

This flag is set to a particular state depending on the operation being performed.

For arithmetic operations, this flag indicates an overflow condition when the result in the Accumulator is greater than the maximum possible number (+127) or is less than the minimum possible number (-128). This overflow condition can be determined by examining the sign bits of the operands.

This flag is also used with logical operations and rotate instructions to indicate the parity of the result. The number of '1' bits in a byte are counted. If the total is odd, then P is set to 0. If the total is even then P is set to 1.

When inputting a byte from an I/O device, the flag will be adjusted to indicate the parity of the data.

Zero Flag (Z)

The zero flag is set or reset if the result generated by the execution of certain instructions is a zero.

For 8 bit arithmetic and logical operations, the Z flag will be set to a 1 if the resulting byte in the Accumulator is zero. If the byte is not zero, the Z flag is reset to 0.

For compare and search instructions, the Z flag will be set to a 1 if a comparison is found between the value in the accumulator and the memory location pointed to by the contents of the register pair HL.

When testing a bit in a register or memory location, the Z flag will contain the complemented state of the indicated bit.

Sign Flag (S)

The sign flag stores the state of the most significant bit of the accumulator. When the CPU performs arithmetic operations on signed numbers, binary two's complement notation is used to represent and process numeric information. Therefore bit 7 of the accumulator indicates the sign of the result.

When inputting a byte from an I/O device to a register, the S flag will indicate either positive (S=0) or negative (S=1) data.

CHAPTER 9

INTERFACING TO OASIS

9.1 General Information

All programs to be accessed by the Command String Interpreter should be written as a "large" subroutine using a RET instruction when finished or, preferably, SC 0 (QUIT).

When a program is executed by the CSI the HL register pair will contain the address of the first character of the tokenized command string (the program name is excluded); the IX index register will contain the address of the list of delimiters used in the command string; the B register will contain the drive code that the program came from; the DE register pair will contain the starting sector number of the program on disk.

The tokenized command string is a list of the words used in the command, each word translated to upper case and filled out (or truncated) to eight characters (trailing spaces are added when necessary). The open parentheses at the beginning of an option list is considered to be a word by itself and the list is terminated by a token of a carriage return (0DH).

The list of delimiters used is merely a list of the characters that were used to separate the words in the command string. This list matches in a one-to-one relation to the tokenized command string starting with the delimiter between the program name and the first word following. When multiple characters (spaces) are used to separate two words only the first character is placed in the list of delimiters. An open parentheses is assumed to be followed by a space character even when no delimiter is actually used. The list is always terminated by a CR charcter.

For example:

```
>PROG NAME.TYPE:LABEL (OPT1 OPT2,OPT3
```

When control is passed to the program named PROG the HL and IX registers will be addressing the following character strings:

```
(HL): 4E414D45 20202020 54595045 20202020 'NAME    TYPE    '
      4C414245 4C202020 28202020 20202020 'LABEL   (       '
      4F505431 20202020 4F505432 20202020 'OPT1    OPT2    '
      4F505433 20202020 0D202020 20202020 'OPT3    .       '

(IX): 202E3A20 20202C0D                   ' .:   ,.'
```

The quotes used in the tokenized list are only for documenting the trailing spaces and are not actually in the list.

Note: The list of tokens is always terminated by a CR token.

The information provided by these two registers allows the program to access all of the data and options specified in the command.

The information provided in the B and DE registers allows the program to get any program overlay segments, if used.

9.2 Peripheral Device Drivers

The OASIS operating system contains many of the device drivers that are normally needed. For special peripherals or applications it might be desirable for you to write your own device driver

A user written device driver should be written using the same format and protocalls as the OASIS device drivers, even when you don't plan to interface OASIS to your driver--you may want to in the future.

OASIS device drivers are written as relocatable subroutines. Each device driver has five entry point vectors, one for each major function of the driver. The sequence of these entry point vectors is as follows:

```
    JP  ST      ; ST is entry point of device status subroutine
    JP  IN      ; IN is entry point of input byte routine
    JP  OUT     ; OUT is entry point of output byte routine
    JP  INIT    ; INIT is entry point of device initialization
    JP  UNINIT  ; UNINIT is entry point of device de-intialization
```

It is not necessary to actually use the jump instructions at these entry points but each entry point vector must be three bytes in length.

Each of the five routines in a device driver is a subroutine that is called by certain system calls. These subroutine functions, requirements, and system calls are described below.

ST Accessed by system call 62. Input to this routine is the physical device number in the B register, and the UCB address in the IY register. The responsibility of this routine is to return the status of the device in the Z and C flags. This routine should not actually read the byte of data. If it is necessary to read the byte to determine the status then the byte should be saved in an input buffer area.

Z	Set = no input available
Z	Reset = input available
C	Set = output ready
C	Reset = output not ready

If the device is an output only device then this routine should always set the Z flag, indicating that there is no data to be read in from the device.

IN Accessed by system call 63. Input to this routine is the physical device number in the B register, and the UCB address in the IY register. The responsibility of this routine is to return one byte of input from the device in the A register. If no byte is available from the device this routine should wait (use SC 107 for interrupt driven device or SC 79 for non-interrupt driven devices). It should be the responsibility of the calling program to test if a byte was available or not. When register A is set to zero it means that a data byte of zero was input, not that there was no byte available.

If the device driver is for an output only device then this entry point should return immediately.

This routine (non-interrupt system) or the interrupt input routine should use system call 102 (CHARIN) for every character input to trap any escape sequence entered and to perform character translations.

OUT Accessed by system call 64. Input to this routine is the physical device number in the B register, the UCB address in the IY register, and the character to be output in register C. This routine accepts a byte of output from register C and outputs the byte to the device. An interrupt driven device might just store the byte in its buffer and return control to the caller, allowing an interrupt service routine to actually output the byte. However, this routine should handle all error conditions relating to output to the device.

INIT Accessed by system call 61. Input to this routine is the physical device number in the B register, and the UCB address in the IY register. The responsibility of this routine is to initialize the device driver and the device. The OASIS ATTACH command calls this entry point once when the device is attached to a logical name.

If the device is an interrupt driven device this routine would establish the interrupt vector using SC 103, initialize the I/O buffer, etc.

UNINIT Accessed by system call 68. Input to this routine is the physical device number in the B register, and the UCB address in the IY register. The responsibility of this routine is to un-intiialize the device. The OASIS ATTACH command calls this entry point once when the device is detached from a logical name.

If the device is an interrupt driven device this routine would probably make sure that the I/O buffer was empty, disable the interrupt for this routine using SC 103, etc.

When an interrupt service routine is entered the interrupts are disabled. The routine must enable the interrupts before an RETI instruction is executed. The interrupts may be enabled any time after entry to the routine but make sure that the routine is prepared for another interrupt to itself when the interrupts are enabled.

All routines, interrupt or otherwise, should restore the status of any registers used and not specified as part of the input or output parameters.

Multi-user note: an interrupt driven device driver must take into account the fact that the owning partition may not be the active partition when the calling interrupt occurs. It may be necessary to activate the owning partition in order to service the interrupt. The system calls 84 (ONEONLY), 85 (NOTONLY), and 86 (SETPIN) may assist you in this task.

Interfacing user written device drivers to OASIS

To interface a user written device driver to the OASIS operating system you must follow these steps:

1. Decide upon a device number. OASIS references physical device drivers by their number. The numbers used by OASIS for the device drivers supplied may be found by listing the file SYSTEM.DEVNAMES. If your device driver is to replace the one provided with the operating system then you should use the same number as that (you may want to save the OASIS driver by renaming it).

2. After you have decided upon a number for your device driver then you must give it a name that OASIS will recognize as a device driver. All device drivers have a file name of SYSTEM and a file type of DEVnn where nn is the device number. The OASIS LINK command has an option (SYSTEM) that will cause the load image program generated to have a name of SYSTEM and a file type equal to the file name of the object file being processed.

   The device number that you use to give a name to your device driver also determines the UCB number that it uses. Keep in mind that external device numbers (device names, attach numbers, etc.) are base 1 and the internal device numbers are base 0.

3. If you are not replacing an existing device driver you will probably have to add an entry to the SYSTEM.DEVNAMES file so that the driver can be loaded by the ATTACH command by specifying a name rather than a number. The format of this file is discussed in the OASIS System Reference Manual in the appendix "System Files".

4. Attach your device to a logical device name using the ATTACH command. Your device driver is now available for other programs to use by referencing the logical name or number attached to the device. If the system is re-booted the driver will not be reloaded automatically unless a SYSGEN was performed while your device was ATTACHed. To reload your driver all that is necessary is that it be re-ATTACHed.

For an example listing of a peripheral device driver refer to the appendix on "Program Examples".

9.3 Disk Device Drivers

The OASIS operating system contains at least one disk device driver to handle the disk(s) that the operating system resides on. Disk drivers to handle other types of disk drives and controllers can be written by the end user or distibutor and can be loaded with the ATTACH command to make multiple disk drivers on-line at one time.

A user written disk device driver should be written using the same format and protocalls as the OASIS disk device driver.

OASIS disk drivers are written as relocatable subroutines. Each disk driver has four entry point vectors, one for each major function of the driver. The sequence of these entry point vectors is as follows:

```
JP  SELECT   ; SELECT is entry point of disk select subroutine
JP  RESTORE  ; RESTORE is entry point of disk restore subroutine
JP  READ     ; READ is entry point of disk read subroutine
JP  WRITE    ; WRITE is entry point of disk write subroutine
```

It is not necessary to actually use the jump instructions at these entry points but each entry point vector must be three bytes in length.

Each of the four routines in a disk device driver is a subroutine that is called by certain system calls. These subroutine functions, requirements, and system calls are described below.

SELECT Accessed by system calls 50 and 51. Index register IY contains the address of the UCB of the disk to be selected; register A contains the physical drive number (0 - 7) of the drive to be selected. This physical drive number may have to be adjusted to properly address the drive(s) associated with this device driver. This routine doesn't perform any function with the disk drive or controller--it merely specifies which drive subsequent operations are to be performed on.

RESTORE Accessed by system calls 50 and 51. Index register IY contains the address of the UCB of the disk to be restored. This routine's function is to "recalibrate" the drive--position the heads on track 0 with the assumption that it is unknown where the heads are currently located at.

It is probable that this routine would perform no direct function other than setting a switch indicating that the next read or write operation to this drive is to first perform the restore operation.

READ Accessed by system call 50. Index register IY contains the address of the UCB of the disk to be read from; register A contains the number of consecutive sectors to be read; register B contains the head number; register C contains the sector number; register pair DE contains the cylinder number; register pair HL contains the address in memory that the information is to be read into. All values are base zero.

This routine should perform the physical I/O required to read the specified sectors into the memory area indicated. Sectors are always considered 256 bytes long, independant of the actual sector size of the disk. It is the responsibility of this routine to adjust the number and location of the sectors desired to correspond with the physical sector size of the disk, if different.

This routine should not perform any error recovery procedures. If an error occurs the operation should be stopped, the pertinent registers adjusted to reflect the location of the error, the A register should be set to reflect the type of error, and the Z flag should be reset to indicate that an error occured. Any retry or recovery operations will be handled by system software outside of this device driver.

When the disk read is succesfull the pertinent registers should be adjusted to point to the sector following that which was just read, the A register should be set to zero and the Z flag should be set.

