# DATABUS 1100
# DB11SYS 1.
# Preliminary User's Guide

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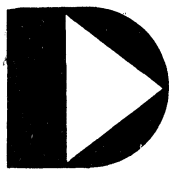
DATAPOINT CORPORATION



**The Leader in Dispersed Data Processing**

# PREFACE

DATABUS 1100 is a high level business language compiler designed for use with the Datapoint Diskette Operating System, DOS.C. This User's Guide describes the characteristics and use of the DATABUS 1100 Compiler.

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# CHAPTER 1. INTRODUCTION

DATABUS 1100 is similar to the Datapoint DATASHARE 3 Multiple Terminal computer system. The primary difference is that DATASHARE 3 operates under either the Cartridge Disk Operating System, DOS.A or the Mass Storage Disk Operating System, DOS.B and supports multiple remote terminals whereas DATABUS 1100 operates under the Diskette Operating System, DOS.C and supports only the processor console as an operator input/output device. DATABUS 1100 also handles a high-speed line printer or servo printer and provides indexed-sequential as well as random and sequential file accessing, thus providing a powerful data entry and processing facility.

In addition, DOS.C with its variety of utility and higher level language systems may be used alternately to DATABUS 1100, enabling processing of tasks not appropriate to the DATABUS language.

Using virtual memory techniques, DATABUS 1100 allows programs with a 16K byte area for executable statements. This, in combination with the ability of the compiler to accommodate over 3400 labels, enables the user to create and use programs of over one hundred pages (a very large high level language program). To provide rapid program execution, the data area the executing program is maintained in main memory and not swapped.

Any of the Datapoint system printers may be connected to the DATABUS 1100 configuration. Printer output is buffered to allow maximum program execution speed.

All program execution in DATABUS 1100 occurs in the DATABUS language. Console command interpretation is handled in a special MASTER program which is provided with the system but may be compiled like any other DATABUS program, enabling the user to completely define his own console command and security system.

Program generation is performed under the Flexible Disk Operating System, DOS.C using the general purpose DOS editor and DATABUS 1100 compiler.

# CHAPTER 2. STATEMENT STRUCTURES

There are five basic types of statements in DATABUS 1100: comment, compiler directive, file declaration, data definition, and program execution.

## 2.1 Comments

Comment lines have a period, asterisk, or plus sign in the first column, and may appear anywhere in the program. Comments are most useful in explaining program logic and subroutine function and parameterization to enable someone reading through the program to more easily understand it's logic. The comment which begins with an asterisk will be printed at the top of the next page if fewer than 12 lines are available at the bottom of the current page. This allows comments to be presented on the same page as the program statements without having to know where the listing currently stands on the page. The comment which begins with a plus sign will always be printed at the top of the next page. This allow major sections of the program to be started at the top of a page. Use of the asterisk at the beginning of each section or subroutine description is encouraged since this greatly enhances program readability. Use of the plus sign should be cautious since it can easily waste great quantities of paper.

## 2.2 Compiler Directives

Compiler directives enable the programmer to include other files in the current compilation and to define the absolute value of a symbolic name for use in tab positioning in file I/O statements and column positioning in I/O statements. The inclusion directive allows one to break a large program into several files for ease in editing. Another useful aspect is that one can have a common set of subroutines or data definition blocks which are included into a number of different programs. Therefore, when a change is made in one of the routines or in the definition of a data item, one need edit the change only once, reducing both the amount of manual labor involved and the chance for error. See Section 8 (Program Generation) for more complete information on the use of compiler directives.

## 2.3 File declarations and data definitions

File declaration and data definition statements must occur before any program execution statements and are used for setting up all of the logical files and data variables in the program. All file declaration and data definition statements must have labels. All compiler directive, file declaration, and data definition statement labels must be unique among themselves. Program execution statements must appear after any file declaration or data definition statements and may or may not have labels. The labels on program execution statements may be the same as labels on the compiler directive, file declaration, and data definition statements. Program execution always begins with the first executable statement.

## 2.4 Program execution

Labels for variables and executable statements can consist of any combination of up to eight letters and digits beginning with a letter. The following are examples of valid labels:

```
A
ABC
A1BC
B1234
ABCDEF
BIGLABEL
```

The following are examples of invalid labels:

```
HI,JK    (contains an invalid character)
4DOGS    (does not begin with a letter)
```

Statements other than comments consist of a label field, an operation field, an operand field, and a comment field. The label field is considered empty if a space appears in the first column of the line. The operation field denotes the operation to be performed on the following operands. In many operations, two operands are required in the operand field. These operands may be connected either by an appropriate preposition (BY, TO, OF, FROM, IN, AMONG, WITH, ABOUT, or INTO) or a comma. One or more spaces should follow each element in a statement except where a comma is used, in which case the comma must be the terminating character of the previous element and may be followed by any number (including zero) of spaces. For example, the following are all examples of

valid statements:

```
LABEL1  ADD PCS TO TOTAL
LABEL2  ADD PCS OF TOTAL      THIS IS A COMMENT
LABEL3  ADD PCS, TOTAL
LABEL4  ADD PCS,TOTAL
```

Note that any preposition may be used even if it does not make sense in English. The following are examples of invalid statements:

```
LABEL1  ADD PCS TOTAL      (missing connective)
LABEL2  ADD PCS ,TOTAL     (space before comma)
```

Certain DATABUS 1100 statements allow a list of items to follow the operation field. In many cases, this list can be longer than a single line, in which case the line must be continued. This is accomplished by replacing the comma that would normally appear in the list with a colon and continuing the list on the following line. For example, the two statements:

```
DISPLAY A,B,C,D:
        E,F,G
DISPLAY A,B,C,D,E,F,G
```

will perform the same function.

## 2.5 Literals

In an effort to reduce the amount of data area needed by a program, literals are allowed in certain statements which would otherwise need constant data in the user's data area. The instructions which can contain literals are: STORE, ROLLOUT, CHAIN, MOVE, APPEND, MATCH, ADD, SUB, MULT, DIV, COMPARE, OPEN, PREPARE, REPLACE, CHECK11, and CHECK10. In all except the program control and I/O statements, the literal must be the first operand. The literal is always enclosed within a pair of double quotes (see the following section on the forcing character) and may be from 1 through 40 characters in length (excluding the quotes). When a literal is used as a string variable, its formpointer is always equal to one and its logical length always points to the last character that is quoted. Examples of the statements which can contain literals follow:

```
STORE    "APPLES" INTO X OF S1,S2,S3
ROLLOUT  "CHAIN FIX22"
CHAIN    "NEXTPROG"
```

```
OPEN      FILE1,"DATAFILE"
PREPARE   FILE1,"USERDATA"
MOVE      "MESSAGE" TO M3442
MOVE      "100.55" TO VALUE
APPEND    "." TO STR1
MATCH     "YES" TO ANSWER
ADD       "23.46" TO TOTAL
SUB       "1" FROM COUNT
MULT      ".1" BY TAX
DIV       "33.3333" INTO FACTOR
COMPARE   "10" TO LINENUMB
```

## 2.6 The forcing character

The pound sign (#) is interpreted by the compiler as a forcing character in any quoted item which can contain multiple characters. The character immediately following the pound sign is used in the quoted item simply as a character value regardless of its significance to the compiler. Thus, the pound sign itself and the quote (") may be used in DATABUS 1100 statements. For example,

```
DISPLAY "CUSTOMER## SHOULD BE #"2222#""
```

would display exactly:

```
CUSTOMER# SHOULD BE "2222"
```

on the screen. Note carefully the wording used above to describe the cases where the pound sign is used to denote a forcing character. This wording excludes the cases of RESET, CMATCH, and CMOVE since those operations cannot have quoted items which contain multiple characters. For example,

```
CMOVE     """ TO STRING
```

would be used to move a double quote sign into the variable STRING. However, the use of a literal in a MOVE instruction would require the use of the forcing character, even in a single character move, since the quoted item can be a mutiple character quote. For example:

```
MOVE      "#"" TO STRING
```

would be used to move a double quote sign into the variable STRING. The RESET, CMOVE, and CMATCH instructions are the only

exceptions to the forcing character convention within quoted items.

Examples:

```
RESET STRING TO "#"
CMOVE "#" TO STRING
CMATCH """ TO STRING
```

## 2.7 A sample program

```
          .
          . PROGRAM TO DISPLAY A MULTIPLICATION TABLE
          .
          COUNT1   FORM     "0"
          COUNT2   FORM     "0"
          PROD     FORM     2
          *
          . HERE IS THE START OF THE EXECUTABLE CODE
          .
START     DISPLAY *ES,"MULTIPLICATION TABLE:",*N
LOOP      MOVE     COUNT1 TO PROD
          MULT     COUNT2 BY PROD
          DISPLAY COUNT1,"X",COUNT2,"=",PROD," ";
          ADD      "1" TO COUNT2
          GOTO     LOOP IF NOT OVER
          DISPLAY *N
          ADD      "1" TO COUNT1
          GOTO     LOOP IF NOT OVER
          STOP
```

# CHAPTER 3. FILE DECLARATION AND DATA DEFINITION

There are two types of statements in DATABUS 1100 which cause space within the user's data area to be assigned. The first is logical file declaration where the space is used to store the DOS system information about the file being used and the second is data definition where the space is used to keep the variable information within the DATABUS 1100 program.

## 3.1 File declaration

Two types of files can be declared in DATABUS 1100. The first is a type that will be used for random or physically sequential accessing. This type is declared using the FILE statement:

```
INFILE  FILE
```

The label INFILE is the label which will be used in all disk I/O statements that are to use this particular logical file. This statement causes 17 bytes of data area to be consumed. This area stores the 15 bytes used in the DOS logical file table, a space compression counter, and a flag indicating that this is a physically random or sequential access only file. Note that since logical file information is stored in the user's data area, the user may have any number of logical files active at any one time providing his data area will contain all of the necessary declaration information.

The second type of file declaration is used for indexed-sequential file accessing. This type is declared using the IFILE statement:

```
ISAMFILE  IFILE
```

The label ISAMFILE is the label which will be used in all disk I/O statements which are to use this particular logical file. This statement causes 26 bytes of data area to be consumed. This area stores the information that a FILE declaration stores plus three three-byte pointers for use in the access method. These pointers point to the beginning of the last record accessed (for updating operations), to the next sequential key (for sequential by key accessing), and to information in the DOS R.I.B. of the index file (used in all accessing operations).

## 3.2 Data definition

There are two types of data used within the DATABUS 1100 language. They are numeric strings and character strings. The arithmetic operations are performed on numeric strings and string operations are performed on character strings. There are also operations allowing movement of numeric strings into character strings and vice versa. Numeric strings have the following memory format:

```
0200    1   2   .   3   0203
```

The leading character (0200) is used as an indicator that the string is numeric. The trailing character (0203) is used to indicate the location of the end of the string (ETX). Note that the format of a numeric string is set at definition time and does not change throughout the execution of the program. A numeric string can be defined to contain at most 21 characters.

When a move into a number occurs from a string or differently formatted number, reformatting will occur to cause the information to assume the format of the destination number (decimal point position and the number of digits before and after the decimal point) with truncation occurring if necessary (rounding occurs if truncation is to the right of the decimal point).

Character strings have the following memory format:

```
9     5     THE QUICK BROWN     0203
```

The first byte is called the logical length and points to the last character currently being used in the string (K in the above example). The second byte is called the formpointer and points to a character currently being used in the string (Q in the above example). The use of the logical length and formpointer in character strings will be explained in more detail in the explanations of each character string handling instruction. Basically, however, these pointers are the mechanism via which the programmer deals with individual characters within the string.

The term physical length will be used to mean the number of possible data characters in a string (15 in the above example). The logical and physical lengths of string variables is limited to 127.

Whenever a data variable is to be used in a program, it must be defined at the beginning by using either the FORM, INIT, or DIM instructions. These instructions reserve the memory space described above for the data variable whose name is given in the label field. Note that all variables must be defined before the first executable statement is given in the program and that once an executable statement is given, no more variables may be defined. Numeric strings are created with the FORM instruction while character strings are created with the INIT or DIM instruction.

### 3.2.1 Numeric string variables

Numeric variables are defined in one of two ways with the FORM instruction as shown in the following illustration:

```
EMRATE  FORM 4.2
XAMT    FORM " 382.4  "
```

In this example, EMRATE has been defined as a string of decimal digits which can cover the range from 9999.99 to -999.99. The FORM instruction illustrated reserves spaces in memory for a number with four places to the left of a decimal point and two places to the right of a decimal point and initializes the value to zero. When the number is negative, one of the places to the left of the decimal point is used by the minus sign. XAMT, in the example, is defined with four places to the left of the decimal point and three to the right but with an initial decimal value of 382.400. The physical length of a numeric variable is limited to 21 characters (decimal point and sign included).

### 3.2.2 Character string variables

Character strings are defined with either a DIM or INIT instruction. DIM reserves a space in memory for the given number of characters but sets the logical length and formpointer to zero and initializes all the characters to spaces. For example:

```
STRING  DIM 25
```

A character string can also be defined with some initial value by using the INIT instruction. For example:

```
TITLE   INIT "PAYROLL PROGRAM"
```

initializes the string TITLE to the characters shown and gives it a logical length of 15. The formpointer is set to one. Note that in the case of strings, the actual amount of memory space reserved is three bytes greater than the number specified in the DIM or quoted in the INIT instruction (TITLE occupies 18 bytes in memory, 15 of which hold characters).

Octal control characters (000 to 037) may be included when initializing a string. The control character is separated by commas, without quotes, and is preceded by a zero. For example,

```
TITLE    INIT "PAYROLL PROGRAM",015,"TEST1"
```

would initialize a string with a logical and physical length of 21 characters. The octal control character, 015, would appear after the M in PROGRAM and before the first T in TEST1. It is the responsibility of the programmer to remember that some of these characters (000, 003, 011, and 015) are used for control purposes in disk files. More importantly, these characters are used as control characters in DISPLAY and KEYIN statements, and improper use of these characters in such statements can result in invalid program execution.

### 3.2.3 Common data areas

Since DATABUS 1100 has the provision to chain programs so that one program can cause another to be loaded and run, it is desirable to be able to carry common data variables from one program to the next. The procedure for doing this is as follows:

a. Identify those variables to be used in successive programs and in each program define them in <u>exactly</u> the same order and way and preferably at the beginning of each program. The point in this is to cause each common variable to occupy the same locations in each program. Strange results in program execution usually occur if a common variable is misaligned with respect to the variable in the previous program.

b. For the first program to use the variables, define them in the normal way. Then, for all succeeding programs, place an asterisk in each FORM, DIM, or INIT statement, as illustrated below, to prevent those variables from being initialized when the program is loaded into memory.

Examples:

```
MIKE FORM *4.2
JOE  DIM  *20
BOB  INIT *"THIS STRING WONT BE LOADED"
```

File declarations may not be made common between programs. The reasoning behind this restriction is that mis-alignment in file declarations could easily cause catastrophic destruction of the file structure under DOS.C. Therefore, whenever a program is loaded, all logical files are initialized to being closed and must be opened before any file I/O can occur. When chaining between programs, one should always close all files in which new space could have been allocated and then re-open the files in the next program.

Untrapped errors (those causing DATABUS 1100 error messages followed by a CHAIN to the MASTER program) cause the first 20 or so bytes of common area to be destroyed. Since the MASTER program is always reloaded open, COMMON should be initialized there.

# CHAPTER 4. PROGRAM CONTROL INSTRUCTIONS

DATABUS 1100 normally executes statements in a sequential fashion. The program control instructions allow this flow to be altered depending on the state of the condition flags. There are five condition flags in DATABUS 1100: OVER, LESS, EQUAL, ZERO, and EOS. EQUAL and ZERO are two names for the same flag. Only the numeric and character string manipulating instructions, the READ instruction, and the READKS instruction alter the states of these flags. Reference should be made to the individual instruction explanations for the meanings of the flags.

## 4.1 GOTO

The GOTO instruction transfers control to the program statement indicated by the label following the instruction:

```
GOTO CALC
```

causes control to be transferred to the instruction labeled CALC.