This routine, as called by the OASIS system call, <u>never</u> asks to read consecutive sectors that cross a cylinder or head boundary.

WRITE Accessed by system call 51. Index register IY contains the address of the UCB of the disk to be written to; register A contains the number of consecutive sectors to be written; register B contains the head number; register C contains the sector number; register pair DE contains the

cylinder number; register pair HL contains the address in memory that the information is to be written from. All values are base zero.

This routine should perform the physical I/O required to write the specified sectors from the memory area indicated. Sectors are always considered 256 bytes long, independant of the actual sector size of the disk. It is the responsibility of this routine to adjust the number and location of the sectors desired to correspond with the physical sector size of the disk, if different.

This routine should not perform any error recovery procedures. If an error occurs the operation should be stopped, the pertinent registers adjusted to reflect the location of the error, the A register should be set to reflect the type of error, and the Z flag should be reset to indicate that an error occured. Any retry or recovery operations will be handled by system software outside of this device driver.

When the disk write is succesfull the pertinent registers should be adjusted to point to the sector following that which was just written, the A register should be set to zero and the Z flag should be set.

This routine, as called by the OASIS system call, never asks to write consecutive sectors that cross a cylinder or head boundary.

Note that there is no initialization entry point. It is the responsibility of the select routine to check if the device needs initialization (maybe a DC of zero is coded--when routine is first loaded that location will still be zero--that the select routine sets to a one after the device is initialized).

Disk error codes

The following standard error codes should be returned by a disk device driver when an error occurs:

1 - Disk not ready
2 - Disk write protected
3 - Disk not initialized -- possibly a time out or wrong density dete
4 - Data CRC error
5 - Invalid parameters -- can't happen
6 - Disk label changed -- or disk changed or door opened
7 - Sector not found
8 - Track not found
9 - Address CRC error

Interfacing user written disk device drivers to OASIS

To interface a user written disk device driver to the OASIS operating system you must follow these steps:

1. Decide upon a device number--OASIS references the disk drivers by their number. The numbers used by OASIS for disk devices are in the range of 1 through 8. however, do not use a number associated with the disk driver included in the OASIS NUCLEUS (generally 1 thru 4).

2. After you have decided upon a number for your driver then you must give it a name that OASIS will recognize as a device driver. All device drivers have a file name of SYSTEM and a file type of DEVnn where nn is the device number. The OASIS LINK command has an option (SYSTEM) that will cause the load image program generated to have a name of SYSTEM and a file type equal to the file name of the object file being linked.

3. Add the device name of your driver to the SYSTEM.DEVNAMES file. A disk driver may have multiple entries in this file to reflect the multiple disks that it controls. A record in this file for a disk device driver has the following format:

   <logical name> <device number> D <other numbers shared>

   The <logical name> is a two to eight character name that you will use when you ATTACH a drive code to a disk. It is best if the name also identifies the disk drive in some meaningful manner. For example, a disk driver for a XYZ hard disk drive should probably be named XYZ1 or XYZ2, etc.

   The <device number> is the number that you decided upon in step 1.

<Other numbers shared> is a list of device numbers that are controlled by this one disk driver. This is best explained by an example. Say that you have written a disk driver for a disk controller that interfaces to four drives, numbered 5, 6, 7, and 8. You would probably use the number 5 for the disk driver number and the name XYZ5 for its logical name. The entries in the SYSTEM.DEVNAMES file would then look like this:

```
XYZ5 5 D 5 6 7 8
XYZ6 6 D 5 6 7 8
XYZ7 7 D 5 6 7 8
XYZ8 8 D 5 6 7 8
```

The above example indicates that device numbers 5, 6, 7, and 8 are all controlled by device driver number 5. There will only be one copy of the driver loaded into memory for all four drives that may be attached to it.

4. Attach your device to a logical name using the ATTACH command, similar to the way you attach logical names to the OASIS supplied disk driver--A, B, etc.

Note that there is no un-initialize entry point in a disk device driver. This means that the device driver will not be unloaded from memory when all disks are detached from it. Once this auxillary disk driver is loaded into memory the only way to recover the memory used by the driver is to re-boot the system (assuming that it was not sysgened).

For an example listing of a disk device driver refer to the appendix on "Program Examples".

9.4 Tape Device Drivers

Tape drivers that interface to certain tape controllers are available with the OASIS operating system. For other tape controllers it might be desirable for you to write your own device driver.

A user written tape device driver should be written using the same format and protocalls as the OASIS device drivers, even when you don't plan to interface OASIS to your driver--you may want to in the future.

OASIS device drivers are written as relocatable subroutines. Each tape device driver has six entry point vectors, with the first five being dummy entry points corresponding to the five entry points for general peripheral device drivers. These first five entry points merely clear the carry flag, set the zero flag and return. The six entry point is the only real entry to the tape driver. Upon entry to this routine the A register contains the command to be performed by the driver:

```
80   Select drive and track
81   Rewind selected drive
82   Read from selected drive
83   Write to selected drive
84   Backspace selected drive one record
85   Forspace selected drive one record
86   Write record gap on selected drive
87   Write tape mark on selected drive
88   Stop the selected tape
89   Return status of selected tape
```

The return status from the driver is in the Z flag and the A register:

```
 Z 00 Success - okay
NZ 01 Drive not ready
NZ 02 Drive write protected
NZ 03 Tape mark sensed
NZ 04 CRC error detected
NZ 05 End of tape sensed
NZ 06 Start of tape sensed
NZ 07 Data late
```

Interfacing user written tape drivers to OASIS

Refer to the section 'Peripheral Device Drivers' in this chapter for information about interfacing your tape driver.

For a listing of a model that can be used to write your tape driver routine refer to the appendix on "Program Examples".

9.5 Terminal Class Code Drivers

The OASIS operating system provides a uniform interface to the console terminal cursor controls. Because most terminal manufacturers use a slightly different and unique coding sequence to control the actions of the terminal it is cumbersome for an application program to be coded such that it is capable of communicating with different types of terminals. In OASIS an application program is coded using an internally defined standard (another, unique standard) for cursor control. The characters used in the standard are described in the OASIS System Reference Manual, appendix "Terminal Class Codes".

The translation between the OASIS internal standard and the control codes used by the actual terminal is performed in a small subroutine that interfaces between the operating system and the device driver. Several different terminal class code subroutines are supplied with the operating system.

If your terminal uses a set of cursor control codes that is not handled by one of the class code subroutines supplied you will have to write your own or not use cursor control. However it is very easy to write your own subroutine to handle your particular terminal due to the macro definitions supplied in the file CLASS.MACLIB.

To write your own terminal class code subroutine create an assembly program with the name CLASSnn where the nn is the class code number you wish to use. Use the MACLIB pseudo op-code to get the macro definitions in CLASS.MACLIB file into your program. The three macros you will be using are described below:

INIT Performs the subroutine initialization required of a class code subroutine. This macro reference must be the first code in your program. This macro routine has all the code in it to handle any character translations undefined with the following macro (DEFINE) and handles all of the standard, OASIS input escape sequences (see OASIS System Reference Manual, chapter "System Control Keys").

This macro also allows you to specify up to eight characters that are to be translated and the values that they are translated to. To use this feature merely specify the translation list in the operand field (see example six in the appendix of program examples in this manual).

DEFINE Defines the relationship between the internal codes and the codes used by the terminal. The first argument to this macro is the name of the internal code such as CLEAR, HOME, EOL, etc. Subsequent arguments to this macro are the characters to be sent to the terminal to perform the desired function. All of the ASCII control characters are defined with the appropriate value so that you may use names such as ESC, DC1, etc.

The DEFINE macro reference is used as many times as is necessary to define the functions of the terminal. No special sequence is required and any undefined functions may be omitted.

Any function that your terminal is not capable of performing (i.e., BON) should be defined with no output list (see example six again).

Any function that your terminal is not capable of performing but can be simulated by the operating system (EOL and EOS only) should not be defined in your program. When this is done the operating system will simulate the function by outputting spaces and repostioning the cursor to the orginal location.

Any function that should be followed with the ATTACHed form feed delay should have its definition end with the argument 8CH which will be interpreted by the macro as indicating the form feed delay is to be added after the output of the function.

DCA Indicates the start of the cursor address coding routine. The DCA macro name may be followed by a numeric operand specifying the pre-defined class code number that uses the exact same cursor control algorithm.

The DCA macro call is followed by the routine that will output to the terminal the proper codes to perform the addressing of the cursor. Upon entry to the routine the following registers will be defined:

A Control character to translate (not used by your cursor address routine)
B Device number of the console terminal (always a 9)
C Same as register A
H Column number to position to, base 0
L Line number to position to, base 0

When your routine outputs the codes to the terminal you must use system call 64. (Using system call 2, 5, 7, or 52 might cause an infinite loop.)

After you have output the proper codes to the terminal clear the carry flag and perform a return. If the carry flag is set when you return it will indicate to OASIS that the function could not be performed and that OASIS is to try to simulate it with software. This may be done by performing a HOME followed by line feeds and non-destructive cursor advances.

Example six in the appendix of program examples lists a terminal class code subroutine for the SOROC IQ 120 terminal.

9.6 System Start-up Program

The OASIS operating system provides the capability of loading and executing a program (machine language) automatically whenever the operating system is "booted". The program that is loaded must be named SYSTEM.STARTUP, must reside on the system disk, be owned by the system (public) account, and be relocatable.

The SYSTEM.STARTUP program may do "anything" that you may require this type of program to do (i.e., automatically interface to calendar circuitry). This program is loaded after memory is sized by the operating system but before any device drivers are loaded. The program is loaded into current high memory and is called by the operating system. The program should do whatever is necessary at this time and exit by executing a RET instruction.

It is the responsibility of this program to protect itself when you want it to be in memory after the system is started. Use system call 55 and 56 to protect the memory that the program needs.

If you are using the SYSTEM.STARTUP program capability to interface a calendar/clock device you should be aware of four locations in the SYSTEM.NUCLEUS that help you in this regards:

BASE+004AH Should contain the address of your subroutine that will return the current time of day.

BASE+004CH Should contain the address of your subroutine that will return the current date.

BASE+0062H Should contain the address of your subroutine that will program your clock to the currently set system time. This location is used by SC 109 and the SET TIME command to program your clock.

BASIC+0064H Should contain the address of your subroutine that will program your calendar to the currently set system date. This location is used by SC 110 and the SET DATE command to program your calendar.

The system startup program must set these locations in the NUCLEUS to the proper addresses of your subroutines (contained in the SYSTEM.STARTUP program) if you want OASIS and its utilities to use your calendar/clock hardware.

9.7 USR Programs

A USR program is an assembler language subroutine accessed by a BASIC language program through a special function call. Only one parameter is passed to the subroutine and only one parameter may be returned to the BASIC program. The input and output parameter types must be the same: 16 bit numeric or a character string.

The USR routine must be a relocatable program

A USR subroutine may have an unlimited number of entry points but each entry point may only perform processing on one type of parameter. This is due to the fact that there is no way of detecting what the parameter type is. A USR routine may perform processing independent of the input and/or output parameter.

The BASIC program accesses the various entry points of a USR routine by specifying the address of the entry point relative to the load address of the subroutine. It is best to make the entry points simple, such as: 0, 3, 6, etc. To do this jump vectors should be used, similar to the device drivers discussed above. This not only makes the entry point addressing simple but also allows for modifications to the program without requiring changes to the entry point addressing in the BASIC program.