The GOTO instruction may be made conditional by following the label by the preposition IF and one of the condition flag names. For example:

```
GOTO CALC IF OVER
```

will transfer control to the instruction labeled CALC if an overflow occurred in the last arithmetic operation. Otherwise, the instruction following the GOTO is executed.

The sense of the condition can be reversed by inserting the word NOT before the condition flag name as follows:

```
GOTO CALC IF NOT OVER
```

meaning control is transferred only if the overflow did not occur.

## 4.2 BRANCH

The BRANCH instruction transfers control to a statement specified by an index. For example:

```
BRANCH N OF START,CALC,POINT
```

causes control to be transferred to the label in the label list pointed to by the index N (i.e. START if N = 1, CALC if N = 2, and POINT if N = 3). If N is negative, zero, or larger than the number of labels in the list, control continues with the following statement. The index is truncated to no decimal places before it is used (1.7 = 1).

The BRANCH instruction statement may be continued to the next line by the use of a colon in place of one of the variable delimiting commas. For example:

```
BRANCH N OF LOOP, START, READ1, WRITE1:
        WEOF1,STOP
```

## 4.3 CALL

The CALL instruction is very similar to the GOTO instruction except that when a RETURN instruction is encountered after a transfer, control is restored to the next instruction following the CALL instruction. CALL instructions may be nested up to 8 deep. That is, up to eight CALL instructions may be executed before a RETURN instruction is executed. Being able to call subroutines eliminates the need to repeat frequently used groups of statements. Note, however, that in DATABUS 1100 the space allowed for a program is very large and that, due to the virtual nature of this space, calling a subroutine is considerably more time consuming than executing the code in line if a page swap is invoked by the subroutine call. Therefore, in many cases it is much better to put some code in line instead of making it a subroutine, especially if the amount of code is quite small (say, less than a dozen lines). This is a trade-off which should be considered when one is dealing with code that will be executed very often (for instance, code that is executed every time a data item is entered). CALL instructions may be made conditional like the GOTO instruction. For example:

```
CALL FORMAT
CALL XCOMP IF LESS
```

## 4.4 RETURN

The RETURN instruction is used to transfer control to the location indicated by the top address on the subroutine call stack. This instruction has no operand field but may be made conditional. For example:

```
RETURN
RETURN IF ZERO
```

## 4.5 STOP

The STOP instruction causes the program to terminate and return to the MASTER program. This instruction has no operand field but may be made conditional. For example:

```
STOP
STOP IF NOT EQUAL
```

Execution of the STOP instruction in the MASTER program returns control back to DOS.C.

## 4.6 CHAIN

The CHAIN instruction causes the program, whose DOS name (with extension DBC) is in the literal or specified string, to be loaded and for control to be passed to its first executable statement. The characters used for the name start from under the formpointer of the specified string variable (or with the first quoted character in the case of a literal) and continue until either the logical end of the string has been reached or eight characters have been obtained. If the end of the string is reached before eight characters are obtained, the rest of the characters are assumed to be spaces. All DATABUS 1100 program object files are of extension DBC. The character after the 8th in the name variable (or the character after the logical length if the name is less than 8 characters long) is used as the drive number specification for the file. If the characters is not an ASCII 0, 1, 2, or 3 or no character physically exists past the name, no drive specification is assumed and all drives starting with drive zero are searched when looking for the program name in the DOS directory (or directories). Otherwise, only the specified drive is searched for the name. For example, if in the following example NXTPGM's formpointer was 4 and logical length was 6, the CHAIN command would try to load the program named

"ROL/D11" from drive 1.

```
NXTPGM  INIT "PAYROL1"
        '
        '
        CHAIN NXTPGM
```

In the following example, however, the CHAIN command would try to load the program named "PAYROL1/DBC" off of any drive starting from the zeroth.

```
CHAIN "PAYROL1"
```

To make the CHAIN command try to load the program named "PAYROL/DBC" from drive one, one would have to execute the statement:

```
CHAIN "PAYROL  1"
```

since the 1 would appear after the eighth character in this case.

## 4.7 TRAP

TRAP is a unique instruction because, rather than taking action at the time it is executed, it specifies the location to which a transfer of control (via the CALL mechanism) should occur if a specified event occurs during later execution. For example:

```
TRAP EMSG IF PARITY
```

specifies that control should be transferred to EMSG if a parity failure is encountered during a READ or WRITE instruction. The control transfer is performed in a manner similar to the CALL instruction. Therefore, in the above example, if the parity error occurred during a disk READ instruction, the effect would be to insert a CALL EMSG instruction between the READ and the instruction immediately following it.

If an event occurs and the trap corresponding to that event has not been set, the message:

```
* ERROR * LLLLL X *      or
* ERROR * LLLLL X * Q
```

appears on the line currently positioned to on the console display. The first form appears for all traps except I/O traps. In the event of an I/O trap, a qualification letter is given

where a "Q" is shown in the example (explained below under the "IO" trap). The LLLLL is the current value of the program counter and the X is an error letter. In most cases, LLLLL points to the instruction following the one that caused the problem. However, in certain I/O errors, LLLLL will point after the list item where the problem occurred. The following error letters can appear:

P - parity failure
R - record number out of range
F - record format error
C - chain failure
I - I/O error
B - illegal operation code
U - call stack underflow
A - interruptions already prevented

Note that the last three items shown above cannot be trapped. The B error will only show up if somehow an invalid object file is executed or if the system is failing. The U error will happen if the programmer forgets to perform a call or in some other fashion manages to execute a RETURN instruction without a corresponding CALL having been previously executed. The A error will happen if a PI instruction is executed while interrupts are currently prevented.

The events that may be trapped are shown below. The capitalized name is the one used in the TRAP statement.

PARITY - disk CRC error during READ or disk CRC error during write verification (the DOS retries an operation up to 5 times to get a good CRC before giving up and causing this event).

RANGE - record number out of range (an access was made that was off the physical end of the file, a record was read which was never written, or a WRITAB was used on record which was never written)

FORMAT - non-numeric data read into number (the read stops at the list item in error so the rest of the list items will not be changed)

CFAIL - the specified program was not in the DOS directory or a ROLLOUT was attempted with one of the necessary system files missing

IO - there is only one trap for all of the following conditions. Usually, however, the trap is used only for detecting whether a file

exists or not. It is a good idea keep this trap clear whenever it is not being used specifically to detect the presence of a file to prevent confusion if one of the other conditions occurs. If the trap is not set then one of the following qualification letters indicates the nature of the I/O problem:

A - an access sequentially by key was attempted before any indexed sequential access was made using the logical file.
B - the READ mechanism ran off the end of a sector without encountering a physical end of record character (003).
C - an operation on a closed logical file was attempted.
D - a WRITE or INSERT indexed sequential operation was attempted where the specified key already exists in the index.
E - an EOF mark without at least four zero's was encountered.
I - the index file specified in an OPEN statement does not exist on the specified drive(s).
J - the index file found by the OPEN statement does not reside in the correct physical location on the disk (index files may never be moved, they must always be re-created).
K - a null key was supplied in an operation where the key may not be null.
M - the data file specified in the OPEN statement does not exist on the specified drive(s).
N - the data file name specified in the OPEN or PREPARE statement was null.
O - the index file name specified in the OPEN statement was null.
P - the file specified in the PREPARE statement had some type of DOS protection (either write, delete, or both).
T - the tab value in the READ or WRITAB statement was off the end of the sector.
U - an EOF mark was encountered while a record was being deleted in the indexed sequential file.
V - one of the indexed sequential access overlays could not be loaded by the DOS loader.
W - an index file pointer sector could not be read.

X - an index file header sector could not be read.
Y - the R.I.B. of the data file pointed to by the index file could not be read. (VWXY errors can be caused by parity errors, the drive being switched off line, or the disk cartridge being swapped with another while an operation is taking place.)

Note that the trap locations are cleared whenever a CHAIN occurs. Therefore, each program must initialize all of the traps it wishes to use. Also, whenever a certain event is trapped, the trap location for that event is cleared, which implies that, if the event is to be trapped again, its location must be reset by the trap routine.

## 4.8 TRAPCLR

This instruction will clear the specified trap. For example:

```
TRAPCLR PARITY
```

will clear the parity trap previously set.

## 4.9 ROLLOUT

The ROLLOUT feature allows the execution of the DATABUS 1100 system to be temporarily suspended while certain functions are performed under DOS.C. When a ROLLOUT occurs, the program ROLLOUT/SYS will be run which writes system status and memory in a file called ROLLFILE/SYS. A beep is sounded at the console to alert the operator when a ROLLOUT is initiated. Clicks are sounded as ROLLFILE/SYS is created and another beep occurs when the file creation is completed. The DOS is then brought up at the console by the loading of SYSTEM0/CMD. The ROLLOUT/SYS program then supplies the characters in the string specified by the Databus ROLLOUT instruction as if they were keyed in from the console (this will usually call the CHAIN program). When the DOS functions are completed, the DOS file DBBACK/CMD may be executed to restore the DATABUS 1100 system to its previous status (this is usually the last program specified in the CHAIN file). DBBACK/CMD re-initializes the screen and then loads the ROLLFILE/SYS object file. This returns the DATABUS 1100 program to the point of execution when the ROLLOUT occurred. ROLLOUT/SYS is provided with the DATABUS 1100 System.

ROLLOUT is initiated by a DATABUS 1100 program with the

following instruction,

```
ROLLOUT (string variable)     or
ROLLOUT (string literal)
```

The string variable or literal specifies what function is initially to be executed under DOS and should be a command line acceptable to the DOS command handler. The string used is that in the variable from under the formpointer up to before a character that has a value less than 040 (octal), is a vertical bar (0174 octal), or has its sign bit set. In the normal case, this means the string used will be that from under the formpointer up through the physical length of the string. If it is desired for less than through the physical end of the string to be used, one should store a vertical bar in the position after the last character to be used in the DOS command line string. A CFAIL trap will occur if the string variable is null. For example, the string's contents could be

```
CHAIN DBCFILE
```

When DOS is brought up by the ROLLOUT, the first thing to occur would be a chain to DSCFILE. The commands found in DSCFILE would then be executed (see the DOS Program User's Guide for additional information concerning the DOS CHAIN command). DSCFILE could consist of these commands:

```
SORT AFILE,BFILE
SORT CFILE,DFILE
DBBACK
```

By using the CHAIN command, several DOS functions can be performed and the system automatically restored with the DBBACK command. If DBBACK is not included in the chain file, if the CHAIN aborted for some reason, if DOS was booted during the CHAIN, or if the string specified in the ROLLOUT consisted of a DOS function other than CHAIN, the DATABUS 1100 system will have to be restored by the operator keying in DBBACK at the console.

The ROLLOUT feature is particularly useful when a file needs to be sorted with the DOS SORT command or an indexed file needs to be re-indexed using the DOS INDEX command. Note that the time clock will be put behind however long the DATABUS 1100 system is not executing.

There are a number of precautions which must be observed during the use of ROLLOUT. The functions performed while under

the DOS must not effect any of the operations that were taking place under the DATABUS 1100 system. For example, the MASTER program must not be changed and files that are open and in use must not be modified or deleted. The reason behind this is that when the DATABUS 1100 operation is restored, certain items in memory reflecting the state of the DOS file structure will also be restored. If these items are no longer accurate in their reflection due to the fact that the file structure has been changed, terrible things can happen to the DATABUS 1100 system. Operations to be watched in particular include the changing of the object code of any program that is running, the changing of any files that are open, and the re-arrangement of any disks with files in use within a multi-drive system.

## 4.10 PI

This instruction (Prevent Interruptions) enables the programmer to prevent his program from being interrupted for up to 20 Databus instruction executions. This instruction has no effect upon the foreground one millisecond interrupt which performs the printer I/O.

Normally, background execution can be interrupted through execution of the Interrupt procedure at the console. By executing the PI instruction, the programmer can postpone this interruption for a specified number of instructions (up to a maximum of 20).

The number of instructions specified in the PI instruction is always a fixed decimal number (it may not be a numeric variable). For example:

```
PI      4
READ    F,KEY;PN,QTYONH,LOD
SUB     QTY FROM QTYONH
GOTO    NOTNUFF IF LESS
UPDATE  F;PN,QTYONH,LOD
```

Interruptions will be prevented from the PI instruction through the UPDATE instruction. Note that the number supplied to the PI instruction denotes the number of instructions <u>after</u> the PI instruction.

If a DISPLAY, KEYIN, or PRINT instruction is executed while interruptions are prevented, the effect of the PI instruction is canceled. If a PI instruction is executed while interruptions are currently prevented, execution of the program is aborted with

an error 'A' message. This prevents a program from being able to prevent interruptions for more than 20 instruction executions.

Note that when devising systems with complex data file structures one must always be prepared for his program being interrupted at any point in its execution without harming the file structuring beyond repair. One can use the PI instruction to prevent the operator from causing such a disturbance. However, this should not be used by the programmer as a panacea for the interruption problem since interruptions can still be caused by power failures or the system operator restarting the processor. The PI can be very useful in preventing the operator from causing a situation which could require extensive recovery effort but the precautions which allow recovery in the event of an interruption at any point in the program must still be built in to allow recovery in the other less likely but still possible interruption cases.

## 4.11 TABPAGE

This instruction allows the programmer to improve the execution speed of his program by letting him force sections of his program into certain pages of object code. Execution speed can be enhanced in this way because of the way the virtural storage mechanism for the object code works. The instruction consists only of the verb TABPAGE and has no operands (a label may be placed on a TABPAGE instruction line, however). Execution of the TABPAGE instruction causes control to be transferred to the first byte of the next page.

# CHAPTER 5. CHARACTER STRING HANDLING INSTRUCTIONS

Each string instruction, except LOAD and STORE, requires either one or two character string variable names following the instruction. (Note that the MOVE instruction is capable of moving strings to numbers, numbers to strings, and numbers to numbers, as well as moving strings to strings. See the following section and Section 6.5 for the entire description of the MOVE instruction. Also note that APPEND can move numbers into strings as well as strings into strings.) In the following sections, the first variable will be referred to as the source string and the second variable will be referred to as the destination string. In some cases, the source may be a literal. When it is, the formpointer always points to the first physical character in the string and the logical length always points to the last physical character in the string.

## 5.1 MOVE

MOVE transfers the contents of the source string into the destination string. Transfer from the source string starts with the character under the formpointer and continues through the logical length of the source string. Transfer into the destination string starts at the first physical character and when transfer is complete, the formpointer is set to one and the logical length points to the last character moved. The EOS flag is set if the ETX in the destination string would have been overstored and transfer stops with the character that would have overstored the ETX.

The MOVE instruction can also move character strings to numeric strings and vice versa. (The movement of numeric strings to numeric strings is covered in section 6.5.) A character string will be moved to a numeric string only if the character string from the formpointer through the logical length is of valid numeric format (only digits, spaces, a leading minus sign, and one decimal point allowed). Otherwise, the numeric string is not changed. Note that only the part of the character string starting with the formpointer is considered in the validity check and transferred if the string is of valid numeric format. The number in the character string will be reformatted to conform to the format of the numeric string. Rounding occurs if the number in the character string is too large to fit into the format of the numeric string (see Section 6 for rounding rules followed).

The TYPE instruction is available to allow checking the character string for valid numeric format before using the MOVE instruction.

When a numeric string is moved to a character string, all characters of the numeric item (unless the ETX in the destination string would be overstored) are transferred starting with the physically first character in the destination string. When the operation is completed, the logical length is set to point to the last character transferred. The EOS condition is left true if the ETX of the destination string would have been overstored. In this case, transfer stops with the character before the one that would have overstored the ETX and the logical length is left pointing to the physical end of the string (which contains the last character transferred).

In the following examples, the logical length, formpointer, and content of each variable is shown before the statement is executed, the statement is shown and the contents of the variable that is changed by the execution of that statement is shown. The ^ denotes a space in the contents of a variable.

| VAR | LL | FP | Contents |
|---|---|---|---|
| STRING1 | 4 | 2 | ABCDXLM ETX |
| STRING2 | 6 | 3 | DOGCAT ETX |

```
MOVE STRING1 TO STRING2
```

| | | | |
|---|---|---|---|
| STRING2 | 3 | 1 | BCDCAT ETX |
| STRING2 | 6 | 3 | DOGCAT ETX |

```
MOVE "HELLO" TO STRING2
```

| | | | |
|---|---|---|---|
| STRING2 | 5 | 1 | HELLOT ETX |

```
STRING1   9  3    AB100.327    ETX
NUMBER    0200    ^39.00       ETX
     MOVE STRING1 TO NUMBER
NUMBER    0200    100.33       ETX


NUMBER    0200    100.33       ETX
STRING1   9  3    AB100.327    ETX
     MOVE NUMBER TO STRING1
STRING1   6  1    100.33327    ETX
```

Note that in the statement:

```
     MOVE   "ABC" TO NUMBER
```

the compiler will give an E error flag since it knows that this cannot be a valid operation (the move will not occur because the literal is not of valid numeric format). In the statement:

```
     MOVE   "2.3" TO STRING1
```

the compiler will generate a string to string move rather than a numeric to string move.

## 5.2 APPEND

APPEND appends the source string or number to the destination string. A numeric item is treated exactly as if it were a string with a formpointer pointing to the first physical character and a logical length pointing to the last physical character in the number. The characters appended are those from under the formpointer through under the logical length pointer of the source string. The characters are appended to the destination string starting after-the-formpointed-character in the destination string. The source string pointers remain unchanged, but the destination string pointers both point to the last character transferred. The EOS condition will be set if the new string will not fit physically into the destination string, but all characters that will fit will be transferred.

The following example shows two strings before the operation, the operation, and the result in the second string after the operation:

```
STRING1     8   6   JOHN^DOE    ETX

STRING2    11  11   MARY^JONES^^^^^^^^^^    ETX

     APPEND STRING1 TO STRING2

STRING2    14  14   MARY^JONES^DOE^^^^^^^   ETX
```

The following example shows a destination string before the operation, an operation appending a literal to the destination string, and the destination string after the operation:

```
STRING2     8   9   MARY^JONES^^^^^^^^^^^   ETX

     APPEND ".XX.YY." TO STRING2

STRING2    15  15   MARY^JON.XX.YY.^^^^^^^  ETX
```

The following example shows the use of APPEND to move a numeric item into a string item:

```
NUMBER   0200   100.33      ETX

STRING    9  2   ABCDEFGHI   ETX

     APPEND NUMBER TO STRING

STRING    9  8   AB100.33I   ETX
```

## 5.3 MATCH

MATCH compares two character strings starting at the formpointer of each and stopping when the end of either operand's string is reached. If either formpointer is zero before the operation, the MATCH operation will result in only clearing the LESS and EQUAL flags and setting the EOS flag. Otherwise, the "length" of each string is calculated to be LENGTH-FORMPOINTER+1 and the LESS flag is set if the destination string length is less than that of the source string. The two strings are then compared on a character-for-character basis for the number of

characters equal to the lesser of the two lengths. If all the characters match, the EQUAL flag is set. Otherwise, the LESS flag's meaning is changed to indicate whether the ASCII value of the destination character is less than the ASCII value of the source character (LESS flag set) or vice versa (LESS flag reset) for the first pair of characters that do not match. Some examples and their results follow:

| SOURCE | DESTINATION | RESULT |
|---|---|---|
| ABCDE | ABCD | EQUAL, LESS |
| ABC | Z | NOT EQUAL, NOT LESS |
| ZZZ | AAA | NOT EQUAL, LESS |
| ABC | ABC | EQUAL, NOT LESS |
| ABCD | ABCDE | EQUAL, NOT LESS |

Examples:

```
MATCH A TO B
MATCH STR1,STR2
```

## 5.4 CMOVE

CMOVE moves a character from the source operand to under the formpointer in the destination string. The character from the source operand may be a quoted alphanumeric (note that the forcing character rule does not apply here), the character from under the formpointer of a string variable, or an octal control character (000 to 037). If either operand has a formpointer of zero, an EOS condition and no transfer occurs.

Examples:

```
CMOVE XDATA TO YDATA
CMOVE "A" TO CAT
CMOVE X,Y
CMOVE 015,Y
```

## 5.5 CMATCH

CMATCH compares two characters, one taken from each of the source and destination operands. The characters may be quoted alphanumeric (note that the forcing character rule does not apply here), from under the formpointer of a string variable, or octal control characters (000 to 037). An EOS condition occurs if either formpointer is zero, and no other conditions are set. Otherwise, the EQUAL and LESS conditions are set appropriately.

The LESS condition is set if the destination string character is less than the source string character.

Examples:

```
CMATCH XDATA TO YDATA
CMATCH "A",DOG
CMATCH CAT TO "B"
CMATCH 015,DOG
```

## 5.6 BUMP

BUMP increments or decrements the formpointer of the first operand if the result will be within the string (between 1 and the logical length). If no parameter is supplied, BUMP increments the formpointer by one. However, a positive or negative literal value may be supplied to cause the formpointer to be moved in either direction by any amount. The EOS flag will be set and no change in the formpointer occurs if it would be less than one or greater than the logical length after the movement had occurred.

Examples:

```
BUMP CAT
BUMP CAT BY 2
BUMP CAT,-1
```

## 5.7 RESET

RESET changes the value of the formpointer of the source string to the value indicated by the second operand. If no second operand is given, the formpointer will be reset to one. The second operand may be a quoted character, in which case the ASCII value minus 31 (space gives one, ! two, " three, etc) will be used for the value of the formpointer of the source string. The second operand may also be a character string, in which case the ASCII value minus 31 of the character under the formpointer of that string will be used for the value of the formpointer of the source string. The second operand may also be a numeric string, in which case the value of the number will be used for the formpointer of the source string.

The use of a string variable as the second operand in a RESET instruction may not be obvious at first. One application could be in doing code conversions where each character in the string to be converted is used as a formpointer value in a code

conversion string from which is picked to corresponding converted character to be used as the character in the converted string. Another use is in the coding of item positions within a string into a single character. For example, in a file one might want to place an item in a variable location within the record. The first character of the record could be a character which corresponds to the column position within the record of the start of the item. One could read the first character of the record into a one character string variable and then the rest of the record into a large string variable. The large string variable could then have its formpointer reset to the position indicated by the first character in the record and the item could then be moved to another variable with the MOVE instruction.

RESET also has the capability of extending the logical length of the first operand. If the formpointer value specified is past the logical length of the first operand, the logical length will be extended until it will accommodate the formpointer value. If this would cause the logical length to be past the physical end of the string, the logical length and formponter will both be left pointing to the last physical character in the string. This feature is useful in extracting and inserting information within a large string. The EOS condition will be set if a change in the logical length of the first operand occurs.

Examples:

```
RESET XDATA TO 5
RESET Y
RESET Z TO NUMBER
RESET Z TO STRING
```

Note that the RESET instruction is very useful in code conversions and hashing of character string values as well as large string manipulation.

## 5.8 ENDSET

ENDSET causes the operand's formpointer to point where its logical length points.

Example:

```
ENDSET PNAME
```

## 5.9 LENSET

LENSET causes the operand's logical length to point where its formpointer points.

Example:

```
LENSET QNAME
```

## 5.10 CLEAR

CLEAR causes the operand's logical length and formpointer to be zero. None of the data characters are changed.

Example:

```
CLEAR NBUFF
```

## 5.11 EXTEND

EXTEND increments the formpointer, stores a space in the position under the new formpointer, and sets the logical length to point where the new formpointer points if the new logical length would not point to the ETX at the end of the character string. Otherwise, the EOS flag is set and no other action is taken.

Example:

```
EXTEND BUFF
```

## 5.12 LOAD

LOAD performs a MOVE from the character string pointed to by the index numeric string, given as the second operand, to the first character string specified. The instruction has no effect if the index is negative, zero, or greater than the number of items in the list. Note that the index is truncated to no decimal places before it is used (e.g. 1.7 = 1).

Example:

```
LOAD AVAR FROM N OF NAME,TITLE,HEDING
```

## 5.13 STORE

STORE performs a MOVE from the first character string specified to a character string in a list specified by an index numeric variable given as the second operand. The instruction has no effect if the index is negative, zero, or greater than the number of items in the list. Note that the index is truncated to no decimal places before it is used (e.g. 1.7 = 1).

Examples:

```
STORE Y INTO NUM OF ITEM,ENTRY,ALINK
STORE "XX" INTO NUM OF A1,A2,A3
```

The LOAD and STORE instructions may be continued to the next line by the use of a colon:

Examples:

```
LOAD SYMBOL FROM N OF VAR,CONST,DEC:
     COUNT,FLAG,LIST
STORE NAME INTO NUM OF A,B,C,D,E,F,G:
      H,I,J,K,L,M
```

## 5.14 CLOCK

CLOCK enables the programmer to access the DATABUS 1100 time clock. This interrupt is accurate to approximately 0.005 percent or four seconds per day. There are three variables that the CLOCK instruction can access. These are given the names TIME, DAY, and YEAR. All are character strings with TIME being in the format:

12:34:56

and ranging from 00:00:00 to 23:59:59, DAY being in the format:

123

and ranging from 001 to 365 (except to 366 on leap years), and YEAR being in the format:

12

and ranging from 00 to 99, being the last two digits of the year.

Note that when the TIME goes from 23:59:59 to 00:00:00, the day is incremented. The new day value is not checked to be a valid Julian date, however, implying that the system must be manually reset at midnight at the end of the year. The CLOCK instruction performs a character string to character string move with the special variable in the source and the character string to receive the information in the destination operand specification. Note that the user's program may have variables called TIME, DAY, and YEAR.

For example:

```
          CLOCK     TIME TO TIME
          CLOCK     DAY TO DAY
          CLOCK     YEAR TO YEAR
```

would move the information in the system variables into user defined variables called TIME, DAY, and YEAR also.

Note that the clock value is not allowed to be updated by the foreground interrupt during the actual transfer of characters from the system data into the user's data item. However, an interrupt could occur between the time one clock item was moved and the next, thereby necessitating a precaution if one is to obtain both the time and the day figure. For example, if the time was 23:59:59 and one moved the TIME into a variable and then the foreground interrupted and caused the clock to be incremented to the next second, the TIME would then read 00:00:00 and the DAY would have been incremented. If one then obtained the DAY figure, he would have the wrong day for the time he had gotten. Therefore, when obtaining both the TIME and DAY, one must first get the DAY, then get the TIME, and then go back and make sure the DAY had not changed. For example:

```
          CLOCK     DAY TO DAY
          CLOCK     TIME TO TIME
          CLOCK     DAY TO DAY2
          COMPARE   DAY TO DAY2
          GOTO      TIMEOK IF EQUAL
          CLOCK     DAY TO DAY
TIMEOK    (etc)
```

All CLOCK items are initiated to zero.

## 5.15 TYPE

TYPE sets the EQUAL condition if the string contained from the formpointer through the logical length of the specified string variable is of valid numeric format (only leading minus, one decimal point, and digits or spaces).

## 5.16 SEARCH

SEARCH compares one string of characters (a key) to a series of contiguous variables (a list) and returns the positional number (the index) of the matching item. The search starts at the formpointer of the key variable and the first list variable. Each compare through the list stops when the key length is exhausted (the items do not have to be of equal length). If the key matches the item, even though the item is longer, a match will occur. If the list item is shorter than the key, no match occurs. The instruction must include a numeric variable containing the number of items in the list. The key will be compared to each item in the list until the list length is exhausted or a match occurs.

If a match is found, the number of the matching variable (that is, it's position in the list) is stored in the numeric variable specified as the Index and the EQUAL flag is set.

If no match is found, the Index variable is set to zero and the OVER flag is set.

For example:

```
SEARCH    KEY IN LIST TO LISTEN OF INDEX
SEARCH    ACTNO ON VALIDACT TO TEN OF CLASSNO
```

The key and list may be of either numeric or string type. However both the key and list must be of the same type. Regardless of the type, only and ASCII compare (no alignment) is performed.

## 5.17 REPLACE

The REPLACE (or REP) instruction allows any one ASCII character in a string variable to be replaced by any other ASCII character. The first variable in the instruction contains multiples of two characters; each pair consisting of the

character to be replaced and the replacing character and the second variable is the string to be modified .

```
REPLACE   ABVAR IN SVAR
REP       "AB" IN SVAR
```

The string SVAR will have any "A" character replaced by a "B" character.

# CHAPTER 6. ARITHMETIC INSTRUCTIONS

All of the arithmetic instructions have certain characteristics in common. Except for LOAD and STORE, each arithmetic instruction is always followed by two numeric string variable names. The contents of the first variable is never modified and, except in the COMPARE instruction, the contents of the second variable is always the result of the operation. For example, in:

```
ADD XAMT TO YAMT
```

the content of XAMT is not changed, but YAMT contains the sum of XAMT and YAMT after the instruction is executed.

Following each arithmetic instruction, the condition flags OVER, LESS, and ZERO (or EQUAL) are set to indicate the results of the operation. OVER indicates that the result of an operation is too large to fit in the space allocated for the variable (a result is still given with truncation at the left and rounding at the right, however). LESS or ZERO (EQUAL) indicates respectively that the content of the second variable is negative or zero following the execution of the instruction (or would have been in the case of COMPARE).

Whenever overflow occurs, the higher valued digits that do not fit the variable are lost. For example, if a variable is defined:

```
NBR42     FORM 2.2
```

and a result of 4234.67 is generated for that variable, NBR42 will contain only 34.67.

Whenever an operation produces lower order digits than will fit in the destination variable, the result is rounded up if the digit to the right of the last one that would fit is greater than 4 (standard rounding rules). A variable with the FORM 3.1 would contain:

```
 46.2   for   46.213
812.5   for  812.483
  3.7   for    3.666
  3.9   for    3.850
```

with the OVER condition occurring for only the last result.

Note that if an OVER occurs during an ADD, SUB, or COMPARE of two strings of different physical lengths, the result will not and the LESS condition flag may not be correct.

## 6.1 ADD

ADD causes the content of variable one to be added to the content of variable two:

Examples:

```
ADD X TO Y
ADD DOG,CAT
ADD "1", LEN
```

## 6.2 SUB or SUBTRACT

The SUB instruction (the compiler will also accept a mnemonic of SUBTRACT) causes the content of variable one to be subtracted from the content of variable two.

Examples:

```
SUB RX350 FROM TOTAL
SUB "32.5" FROM RATE
SUBTRACT Z,TOTAL
```

## 6.3 MULT or MULTIPLY

The MULT instruction (the compiler will also accept a mnemonic of MULTIPLY) causes the content of variable two to be multiplied by the content of variable one. The restrictions mentioned in the introduction about the length of multiplication operands are that the sum of the number of characters in the two operands must be less than 32.

Examples:

```
MULT B BY A
MULT ".005" BY TOTAL
MULTIPLY W,Z
```

## 6.4 DIV or DIVIDE

The DIV instruction (the compiler will also accept a mnemonic of DIVIDE) causes the content of of the second variable to be divided by the content of the first variable. The restriction upon division operands is that the number of characters in the dividend plus the number of characters in the divisor plus two times the number of characters after the decimal point in the divisor must be less than 32. Division by zero results in the OVER condition being set and the destination variable not being changed.

If the quotient cannot be represented fully in the destination variable format, the quotient will be rounded to the number of places in the destination variable if the divisor has at least one digit place after the decimal point. If there are no digit places after the decimal point in the divisor, the quotient will be truncated (rounded down) to the number of places in the destination variable.

Examples:

```
DIV SFACT INTO XRSLT
DIV "3.0" INTO QUANTITY
DIVIDE X3,HOURS
```

## 6.5 MOVE

MOVE causes the content of variable one to replace the content of variable two.

Examples:

```
MOVE FIRST TO SECOND
MOVE "0" TO COUNTER
MOVE A,B
```

## 6.6 COMPARE

COMPARE does not change the content of either variable but sets the condition flags exactly as if a SUB instruction has occurred.