A USR routine may use, without restoring, any and all of the registers. BASIC makes no assumptions regarding the integrity of the registers (with the exception of the HL register pair and the SP!). The USR routine, in turn, should make no assumptions about the integrity of the registers (except the HL register pair and the SP!) as BASIC may use any and all of the registers between calls to your USR.

A numeric parameter is passed to a USR routine via the HL register pair. If a parameter is to be returned to the BASIC program it must be placed in the HL register pair. This implies a limit of 16 bit numbers.

A string parameter is passed to a USR routine via the BASIC string accumulator. The string accumulator start address is in the HL register. The string accumulator is a 256 byte buffer used by BASIC for all string manipulations. The first byte of this buffer is a count of the number of characters following. The string parameter returned to the BASIC program may be in the string accumulator or in an internal buffer (up to 256 bytes). In either case the HL register pair must address the first byte of the buffer used when the return is made to BASIC and this first byte must be the count of the characters in the buffer. If the string accumulator is used care must be taken to insure that the 256 byte limit is not exceeded because volatile information precedes and follows this buffer.

When LINKing your USR routine be sure to use the USR option as it will cause the file type of your load module to be BASICUSR, a requirement of the BASIC interpreter.

For example listings of USR routines refer to the appendix on Program Examples.

9.8 BASIC Fields

It is not advised that you write programs that access the variables in a BASIC program directly. This is primarily due to the fact that the variable storage area of BASIC is dynamic, even its base address. You should use the USR feature of BASIC to pass the field to your assembly program. However, it may be necessary for you to know the format of variables maintained by BASIC, internally to BASIC and/or externally in a file.

Format of BASIC Variables

BASIC variables are formatted the same whether maintained internally or on a disk file. However, file fields have an extra byte of information preceding the content of the field. This extra byte is a code indicating that the field is a string, integer, or floating point field.

String Fields

String fields are simplistic in format: the code is a binary 6 followed by the length of the string (range of 0 to 255) followed by the individual characters of the string.

Integer Fields

An integer field has a code of a binary 4 followed by the 16 bit signed binary number, most significant byte first.

Floating Point Fields

A floating point field has a code of a binary 3 followed by a one byte characteristic in excess 128 format (characteristic in two's complement plus 128), followed by a nibble (four bits) specifying the sign of the mantissa, followed by 52 bits of the normalized mantissa in BCD.

A code field of 0 indicates the end of record.

Examples:

Field	Type	Contents
060550616765 20	S	Page
041234	I	+4660
04FEA7	I	-345
038202345678000000	F	+.2345678E+2
037E81234567890123	F	-.1234567890123E-2

APPENDIX A

SYSTEM CALL SUMMARY

0	QUIT	Reload the Command String Interpreter - restart
1	KEYIN	Accept a line of input from the console keyboard
2	DISPLAY	Display characters on console output device
3	CONST	Get status of console input device
4	CONIN	Accept one character from the console input device
5	CONOUT	Display one character on console output device
6	SYSIN	Accept one character from console, ignoring ESC,O and ESC,P
7	SYSOUT	Display one character on console, ignoring ESC,O and ESC,P
8	PRTOUT	Output one character to PRINTER1 device
9	MOUNT	Allow change of diskette on a specified drive
10	RD1	Read one sector from disk
11	WR1	Write one sector to disk
12	IPL	Perform initial program load
13	WRFDIR	Create new file directory entry
14	HEXI	Convert hexadecimal number to 16 bit binary
15	DECI	Convert decimal number to 16 bit binary
16	HEXO	Convert 8 bit value to hexadecimal characters
17	DECO	Convert 16 bit unsigned value to decimal string
18	CRLF	Display carriage return, line feed on console
19	MSEC	Wait specified number of milliseconds
20	LOOKUP	Locate directory entry of file
21	GETUCB	Get address of UCB
22	LOAD	Load a program
23	PRINT	Output a line to PRINTER1 device
24	ASSIGN	Store ACB
25	ADRV	Convert logical drive code to drive number
26	BDRV	Convert drive number to logical drive code
27	ALLOC	Allocate space for file on disk
28	DEALL	Deallocate space for file on disk
29	ERASE	Erase logical file from a disk
30	FETCH	Load program in memory, execute, restart
31	RENAME	Rename a logical disk file
32	OPEN	Open a logical file
33	CLOSE	Close a logical file
34	RDSEQ	Read a logical record from a sequential file
35	WRSEQ	Write a logical record to a sequential file
36	GETDATE	Get formatted date
37	GETTIME	Get formatted time
38	DIV	16 bit, binary, unsigned divide
39	MUL	16 bit, binary, unsigned, integer multiply
40	RDDIR	Read logical record from a direct disk file
41	WRDIR	Write a logical record to a direct disk file
42	NUMBER	Convert numeric string to 16 bit value
43	RDIX	Read a logical record from an indexed disk file
44	RDNIX	Read the next logical record from an indexed disk file
45	WRIX	Write a logical record to an indexed disk file
46	DATEPACK	Pack system date and time into 24 bits
47	LABEL	Find disk with specified label
48	GETSCR	Get base address of user System Communication Region
49	WAIT	Wait for operator to release current console page
50	RD	Read multiple sectors of a disk
51	WR	Write multiple sectors to a disk
52	SYSDISP	Display characters on console, ignoring ESC,O and ESC,P
53	TIMER	Set up for a clocked interrupt
54	EXCMD	Execute a command
55	GETMEM	Get current high memory
56	PUTMEM	Set new high memory
57	PUTQET	Change routine for service of System Cancel-key
58	TSTDEV	Test device attachment
59	GETPL	Get console/printer page and line parameters
60	DELIX	Delete a record from an indexed file
61	DEVINIT	Initialize a device driver
62	DEVST	Get status of device driver
63	DEVIN	Get input from device driver
64	DEVOUT	Put output to device driver
66	GETLAB	Get label of specified disk drive
67	PUTDEV	Store device driver address
68	DEVUNINIT	Uninitialize a device driver
69	TSTESCC	Test if Program Cancel-key entered
70	EXCMDR	Execute a program and return
71	BUFFI	Get character from buffer
72	BUFFO	Put character to buffer
73	PUTCON	Get/set console control byte
74	PUTDET	Set address of disk error trap

75	NEWSYS	Change system disk
76	DELAY	Delay processing for specified period of time
77	GETACB	Point to Assign Control Block
78	CONESC	Perform System Control-key function
79	SNU	Select next user
80	GETBASE	Get base address of NUCLEUS
81	GETMFG	Get system manufacturer number
82	GETPIN	Get your user partition id number
83	UNLOCK	Unlock record of file
84	ONEONLY	Set flag for exclusive use of resource
85	NOTONLY	Release exclusive use of resource
86	ACTIVATE	Activate specific partition
87	GETLUB	Get Logical Unit Block table base address
88	MSG	Send message to another user's console
89	EXCLUSIVE	Get exclusive control of key resources
90	UNEXCLUSIVE	Release exclusive control of key resources
91	GETWORK	Get user System Communication work area address
92	GETPRIVLEV	Get current privilege level
93	COMPARE	Perform string comparison
94	RDBIN	Get binary data stream from file
95	WRBIN	Put binary data stream to file
96	ERRDIS	Display error message
97	ERRQUI	Display error message and quit
98	OVERLAY	Load overlay of program
99	CONDALL	Conditional allocation
100	DISPATCH	Perform table lookup
101	GETUSER	Get current user account number
102	CHARIN	Console input character analysis
103	PUTVECT	Point vector to interrupt service routine
104	GETBYTE	Get bytes from another partition
105	PUTBYTE	Put bytes to another partition
106	DATEOUT	Convert BCD date to standard format
107	WAITINT	Deactivate partition until interrupt occurs
108	FINDPGM	Get address of re-entrant program
109	PUTTOD	Put time of day to clock device
110	PUTDAY	Put date to calendar device

SC		Inputs	Outputs
0	QUIT	A=return code	no return
1	KEYIN	DE=addr,B=len	A=len,DE=next
2	DISPLAY	DE=addr	DE=next
3	CONST		Z
4	CONIN		A=char
5	CONOUT	C=char	
6	SYSIN		A=char
7	SYSOUT	C=char	
8	PRTOUT	C=char	
9	MOUNT	B=drive	
10	RD1	B=drive,DE=sect,HL=addr	
11	WR1	B=drive,DE=sect,HL=addr	
12	IPL	B=drive,DE=sect	
13	WRFDIR	B=drive,DE=DEB	
14	HEXI	DE=addr	HL=num,DE=next
15	DECI	DE=addr	HL=num,DE=next
16	HEXO	B=number,DE=addr	DE=next
17	DECO	DE=addr,HL=number	DE=next
18	CRLF		
19	MSEC	A=msec count	
20	LOOKUP	DE=DCB,HL=buffer addr	Z,DE=sec,HL=addr
21	GETUCB	B=device	HL=UCB
22	LOAD	DE=DCB,HL=addr	CY,A=code,B=drive
23	PRINT	DE=addr	DE=next
24	ASSIGN	B=ACB #,DE=ACB	
25	ADRV	B=ASCII drive #	A=bin drive
26	BDRV	B=bin drive #	A=ASCII drive
27	ALLOC	B=drive,DE=block count	HL=sect
28	DEALL	B=drive,DE=block count,HL=sect	
29	ERASE	DE=DCB	
30	FETCH	B=drive,DE=DEB	no return
31	RENAME	DE=old DCB,HL=new DCB	
32	OPEN	DE=FCB	
33	CLOSE	DE=FCB	
34	RDSEQ	DE=FCB,HL=addr	
35	WRSEQ	DE=FCB,HL=addr	
36	GETDATE	DE=addr	DE=next
37	GETTIME	DE=addr	DE=next
38	DIV	DE=divisor,HL=dividend	HL=quotient
39	MUL	DE=multiplier,HL=muliplicand	HL=product
40	RDDIR	BC=key,DE=FCB,HL=addr	
41	WRDIR	BC=key,DE=FCB,HL=addr	
42	NUMBER	DE=addr	DE=next,HL=number
43	RDIX	BC=key addr,DE=FCB,HL=addr	
44	RDNIX	BC=key addr,DE=FCB,HL=addr	
45	WRIX	BC=key addr,DE=FCB,HL=addr	
46	DATEPACK	DE=addr	DE=next
47	LABEL	DE=label addr	A=drive
48	GETSCR		IY=SCR
49	WAIT		
50	RD	B=drive,C=count,DE=sect,HL=addr	
51	WR	B=drive,C=count,DE=sect,HL=addr	
52	SYSDISP	DE=addr	DE=next
53	TIMER	DE=count,HL=TEB	
54	EXCMD	DE=addr	no return
55	GETMEM		HL=addr
56	PUTMEM	HL=addr	
57	PUTQET	HL=addr	
58	TSTDEV	B=device #	NZ,A=code
59	GETPL	B=dev	B=line,C=page
60	DELIX	BC=key,DE=FCB,HL=rec	
61	DEVINIT	B=dev	
62	DEVST	B=dev	NZ=in rdy,CF=out rdy
63	DEVIN	B=dev	A=char
64	DEVOUT	B=dev,C=char	
66	GETLAB	B=dev,DE=addr	
67	PUTDEV	B=phy dev,DE=addr	
68	DEVUNINIT	B=dev	
69	TSTESCC		Z=no ESC,C
70	EXCMDR	DE=cmd,HL=ret addr	All regs modified
71	BUFFI	HL=buffer	A=char
72	BUFFO	A=char,HL=buffer addr	
73	PUTCON	B=sets,C=clears	A=new mask
74	PUTDET	HL=addr	