Examples:

```
COMPARE XFRM TO YFRM
COMPARE "100" TO LINENR
COMPARE TIME1,TIME2
```

## 6.7 LOAD

The LOAD instruction selects the numeric string variable out of a list based on a numeric index variable. It then performs a MOVE operation from the contents of the selected variable into the first operand. If the index is rounded to no decimal places before it is used (e.g. 0.1=0).

**Example:**

```
LOAD  CAT FROM N OF CAT,MULT,SPACE
```

## 6.8 STORE

The STORE instruction selects a numeric string variable from a list based on the value of a numeric index variable. It then performs a MOVE operation form the contents of the first operand into the selected variable. If the index is negative, zero, or greater than the number of items in the list, the instruction has no effect. Note that the index is rounded to no decimal places before it is used (e.g. 0.1=0).

**Example:**

```
STORE  X INTO NUM OF VAL,SUB,TOT
```

The LOAD and STORE instruction statements may be continued to the next line by the use of a colon.

**Examples:**

```
LABEL  LOAD NUMBER FROM N OF N1,N2,N3,N4,N5:
       N6,N7,N8,N9
ENTRY  STORE "2.3" INTO X OF N1,N2,N3
```

## 6.9 CHECK11

The CHECK11 (or CK11) instruction performs a check digit calculation (modulo 11) on two numeric variables (or literals). The first variable is the base number and the check digit to be validated:

```
| 1 2 3 4 | 7 |
BASE | CHECK DIGIT
```

The second variable is the weighting factor:

```
| 5 4 3 2 |
```

Note that the weighting factor and the base portion of the number are of the same length. The weighting factor is assumed to have the length of the base. If it is shorter, an EOS condition is set and the instruction is not completed.

The calculation is performed starting at the form pointer of each variable using the length - 1 of the first variable. When the check digit value has been computed, it is compared to the last digit of the base. If they match, the EQUAL flag is set; if the resultant check digit does not match, the OVER flag is set and the EQUAL flag is cleared.

For example:

```
CHECK11   BASECK BY "7654327"
CK11      NMBR BY WEIGHT
```

The algorithm used to generate the modulo 11 check digit value is:

1) Each digit in the base is multiplied by the corresponding digit in the weighting factor.

2) The individual products are added.

3) The sum of the products is divided by eleven.

4) The remainder of the division is subtracted from eleven giving the check digit.

5) A check digit with a value of 10 cannot be used and causes the OVER flag to be set.

## 6.10 CHECK10

The CHECK10 (or CK10) conforms to the same restrictions and is performed in the same manner as the CHECK11 instruction with the exception of the algorithm used to compute the check digit.

For example:

```
CHECK10   ACTNO BY "21212"
CK10      A BY B
```

The algorithm for modulo 10 check digit computation is:

1) Each digit in the base number is multiplied by the corresponding digit in the weighting factor.

2) The individual digits in these products are added.

3) The sum of the digits is divided by 10.

4) The remainder of the division is subtracted from 10 with the result being the check digit.

# CHAPTER 7. INPUT/OUTPUT INSTRUCTIONS

The DATABUS 1100 statements that move data between the program variables and the terminal, printer, or disk, allow a list of variables to follow the operation mnemonic. This list may be continued on more than one line with the use of a colon.

The I/O list may contain some special control information besides the names of the variables to be dealt with. It may also include octal control characters (000 through 037). Care must be taken in the use of these special control characters as their use can cause unpredictable results if the I/O device (such as the Servo Printer) does not have provision of them. DATABUS 1100 has no formatting information in its input and output operations other than the list controls and that implied by the format of the variables. The number of characters transferred is always equal to the number of characters physically allocated for the string (except in some special cases) allowing the programmer to set up his formatting by the way he dimensions his data variables.

## 7.1 KEYIN

KEYIN causes data to be entered into either character or numeric strings from the keyboard. A single KEYIN instruction can contain many variable names and list control items. When characters are being accepted from the keyboard, the flashing cursor is on. At all other times the cursor is off.

When a numeric variable is encountered in a KEYIN statement, only an item of a format acceptable to the variable (not too many digits to the left or right of the decimal point and no more than one sign or decimal point) is accepted. If a character is struck that is not acceptable to the format of the numeric variable, the character is ignored and a beep is returned to the console. Note that if fewer than the allowable number of digits to the left or right of the decimal point are entered, the number entered will be reformatted to match the format of the variable being entered. When the ENTER key is struck, the next item in the instruction list is processed.

When a character string variable is encountered, the system accepts any set of ASCII characters up to the limit of the physical length of the string. The formpointer of the string

variable is set to one and characters are stored consecutively starting at the physical beginning of the string. When the ENTER key is struck, the logical length is set to the last character entered and the next item in the keyin list is processed. If the ENTER key is struck without any other characters having been entered (a null string is entered), both the logical length and form pointer of the string are set to zero. The program can check for a variable with a null entry by checking for an EOS condition after doing a RESET or CMATCH instruction on the variable in question .

### 7.1.1 Displaying with KEYIN

Other than variable names, the KEYIN instruction may contain quoted items, list controls, and octal control characters (000 to 037). Quoted items are simply displayed as they are shown in the statement. The list controls begin with an asterisk and allow such functions as cursor positioning and screen erasure. The *P<n>:<m> control positions the cursor to horizontal position <n> and vertical position <m>. Note that these numbers may either be literals or numeric variables and both positions must always be given in a *P command. The horizontal position is restricted by the interpreter to be from 1 to 80 and the vertical position is restricted to be from 1 to 12. Numbers outside this range have the effective value of 1.

### 7.1.2 Erase Screen

The *ES control positions the cursor to 1:1 and erases the entire screen, the *EF control erases the screen from the current cursor position, the *EL control erases the rest of the line from the current cursor position, the *C control causes the cursor to be set to the beginning of the current line, the *L control causes the cursor to be set to the following line in the current horizontal position, the *N control causes the cursor to be set to the first column of the next line, and the *R control causes the screen to roll up.

Normally, the cursor is positioned to the start of the next line at the termination of a KEYIN statement. However, placement of a semicolon after the last item in the list will cause this positioning to be suppressed, allowing the line to be continued with the next KEYIN or DISPLAY statement. This feature is also true of the PRINT command.

Example:

```
KEYIN *ES,"NAME: ",NAME,*P35:1,"ACNT NR: ":
      ACTNR,"  ADDRESS: ",STREET,*P10:3:
      CITY,*PX:4,"ZIP: ",ZIP;
KEYIN "ABC",021,NVAR
```

### 7.1.3 KEYIN Continuous

During a KEYIN, any unrecognizable characters (not in the printing ASCII set) sent in from the console will be ignored and a beep returned. Also, a mode called keyin continuous is available (turned on with list control *+ and turned off with list control *- or the end of the statement) which causes the system to react as if an ENTER key had been struck when the operator enters the last character that will fit into a variable. This mode allows the system to react in much the same way as a keypunch machine with a control card.

### 7.1.4 BACKSPACE and CANCEL

While keying a given variable, the operator can strike the BACKSPACE key and cause the last character entered to be deleted. He may also strike the CANCEL key and cause all of the characters entered for that variable to be deleted.

A circular input buffer allows the operator to send up to seven characters from the keyboard before they are requested by the system. Note that there is no feedback at this level as the characters are fed back only as they are taken from the buffer. This buffer allows the operator to continuously enter data without having minor delays in the response of the system break his stride.

### 7.1.5 Operator Interrupt Procedure

A special case of KEYIN is the interrupt procedure, entered by keying CANCEL with both the KEYBOARD and DISPLAY keys depressed on the system console. Normally, when the cursor is not flashing, all characters will be ignored (not accepted from the seven character circular input buffer) until input is requested. The exception, however, is the interrupt character, which may be keyed at any time (it will be postponed if a PI instruction is in effect) and will result in an immediate CHAIN to the MASTER program. Thus, the currently executing program will stop, the printer, if being used , will be RELEASED, and the

MASTER program will begin execution.

### 7.1.6 New Line

Another special case of KEYIN is the NEW LINE character, which is the DEL or underline character on the system console. If this key is struck during a KEYIN statement, the current variable is terminated as if the ENTER key was struck and all subsequent variables in the statement will be set to zero or their formpointers and logical lengths set to zero depending on whether they are numeric or string variables. Control will fall through to the next DATABUS 1100 statement.

### 7.1.7 KEYIN Timeout and Pause

The list control, *T, may be included in the KEYIN statement causing a time out if more than two seconds elapse between the entry of two characters. The time out has the same results as if the NEW LINE key had been struck.

The list control, *W, may be included in the KEYIN statement causing a one second pause at that point in the list sequence. This control is especially useful in programs which wish to simply pause for a number of seconds. Any number of seconds of pause may be achieved by simply putting in the required number of *W controls in the list.

### 7.1.8 Echo Control

The list controls *EOFF and *EON may be included in the KEYIN statement causing the echo of entered characters to be inhibited or enabled respectively. When echo is inhibited, the KEYIN statement causes only the characters specifically mentioned in the list to be displayed on the console. Therefore, the statement:

```
KEYIN   *EOFF,INLINE;
```

would allow the variable INLINE to be entered from the keyboard with absolutely no characters being displayed at the console. Since the cursor display at the console will not be enabled, there will be no indication in this case that input is being requested. This feature could be used where passwords are to be entered and it is desired to suppress their display. In this case, the statement:

```
KEYIN   *EOFF,*P1:10,"ENTER PASSWORD: ":
```

```
022,PASSWORD,024
```

could be used. Note that even though echo is inhibited, the cursor positioning and literal characters are still displayed on the console since they are specifically mentioned. Notice also that the carriage return and line feed will be sent at the end of the statement since a semi-colon is not supplied. The 022 character is a cursor on and the 024 is a cursor off for the system console. The cursor controls must be specifically mentioned since the echo inhibit prevents them from being sent automatically. The echo is always enabled at the conclusion of the KEYIN statement. Therefore, one must always inhibit the echo at the start of each statement in which no echo is desired.

### 7.1.9 Special KEYIN Controls

Numeric and String variables in the KEYIN may be preceeded by a format control function which can change the justification and/or fill control normally performed during KEYIN.

The *JL control left-justifies Numeric input and zero-fills at right if there is no decimal point entered.

```
KEYIN     *JL,NVAR
```

The *JR control right-justifies String input and blank-fills at left.

```
KEYIN     *JR,SVAR
```

The *ZF control performs zero-fill on String entry.

```
KEYIN     *ZF,SVAR
```

The combination of *ZF and *JR is valid.

```
KEYIN     *ZF,*JR,SVAR
```

The *DE control can be used to restrict String input to digits only (0-9). A non-digit will not be accepted at the keyboard.

```
KEYIN     *DE,SVAR
```

The special KEYIN controls apply only to the variable immediately following in the KEYIN statement.

### 7.1.10 Text Input

The Keyboard input can be programmed for text input through the use of the *IT and *IN controls. The control *IT is used to turn-on the text input mode. This converts all alphabetic characters to shift to upper case as on an office typewriter. The Keyboard remains in the Text Input mode until the control *IN returns the keyboard to normal mode.

```
KEYIN     *IT,SVAR,*IN
```

## 7.2 DISPLAY

DISPLAY follows the same procedure as KEYIN except that when a variable name is encountered in the list following the instruction, the variable's contents is sent to instead of being requested from the console. Character strings are displayed starting with the first physical character and continuing through the logical length. Spaces will be displayed for any character positions that exist between the logical length and physical end of the string unless the *+ mode (keyin continuous in the KEYIN instruction) is active, in which case no more characters are put out after the logical length. Numeric strings are always displayed in total. Quoted strings, list controls, and octal control characters may be included in the display instruction and are handled in the same manner as described for the KEYIN instruction. Note that the *T, *EON, and *EOFF controls will simply be ignored in the DISPLAY statement.

Examples:

```
DISPLAY *P5:1,"RATE: ",RATE:
        *P5:2,"AMOUNT: ",AMNT
DISPLAY "ABC",021,S1;
```

## 7.3 BEEP

BEEP causes a beep to be sent to the console.

Example:

```
BEEP
```

## 7.4 PRINT

DATABUS 1100 supports either one local printer or one servo printer , depending on printer availability and initialization options.

The PRINT instruction causes the contents of variables in the list to be printed in a fashion similar to the way DISPLAY causes the contents of variables to be displayed. The list controls are much the same as DISPLAY except that cursor positioning cannot be used, column tabulation is provided (*<n> causes tabulation to column <n> unless that column has been passed) and *F causes an advance to the top of the next form. Octal control characters may also be included in the print instruction. The PRINT statement may be continued on more than one line by the use of a colon.

Examples:

```
PRINT DATE,*20,"TRANSACTION SUMMARY",*C,*L:
      PNAME,*N,*10,RATE,*20,HOURS,*30:
      AMT,*L
PRINT "ABC",021,S1;
```

The control character, *ZF may be used before any numeric variable to cause zero fill on the left, moving the sign to the left if neccessary. The tabbing in the PRINT statement can move the carriage in the reverse direction and any sequence of printer controls will be executed in precisely the sequence specified. For example, one could print 10 characters, tab back to column 5 and overprint that column, do one line feed, and print five characters which would appear in columns 6 through 10 under the first line. He could then do a form feed and print 10 more characters which would appear in columns 11 through 20 at the top of the next page. One must be careful not to do these things, however, if he plans to use the same program with non-servo printers.

If the servo printer is being used, the paper out condition will be checked whenever a top of form control is given in a PRINT statement. If, after the top of form function is performed, the paper out condition is present, the console will make a uniquely characteristic beeping sound to alert the system operator that more paper must be placed in the printer. The

beeping sound will stop when the front cover of the printer is swung out but will resume if the cover is replaced to its original position with the paper out indicator still on. The recommended procedure is to open the front cover, remove the last form still in the printer, place new paper in the printer with the top of the form aligned with the print head, and finally close the front cover.

Another feature allowed with the servo printer is minor vertical spacing (there are eight minor vertical spaces for one standard line space). Control characters either given directly in the PRINT statement or contained within a string variable can cause the paper to be fed either up or down up to seven minor vertical spaces. The characters zero through seven cause the paper to be fed down the page (the normal spacing direction) a corresponding number of minor spaces. The characters eight through fifteen cause the paper to be fed up the page (opposite to the normal spacing direction) zero through seven minor spaces respectively. The characters sixteen through twenty-two cause the carriage to move to the left seven through one column positions respectively (horizontal minor positioning cannot be performed). The character twenty-three causes no printer action. The characters twenty-four through thirty one cause the carriage to move to the right one through eight column positions respectively. This feature on the servo printer allows different kinds of underscoring and super- and/or sub-scripting in the printed output.

## 7.5 Disk I/O

DATABUS 1100 allows a large variety of file structures and access methods. The structures can be dependent upon the physical sectoring of the disk, physically sequential, or logically indexed. The access methods can be physically random, physically sequential, logically random, or logically sequential with any mix of these being allowed on logically indexed files. This section will describe the various file structures that can be created, how positioning is maintained within these structures, and how access to desired information within the structure can be achieved. It will then describe the various operations that can be performed upon the information within the file.

### 7.5.1 File structures

The most basic structure within a file is a physical record. A physical record can contain at most 249 data characters (note that there is no decimal number compression within any of these file structures so a number always occupies the number of characters that are contained within the FORM which defines the number). A physical record corresponds to exactly one physical sector on the disk and is always terminated by a 003 character.

The next level of structuring is a logical record. Depending upon the way the user structures his file there may or may not be an integral number of logical records within a physical record. A logical record is terminated by a 015 character after which another logical record begins. Note that logical records can extend across physical record boundaries (terminated by 003 characters) so that a file with logical records may appear in the first two physical records as follows (the items in parenthesis are the logical and physical record termination characters):

```
01128558382 AASDFQWERKFKDSKA (015) 1234848 (003)
8483 LAKSJDFLKASDFKKJ (015) 48828388483 KI (003)
```

Note that the first logical record extends about two thirds of the way through the first physical record and is then terminated by the 015 character. The first seven characters of the second logical record are also contained in the first physical record at which point the first physical record is terminated. The rest of the second logical record extends about half way through the second physical record and is then terminated by the 015 character. At this point the third logical record starts and so on.