	SC	Inputs	Outputs
75	NEWSYS	B=new phy S	
76	DELAY	A=time code	A=0
77	GETACB	B=ACB #	HL=ACB addr
78	CONESC	A=2nd esc char	
79	SNU		
80	GETBASE		IY=base
81	GETMFG		A=MFG
82	GETPIN		A=PIN
83	UNLOCK	DE=FCB	
84	ONEONLY	HL=resource	
85	NOTONLY	HL=resource	
86	ACTIVATE	A=PIN,HL=addr	
87	GETLUB		IY=LUB
88	MSG	A=PIN,DE=addr	DE=next
89	EXCLUSIVE		
90	UNEXCLUSIVE		
91	GETWORK		HL=addr
92	GETPRIVLEV		A=priv
93	COMPARE	BC=len,DE=1st,HL=2nd	
94	RDBIN	B=len,DE=FCB,HL=addr	
95	WRBIN	B=len,DE=FCB,HL=addr	
96	ERRDIS	DE=parms,HL=msg #	
97	ERRQUI	A=RC,DE=parm,HL=msg #	no return
98	OVERLAY	B=drive,DE=base,HL=addr	
99	CONDALL	B=drive,DE=min,HL=max	DE=actual,HL=addr
100	DISPATCH	DE=string,HL=table	Z,HL=arg from table
101	GETUSER		A=user
102	CHARIN	A=char	NC,A=new char
103	PUTVECT	A=num,DE=addr	
104	GETBYTE	BC=len,DE=my,HL=his	DI, like LDIR
105	PUTBYTE	BC=len,DE=his,HL=my	DI, like LDIR
106	DATEOUT	C=mm,H=dd,L=yy,DE=addr	DE=next
107	WAITINT		
108	FINDPGM	DE=name	Z,HL=addr
109	PUTTOD		
110	PUTDAY		

APPENDIX B
ERROR MESSAGES

Operator Cancelled

***** Duplicate Label -or- Phase Error *****

Indicates that the address of the instruction has a different value between pass one and pass two. Usually indicates that the label is defined more than once.

nn errors in program

Indicates the total number of detected errors in the program.

***** Invalid Expression *****

***** Label Error *****

Indicates that an invalid character was used in a label. Labels must use only the alphabetic characters and the dollar sign character. Local labels must start with a period character. Macro local labels must start with the at (@) character.

***** Label Required *****

The label field is blank on a directive that requires a label. These directives include: ABS, COM, ENTER, EQU, REL, and VALUE.

***** Macro Definition Error *****

Indicates a construction or syntax error in a macro definition. Usually results from a missing ENDM directive or an attempt to define a macro within a macro definition.

***** Nested too Deep *****

Indicates that an attempt was made to push more than eight IF, ORG, USING, LIST, or macro calls onto their respective nesting stacks or an attempt was made to pop one of the above from their stack when no argument was on their stack.

***** Overflow *****

Indicates that more bits are required to contain value than are permitted in expression type. For example a relative jump of more than +127 or -128.

***** Relocation Error *****

Indicates that an expression containing relocatable symbols is in error. Usually the error is one of the following: a difference between two relocatable symbols of different PABs; the sum of two relocatable symbols; the product of two relocatable symbols; the quotient of two relocatable symbols; the product or quotient of a relocatable symbol and an absolute symbol; a valid relocatable expression used in an operand that may only have eight or seven bits of precision.

***** Segment not Found *****

Indicates that the file description of a COPY or LINK directive can not be found in any of the attached directories.

***** Statement Syntax Error *****

Indicates that the operand is invalid for the op-code or that there is a missing delimiter in the operand.

Symbol Table Overflow

The size of the symbol table is determined by the amount of available memory during the assembly process. There are several things that can be done to remove this error: add more memory; unload the system Debugger if loaded; unload unused device drivers; unload any loaded, re-entrant programs (SPOOLER, BASIC, etc.); remove unreferenced symbols from the program; reduce the use of local labels; use shorter symbol names; segment the program to allow for smaller assemblies (make the LINK program join them together).

***** Undefined Operation *****

Indicates an invalid op-code or directive was used or a reference is made to an undefined macro. Specifically the Assembler searches its op-code table, its directive table, internally defined macros, external macro files. When the op-code field does not match any of these it is determined to be an undefined operation.

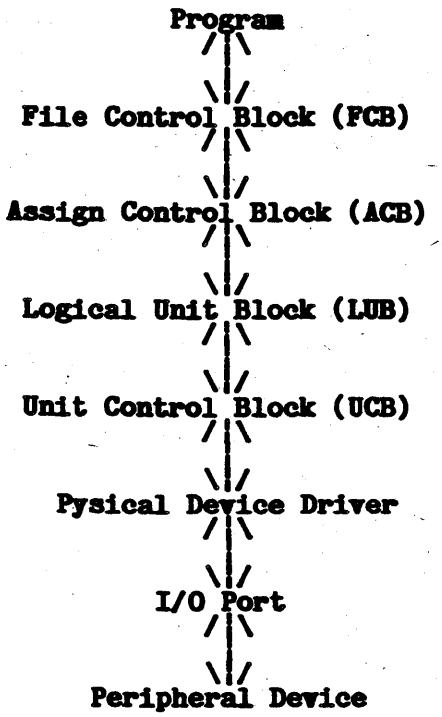
***** Undefined Symbol *****

Indicates a reference was made to a symbol not defined.

APPENDIX C

CONTROL BLOCK DEFINITIONS

The following short diagram illustrates the bidirectional communication linkages that are followed when a program (user or system) requests input or output to a logical file. Non file input or output is similar except that the program links directly to the Logical Unit Block.



Unit Control Block (UCB)

Devices (8 - 31)

Byte	Description
00	Driver address
02	Line length
03	Page length
04	Class code
05	Code Baud / Code Baud / Code Baud

Code	Baud	Code	Baud	Code	Baud
1	75	6	600	11	9600
2	110	7	1200	12	19200
3	134.5	8	2400	13	1800
4	150	9	4800	14	2000
5	300	10	7200	15	3600

Byte	Description
05	Bit 7 on indicates CONIN device Bit 6 on indicates ESC lead in received (used by class code files)
06	CR/LF delay
07	FF/EOS/EOL delay
08	Bit / On / Off

Bit	On	Off
7	Parity enable	No parity
6	Odd parity	Even parity
5	8 bit data	7 bit data
4	Syncronous	Asyncronous
3	Page parity	No page parity
2	Auto LF	No auto LF
1	No FF	FF ability
0	SDLC	

Byte	Description
09	Overflow count
0A	Current line
0B	Reserved
0C	Reserved
0D	Speed delay
0E	Device driver length
10	Translate routine length
12	Input buffer address
14	Output buffer address
16	Translate routine address
18	Video base address/ i-o address base
1A	Video cursor address
1C	Bit / Output-busy / Input-busy

Bit	Output-busy	Input-busy
0	-DTR	-DSR
1	XOFF/XON	XOFF/XON
2	ETX/ACK	ETX/ACK
3	-CTS	-RTS

Byte	Description
1D	Work area (2 bytes)
1F	Owner pin

Unit Control Block (UCB)

Disk Devices (0 - 7)

Byte	Description
00	Driver address
02	Volume id label
0A	Number of heads
0B	Number of cylinders
0D	Number of sectors
0E	Directory size
10	Clusters available (blocks)
12	Interleave count
13	WP/IBM/Additional -

Bit	Meaning
7	Write protected
6	Track 0 single density (IBM 2D)
5-0	Number additional map sectors

14	Current cylinder
16	Head load delay
17	Step time delay
18	Settle time delay
19	Work area (6 bytes)
1F	Owner (0FFH=public)

File Control Block (FCB)

Byte	Description
00	ACB number (0 - 16)
01	File format and I/O mode

Bit	On
7	Sequential
6	Direct
5	Indexed
4	Input
3	Output
2	Append - (sequential format only)
1	Reserved
0	File lock

Both bits 3 and 4 on means update with record lock.
Both bits 5 and 6 on means keyed format.

02-03 Address of I/O buffer
(same length as sector size)

Assign Control Block (ACB)

Byte	Description
00	Drive code (0-7, 255=all)
01-08	File name (trailing blanks, if necessary)
09-10	File type (trailing blanks, if necessary)
11	Logical device number, base 0

0 = not assigned
1 = any disk
8 = console
10 - 23 = logical device number (i.e., PRINTER1, COMM2)
255 = dummy

12-1F System defined

Directory Control Block (DCB)

Byte	Description
00	Drive code (0-7, 255=all)
01-08	File name (trailing blanks, if necessary)
09-10	File type (trailing blanks, if necessary)

Directory Entry Block (DEB)

Byte	Contents
00	File format: 11111111 = Deleted 00000000 = Empty - never used 10000000 = Synonym ...00001 = Relocatable ...00010 = Absolute ...00100 = Sequential ...01000 = Direct ...10000 = Indexed ...11000 = Keyed
01-08	File name.
09-10	File type.
11-12	Record count.
13-14	Block count.
15-16	Address of 1st sector.
17-18	Variable by file format: I,K = Byte 17 is eight lsb of rec len, Byte 18, b0 is msb of rec len; b1-b7 is key length S = Record length of longest record D = Allocated record length A,R = Record length (sector length)
19-1B	Date and time of update.
1C	Owner Id.
1D	Shared from owner Id.
1E-1F	Variable by file format: I,K = Allocated file size S = Disk address of last sector in file D = Zero R = Program length A = Origin address

Timer Event Block (TEB)

Byte	Description
00-01	Number of ticks remaining
02	Reserved
03	Partition id number of owner
04-05	Forward link to TEB (0 = node)

Partition Control Block (PCB)

Byte	Description
00-01	SCR address
02	Bank and activity flags:

Bit	On
7	Not active
6	Waiting for disk
5	Waiting for interrupt
4	Waiting for resource
3-0	Bank number

Bank Control Block (BCB)

Byte	Contents
00-01	Nucleus origin (global bank)
02-03	Nucleus end + 1
04-05	Bank 0 low address
06-07	Bank 0 high address + 1
08-09	Bank 1 low address
0A-0B	Bank 1 high address + 1
.	
.	
.	
40-41	Bank 15 low address
42-43	Bank 15 high address + 1

Re-entrant Program Block (RPB)

Byte	Contents
00-07	Program 1 name, eight character, padded if necessary
08-09	Program 1 start address
0A-11	Program 2 name, eight character, padded if necessary
12-13	Program 2 start address
.	
.	
.	
46-4D	Program 8 name, eight character, padded if necessary
4E-4F	Program 8 start address

Sector Lock Table (SLT)

Byte	Contents
	The following six byte entry is repeated as often as necessary.
00	Drive and ACB number (0FF indicates end of table)

Bit	Meaning
7-3	ACB number
2-0	Drive number

01-02	Sector start address
03-04	Sector end address
05	Owner Partition id number (PIN)

File Lock Table (FLT)

Byte	Contents
	The following four byte entry is repeated as often as necessary.
00	Drive number (0FF indicates end of table)
01-02	Sector number (from DEB)
03	Owner Partition id number (PIN))

APPENDIX D

PROGRAMMING EXAMPLES

This appendix contains a listing of several working programs. The first example is the listing of the program VERIFY, which is an early version of the VERIFY program included with the operating system.

The second example is a USR subroutine to be used by a BASIC program. This routine is not provided as part of the operating system but you might wish to add it as it is a useful routine to have available. The basic function of the routine is to translate a string of characters to uppercase.

Example three is a sophisticated serial device driver (SIO). This driver is probably more lengthy than the serial driver on your system (although it may actually be the driver on your system) because it is designed to interface to a complex, programmable, serial I/O integrated circuit. Included in the driver is all the code necessary to analyze and support the various options that may be specified with the ATTACH command and the various primary devices that a serial device may be used as (CONSOLE, PRINTER, other).

The forth example is a simple, parallel printer device driver. This driver performs the minimum tasks necessary to drive a parallel printer output port.

The fifth example is a disk driver for a hard disk drive. The particular drive and controller that this driver was programmed for is relatively intelligent (performed a lot of the detail work itself), and included direct memory access (DMA) capability.

Example six is a terminal class code control character translator (SYSTEM.CLASS4:S file). The example given is for a SOROC IQ 120 terminal.

Please note the abundant use of comments in the examples. It is a good practice to use a lot of comments, especially in assembly language coding--no speed or memory usage degradation occurs and you, or another programmer, will appreciate them at a later date.

Also note that most of the labels are coded on separate lines. This also facilitates program maintenance.

Example 1 - VERIFY Command

```
Addr Obj-Code  Line *** Source Statement ***

                1 CODE:     REL
0000            2 VERIFY:
0000 E5         3           PUSH   HL              ; Save token loc
0001 113F01     4           LD     DE,HELPL         ; Point literal
0004 0609       5           LD     B,9              ; Len
0006            6 TESTH:
0006 1A         7           LD     A,(DE)           ; Get mask byte
0007 BE         8           CP     (HL)             ; Compare
0008 200C       9           JR     NZ,NOHELP        ; BRIF not HELP
000A 13        10           INC    DE               ; Bump
000B 23        11           INC    HL
000C 10F8      12           DJNZ   TESTH            ; Loop
000E 114801    13           LD     DE,HELPM         ; Message
0011 CF02      14           SC     2                ; Display
0013 AF        15           XOR    A                ; RC = 0
0014 CF00      16           SC     0                ; Quit
0016           17 NOHELP:
0016 E1        18           POP    HL               ; Get loc back
0017 7E        19           LD     A,(HL)           ; Get drive
0018 47        20           LD     B,A              ; Move
0019 CF19      21           SC     25
001B 320501    22           LD     (DRIVE),A        ; Save drive
001E 3009      23           JR     NC,OKFD          ; BRIF ok
0020 11E600    24           LD     DE,MSG1          ; Else display err msg
0023 CF02      25           SC     2                ;  And quit - RC = 16
0025 3E10      26           LD     A,16
0027 CF00      27           SC     0
0029           28 OKFD:
0029 21B800    29           LD     HL,QUIT          ; Set System cancel-key
002C CF39      30           SC     57               ;  clean up
002E 21C100    31           LD     HL,ERR           ; Set disk error routine
0031 CF4A      32           SC     74
0033 3A0501    33           LD     A,(DRIVE)        ; Get drive code
0036 47        34           LD     B,A              ; Move
0037 CF09      35           SC     9                ; Mount drive
0039 CF15      36           SC     21               ; Get UCB
003B E5        37           PUSH   HL               ; Save it
003C DDE1      38           POP    IX               ; Into IX
003E DD7E08    39           LD     A,(IX+8)         ; Get msb
0041 07        40           RLCA                    ; Exchange bits 7-4
0042 07        41           RLCA                    ;  with bits 3-0
0043 07        42           RLCA
0044 07        43           RLCA
0045 E60F      44           AND    0FH              ; Number surfaces
0047 32FD00    45           LD     (SURF),A         ; Save
004A DD6E09    46           LD     L,(IX+9)         ; Get tracks/surface
004D DD7E08    47           LD     A,(IX+8)         ;  12 bit value
0050 E60F      48           AND    0FH              ; Mask
0052 67        49           LD     H,A
0053 220101    50           LD     (TRACKS),HL      ; Save number of track
0056 DD7E0A    51           LD     A,(IX+10)        ; Number sectors/track
0059 6F        52           LD     L,A              ; Move to HL
005A 2600      53           LD     H,0
005C 3AFD00    54           LD     A,(SURF)         ; Get number of surfac
005F 5F        55           LD     E,A              ; Move to DE
0060 1600      56           LD     D,0
0062 CF27      57           SC     39               ; Multiply
0064 22FF00    58           LD     (CYL),HL         ; Store total sect/cyl
0067 ED5B0101  59           LD     DE,(TRACKS)      ; Get tracks/cyl
006B CF27      60           SC     39               ; Compute sect/drive
006D 22F900    61           LD     (TOTLEN),HL      ; Total length
0070 210000    62           LD     HL,0
0073 220301    63           LD     (TRACK),HL       ; Clear track/cyl
0076 22FB00    64           LD     (SECT),HL        ;  and sect/track
0079 CF12      65           SC     18               ; CR/LF on console
007B           66 LOOP:
007B 0E0D      67           LD     C,13             ; Display CR only
007D CF05      68           SC     5                ;  on console
007F 2A0301    69           LD     HL,(TRACK)       ; Get current track #
0082 113501    70           LD     DE,WORK          ; Convert to ASCII str
0085 CF11      71           SC     17
0087 AF        72           XOR    A
```

```
0088 12          73            LD    (DE),A      ; Mark end of string
0089 112E01      74            LD    DE,MSG3     ; Display current track
008C CF02        75            SC    2
008E 2A0301      76            LD    HL,(TRACK)  ; Point to current track
0091 23          77            INC   HL          ; Add one
0092 220301      78            LD    (TRACK),HL  ; Save as next track #
0095 3A0501      79            LD    A,(DRIVE)   ; Drive code
0098 47          80            LD    B,A
0099 3AFF00      81            LD    A,(CYL)     ; Cyl length
009C 4F          82            LD    C,A
009D ED5BFB00    83            LD    DE,(SECT)   ; Sector number
00A1 21C601      84            LD    HL,BUFF
00A4 CF32        85            SC    50          ; Read
00A6 2AFF00      86            LD    HL,(CYL)    ; Get cyl len
00A9 19          87            ADD   HL,DE       ; Compute next sect addr
00AA 22FB00      88            LD    (SECT),HL   ; Store
00AD EB          89            EX    DE,HL       ; Put to DE
00AE 2AF900      90            LD    HL,(TOTLEN) ; Get total size
00B1 B7          91            OR    A           ; Clear CY
00B2 ED52        92            SBC   HL,DE       ; Test if done
00B4 20C5        93            JR    NZ,LOOP     ; Loop if not
00B6 CF12        94            SC    18          ; Else CR/LF
00B8             95 QUIT:
00B8 3A0501      96            LD    A,(DRIVE)   ; Get drive code
00BB 47          97            LD    B,A
00BC CF09        98            SC    9           ; Mount it
00BE AF          99            XOR   A           ; RC = 0
00BF CF00       100            SC    0           ; Quit
00C1            101 ERR:
00C1 F5         102            PUSH  AF          ; Save all registers
00C2 C5         103            PUSH  BC
00C3 D5         104            PUSH  DE
00C4 E5         105            PUSH  HL
00C5 F630       106            OR    '0'
00C7 321801     107            LD    (ERRCD),A   ; Save error code in msg
00CA EB         108            EX    DE,HL       ; Convert track, sect
00CB 112401     109            LD    DE,ERRSECT  ;  for display
00CE 44         110            LD    B,H
00CF CF10       111            SC    16
00D1 45         112            LD    B,L
00D2 CF10       113            SC    16
00D4 3E48       114            LD    A,'H'
00D6 12         115            LD    (DE),A
00D7 13         116            INC   DE
00D8 3E0D       117            LD    A,13        ; Mark end of message
00DA 12         118            LD    (DE),A
00DB 110601     119            LD    DE,MSG2     ; Display error msg
00DE CF02       120            SC    2
00E0 E1         121            POP   HL          ; Restore all register
00E1 D1         122            POP   DE
00E2 C1         123            POP   BC
00E3 F1         124            POP   AF
00E4 AF         125            XOR   A           ; Ignore
00E5 C9         126            RET               ; Continue
00E6 44726976   127 MSG1:      DC    'Drive Code Missing',13
00EA 6520436F
00EE 64652O4D
00F2 69737369
00F6 6E670D
00F9            128 TOTLEN:    DS    2
00FB            129 SECT:      DS    2
00FD            130 SURF:      DS    2
00FF            131 CYL:       DS    2
0101            132 TRACKS:    DS    2
0103            133 TRACK:     DS    2
0105            134 DRIVE:     DS    1
0106 4469736B   135 MSG2:      DC    'Disk Error Code = '
010A 20457272
010E 6F722043
0112 6F646520
0116 3D20
0118            136 ERRCD:     DS    1
0119 2C205365   137            DC    ', Sector = '
011D 63746F72
0121 203D20
0124            138 ERRSECT:   DS    10
```

```
012E 54726163    139 MSG3:     DC    'Track: '
0132 6B3A20
0135             140 WORK:     DS    10
000D             141 CR:       EQU   13
000A             142 LF:       EQU   10
013F 48454C50    143 HELPL:    DC    'HELP    ',CR
0143 20202020
0147 0D
0148 46756E63    144 HELPM:    DC    'Function: Full disk read to check'
014C 74696F6E
0150 3A204675
0154 6C6C2064
0158 69736B20
015C 72656164
0160 20746F20
0164 63686563
0168 6B
0169 20202020    145           DC    '          disk errors.',LF
016D 20202020
0171 20206469
0175 736B2065
0179 72726F72
017D 732E0A
0180 0A          146           DC    LF
0181 53796E74    147           DC    'Syntax:   VERIFY drive',LF
0185 61783A20
0189 20205645
018D 52494659
0191 20647269
0195 76650A
0198 0A          148           DC    LF
0199 57686572    149           DC    'Where:',LF
019D 653A0A
01A0 20206472    150           DC    '  drive   is the drive to be verified'
01A4 69766520
01A8 20206973
01AC 20746865
01B0 20647269
01B4 76652074
01B8 6F206265
01BC 20766572
01C0 69666965
01C4 64
01C5 00          151           DC    0
01C6             152 BUFF:
01C6             153           END
```

No assembly errors.