Also note that there is no restriction upon the length of a logical record (a single logical record may extend across many physical records) but that it is a good idea to keep logical records reasonably short to prevent them from becoming hard to deal with. If one had wanted to keep only one logical record per physical record he would have made the file appear as follows:

```
01128558382 AASDFQWERKFKDSKA (015) (003)
12348488483 LAKSJDFLKASDFKKJ (015) (003)
48828388483 KILKJLKJLKSJDFKD (015) (003)
```

Note that it took more disk space to store the same amount of information in this case than in the previous case. It is sometimes desirable to give up this space in return for the capability of using the fastest accessing method of directly accessing physical records. A structure which allows logical records to cross physical record boundaries is called a record compressed structure.

In some data files large numbers of contiguous spaces appear. These files can be compressed even further than simple use of record compression by the use of space compression (the general purpose DOS editor, the DOS SORT program, a number of the terminal emulator programs, the DATABUS 1100 compiler (listing file output), and DATABUS 1100 programs can all generate space compressed records). A space compressed structure appears much like a record compressed structure except for the addition of the 011 control character. This control indicates that the next byte is a positive 8-bit binary word which tells how many spaces were replaced by the compression code character pair. This number will never be less than 2 (since it is wasteful to expand one or zero spaces into two characters) and may be as large as 255. In addition, the 011 will never appear as the last character in a physical record since the character indicating the number of spaces will always appear after the 011 (otherwise the 003 indicating the end of the physical record and three spaces compressed could not be differentiated). For example, in the following a logical record is shown first without space compression and then with space compression:

```
NOW IS THE  TIME       FOR (015)
NOW IS THE(011)(002)TIME(011)(007)FOR (015)
```

The second record is physically shorter than the first by six characters. It may seem silly to compress two spaces into a two character compression code but most programs do this because it is logically simpler to program. If more than 255 contiguous spaces appear in the data record, multiple space compression codes will appear. Space compressed records are most useful where large numbers of spaces appear in the file (as in print files) and where the records are not to be modified in place. If the record is to be modified in place, space compression is discouraged since the number of spaces could change and the physical length of the logical record could change.

A file which can be accessed physically sequentially must not have any physical records without the proper format between the beginning of the file and an end of file mark. The end of

file mark always starts at the beginning of a physical record and contains exactly six 000 characters followed by the physical record termination character (003). The rest of the characters in the physical record are of no significance. Note that if there are no physical records besides the one containing the end of file mark, the file would be null (which is a valid condition for a file).

A physically sequential data file can be logically indexed. One cannot tell that a file is indexed by looking only at the data file since the indexing information is maintained in a separate file called the index file (and usually of DOS extension ISI). The index file contains the name and extension of the data file which it indexes and a set of keys and pointers which relate the key value of a logical record to its physical position within the data file. DOS utilities exist for the creation of the index file which must always be performed outside of the DATABUS 1100 interpreter.

The index file is a n-ary tree where n is determined by the length of the key and where there are enough levels to make the top node in the tree always fit within one disk sector (contain at most n branches). One can conservatively estimate the number of sectors that will be used in the index file by the following method. The actual number used may be less because trailing spaces in keys are discarded and more than the minimum number of keys may fit in a sector.

To compute the index file length, divide 250 by the key length plus 7 and discard the remainder (do not round up the result). This number should then be divided into the number of logical records to be indexed and the answer rounded up (if the remainder is non-zero then add one to the answer and discard the remainder). Save this number which is the number of sectors at the lowest level of the index tree. Then divide 250 by the key length plus 3 and discard the remainder. This number should then be divided into the number saved before the previous step and the answer rounded up. Save this number which is the number of sectors at the next higher level of the index tree. If the answer produced is greater than one, repeat the previous step (dividing 250 divided by the key length plus 3 into the previous answer). When the answer has been reduced to one, total all of the numbers of sectors required for each level and the result will be the total number of sectors required in the index file.

For example, assume that the data file contains 10000 logical records and the key is 10 characters long. The first

computation is 250/(10+7) = 14.71 or 14 discarding the remainder. The next computation is 10000/14 = 714.29 or 715 rounding up. Therefore, the lowest level of the index tree will require 715 sectors. The next computation is 250/(10+3) = 19.23 or 19 discarding the remainder. The next computation is 715/19 = 37.63 or 38 rounding up. Therefore, the next higher level of the index tree will require an additional 38 sectors. The next computation is 38/19 = 2.00 or 2 rounding up. Therefore, the next higher level of the index tree will require an additional 2 sectors. The next computation is 2/19 = 0.11 or 1 rounding up. Since one sector has been reached, the totals are made: 715+38+2+1 = 756 sectors for the entire index tree.

### 7.5.2 Positioning and accessing

In DATABUS 1100, all files are referenced by way of logical files. These files are declared in the data area of the program using the FILE and IFILE declarations. The declarations relate a logical file to a certain physical file that is specified by the OPEN or PREPARE statement performed upon the logical file. The data space used by the declaration holds all of the physical position information needed for that particular file. During file operations, DATABUS 1100 establishes a position within the file using a specified access method and then increments this position based upon the operation specified.

For physically accessed files, a file position is defined by a physical record number (0 through the maximum number of records in the file) and a character pointer within this record (1 through 249). When the file is initially opened (with OPEN or PREPARE), the physical record number is set to 0 and the character pointer is set to 1. All read and write operations sequentially increment the character pointer as the individual characters are read or written. If the physical record terminator (003) is reached during a read or the 249th character is written during a write, the character pointer is reset to 1 and the physical record number is incremented (when writing, a physical record terminator is automatically written after the 249th data character before the physical record is written out to the disk and movement on to the next physical record is made). If an end of file mark is written, the current physical record is terminated, the physical record number is incremented (unless the position was at the start of a physical record when the operation was entered), the end of file mark is written in the first seven characters of the new physical record, and the character pointer

is left at 1.

The character pointer may be set directly by what is called a tab operation in some disk I/O statements. WRITAB, UPDATE, and all read operations may contain these positioning operators. When physical access is being made to the file, the tab position given in the statement is relative to the beginning of the physical record. When indexed access is being made to the file, the tab position given in the statement is relative to the beginning of the logical record. Note that when tabbing relative to the start of a logical record, it is an illegal operation to tab past the end of a physical record. Therefore, when using tabs in indexed files, there should always be an integral number of logical records per physical record to prevent tabbing past the end of a physical record. Note that tabbing may not be used when physical access is being made to a file declared as indexed. If one needs to do tabbed physical accesses to the file as well as indexed accesses, he must declare two logical files to the same data file. One will be used for physical accesses (having been declared using the FILE directive) and the other will be used for indexed accesses (having been declared using the IFILE directive).

When an indexed file is being used, two additional pointers are kept for the logical file. The first is a physical record number and character pointer to the first character of the last logical record accessed using the index. The second is a pointer to the next sequential key after the last key accessed using the index. The first pointer enables re-reads and updates to be made to the indexed file and the second pointer enables the indexed file to be accessed sequentially by key. Note that neither of these pointers is changed when a physical access is made using the logical file.

An additional counter maintained for all logical files is the space compression counter. This counter is used in the decompression of spaces during read, the compression of spaces during write, and as a flag as to whether or not space compression is to be performed during a write (decompression will always be performed by the read). It is suggested that the reader come back and read the following paragraph closely after he feels he understands the disk read and write access methods and operations since some of these ideas are referenced in the following section. One must understand the following section to be able to effectively deal with space compressed files.

When the space compression counter has a value of -1 during

write operations, spaces will not be compressed in the output. The counter value is set to 0 when the file is initially opened (using OPEN or PREPARE) and at the start of a physically random or indexed access read operation or when a *+ control in a write operation statement is encountered. The counter value is set to -1 when a physically random or indexed access write operation is performed or when a *- control in a write operation statement is encountered. Therefore, space compression will be on at the beginning of a physically sequential write that occurs as the next operation after the file has been opened or a read operation of any kind has been performed, space compression will be off at the beginning of any physically random or indexed access write operation, and the status of space compression will not be changed by any other operations. If the desired space compression mode for a write operation is not obtained by the above rules then the *+ and *- controls will have to be used to get the desired mode. Note that these controls can erase the memory of previously accumulated spaces if used after the beginning of the statement list while space compression has been on.

#### 7.5.2.1 Physically Random Access

The fastest random access method available under DATABUS 1100 is physically random access. To perform a physically random access, a numeric variable containing a positive number is supplied as the record specifier to the statement. Any fractional part of this variable will be discarded and then the physical record number will be set to its value. The character pointer will then be set to one and the read or write operation will proceed. Unfortunately it is often hard to find a map from a key value in the data records to a fairly contiguous set of numbers, necessatating the use of an index structure. However, if such a map can be found, physically random accessing imposes lower overhead than the indexed accessing.

#### 7.5.2.2 Physically Sequential Access

One can cause the read or write operation to simply pick up where the physical record number and character pointer are currently positioned by specifying a numeric variable with a negative value in the record specifier. Usually, when a read or write operation is finished, it leaves these pointers at the

beginning of the next logical record. However, a read or write operation can be parameterized (by placing a semi-colon at the end of the variable list) such that it will simply leave the pointers after the last character dealt with. In this case, the physically sequential access can be used to continue a previous operation from where that operation stopped. The previous operation could have used any access method (including this one) which implies that one can continue a logical record to any length. However, it is often a good idea to keep logical records reasonably short to prevent them from becomimg hard to deal with. Note that the SORT and INDEX utilities require the key value to be within the first 255 characters of a logical record.

### 7.5.2.3 Indexed Access

As described in the previous section, a data file may have an associated index file which associates key values to physical record number and character pointer values. There are five basic indexed operations: read a record of a given key value, read a record of the next ASCII sequential key value, update the record that was last accessed through the index, insert a new record of a given unique key value, and delete a record of a given key value. Since there can be any number of indexes into one data file, the insertion and deletion operations will have to perform key insertions and deletions upon all indexes. Therefore, these operations will have to be performed once for each index that points to the data file.

For the indexed read and write operations, once the indexed access has been performed (the physical record number and character pointer values have been set), the actual operation is performed identically to the operation as performed for physical accesses. The one exception is when a record is being inserted. Since records are always inserted at the physical end of the file, a new end of file mark must be written after the inserted record has been written. In this case, a flag is set so that when the write statement has been finished (and it has not been specified that the write operation is to be continued), then the end of file mark will automatically be written. This automatic end of file mark writing operation will not be performed if the write operation is to be continued, thereby making it the responsibility of the DATABUS 1100 program to write the end of file mark when the record has finally been written in its entirety.

The indexed access using a given key value will cause at least one disk sector to be read for each level in the index in addition to whatever disk functions are required to perform the actual read or write operation. If records have been inserted into the index and the INDEX utility has not been run since then, then additional disk sector reads may take place depending upon the length and path of the linked list at the lowest level in the index. Therefore, when many insertions are being performed the INDEX utility should be run as often as is practical to keep the access time from becoming overly large. Also, when a data base is being initialized, it is not a good idea to build it from a null indexed file doing insertions. It would be much more efficient to build the data base physically sequentially as long as indexed accesses need not be made to it and then create the index file on a reasonably large data file after which additional insertions can then be made using the insertion facility.

#### 7.5.2.4 Physical Access to Indexed Files

Both physically random and sequential accesses may be made to indexed files. Therefore, one can index only on primary records and then obtain the rest of the records using physically sequential accesses. He may also have a file which is already physically randomly accessed and add an index based on some other key value for fast access to other aspects of the file. If the file has been declared as indexed (using the IFILE directive) then all access methods may be used upon it. However, if the file has been declared as non-indexed (using the FILE directive) then only physical access methods may be used upon it.

### 7.5.3 PREP or PREPARE

PREPARE (the compiler will also accept a mnemonic of PREP) is used to create a new file under the DOS file structure. The name used for the DOS file name is given in the string variable or literal specified in the PREPARE instruction. The characters used for the name start from under the formpointer of the specified variable and continue until either the logical end of the string has been reached or eight characters have been obtained. (If the item is a literal, the formpointer is one and the logical length points to the last character.) If the end of the string is reached before eight characters are obtained, the rest of the characters are assumed to be spaces. All data files

used in DATABUS 1100 are of extension TXT. The character after the 8th in the name variable or the character after the logical length, if the name is less than 8 characters, is used as the drive number for that file. If the character is not an ASCII 0, 1, 2, or 3 or no character physically exists past the name, no drive specification is assumed and all drives starting with drive zero are searched when looking for a name in the directory or directories. Otherwise, only the drive specified is searched.

If a file by the name given already exists (and is not delete or write protected), it is deleted and a new file created. If the file has any protection or the drive specified is off line, an IO error P or M respectively will occur.

One always deals with "logical files" in DATABUS 1100 once he has opened them with either the PREPARE or OPEN instructions. Any number of logical files can be opened at one time, the limitation being the amount of space the user has available to devote to the data space needed by each logical file that is declared. The logical files are declared using the FILE or IFILE instructions (see Section 3.1). NOTE: The PREPARE instruction can only create a file that has been declared as a FILE type. The compiler will flag an attempt to PREPARE a file that has been declared as an IFILE type. IFILE type files must be created by use of the INDEX utility running under the DOS.

For example, let the following definitions be made:

```
FDECL     FILE
FNAME1    INIT      "FILE1"
FNAME2    INIT      "FILE2   1"
FNAME3    INIT      "ASDFFILE32"
```

Let the formpointer and logical length of FNAME1 be 1 and 5, that of FNAME2 be 1 and 9, and that of FNAME3 be 5 and 9. Then if the statement:

```
PREPARE   FDECL,FNAME1
```

were executed, the file FILE1/TXT would be prepared as logical file FDECL on the first drive (beginning with drive 0) on which space was available. If the statement:

```
PREPARE   FDECL,FNAME2
```

were executed, the file FILE2/TXT would be prepared as logical file FDECL on drive 1. If the statement:

```
PREPARE   FDECL,FNAME3
```

were executed, the file FILE3/TXT would be prepared as logical file FDECL on drive 2. If the statement:

```
PREPARE   FDECL,"ASDF"
```

were executed, the file ASDF/TXT would be prepared as logical file FDECL on the first drive on which space was available. If the statement:

```
PREPARE   FDECL,"QWER    3"
```

were executed, the file QWER/TXT would be prepared as logical file FDECL on drive 3.

If the logical file specified is already open (having been specified in a previous PREPARE or OPEN instruction and not since in a CLOSE instruction), the old file will be closed before the new one is dealt with.

If the user plans to deal with a vary large file he should run a program that writes a dummy record into the largest record number he plans to use. This will cause the DOS to allocate all records up through the one accessed in as physically contiguous a manner as possible, thus increasing the speed with which the file may be randomly accessed. Note that the use of the DOS implies that a file must be contained on one drive. If the writing of the dummy record tries to extend the file past the amount of space available on the disk, an error R will occur.

Remember that space compression mode for writing is left on by a PREPARE instruction .

### 7.5.4 OPEN

OPEN causes a DOS file already in existence to be prepared for use by the DATABUS 1100 program. Except for the fact that it deals only with files already in existence (giving an IO error if the name specified cannot be found and not killing the file if it already exists), OPEN works in a fashion similar to PREPARE. In addition, OPEN may specify a file that has been declared as an IFILE type (indexed sequential). In the IFILE case, the extension of the name supplied in the literal or string variable is assumed to be ISI instead of TXT (the ISI file header contains the name of the data file it indexes). The opening of the ISI file automatically causes the data file indexed by the ISI file

to be opened. If the data file is indexed by more than one index file (ISI file) then each of the indicies must be opened using a different logical file for each one. (When dealing with indexed files, the data file itself is never explicitly specified since it is automatically specified by the header of the ISI file that is opened.) For example, if the following logical files were declared:

```
FDECL1    FILE
FDECL2    IFILE
FDECL3    IFILE
```

and a data file FILE1/TXT existed and the ISI files FILE1/ISI and FILE1A/ISI had been created using the INDEX utility as follows:

```
INDEX FILE1;1-5
INDEX FILE1,FILE1A;6-10
```

and the following OPEN statements were executed:

```
                        "FILE1"
OPEN      FDECL1,
OPEN      FDECL2,"FILE1"
OPEN      FDECL3,"FILE1A"
```

then the logical file FDECL1 would be opened to the normal (physical access) file FILE1/TXT, the logical file FDECL2 would be opened to the indexed file whose index name was FILE1/ISI and whose data file name (as specified in the FILE1/ISI header) was FILE1/TXT, and the logical file FDECL3 would be opened to the indexed file whose index name was FILE1A/ISI and whose data file name was FILE1/TXT. This would give physical access plus access via two different indicies into the data file FILE1/TXT. Note that an ISI file does not have to reside on the same disk as the data file that it indexes.

Remember that space compression mode for writing is left on by an OPEN instruction .

### 7.5.5 CLOSE

CLOSE closes the specified logical file. This insures that any newly allocated space that was not used in the file will be returned to the DOS for allocation to another file.

Example:

```
CLOSE     FDECL
```

If only reads or updates were performed on the file, the CLOSE instruction does not need to be used. Also, a CLOSE is automatically performed when one opens or prepares a logical file that is already open. When a CHAIN is performed, all files that are currently open are automatically closed without space deallocation being performed. Note that this means files cannot be held open across program chains. Also, if the interrupt key is struck or if the port goes off line a chain is automatically invoked meaning that all files will be closed without space deallocation.

CLOSE is also used to delete a file from the DOS file system. If a PREP is performed on a logical file and the next operation performed upon the logical file is a CLOSE, the file described by the logical file declaration will be deleted from the DOS file system.

### 7.5.6 READ

READ performs all file data reads (physically random, physically sequential, indexed random, tabbed or not) except for indexed key sequential reads. The READ statement format consists of a logical file declaration name, a record specifier variable (numeric or string), and a list of variables to be filled by the data from the record. The list may also contain tab indicators which can specify that only certain portions of the data record actually be read into the variables listed. Tabbing is a DATABUS 1100 feature which can eliminate unwanted data transfers from and to the disk controller buffer and can allow the programmer to save considerable space in his data area. It can only be used, however, when the logical records do not cross physical disk sector boundaries. This condition can usually be enforced through the use of the REFORMAT utility and careful use of the DATABUS 1100 write instructions.

When data is transferred from the record into a numeric variable that is specified in the READ statement list, the number of characters corresponding to the length of the variable are read in. Any non-leading spaces read will be converted to zeros (e.g. s3s2s1, where s stands for a space, would be read as s30201). If a non-numeric character other than a negative sign as the first non-space character, decimal point, or space is read, a FORMAT trap will occur. A FORMAT trap will also occur if the variable is dimensioned to one and the character is a negative sign. A FORMAT trap occurs if the data does not match exactly the format of the numeric variable to be read. For example, if X was dimensioned to 4.2 and the characters read were

7777877, a FORMAT trap would occur since the digit 8 appeared where a decimal point appeared in the variable. If a FORMAT trap occurs during a read, the logical file pointers are left pointing at the current file position before the read was attempted.

If a numeric variable to be read includes a "minus-overpunch" character, the variable is converted to the normal numeric format with the minus sign preceeding the first non-blank digit.

When a string is read, the number of characters corresponding to the physical length of the variable are read into the variable. The formpointer is set to one and the logical length is set to point to the last physical character in the string.

If the end of the logical record is reached before all variables in the list have been read in full, and the variable which is being filled with data when the EOR is detected is a string, it will have its logical length pointer set to the last character entered before the EOR was reached and the rest of the characters physically in the string padded with spaces. Note that this fact can be used to advantage when reading sequential space compressed files. Remember that the trailing spaces in such file records are not written and that the DISPLAY and PRINT statements can be forced to output only up through the character being pointed to by the logical length (using the *+ control). These features can be combined to make listing sequential files on the terminal or printer much faster by the deletion of trailing spaces.

The above discussion deals with the action taken when the end of the logical record is reached while reading data into a string variable. If the data is being read into a numeric variable, the rest of the variable is padded with either spaces or zeros as appropriate. Note that if one of these locations within the variable is the decimal point, a FORMAT trap will occur.

If the list contains more variables after the one being filled when the end of the logical record is detected, these variables will either be set to zero (if numeric) or have their logical lengths and formpointers set to zero.

If the list is exhausted before the logical end of the record is reached, two actions can take place. If a semicolon is placed at the end of the list, the file pointers are simply left

after the last character read so a subsequent I/O operation will pick up where the pointers were left. If a semicolon is not placed at the end of the list, the file pointers are advanced until they are pointing after the next logical end of record marker so a subsequent I/O operation will pick up at the start of the next logical record.

A RANGE trap will occur and the logical file pointers will not be changed if an attempt is made to read a record which has never before been written. (Note that the DOS RANGE or FORMAT traps will both cause a DATABUS 1100 RANGE trap and that the DATABUS 1100 FORMAT trap has nothing to do with the DOS FORMAT trap.)

The following is a list of the different types of READ statements. In the examples, the variable RN is a positive numeric item, SEQ is a negative numeric item, KEY is a non-null string item, NULL is a null string item, FNDECL is a FILE declaration name, FIDECL is an IFILE declaration name, and FDECL is either a FILE or IFILE declaration name.

### 7.5.6.1 Test for End Of File

Before discussing the READ operations, the end of file indicator should be discussed. The OVER condition flag being set indicates that a READ operation has run across an end of file mark on physical accesses and has accessed a non-existent key on indexed accesses. The test for the OVER condition should be made after the READ statement. For example:

```
READ FDECL,SEQ;A,B,C
GOTO LABEL IF OVER
```

If an end of file is read on physical accesses, the variables in the statement will be set to zero or have their logical lengths and formpointers set to zero depending upon whether they are numbers or strings respectively. Note that the OVER condition will also be set if a semicolon appeared at the end of the READ list. The way the READ mechanism works, whenever an end of file mark is found the file pointers "stick" at the beginning of the mark and spaces are supplied for all characters requested to fill variables. Therefore, if one continues to perform READ operations ignoring the fact that the OVER condition flag is being set, the READ operations will simply continue to set the OVER condition flag and clear or zero all variables. This is

also true of READ operations whose lists are terminated by semicolons.

The OVER condition being set after an indexed READ operation indicates that the KEY specified could not be found in the index. For a READKS (read key sequential) operation, the OVER condition being set indicates that the last record in the sequence has been read and the current operation tried to read a non-existent record. See the relevant sections that follow for further information on indexed operations setting the OVER condition flag.

```
READ FDECL,RN;A,B,C
```

This is a physically random access read. The physical record pointer is set to the value of RN and the character pointer is set to the beginning of the physical record (any digits after a decimal point in RN are ignored). Variables A, B, and C are then read. Any remaining characters in the logical record are discarded since the operation leaves the file pointers pointing to the beginning of the following logical record.

```
READ FDECL,RN;A,B,C;
```

This is similar to the above operation except that the file pointers are left pointing to the character after the last one read into the variable C. This enables another I/O operation (write as well as read) to continue from the character after the last one loaded into the variable C.

```
READ FDECL,SEQ;A,B,C
```

This is a physically sequential access read. Variables A, B, and C are read from logical file one beginning at the position indicated by the current file pointer values. The file pointers are left pointing to the beginning of the following logical record.

```
READ FDECL,SEQ;A,B,C;
```

This is similar to the above operation except that the file pointers are left pointing to the character after the last one read into variable C. This enables another I/O operation (write as well as read) to continue from the character after the last one read into the variable C.

```
READ FDECL,ZERO;;
```

Assume that the numeric variable ZERO is defined to be a zero in value. This operation would then cause the file pointers to be positioned to the physical beginning of the file exactly as if a PREPARE or OPEN instruction had just been performed. This implies that space compression will be on if a WRITE is then performed, and the user must turn off space compression if it is not desired.

```
READ FNDECL,RN;A,*100,B,*NVAR,C,*50,D;
```

By including the tabbing controls in the read statement list, selected positions may be read from a record without having to read all of the positions in the record. The list controls *(numeric literal) or *(numeric variable) are used to position the character pointer to the specified character position in the specified physical record and may appear anywhere in the list. Reading for the rest of the list (unless another positioning control is encountered) begins at the character position specified by the positioning list control. Note that tabbing in physically random access reads is allowed only upon logical files that have been declared using the FILE directive (since the tab values are biased by the starting point of the last index accessed record on reads using a logical file that has been declared using the IFILE directive).

Tab positioning in physically random access read operations is calculated from the first data position of the physical record specified. If the tab position is greater than 249 characters, an IO trap will occur. When reading is completed, the character pointer is moved to the beginning of the next logical record if the statement list is not terminated by a semicolon. If the list is terminated by a semicolon, the character pointer is left pointing one character position past the last character read.

Note that tab positioning in a physically random access read operation will inhibit the ability of that operation to detect an EOF mark that may be in the given sector. Either a non-tabbing read can be performed first (to determine whether an EOF exists in the sector in question) followed by the tabbing read if the EOF was not found, or the programmer can invent his own EOF marking convention (which will not require double reads).

The above example would set the physical record pointer to RN and the character pointer to one and variable A would be read. The character pointer would then be set to one hundred and

variable B would be read. The character pointer would then be set to the value contained in the numeric variable NVAR and variable C would be read. The character pointer would finally be set to fifty and variable D would be read. The character pointer would be left pointing after the last character read into variable D since a semicolon appears at the end of the list.

Note that for physically random access reads, it is generally a good idea to place a semicolon at the end of the list if the next read will involve an access to a logical record other than the one which appears next physically. The reason for this is that there is no need to require the processor to scan the rest of the logical record in an attempt to place the file pointers at the beginning of the next logical record when that placement will not be used. This is especially helpful if the read does not leave the character pointer near the end of the logical record as would often be the case where tabbing is being used.

Note that using the read tab on physically sequential access reads (where the record number specified is a negative value) is possible but not advisable. Tab positioning on physical accesses is always calculated from the first character position in the current physical record. The program could obtain characters from a previous or following logical record if tabbing is used in a file where the relationship between logical and physical record boundaries is not known.

```
READ FIDECL,KEY;A,B,C
```

This is an indexed access read. The index file is searched for the key given in the string variable KEY starting with the formpointed character and going through the character pointed to by the logical length. The KEY is considered to match an item in the index file if both have exactly the same number of characters and all of them match or if all of the characters up through the length of the index item match and then the rest of the characters in the key variable are spaces. Remember that there are no trailing spaces in the index file key items. This means that even if the INDEX utility was told to index on columns 1 through 10, if that field in a certain record consisted of an "A" followed by 9 spaces, the index file key item would consist of an "A" followed by the key terminator character.

If a match is found, the next key pointers are left pointing to the following item in sequence in the index file, the physical record and character pointers are obtained from the index file,

and the rest of the read proceeds precisely as if a physically sequential read were being performed. When finished, the file pointers are left at the start of the physically next logical record in the file.

If no match is found, the OVER condition flag is set, all of the variables in the list are left with the values they had before the READ was attempted, and the next key pointers are left pointing to the next item in sequence in the index file. Therefore, a read key sequential (see the section on READKS) can be performed to obtain the first item by collating sequence following the item that could not be found. This can be very useful for obtaining lists of classes of items.

For example, one could have a file of serialized items with model codes. One could index the file on the model code followed by the serial number. He could then access a given model code with a serial number of all spaces (spaces being lower in collating value than zeros). The access would return with the OVER condition flag set indicating that no such item existed in the file. The program could then proceed to read sequential by key obtaining a list of the serial number of all items of a given model code by the collating sequence of the serial number. The program would have to detect when the model code changed to determine when the list of a given model code should be terminated.

Another feature is that physically sequential accesses can be made after an indexed access. The INDEX utility allows a file to be indexed only upon what are called primary records (this is a SORT utility option). For example, a file could consist of a primary record followed by five secondary records followed by another primary record followed another five secondary records and so forth. If the index were built only on the primary records, one could do an indexed access to the primary record and then do five physically sequential accesses to read the five secondary records.

An indexed access read takes approximately half a second regardless of the size of the data file. This assumes that relatively few insertions have been made upon the file and that only one program is executing in the system. See the section below on index insertions (WRITE) for a discussion on how insertions can affect the indexed access timing.

```
READ FIDECL,KEY;A,B,C;
```

This is similar to the above operation except that the physical file pointers are left after the last character read rather than at the beginning of the physically next logical record. This is useful if one is not going to do a physically sequential access afterwards since it saves time not scanning to the end of the logical record. It is also useful if one wants to read the rest of the record in a later READ operation or if he wants to update the rest of the record by following the indexed read by a physically sequential write.

```
READ FIDECL,NULL;A,B,C
```

This is an indexed re-read. If the index key supplied to the READ operation is null (logical length and formpointer equal to zero), then instead of accessing a given item based on the key, the operation re-reads the last logical record that was accessed using the index specified by the given logical file. Remember that physical accesses do not change the pointer to the last record accessed using an indexed access.

This operation enables one to re-read an indexed record without having to search the index file for a given key. An IO error is given if there has not previously been a successful READ performed using a non-null key on the specified logical file. Otherwise, the operation proceeds exactly as in the normal indexed access READ.

```
READ FIDECL,NULL;A,B,C;
```

This is similar to the above operation except that the physical file pointers are left after the last character read into the variable C.

```
READ FIDECL,KEY;*25,B,*NVAR,C,*10,D;
```

This operation performs an indexed access, positions the character pointer to column 25 relative to the beginning of the logical record, reads the required number of characters into the variable B, positions the character pointer to the column specified in the numeric variable NVAR relative to the beginning of the logical record, reads the required number of characters into the variable C, positions the character pointer to column 10 relative to the beginning of the logical record, reads the required number of characters into the variable D, and leaves the physical record pointers after the last character read. Note the

difference between using tabbing in physical accesses and indexed accesses is that in indexed accesses the tab position specified is made relative to the beginning of the logical record and not to the beginning of the physical record. The reason for this is that one may desire to have several logical records per physical record in an indexed file and be able to use tabbing on the accesses to that file. The problem is that when doing indexed accesses, the program has no idea of where the logical record is in the physical record so the system must make the tab values relative to the beginning of the logical record to make tabbing in indexed files useful. Remember that an attempt to cross a physical record boundary with a tab results in an IO error.

Note that once again it is usually advisable to use a semicolon at the end of statements using tabs since it just wastes time to cause the processor to scan to the beginning of the next logical record if the next access to the file will not be to the physically next logical record.

```
READ FIDECL,NULL;*25,B,*NVAR,C,*10,D;
```

This is similar to the above operation except that the last key-accessed record in the given logical file is read instead of a new index access being made.

### 7.5.7 READKS

This is a read key sequential operation. As mentioned in Section 7.7.2, whenever an indexed access is made the access routines update a pointer to point to the following key entry in the lowest level of the index. When a READKS operation is performed, instead of searching for a key of a given value, the key pointed to by the next key pointer is used (no key is supplied to the READKS operation). READKS also bumps the pointer to the next key in the index causing successive READKS operations to obtain records in collating sequence. If the pointer to the next key in the index is pointing past the last key in the index (either a key larger than any existing was accessed in the last indexed access or the last key sequential read obtained the last record in the collating sequence) then execution of the READKS operation causes the OVER condition flag to be set and all of the variables in the list will have an indeterminant value. The READKS instruction can appear as follows:

```
READKS FIDECL;A,B,C
READKS FIDECL;*25,A,*NVAR,B,*10,C;
```

Except for the access method, the functioning of READKS is identical to the functioning of an indexed access READ (this is in reference to the action taken once the desired logical record is located).