Cross Reference List

Symbol---	Value	Type	Line	*** References ***				
BUFF	01C6	R 00	152	84				
CR	000D	A 00	141	143				
CYL	00FF	R 00	131	58	81	86		
DRIVE	0105	R 00	134	22	33	79	96	
ERR	00C1	R 00	101	31				
ERRCD	0118	R 00	136	107				
ERRSECT	0124	R 00	138	109				
HELPL	013F	R 00	143	4				
HELPM	0148	R 00	144	13				
LF	000A	A 00	142	145	146	147	148	149
LOOP	007B	R 00	66	93				
MSG1	00E6	R 00	127	24				
MSG2	0106	R 00	135	119				
MSG3	012E	R 00	139	74				
NOHELP	0016	R 00	17	9				
OKFD	0029	R 00	28	23				
QUIT	00B8	R 00	95	29				
SECT	00FB	R 00	129	64	83	88		
SURF	00FD	R 00	130	45	54			
TESTH	0006	R 00	6	12				
TOTLEN	00F9	R 00	128	61	90			
TRACK	0103	R 00	133	63	69	76	78	
TRACKS	0101	R 00	132	50	59			

```
VERIFY    0000  R 00     2
WORK      0135  R 00   140     70
```

Example 2 - BASIC USR Subroutine

```
Addr Obj-Code  Line *** Source Statement ***

                2 UPPER:   REL
0000 C30300     3          JP    ENTRY0       ; Convert to upper case only
0003            4 ENTRY0:
0003 E5         5          PUSH  HL           ; Save current HL
0004 7E         6          LD    A,(HL)       ; Get string length
0005 47         7          LD    B,A          ; Copy to B reg
0006            8 .LOOP:
0006 23         9          INC   HL           ; Point next character
0007 7E        10          LD    A,(HL)       ; Get character
0008 FE61      11          CP    'a'          ; Test lowercase a
000A 3807      12          JR    C,.NOTLOW    ; Ignore if not lowercase
000C FE7B      13          CP    '{'          ; Test lowercase z
000E 3003      14          JR    NC,.NOTLOW   ; Ignore if not lowercase
0010 D620      15          SUB   32           ; Translate to uppercase
0012 77        16          LD    (HL),A       ; Restore to string
0013           17 .NOTLOW:
0013 10F1      18          DJNZ  .LOOP        ; Repeat
0015 E1        19          POP   HL           ; Restore HL register
0016           20 STRIP:
0016 E5        21          PUSH  HL           ; Restore
               22                             ; The following code will str
               23                             ; trailing blanks from the st
0017 7E        24          LD    A,(HL)       ; Get string length
0018 47        25          LD    B,A          ; Copy to B reg
0019 85        26          ADD   L            ; Compute end address
001A 3001      27          JR    NC,.NOC
001C 24        28          INC   H
001D           29 .NOC:
001D 6F        30          LD    L,A
001E           31 .LOOP:
001E 7E        32          LD    A,(HL)       ; Get ending character
001F FE20      33          CP    ' '          ; Test if space
0021 2003      34          JR    NZ,.RET
0023 2B        35          DEC   HL           ; Point prior
0024 10F8      36          DJNZ  .LOOP
0026           37 .RET:
0026 78        38          LD    A,B
0027 E1        39          POP   HL
0028 77        40          LD    (HL),A       ; Store adjusted count
0029 C9        41          RET                ; Return to caller
0000           42          END

No errors in program
```

Example 3 - Serial Device Driver

```
Addr Obj-Code  Line *** Source Statement ***

                    1
                    2 DEV17:    REL                 ; relocatable
                    3
0000 C30F00         4           JP      ST          ; get status
0003 C35D00         5           JP      IN          ; get byte
0006 C37F00         6           JP      OUT         ; put byte
0009 C39C00         7           JP      INIT        ; initialize
000C C35401         8           JP      UNIN        ; un-initialize
                    9
000F               10 ST:
                   11 ;
                   12 ; get SIO status
                   13 ;
000F 3A5C01        14           LD      A,(BUFI)    ; get count
0012 B7            15           OR      A           ; test if any
0013 F5            16           PUSH    AF          ; save
0014 DB13          17           IN      A,(DA+2)    ; get port status
0016 CB57          18           BIT     2,A         ; test txrdy
0018 2841          19           JR      Z,.NOTRDY   ; brif not ready
001A FD7E1C        20           LD      A,(IY+28)   ; get enab type
001D CB47          21           BIT     0,A         ; CTS/DTR
001F 202D          22           JR      NZ,.ENAB1   ;
0021 CB4F          23           BIT     1,A         ;
0023 2021          24           JR      NZ,.ENAB2   ; brif DC1/DC3
0025 CB57          25           BIT     2,A         ; test
0027 282F          26           JR      Z,.RDY      ; brif not ETX/ACK
0029               27 .ENAB3:
0029 F1            28           POP     AF          ; get in flags
002A F5            29           PUSH    AF          ; re-save
002B 2810          30           JR      Z,.TEST3    ; brif no char rdy
002D F1            31           POP     AF          ; else, throw away
002E CD6600        32           CALL    INCH        ; get char
0031 E67F          33           AND     7FH         ; mask
0033 FE06          34           CP      ACK         ; test ACK
0035 20D8          35           JR      NZ,ST       ; brif not
0037 FD361D00      36           LD      (IY+29),0   ; store
003B 18D2          37           JR      ST          ; go around
003D               38 .TEST3:
003D FD7E1D        39           LD      A,(IY+29)   ; get busy
0040 FE80          40           CP      128         ; wait for ACK?
0042 2014          41           JR      NZ,.RDY     ; brif ready
0044 1815          42           JR      .NOTRDY     ; else, busy
0046               43 .ENAB2:
0046 FD7E1D        44           LD      A,(IY+29)   ; get busy flag
0049 B7            45           OR      A           ; test
004A 200F          46           JR      NZ,.NOTRDY  ; brif busy
004C 180A          47           JR      .RDY        ;
004E               48 .ENAB1:
004E 3E10          49           LD      A,10H       ;
0050 D313          50           OUT     (DA+2),A    ; reset ext/status int
0052 DB13          51           IN      A,(DA+2)    ; get reg 0
0054 CB5F          52           BIT     3,A         ; test DTR
0056 2803          53           JR      Z,.NOTRDY   ;
0058               54 .RDY:
0058 F1            55           POP     AF          ; get input status
0059 37            56           SCF                 ; turn on cy
005A C9            57           RET                 ; return
005B               58 .NOTRDY:
005B F1            59           POP     AF          ; get input status
005C C9            60           RET                 ; return
                   61
005D               62 IN:
                   63 ;
                   64 ; get byte from SIO
                   65 ;
005D CD0F00        66           CALL    ST          ; get status
0060 2004          67           JR      NZ,INCH     ; brif some char
0062 CF6B          68           SC      107         ; deactivate until interrupt
0064 18F7          69           JR      IN          ; loop
0066               70 INCH:
0066 C5            71           PUSH    BC          ; save regs
0067 D5            72           PUSH    DE          ;
```

```
0068 E5          73          PUSH  HL          ;
0069 215C01      74          LD    HL,BUFI     ; point buffer
006C F3          75          DI                ;
006D 35          76          DEC   (HL)        ; decr length
006E 4E          77          LD    C,(HL)      ; get length
006F 0600        78          LD    B,0         ; zero msb
0071 23          79          INC   HL          ; point first char
0072 7E          80          LD    A,(HL)      ; load it
0073 2805        81          JR    Z,.MT       ; brif buffer now empty
0075 545D        82          LD    DE,HL       ; copy register
0077 23          83          INC   HL          ;
0078 EDB0        84          LDIR              ; compress the buffer
007A             85  .MT:
007A FB          86          EI                ; turn on ints
007B E1          87          POP   HL          ; restore regs
007C D1          88          POP   DE          ;
007D C1          89          POP   BC          ;
007E C9          90          RET               ; return
                 91
007F             92  OUT:
                 93  ;
                 94  ; put byte to device
                 95  ;
007F CD0F00      96          CALL  ST          ; get status
0082 3804        97          JR    C,OUT1      ; brif output ready
0084 CF4F        98          SC    79          ; snu (non interrupt output)
0086 18F7        99          JR    OUT         ; loop
0088            100  OUT1:
0088 FD341D     101          INC   (IY+29)     ; bump count
008B FD7E1D     102          LD    A,(IY+29)   ; load
008E FE80       103          CP    128         ; max?
0090 2006       104          JR    NZ,OUT2     ; no
0092 3E03       105          LD    A,ETX       ; else, send ETX
0094 D311       106          OUT   (DA),A      ; write
0096 18E7       107          JR    OUT         ; wait for ACK
0098            108  OUT2:
0098 79         109          LD    A,C         ; get char
0099 D311       110          OUT   (DA),A      ; write
009B C9         111          RET               ; return
009C            112  INIT:
009C FD229D01   113          LD    (UCB),IY    ; save ucb address
00A0 3E18       114          LD    A,18H       ;
00A2 D313       115          OUT   (DA+2),A    ; reset device
00A4 FD7E05     116          LD    A,(IY+5)    ; get baud rate
00A7 E6F0       117          AND   0F0H        ; mask
00A9 47         118          LD    B,A         ; save enab
00AA FD7E05     119          LD    A,(IY+5)    ; load again
00AD E60F       120          AND   0FH         ; mask
00AF 2006       121          JR    NZ,.SOMEB   ; brif some
00B1 3E0B       122          LD    A,11        ; default to 9600
00B3 B0         123          OR    B           ; merge
00B4 FD7705     124          LD    (IY+5),A    ;
00B7            125  .SOMEB:
00B7 E60F       126          AND   0FH         ; mask
00B9 FE0E       127          CP    14          ; too big?
00BB 3806       128          JR    C,.OKB      ; brif ok
00BD 3E0B       129          LD    A,11        ; else, 9600
00BF B0         130          OR    B           ; merge
00C0 FD7705     131          LD    (IY+5),A    ;
00C3            132  .OKB:
00C3 E60F       133          AND   0FH         ; mask
00C5 3D         134          DEC   A           ; less one
00C6 5F         135          LD    E,A         ; save
00C7 87         136          ADD   A           ; times two
00C8 83         137          ADD   E           ; times three
00C9 5F         138          LD    E,A         ;
00CA 1600       139          LD    D,0         ; zero high
00CC 219F01     140          LD    HL,BAUD     ; point table
00CF 19         141          ADD   HL,DE       ; offset
00D0 0E25       142          LD    C,CTC       ;
00D2 0602       143          LD    B,2         ; two bytes
00D4 EDB3       144          OTIR              ; program it
00D6 E5         145          PUSH  HL          ; save pointer
00D7 F3         146          DI                ; turn off ints
00D8 3E08       147          LD    A,8         ; vector/2
00DA 11CA01     148          LD    DE,RETI     ; dummy addr
```

```
00DD CF67          149            SC    103          ; put vect
00DF 3C            150            INC   A            ;
00E0 CF67          151            SC    103          ; put vect
00E2 11CD01        152            LD    DE,INTI      ; input interrupt
00E5 3C            153            INC   A            ;
00E6 CF67          154            SC    103          ; put vect
00E8 3C            155            INC   A            ;
00E9 CF67          156            SC    103          ;
00EB 3E02          157            LD    A,2          ; reg 2
00ED D313          158            OUT   (DA+2),A     ;
00EF 3E10          159            LD    A,010H       ; int vector
00F1 D313          160            OUT   (DA+2),A     ;
00F3 E1            161            POP   HL           ; get pointer
00F4 3E04          162            LD    A,4          ; wr 4
00F6 D313          163            OUT   (DA+2),A     ;
00F8 FDCB087E      164            BIT   7,(IY+8)     ; parity enable?
00FC 280C          165            JR    Z,.NOPAR     ; brif none
00FE FDCB0876      166            BIT   6,(IY+8)     ; test even/odd
0102 3E0D          167            LD    A,00001101B  ; even
0104 2006          168            JR    NZ,.OUT      ;
0106 3E0F          169            LD    A,00001111B  ; odd
0108 1802          170            JR    .OUT         ;
010A               171 .NOPAR:
010A 3E0C          172            LD    A,00001100B  ; noparity
010C               173 .OUT:
010C B6            174            OR    (HL)         ; merge clocks
010D D313          175            OUT   (DA+2),A     ;
010F 3E03          176            LD    A,3          ; wr 3 (rcv logic)
0111 D313          177            OUT   (DA+2),A     ;
0113 FDCB087E      178            BIT   7,(IY+8)     ; parity?
0117 3EC1          179            LD    A,11000001B  ; default
0119 2802          180            JR    Z,.NP        ; brif ok
011B 3E41          181            LD    A,01000001B  ; else, 7 bits
011D               182 .NP:
011D FDCB1C66      183            BIT   4,(IY+28)    ; auto enable?
0121 2802          184            JR    Z,.NOEN      ; no
0123 CBEF          185            SET   5,A          ; else, turn on
0125               186 .NOEN:
0125 D313          187            OUT   (DA+2),A     ;
0127 3E01          188            LD    A,1          ; wr 1 (control)
0129 D313          189            OUT   (DA+2),A     ;
012B 3E1C          190            LD    A,00011100B  ; int mask
012D D313          191            OUT   (DA+2),A     ;
012F 3E05          192            LD    A,5          ; wr 5 (trns)
0131 D313          193            OUT   (DA+2),A     ;
0133 FDCB087E      194            BIT   7,(IY+8)     ; test parity
0137 3EEA          195            LD    A,11101010B  ; default
0139 2802          196            JR    Z,.NTP       ; brif ok
013B 3EAA          197            LD    A,10101010B  ; else parity = 7 bits
013D               198 .NTP:
013D D313          199            OUT   (DA+2),A     ;
013F FB            200            EI                 ; allow ints now
0140 AF            201            XOR   A            ; leave pointing to 0
0141 D313          202            OUT   (DA+2),A     ;
0143 FD771D        203            LD    (IY+29),A    ;
0146 FD771E        204            LD    (IY+30),A    ;
0149 FDCB1C6E      205            BIT   5,(IY+28)    ; test enable 2
014D C8            206            RET   Z            ;
014E 3EFF          207            LD    A,0FFH       ;
0150 FD771E        208            LD    (IY+30),A    ; set sw
0153 C9            209            RET                ; return
                   210
0154               211 UNIN:
0154 AF            212            XOR   A            ;
0155 D313          213            OUT   (DA+2),A     ;
0157 3E18          214            LD    A,00011000B  ; reset channel
0159 D313          215            OUT   (DA+2),A     ;
015B C9            216            RET                ; return
                   217
015C 00            218 BUFI:      DC    0            ; buffer length
015D               219            DS    64           ; the buffer itself
                   220
0011               221 DA:        EQU   11H          ; port address
0025               222 CTC:       EQU   25H          ;
019D               223 UCB:       DS    2            ;
0011               224 DC1:       EQU   11H          ;
```

```
0013                    225 DC3:    EQU   13H          ;
0003                    226 ETX:    EQU   03H          ;
0006                    227 ACK:    EQU   06H          ;
                        228
019F                    229 BAUD:
019F 076680             230         DC    7,102,80H    ; 75 = 32x16x102.4 timer
01A2 074680             231         DC    7,70,80H     ; 110 = 32x16x699.8181 timer
01A5 073980             232         DC    7,57,80H     ; 134.5 = 32x16x57.1003 timer
01A8 4780C0             233         DC    47H,128,0C0H ; 150 = 64x128
01AB 4740C0             234         DC    47H,64,0C0H  ; 300 = 64x64
01AE 4720C0             235         DC    47H,32,0C0H  ; 600 = 64x32
01B1 4710C0             236         DC    47H,16,0C0H  ; 1200 = 64x16
01B4 4708C0             237         DC    47H,8,0C0H   ; 2400 = 64x8
01B7 4704C0             238         DC    47H,4,0C0H   ; 4800 = 64x4
01BA 470580             239         DC    47H,5,80H    ; 7200 = 32x5.3333
01BD 4702C0             240         DC    47H,2,0C0H   ; 9600 = 64x2
01C0 4701C0             241         DC    47H,1,0C0H   ; 19200 = 64x1
01C3 470240             242         DC    47H,2,40H    ; 38400 = 16x2
                        243
                        244
01C6                    245 SIORET:
01C6 C1                 246         POP   BC           ; restore regs
01C7 FDE1               247         POP   IY           ;
01C9 F1                 248         POP   AF           ; restore a,flag
01CA                    249 RETI:
01CA FB                 250         EI                 ; turn on ints
01CB ED4D               251         RETI               ; return
                        252
01CD                    253 INTI:
                        254 ;
                        255 ; service receiver interrupt
                        256 ;
01CD FB                 257         EI                 ; turn on ints
01CE F5                 258         PUSH  AF           ; save reg A,F
01CF FDE5               259         PUSH  IY           ;
01D1 FD2A9D01           260         LD    IY,(UCB)     ; point to ucb
01D5 C5                 261         PUSH  BC           ; save B,C
01D6 3E01               262         LD    A,1          ; read reg 1
01D8 D313               263         OUT   (DA+2),A     ;
01DA DB13               264         IN    A,(DA+2)     ; get second status
01DC 47                 265         LD    B,A          ; save it
01DD DB11               266         IN    A,(DA)       ; get char
01DF FDCB086E           267         BIT   5,(IY+8)     ; 8 bit char
01E3 2002               268         JR    NZ,.EIGHT    ; yes
01E5 CBBF               269         RES   7,A          ; turn off parity
01E7                    270 .EIGHT:
01E7 4F                 271         LD    C,A          ; save char
                        272 ;
                        273 ; test parity
                        274 ;
01E8 CB60               275         BIT   4,B          ; test for parity even
01EA 2806               276         JR    Z,.NOPE      ; brif not
01EC 0E3F               277         LD    C,'?'        ; replace char
01EE 3E30               278         LD    A,30H        ;
01F0 D313               279         OUT   (DA+2),A     ; reset parity error
01F2                    280 .NOPE:
01F2 AF                 281         XOR   A            ; reset to zero
01F3 D313               282         OUT   (DA+2),A     ;
01F5 CF66               283         SC    102          ; translate input char
01F7 38CD               284         JR    C,SIORET     ; ignore it?
01F9 4F                 285         LD    C,A          ; save char
01FA 3A5C01             286         LD    A,(BUFI)     ; get prev count
01FD FE40               287         CP    64           ; test full
01FF 28C5               288         JR    Z,SIORET     ; full?, ignore
0201                    289 ROC:
0201 FD7E1E             290         LD    A,(IY+30)    ; see if enab2
0204 B7                 291         OR    A            ;
0205 2814               292         JR    Z,.NOENAB    ; not
0207 79                 293         LD    A,C          ;
0208 E67F               294         AND   7FH          ;
020A FE11               295         CP    DC1          ;
020C 280A               296         JR    Z,.CTLQ      ;
020E FE13               297         CP    DC3          ;
0210 2009               298         JR    NZ,.NOENAB   ;
0212                    299 .CTLS:
0212 FD771D             300         LD    (IY+29),A    ; set the busy sw
```

```
0215 C3C601      301             JP      SIORET          ;
0218             302 .CTLQ:
0218 AF          303             XOR     A               ; reset
0219 18F7        304             JR      .CTLS           ; turn off busy sw
021B             305 .NOENAB:
021B 79          306             LD      A,C             ; get this char
021C             307 R2:
021C D5          308             PUSH    DE              ; save DE and HL regs
021D E5          309             PUSH    HL              ;
021E 215C01      310             LD      HL,BUFI         ; point buffer
0221 F3          311             DI                      ; turn off ints
0222 34          312             INC     (HL)            ; incr count
0223 5E          313             LD      E,(HL)          ; load it
0224 1600        314             LD      D,0             ; zero high
0226 19          315             ADD     HL,DE           ; point next
0227 FB          316             EI
0228 77          317             LD      (HL),A          ; store the character
0229 E1          318             POP     HL              ; restore regs
022A D1          319             POP     DE              ;
022B C3C601      320             JP      SIORET          ; return
                 321
022E             322             END

No assembly errors.
```