### 7.5.8 WRITE

The write statement is used for physically random, physically sequential, or indexed insertion writes. The write statement consists of a logical file declaraction name and a record specifier (a numeric variable for physical accesses and a string variable for indexed insertions) followed by a list. The list may include variable names, quoted characters, and octal control characters (000 through 037). Note that tab positioning is not allowed in the WRITE operations (the WRITAB operation must be used to do tabbing in writing functions).

Each character string variable in the write list will be written from its first physical character through the logical length. Spaces will be written for any character positions between the logical length pointer and the physical end of string. Each numeric item will be written in total. Note that only the data in each variable is written and not any of the control information (logical length, formpointer, 0200, or ETX). The quoted items and octal control characters will be written exactly as they appear in the list. For example, if the following definitions were made:

```
TIME INIT "10:23"
TOTAL FORM "001"
FDECL FILE
```

and the statement:

```
WRITE FDECL,RN;"TIME: ",TIME,015,"TOTAL: ",TOTAL
```

were executed, the file would be written with the characters:

```
TIME: 10:23(015)TOTAL: 001(015)(003)
```

where the (015) and (003) denote control characters. Remember that certain control characters (000, 003, 011, and 015) mean special things to the read operations and their use can cause confusion. In the example above, two logical records were written with the one write statement because of the 015 written in the middle.

The format control, *ZF may be used before any numeric variable to cause zero-fill on the left, moving the sign to the left if neccessary.

The format control *MP converts a numeric variable to a "minus-overpunch" format, where, on negative numeric variables, the minus sign is over-punched over the rightmost digit. The *ZF and *MP are valid for the immediately following variable only.

```
WRITE     FDECL,RN;*ZF,A,*MP,B,C
```

A negative overpunched zero converts to a right bracket "}" and one thru nine convert to "J" thru "R".

The following is a list of the different types of write statements. Although the following examples show lists with only three variables, it should be remembered that all of the WRITE operation lists can contain the various items shown in the above example.

```
WRITE FDECL,RN;A,B,C
```

This is a physically random access write. The physical record pointer is set to the numeric value contained in RN and the character pointer is set to the beginning of the physical record (any digits after a decimal point in RN are ignored). Variables A, B, and C are then written followed by end of logical record (015) and end of physical record (003) characters. The character pointer is left pointing to the 003 character. Note that all WRITE statements are allowed on either FILE or IFILE declared logical files.

```
WRITE FDECL,RN;A,B,C;
```

This is similar to the above operation except that the 015 and 003 characters are not written after the last data character. The character pointer is left pointing after the last character written. This operation is useful for writing the first part of a record where more of the record will be written later or for updating part of a record where the 015 and 003 would, if they were written, destory data characters that followed.

```
WRITE FDECL,SEQ;A,B,C
```

This is a physically sequential access write. Variables A, B, and C are written beginning at the character position currently being pointed to by the logical file pointers. If the

file had just been opened, the current position would be the first character position in physical record zero of the specified logical file. Otherwise, the file pointers would be positioned according to the results of the last read or write operation executed. End of logical record (015) and end of physical record (003) characters are written after the last character in variable C. The character pointer is left pointing at the 003 character. Remember that space compression mode will be on after the file is opened which means if the file is to be opened and then written sequentially but space compression is not to be used, one must execute a write statement whose first list item is a *- control. For example:

```
OPEN FDECL,"FILE"
WRITE FDECL,SEQ;*-,A,B,C
```

See Section 7.7.2 for a discussion of when space compression mode is turned on or off.

```
WRITE FDECL,SEQ;A,B,C;
```

This is similar to the above operation except that the 015 and 003 characters are not written after the last character in the variable C. The character pointer is left pointing after the last character written.

```
WRITE FIDECL,KEY;A,B,C
```

This is an indexed access record insertion. The KEY variable must not be null and the key specified must not already exist in the index specified by the given logical file (either condition will cause an IO error). The search algorithm used to determing that the key is not already in the index is identical to that used in the indexed access READ operation.

The key whose value lies from the formpointer through the logical length of the KEY variable is inserted in the index file specified by the given logical file and the record is written at the physical end of the data file. The record is always started at the beginning of the physical record which contains the EOF mark and then a new EOF mark is automatically written in the physical record which physically follows the new record. Note that this implies that for each record inserted into the data file, at least one physical record will be used (even if the record inserted is only 30 characters long). The record inserted may be longer than one physical record, in which case an integral number of physical records will be used for the inserted record.

The reason the inserted record is always started at the beginning of a physical record is that this insures that tabbed operations can then be performed upon the new record in case they are desired (assuming the new record will fit within one physical record).

Insertions will take longer if many records very close together in collating sequence are inserted together. When inserting items whose keys fall randomly within the collating sequence one can usually insert a number of records equal to one tenth of the total number of records in the file before the insertions will start to take significantly longer. It is generally a good idea to run the INDEX utility as often as practical when many insertions and deletions are being performed to keep the speed of insertions and indexed accesses as high as possible.

```
WRITE FIDECL,KEY;A,B,C;
```

This operation is also an indexed insertion write except that the new EOF mark is not automatically written at the end of the file. One could desire to finish writing the record with a later operation and could do this by following the above statement by physically sequential write operations and then writing the EOF mark at the end of the file himself. He must make certain, however, that if he is going to do this that no other program can try to do an insertion before the EOF is written or the other program will get a RANGE trap since it will not be able to find the EOF which it will want to overstore.

### 7.5.9 WRITAB

This operation is the write tab feature which requires a different instruction mnemonic from the normal write operations. With this feature, characters may be written into any character position of a physical record without disturbing the rest of the record. A RANGE trap will occur and the logical file pointers will not be changed if a write tab is used on a record of the file that has never been written before. The write tab can be performed only upon logical files which have been delcared using the FILE declaration. The UPDATE operation is used to do tabbed writes into indexed files. The list controls *(numeric literal) or *(numeric variable) are used to position the character pointer to the specified character position in the current physical record. Writing of the variable begins at the point specified by the position control. If no positioning is specified, the writing of the first variable starts at the beginning of the

physical record.

Tab positioning in physically random accessed writes is calculated from the first position in the specified physical record. If the tab position is greater than 249 characters, an IO trap will occur. Only the quoted characters, octal control characters, and variables appearing in the list are written. The character pointer is left pointing one character past the last character written (there is an implied semicolon at the end of the WRITAB operation). For example,

```
WRITAB FNDECL,RN;A,*70,B,*10,C,*NVAR,"TIME"
```

would write variable A beginning with the first position in the physical record specified by RN. Variable B would be written beginning at position 70 in the physical record and variable C would be written beginning at position 10 in the physical record. The characters "TIME" would be written beginning at the position specified by the numeric variable NVAR (any places after a decimal point will be ignored) and the character pointer would be left pointing one character past the "E" written for the quoted characters "TIME". An IO trap would occur and the record would not be written if NVAR was greater than 249.

A word of caution is appropriate at this point in the discussion. If in the above example NVAR had had a value of 248, the letter "T" would have been written as the last character in the physical record specified by RN. That physical record would then be written and the following physical record would have been read into the buffer. The letters "IME" would have then been written into the first three positions of this new physical record and the record then written back out. If more tab positions had followed the writing of the characters "TIME", these would have been in the new physical record, not in the one specified by the contents of RN. This action would probably not be that expected by the programmer and would all take place without a wimper of an error message from the interpreter. Just be careful about your tab positions!

Note that using WRITAB with a physically sequential access (where RN contains a negative value) is possible but not advisable. Tab positioning on physical accesses is always calculated from the first character position in the current physical record. The program could obtain characters from a pervious or following logical record if tabbing is used in a file where the relationship between logical and physical record boundaries is not known.

### 7.5.10 UPDATE

This operation allows modification of the last record that was accessed with a READ or READKS operation. Only the logical file declaration name is supplied to this operation (no key is supplied) but the list may have all of the items allowed in the WRITAB list. For example,

```
UPDATE FIDECL;A,*20,B,*40,"ASDF",033
```

would read the last indexed accessed record in the logical file FIDECL and would overstore the first characters in the logical record with the contents of the variable A, would overstore the characters starting with the 20th character in the logical record with the contents of the variable B, and would overstore the characters starting with the 40th character in the logical record with the characters "ASDF" followed by the octal character 033. The character pointer would be left pointing after the 033 character (the last character written from the list). Note that as in indexed access reads using tab positioning, the tab positions in the UPDATE operation are relative to the beginning of the logical record (and not the beginning of the physical record as in WRITAB). As in the WRITAB operation, the UPDATE has an implied semicolon at the end of its list.

### 7.5.11 INSERT

This operation allows an index insertion into more than one index file. The WRITE operation mentioned earlier is used to physically insert the record into the data file and insert the key into one index file. If more than one index is being used, one INSERT operation must be performed for each additional index into which an insertion is to be made. When the WRITE operation performs the physical record insertion, a pointer is kept which contains the physical location of the newly inserted record in the data file. When the INSERT operation is performed, the specified key (with a pointer to the remembered physical location into the data file) is inserted into the specified index file. Since only one of these insertion memory pointers is kept for each program, one must make sure that he performs all insertions necessary for a given record before performing the next WRITE to insert the next record. For example, the sequence to insert two records into two indicies would be WRITE INSERT WRITE INSERT and not WRITE WRITE INSERT INSERT.

The format of the INSERT statement is as follows:

```
INSERT FIDECL,KEY
```

where FIDECL is the name of the logical file declared for the index being used and KEY is the string variable in which from the formpointer through the logical length is contained the key to be inserted in the index. An IO error is given if KEY is null or if the key specified already exists in the specified index file. Otherwise, the key is simply inserted into the index. Note that it is not necessary to prevent the program from being interrupted between the WRITE and INSERT operations since the pointer to the record which was inserted is kept for each program and even if another program inserted a record in the same file or index between the WRITE and INSERT of the program in question, all insertions would be performed correctly.

### 7.5.12 DELETE

This operation allows a record to be physically deleted from a data file and for its key to be deleted from the specified index. The DELETE instruction is also used to delete keys from other indicies which can index the data file. For example,

```
DELETE FIDECL,KEY
```

will delete the record specified by the key (whose value lies from the formpointer through the logical length in the variable KEY) in the data file specified by the index file specified by the logical file whose declaration name is FIDECL. The record is physically deleted by having all of its characters up through the logical end of record mark (015 character) overstored with 032 control characters. The 032 character does not appear to exist when the record is read using the DATABUS 1100 read mechanism or the REFORMAT utility read mechanism since when these mechanisms see such a character they simply bump the character pointer (moving on to the next physical record if running off the end of the current physical record) and try to fetch the next character. Therefore, when DATABUS 1100 performs physically sequential reads across records that have been physically deleted, the records no not appear to exist. The REFORMAT utility eliminates these 032 characters to close up the deleted space in a file and to make the file readable by other DOS utility programs such as SORT.

The DELETE operation will not try to overstore the record being deleted with 032 characters if the first character already contains a 032 character. This allows the DELETE operation to be

used to delete the key entries from all index files which index the given data file. For example,

```
DELETE FIDECL1,KEY1
DELETE FIDECL2,KEY2
DELETE FIDECL3,KEY3
```

would be used to delete the record and keys out of the three indicies which pointed to that record. The first DELETE would actually overstore the logical record with 032 characters and delete the key from the index file specified by the logical file whose declaration name was FIDECL1. The other two DELETE operations would only remove the keys from their respective index files since it would be noted that the logical record already contained a 032 character in its first position.

### 7.5.13 WEOF

Standard DOS end of file marks (000 000 000 000 000 000 003) in the first seven character positions of a physical record) can be written in DATABUS 1100. WEOF does not change the physical record or character pointers for the given logical file. For example,

```
WEOF FDECL,RN
```

will write an end of file mark in physical record RN while

```
WEOF FDECL,SEQ
```

will write an end of file mark in the next physical record after the current physical record pointer. Note that the WEOF operation may be performed upon logical records which have been declared either FILE or IFILE but that the record is always specified using a numeric variable for the record number. This implies that one cannot write an end of file mark using an indexed access.

# CHAPTER 8. PROGRAM GENERATION

## 8.1 Preparing Source Files

Files containing the source language for DATABUS 1100 programs are prepared using the general purpose editor running under DOS.C and whose use is covered in a separate document. The editor tab stops may be set to be suitable for keyin of DATABUS 1100 programs by using the :T command and setting two tabs, one at 10 and the other at 20.

## 8.2 Compiling Source Files

DATABUS 1100 programs are compiled using the DATABUS 1100 compiler running under DOS.C. The DATABUS 1100 compiler is parameterized in the following manner:

DB11CMP <source>[,<object>][,<print>][;<L><C><E><R><X><D>]

File Specifications:

The compiler may be parameterized with up to three file specifications. These file specifications follow the standard DOS conventions. Refer to the DOS User's Guide for further information concerning DOS file specifications. A bad drive specification for any of the files will result in the error message:

BAD DEVICE SPECIFICATION

If any of the file specifications are identical, the message:

SOURCE AND OBJECT FILES THE SAME or
SOURCE AND PRINT FILES THE SAME or
OBJECT AND PRINT FILES THE SAME

will be displayed.

The source file contains the DATABUS 1100 program text created with the editor. This file must always be specified. If no extension is given on the source file name, the extension TXT is assumed. If the source file name is not supplied, the

message:

NAME REQUIRED.

will be displayed. If the source file name does not exist in the DOS directory, the message:

NO SUCH NAME.

will be displayed. If no drive is specified, all drives beginning with drive 0 will be searched for the source file.

The object file will contain the object code generated by the compiler from the specified source code. If the name of the object code file is not given, the name of the source code file with an extension of DBC will be used for the name of the object code file. Note that DATABUS 1100 can run only those files with extension DBC. If the source code file is specified without a drive number, the compiler will search all drives for the name given. If the object code file name (with the extension specified or the assumed extension DBC) is not found on any drive, the object code file is placed on the same drive as the source code file. If the object code file is found, it is killed and re-opened on the same drive it was found on to assure a maximally contiguous file space is available.

The print file specification is also optional. If it is given, any print output requested will be written in this file (in the standard GEDIT format) instead of being printed on the local printer. Top of form will be indicated by the character '1' in column one of the print line. Otherwise, column one is always blank and the line starts with column two (this is the standard COBOL and FORTRAN print file format).

If no name is given for the print file specification, the source file name will be assumed. If no extension is given, an extension of PRT will be assumed. However, if the print file is to be read under DATABUS 1100 it must have an extension of TXT since all DATABUS 1100 data files must have that extension. If no drive number is specified, the print file will be placed on the same drive as the source file. A print file may be specified simply by keying in a comma after the object file specification or, if no object file is specified, by keying in two commas after the source file specification. Note, however, that the extension assumed in this case will be PRT.

Output Parameters:

These parameters allow the user to specify what type of output is wanted in addition to the object file. If a print file is specified, any print output is written in that file instead of being sent to the printer. If the semicolon but no parameters are specified, the only output is the object file (if in this case a print file was specified it would be null).

The DATABUS 1100 compiler can output to either a local or servo printer. The compiler is self-configuring in this respect and will output to whichever printer it finds connected to the system I/O bus. Since the compiler looks first for a servo printer, output will be to the servo printer if both a local and servo printer are addressable by the system.

Any source code lines which have errors are displayed on the screen during pass II, with the appropriate error flag. Additionally, the compiler displays at the lower left corner of the screen the current line number being compiled, for every 10th line. Every 10th line is indicated because displaying the line number for every line would slow down the compiler. No numbers will be displayed if the program is fewer than 10 lines long. This line number display is cleared when processing of included files begins or ends, so the line number display will blink off momentarily during compilation of source files using included files.

To specify output options, a semicolon plus one or more of the following should be placed after the last file specification:

L A listing of the compilation results is printed. Each line of source code is numbered and the object code location counter value for the first byte of code generated for the line is listed to the left of each source code line. A '+' appearing as the first character of a line causes a new print page to be started. The rest of the line following the + may be used as a comment line. A '*' appearing as the first character of a line causes a new print page to be started if the current line is within two inches of the bottom of the current page. A good way to improve the readability of a program is to begin each section or routine with a comment before which a line is entered which contains a star in its first column. This will make sure the comment appears on the same page as the first lines of the code to which it is attached.