Example 4 - Parallel Printer Device Driver

```
Addr Obj-Code  Line *** Source Statement ***

                    1           REL
0000                2 BEGDEV:
0000 C30F00         3           JP    STATUS      ; Return status
0003 C31900         4           JP    INPUT       ; Get input from device
0006 C31A00         5           JP    OUTPUT      ; Put output to device
0009 C31900         6           JP    INIT        ; Initialize driver
000C C32300         7           JP    DEINIT      ; Deinitialize driver
                    8 ;
                    9 ; Status routine - output only device
                   10 ;
000F               11 STATUS:
000F DB01          12           IN    A,(STATO)   ; Get device status byte
0011 E601          13           AND   STAMSK      ; Test for busy
0013 2002          14           JR    NZ,.BUSY    ; BRIF not ready
0015 37            15           SCF               ; Turn on carry flag
0016 C9            16           RET               ; Return with Z and C set
0017               17 .BUSY:
0017 AF            18           XOR   A           ; Set Z flag - reset C flag
0018 C9            19           RET               ;
                   20 ;
                   21 ; Input routine - output only device
                   22 ;
0019               23 INPUT:
0019 C9            24           RET
                   25 ;
                   26 ; Output routine
                   27 ;
001A               28 OUTPUT:
001A CD0F00        29           CALL  STATUS      ; Get device status
001D 30FB          30           JR    NC,OUTPUT   ; Loop till ready
001F 79            31           LD    A,C         ; Copy character to A reg
0020 D300          32           OUT   (DATAO),A   ; Output the character
0022 C9            33           RET               ; Return to caller
                   34 ;
                   35 ; Initialization routine
                   36 ;
0019               37 INIT:     EQU   INPUT       ; No initialization needed
                   38 ;
                   39 ; Deinitialization routine
                   40 ;
0023               41 DEINIT:   EQU   INPUT       ; No deinitialization
0001               42 STATO:    EQU   1           ; Printer status port
0000               43 DATAO:    EQU   0           ; Printer data port
0001               44 STAMSK:   EQU   01          ; Mask to get status bit
                   45           END
No assembly errors.

Cross Reference List

Symbol--- Value Type  Line *** References ***
 BEGDEV   0000  C 00     2
.BUSY     0017  C 00    17    14
 DATAO    0000  A 00    43    32
 DEINIT   0019  C 00    41     7
 INIT     0019  R 00    37     6
 INPUT    0019  C 00    23     4    37
 OUTPUT   001A  C 00    28     5    30
 STAMSK   0001  A 00    44    13
 STATO    0001  A 00    42    12
 STATUS   000F  C 00    11     3    29
```

Example 5 - Disk Device Driver

```
Addr Obj-Code  Line *** Source Statement ***

                  2 N$DISKIO: REL
                  3
                  4           ENTRY DISK
                  5
0000              6 DISK:
                  7 ;
                  8 ; transfer vector
                  9 ;
0000 C30C00      10           JP    SEL
0003 C31700      11           JP    RES
0006 C31900      12           JP    READ
0009 C32000      13           JP    WRITE
                 14 ;
                 15 ; select drive
                 16 ;
000C             17 SEL:
000C E603        18           AND   3             ; mask
000E 327F00      19           LD    (DESC+4),A    ; store
0011 3E07        20           LD    A,7           ; force controller to select
0013 328A00      21           LD    (DESC+15),A
0016 C9          22           RET                 ; return
                 23 ;
                 24 ; rezero
                 25 ;
0017             26 RES:
0017 AF          27           XOR   A             ; not implemented
0018 C9          28           RET
                 29 ;
                 30 ; read
                 31 ;
0019             32 READ:
0019 328300      33           LD    (DESC+8),A    ; store
001C 3E00        34           LD    A,0           ; get cmd
001E 1805        35           JR    COM           ; go common
                 36 ;
                 37 ; write
                 38 ;
0020             39 WRITE:
0020 328300      40           LD    (DESC+8),A    ; store
0023 3E01        41           LD    A,1           ; cmd
                 42 ;
                 43 ; common
                 44 ;
0025             45 COM:
0025 DDE5        46           PUSH  IX            ; save ix
0027 DD217B00    47           LD    IX,DESC
002B DD7701      48           LD    (IX+1),A      ; store
                 49 ;
                 50 ; store head, cyl and sector
                 51 ;
002E DD7105      52           LD    (IX+5),C      ; sector
0031 DD7202      53           LD    (IX+2),D      ; msb cyl
0034 DD7303      54           LD    (IX+3),E      ; lsb cyl
                 55 ;
                 56 ; store mem address
                 57 ;
0037 DD7406      58           LD    (IX+6),H      ; msb mem
003A DD7507      59           LD    (IX+7),L      ; lsb
                 60 ;
                 61 ; perform operation
                 62 ;
003D C5          63           PUSH  BC            ; save regs
003E D5          64           PUSH  DE
003F E5          65           PUSH  HL
0040 CD7700      66           CALL  DESC-4        ; jump to vector
0043 E1          67           POP   HL            ; restore regs
0044 D1          68           POP   DE
0045 C1          69           POP   BC
                 70 ;
                 71 ; restore regs
                 72 ;
0046 DD4E05      73           LD    C,(IX+5)      ; sector
```

```
0049 DD6606      74          LD    H,(IX+6)     ; mem
                 75 ;
                 76 ; test for error
                 77 ;
004C DD7E00      78          LD    A,(IX)       ; get status
004F DDE1        79          POP   IX           ; restore ix reg
0051 B7          80          OR    A            ; test
0052 C8          81          RET   Z            ; return no error
                 82 ;
                 83 ; decode the error
                 84 ;
0053 CB6F        85          BIT   5,A          ; test illegal
0055 2018        86          JR    NZ,ERR5      ; brif is
0057 CB5F        87          BIT   3,A          ; test format error
0059 200C        88          JR    NZ,ERR3
005B CB57        89          BIT   2,A          ; test checksum
005D 200C        90          JR    NZ,ERR4
005F CB67        91          BIT   4,A          ; test seek
0061 2010        92          JR    NZ,ERR7
                 93 ;
                 94 ; else, disk fault - overrun
                 95 ;
0063 3E01        96          LD    A,1
0065 180E        97          JR    ERR
0067             98 ERR3:
0067 3E03        99          LD    A,3
0069 180A       100          JR    ERR
006B            101 ERR4:
006B 3E04       102          LD    A,4
006D 1806       103          JR    ERR
006F            104 ERR5:
006F 3E05       105          LD    A,5
0071 1802       106          JR    ERR
0073            107 ERR7:
0073 3E07       108          LD    A,7
0075            109 ERR:
0075 B7         110          OR    A            ; set nz
0076 C9         111          RET                ; return
                112 ;
                113 ; descriptor follows
                114 ;
0077 CD40F4     115          CALL  0F440H       ; prom address
007A C9         116          RET                ; return
007B 00         117 DESC:    DC    0            ; status
007C 00         118          DC    0            ; command (0=read,1=write)
007D 00         119          DC    0            ; msb track
007E 00         120          DC    0            ; lsb track
007F 00         121          DC    0            ; head
0080 00         122          DC    0            ; sector
0081 00         123          DC    0            ; msb mem addr
0082 00         124          DC    0            ; lsb mem addr
0083 00         125          DC    0            ; sector count
0084 00         126          DC    0            ; unit
0085 01         127          DC    1            ; option
0086 00         128          DC    0            ; max head
0087 03         129          DC    1000.SHR.8   ; max track msb
0088 E8         130          DC    1000.AND.0FFH ; max track lsb
0089 40         131          DC    64           ; max sector
008A 07         132          DC    7            ; curr unit
008B 00         133          DC    0            ; curr track msb
008C 00         134          DC    0            ; curr track lsb
008D 00         135          DC    0            ; error count
008E 00         136          DC    0            ; err track
008F 00         137          DC    0            ; err track
0090 00         138          DC    0            ; err head
0091 00         139          DC    0            ; err sector
0092 FF         140          DC    0FFH         ; bad track table
                141
0093            142          END

No assembly errors.
```

Example 6 - Class Code Conversion

```
TITLE     'Class Code 4 (SOROQ IQ) Terminal Conversion'
          ;
          ; Entry parameters:
          ;
          ; A - control character to translate
          ; B - console device number
          ; C - control character to translate
          ; H - cursor address column number
          ; L - cursor address line number
          ;
MACLIB    CLASS ; Get MACRO definitions

          ; Translate value 11 to 26 (UP ARROW)
          ; Translate value 12 to 6 (RIGHT ARROW)
          ; Translate value 30 to 1 (HOME)

INIT      0BH,1AH,0CH,06H,1EH,01H
DCA       4     ; Use class 4 cursor controls
DEFINE    HOME,RS
DEFINE    CLEAR,ESC,'*',8CH
DEFINE    EOS,ESC,'Y',8CH
DEFINE    EOL,ESC,'T',8CH
DEFINE    LEFT,BS
DEFINE    RIGHT,FF
DEFINE    UP,VT
DEFINE    EU,ESC,+,8CH
DEFINE    PON,ESC,29H
DEFINE    POFF,ESC,28H
DEFINE    FON,ESC,26H
DEFINE    FOFF,ESC,27H
DEFINE    BON   ; Function not available
DEFINE    BOFF  ; Function not available
DEFINE    RVON  ; Function not available
DEFINE    RVOFF ; Function not available
DEFINE    ULON  ; Function not available
DEFINE    ULOFF ; Function not available

END
```

```
>ASM CLASS4 ( / SYSTEM

>MACRO CLASS4

>LINK CLASS4 (SYSTEM

>ATTACH CONSOLE SIO1 (B19200 C4 FF6
```

Example 7 - Tape Driver Model

```
          TITLE          'Tape Driver Model'
TAPEDRV:  REL

;
; fake transfer vector
;
FAKESEL:  XOR  A         ; set nc,z
          RET            ; return
          NOP            ; filler
FAKEIN:   JP   FAKESEL
FAKEOUT:  JP   FAKESEL
FAKEINIT: JP   FAKESEL
FAKEUNIN: JP   FAKESEL
;
; now the cmd vector
;
TAPEDRV:
;
; enter with a = cmd code
;
; 80 = select drive and track
; 81 = rewind
; 82 = read
; 83 = write
; 84 = back space record
; 85 = forward space record
; 86 = write gap (erase)
; 87 = write tape mark
; 88 = stop the tape
; 89 = return tape status
;
; return codes:
; 00 Z   success
; 01 NZ  not ready
; 02 NZ  write protected
; 03 NZ  tape mark
; 04 NZ  crc error
; 05 NZ  end of tape
; 06 NZ  begin of tape
; 07 NZ  data late
;
;*************************************************************
;
; test cmd code
;
          CP   80H       ; min
          RET  C         ; return no good
          CP   89H+1     ; max
          CCF            ; invert
          RET  C         ; return no good
;
; dispatch to proper routine
;
          SUB  80H       ; strip off msb
          PUSH HL        ; save hl
          PUSH DE        ; and de
          ADD  A         ; times two
          LD   E,A       ; to de
          LD   D,0
          LD   HL,DISPTAB ; point table
          ADD  HL,DE     ; sum
          LD   E,(HL)    ; load address
          INC  HL
          LD   D,(HL)    ; msb
          EX   DE,HL     ; to hl
          POP  DE        ; restore de
          EX   (SP),HL   ; get hl
          RET            ; jump indirect
;
; dispatch table
;
DISPTAB:
          DC   (SEL)
          DC   (REW)
```

```
            DC   (RDB)
            DC   (WRB)
            DC   (BSR)
            DC   (FSR)
            DC   (GAP)
            DC   (WTM)
            DC   (STOP)
            DC   (GETST)
            SUBT 'Select unit, track'
SEL:
;
; on entry:
;  D = unit (0 - 3)
;  E = track (0 - 3)
;
; *** INSERT CODE HERE ***
            SUBT 'Rewind routine'
REW:
;
; rewind tape to loadpoint
;
; possible errors:
; 00 success
; 01 not ready
;
; *** INSERT CODE HERE ***
            SUBT 'Read block'
RDB:
;
; on entry:
;  DE = block length >= 80
;  HL = buffer location
;
; possible errors:
;  00 success
;  01 not ready or not select
;  03 tape mark
;  04 crc
;  05 eot (not an error)
;  07 late
;
; *** INSERT CODE HERE ***
            SUBT 'Write block routine'
WRB:
;
; on entry:
;  DE = block size (min 80)
;  HL = buff address
;
; possible errors:
;  00 success
;  01 not ready
;  02 write protect
;  04 crc error
;  05 eot (warning)
;  07 late
;
; *** INSERT CODE HERE ***
            SUBT 'Backspace record'
BSR:
;
; backspace one record
;
; *** INSERT CODE HERE ***
            SUBT 'Forward space record'
FSR:
; *** INSERT CODE HERE ***
            SUBT 'Write gap'
GAP:
; *** INSERT CODE HERE ***
            SUBT 'Write tape mark'
WTM:
; *** INSERT CODE HERE ***
            SUBT 'Stop tape'
STOP:
; *** INSERT CODE HERE ***
```

```
            SUBT 'Get tape status'
GETST:
;
; return coded status in A:
;
; bit    meaning if high
;  7     selected
;  6     ready
;  5     BOT
;  4     EOT
;  3     write protected
;  2     busy
;  1&0   max number of tracks (base zero)
;
;  D     has last unit selected
;  E     has last track selected
;
            END
```

APPENDIX E

CHARACTER SET

LSD \ MSD	0	1	2	3	4	5	6	7
	000	001	010	011	100	101	110	111
0 0000	NUL	DLE	SP	0	@	P	`	p
1 0001	SOH	DC1	!	1	A	Q	a	q
2 0010	STX	DC2	"	2	B	R	b	r
3 0011	ETX	DC3	=	3	C	S	c	s
4 0100	EOT	DC4	$	4	D	T	d	t
5 0101	ENQ	NAK	%	5	E	U	e	u
6 0110	ACK	SYN	&	6	F	V	f	v
7 0111	BEL	ETB	'	7	G	W	g	w
8 1000	BS	CAN	(	8	H	X	h	x
9 1001	HT	EM	)	9	I	Y	i	y
A 1010	LF	SUB	*	:	J	Z	j	z
B 1011	VT	ESC	+	;	K	[	k	{
C 1100	FF	FS	,	<	L	\	l	|
D 1101	CR	GS	-	=	M	]	m	}
E 1110	SO	RS	.	>	N	↑	n	~
F 1111	SI	US	/	?	O	_	o	DEL

A more complete character set chart is available in the OASIS System Reference Manual.