C A listing of the compilation results is printed and the generated object code is listed to the left of the source code. Printing the object code usually makes the listing about twice as long. If this option is given, the L option is implied and need not also be given.

E The source code for lines with errors will be printed in addition to being displayed on the screen. This parameter has no meaning if the L or C options are given since listings produced under those options will include error flags anyway.

R The line numbers for referenced labels in an operand string will be printed at the right margin of the listing. The line number is the line on which the Referenced label was defined. If the L, C, or E option is not also given, this option has no effect. This option may be given instead of or in addition to the X option. The R option is especially convenient with GOTO or CALL instructions in following the logic path of a complex set of code. Note that for the R option to be effective, a printer with at least 130 column printing capability must be used.

X A cross-reference listing is printed at the end of the compilation. There will actually be two cross-references: one for the data labels and one for the executable labels. Each cross-reference is sorted alphabetically. The data or executable label is given preceded by the octal location where the label was defined and followed by a list of all line numbers in which the item was defined or referenced. An asterisk flags those line numbers which are definitions. The SORT utility is called by the compiler to do the actual reference sorting, and the messages displayed on the screen will be appropriate to the progress of the sort. A cross-reference may be obtained regardless of whether a listing was requested.

D A copy of the source code is displayed on the screen during the compilation.

If a listing has been requested, the compiler will ask:

HEADING:

This may be 70 characters long and is printed at the top of each page. Indicating the time and date of the listing is helpful in keeping listings in chronological order. The source file name is

automatically listed to the left of the heading.

Examples:

```
DB11CMP PROGRAM
```

This is the simplest compilation specification. The source code found in file PROGRAM/TXT would be compiled with the object code placed in file PROGRAM/DBC. No other output would be given except for errors displayed on the screen.

```
DB11CMP CHECK,CHECKNO;CX
```

The source code in CHECK/TXT would be compiled and the object code placed in CHECKNO/DBC. A listing would be printed on the printer and consist of the source and object code with a data and executable label cross-reference at the end.

```
DB11CMP FILE:DR0,,FILELST/TXT:DR1;LX
```

The source code in FILE/TXT on drive 0 would be compiled and the object code placed in FILE/DBC on drive 0. A copy of the source code and a data and label cross-reference will be written in FILELST/TXT on drive 1.

The compiler may be stopped temporarily by depressing the DISPLAY key. The DISPLAY light will be turned on and execution will not be resumed until the DISPLAY key is depressed again (the DISPLAY light will then be turned off). Compilation may be aborted at any time before the cross-reference sort is begun by depressing the KEYBOARD key. If the compilation is aborted in this manner the object file and the dictionary file are deleted, as are the reference file and the print file if a cross-reference list or print file was specified.

## 8.3 Compilation directives

Two directives are available in the DATABUS 1100 compiler as mentioned in Section 2.2. One is the EQU statement which allows a label to be assigned a decimal numeric value from 1 through 249. For example:

```
LM      EQU     5
```

A label which is defined in this manner may be used as tab values in disk I/O statements and as cursor positions in KEYIN and DISPLAY statements. This is particularly useful when one defines

a data base record format. If all item positions within the record are defined using the EQU directive, then changes in item positions can be achieved by simply changing the one directive value. If the EQU were not used, the user would have to hunt through all programs to change all disk I/O statements to change the item position in the record.

The second compiler directive is INCLUDE (the compiler also accepts a mnemonic of INC) which allows another text file to be included at that point as if the lines actually existed in the main file. For example:

```
INC     RECDEFS
```

will cause the file RECDEFS/TXT to be scanned as if all of its lines existed in the place of the INCLUDE line. The assumed extension on included files is TXT but may be specified to be any extension. If no drive is specified, all drives starting with drive zero will be scanned for the file. Inclusions may be nested up to four deep, with a maximum of 16 included files. The INCLUDE directive can be used to include a file containing the EQU directives and data variable definitions which define the format of a data base file record. This can prevent the programmer from having to keyin the data area (and common data area) definitions over and over for each program to use a certain data file. It also will make it much easier to update the data area definition since the programmer would have simply to update the one text file and then compile all the programs (which would include the modified definition file) to update all programs to the new data area definition.

## 8.4 Compilation diagnostics

The compiler prints and displays diagnostic messages on the listing to help the programmer debug syntatical errors in his code. These messages take the form of an error code letter at the left of the listing and an asterisk under the line at the position of the scanning pointer when the error occurred. The letters are E for an expression error (a generalized syntactical error), U for an undefined variable or label, and I for an undefined instruction. In the case of E errors a number is given on the line with the asterisk pointing out the error position in the source line. This number refers to the list of detailed error explanations in Appendix C of this document. If any of these flags appear, the compiler will flag the program as being non-executable. If the faulty program is then executed, it will return control to the MASTER program or to DOS.C.

The DATABUS 1100 system uses the DOS logical file zero for reading and writing all data to and from the disk. This implies that a segment boundary may not be crossed by the object code during a READ or WRITE statement (since fetching the statement also involves disk I/O). For this reason, the DATABUS 1100 compiler will insert a TABPAGE instruction if it detects a READ or WRITE statement crossing a segment boundary. Normally, this is of no particular concern to the user, however, programs using TABPAGE and doing extensive optimization should be aware that this may occur.

## 8.5 Disk space requirements

The DATABUS 1100 compiler maintains its label dictionary on disk in the file named DSCDICT/SYS. Moreover, this file is always placed on the same drive as the output object file because it is reasonably certain that that drive will not be write protected. For these reasons, there may not be more than 254 files named (255 if the object file name already exists) on the disk onto which the object file is to be written.

Further, if a cross reference is desired, there must be four more file name places available among the drives on-line. One of the file names that will be in use during the compilation is DSCREF/SYS (the file onto which the compiler writes information about each label reference). Three files will be generated by SORT: *SORTMRG/SYS, *SORTKEY/SYS, and DSCREFT/SYS. The first of the two files by SORT are scratch files, and the third is a tag-file pointing back into the DSCREF/SYS file. At normal completion of the compilation, all files mentioned above (except the output object file) will have been deleted and the file space again made available to the user.

# CHAPTER 9. SYSTEM OPERATION

This chapter discusses loading the DATABUS 1100 System on Diskette under DOS.C and the use of the DATABUS 1100 Interpreter. The use of the DATABUS 1100 Compiler is discussed in the previous chapter.

## 9.1 System Loading

The DATABUS 1100 System is available on either Cassette or Diskette media. The DOS files furnished with DATABUS 1100 are the Interpreter, DB11/CMD and DB11/OV1 thru DB11/OV5; the Compiler, DB11CMP/CMD and DB11CMP/OV0 thru DB11CMP/OV2; and ROLLOUT/SYS.

### 9.1.1 Loading From Cassette

The DATABUS 1100 compiler and interpreter system programs are contained on one cassette. The cassette is in the DMF (DOS Multiple File) format which includes a directory of the files on the tape. To load the DATABUS 1100 files to Diskette, keyin:

```
MIN;A
```

The MIN (Multiple IN) program will be activated and will display the date of creation of the tape, the file names in the tape directory, and each file name as the file is being loaded. If the file already exists on the diskette, the MIN program will ask if it is to be overstored. The operator can decide to overstore the file or can tell it not to overstore the file in which case MIN will allow the file to be stored under a different name. Consult the DOS USER'S GUIDE for further information on its operation.

The DATABUS 1100 interpreter system files can be re-named to any name desired as long as the command file and all the overlays have the same name. For example, if DB11/CMD was re-named DB/CMD, then DB11/OV1 thru DB11/OV5 would have to be named DB/OV1 thru DB/OV5.

### 9.1.2 Loading from Diskette

If the DATABUS 1100 System is obtained on Diskette media, additional copies of the saystem should be generated for backup purposes using the DOS.C commands, DOSGEN, COPY, and/or BACKUP.

## 9.2 Program Execution

If the DATABUS 1100 Interpreter is named DB11/CMD then a DATABUS 1100 program can be executed by entering:

```
DB11 PROGA
```

The DATABUS program compiled and filed under the name PROGA/DBC will begin execution. This program will continue executing until an irrecoverable erro is detected or until a STOP instruction is executed. At this time system control will return to DOS.C.

The general form for the DATABUS 1100 interpreter command is:

```
DB11[<object>][;<S>]
```

If a DATABUS 1100 program is not specified, the Interpreter will search for a special program cataloged as MASTER/DBC and begin executing this program:

```
DB11
```

The MASTER program will continue execution until a STOP is executed, at which time control will return to DOS.C.

The MASTER program can cause another DATABUS 1100 program to begin execution through the use of the CHAIN instruction. In this case, when this new program executes a STOP instruction, control is transferred to the start of the MASTER program instead of to DOS.C.

The printer option [;S] is used to specify the configuration of a Servo Printer. If a Local Printer is configured on the system, DATABUS 1100 will automatically use this printer unless the Servo Printer option is selected.

Other programs which should be on the system include the INDEX, REFORMAT, and SORT Commands (provided with DOS.C) for the

generation of index files.

# APPENDIX A. INSTRUCTION SUMMARY

## SYNTACTIC DEFINITIONS

| | |
|---|---|
| condition | The result of any arithmetic or string operation: OVER, LESS, EQUAL, ZERO, or EOS (EQUAL and ZERO are two names for the same condition). |
| character string | Any string of printing ASCII characters. |
| event | The occurrence of a program trap: PARITY, RANGE, FORMAT, CFAIL, or IO. |
| list | A list of variables or controls appearing in an input/output instruction. |
| name | Any combination of letters (A-Z) and digits (0-9) starting with a letter (only the first eight characters are used). |
| label | A name assigned to a statement. |
| nvar | A name assigned to a statement defining a numeric string variable. |
| nval | A name assigned to an operand defining a numeric string variable or an immediate numeric value. |
| nlit | An immediate numeric value. |
| svar | A name assigned to a statement defining a character string variable. |
| sval | A name assigned to an operand defining a character string variable or a quoted alphanumeric character. |
| slit | An immediate character string, enclosed in double quotes ". |

| | |
|---|---|
| nlist | A series of contiguous numeric variables. |
| slist | A series of contiguous string variables. |
| RN | A positive record number ( >= 0) used to randomly READ or WRITE on a file. |
| SEQ | A negative number ( < 0) used to READ or WRITE on a file sequentially. |
| KEY | A non-null string used as a key to indexed accesses. |
| NUL | A null string used as a key to an indexed read. |

FOR THE FOLLOWING SUMMARY:

Items enclosed in brackets [ ] are optional.

Items separated by the | symbol are mutually exclusive (one or the other but not both must be used).

COMPILER DIRECTIVES

```
EQU       10          (a label is required)
EQUATE    100         (a label is required)
INC       filename[/ext]
INCLUDE   filename[/ext]
```

FILE DECLARATIONS

```
FILE
IFILE
```

DATA DEFINITIONS

```
FORM      n.m
FORM      "456.23"
DIM       n
INIT      "character string"
INIT      "character string"
FORM      *n.m
```

```
          FORM      *"456.23"
          DIM       *n
          INIT      *"CHARACTER STRING"
```

CONTROL

```
          GOTO      (label)
          GOTO      (label) IF (condition)
          GOTO      (label) IF NOT (condition)
          BRANCH    (nvar) OF (label list)
          CALL      (label)
          CALL      (label) IF (condition)
          CALL      (label) IF NOT (condition)
          RETURN
          RETURN    IF (condition)
          RETURN    IF NOT (condition)
          STOP
          STOP      IF (condition)
          STOP      IF NOT (condition)
          CHAIN     (svar)
          CHAIN     (slit)
          TRAP      (label) IF (event)
          TRAPCLR   (event)
          ROLLOUT   (svar)
          ROLLOUT   (slit)
```

CHARACTER STRING HANDLING

```
          MATCH     (svar) TO (svar)
          MATCH     (slit) TO (svar)
          MOVE      (svar) TO (svar)
          MOVE      (slit) TO (svar)
          MOVE      (svar) TO (nvar)
          MOVE      (nlit) TO (nvar)
          MOVE      (nvar) TO (svar)
          APPEND    (svar) TO (svar)
          APPEND    (slit) TO (svar)
          APPEND    (nvar) TO (svar)
          CMOVE     (sval) TO (svar)
          CMATCH    (sval) TO (sval)
          BUMP      (svar)
          BUMP      (svar) BY (nlit)
          RESET     (svar) TO (sval)
          RESET     (svar) TO (nvar)
          RESET     (svar)
          ENDSET    (svar)
          LENSET    (svar)
```

```
          CLEAR      (svar)
          EXTEND     (svar)
          LOAD       (svar) FROM (nvar) OF (slist)
          STORE      (svar) INTO (nvar) OF (slist)
          STORE      (slit) INTO (nvar) OF (slist)
          CLOCK      TIME TO (svar)
          CLOCK      DAY TO (svar)
          CLOCK      YEAR TO (svar)
          TYPE       (svar)
          SEARCH     (nvar) IN (nlist) TO (nvar) OF (nvar)
          SEARCH     (svar) IN (slist) TO (nvar) OF (nvar)
          REPLACE    (svar) IN (svar)
          REPLACE    (slit) IN (svar)

ARITHMETIC

          ADD        (nvar) TO (nvar)
          ADD        (nlit) TO (nvar)
          SUB        (nvar) FROM (nvar)
          SUB        (nlit) FROM (nvar)
          SUBTRACT   (nlit|nvar) FROM (nvar)
          MULT       (nvar) BY (nvar)
          MULT       (nlit) BY (nvar)
          MULTIPLY   (nlit|nvar) BY (nvar)
          DIV        (nvar) INTO (nvar)
          DIV        (nlit) INTO (nvar)
          DIVIDE     (nlit|nvar) INTO (nvar)
          MOVE       (nvar) TO (nvar)
          MOVE       (nlit) TO (nvar)
          COMPARE    (nvar) TO (nvar)
          COMPARE    (nlit) TO (nvar)
          LOAD       (nvar) FROM (nvar) OF (nlist)
          STORE      (nvar) INTO (nvar) OF (nlist)
          STORE      (nlit) INTO (nvar) OR (nlist)
          CHECK11    (nvar) BY (nvar)
          CHECK11    (nvar) BY (nlit)
          CHECK10    (nvar) BY (nvar)
          CHECK10    (nvar) BY (nlit)

INPUT/OUTPUT

          KEYIN      (list)
          DISPLAY    (list)
          BEEP
          PRINT      (list)
          PREPARE    (file),(svar|slit)
          PREP       (file),(svar|slit)
```

```
OPEN      (file|ifile),(svar|slit)
CLOSE     (file|ifile)
WRITE     (file|ifile),RN|SEQ|KEY[;[(list)][;]]
WRITAB    (file),RN|SEQ;(list)[;]
WEOF      (file|ifile),RN|SEQ
UPDATE    (ifile)[;[(list)][;]]
READ      (file|ifile),RN|SEQ|KEY|NUL;(;|(list[;]))
READKS    (ifile);(;|(list[;]))
DELETE    (ifile),(svar)
INSERT    (ifile),(svar)
```

# APPENDIX B. INPUT/OUTPUT LIST CONTROLS

| CONTROL | USED IN | FUNCTION |
|---|---|---|
| *P<m>:<n> | KD | Causes the cursor to be positioned horizontally and vertically to the column and line indicated by the numbers <m> (horizontal 1-80) and <n> (vertical 1-12). These numbers may either be literals or numeric variables. |
| *N | KDP | Causes the cursor or printer to be positioned in Column 1 of the next line. |
| *EL | KD | Causes the line to be erased from the current cursor position. |
| *EF | KD | Causes the screen to be erased from the current cursor position to the end of the line. |
| *ES | KD | Causes the cursor to be positioned at horizontal position 1 of the top row of the display and the entire display to be erased. |
| *EOFF | K | Causes the echo during input operations from the terminal to be defeated. |
| *EON | K | Causes the echo during input operations |
| *+ | KDP | Turn on Keyin Continuous for KEYIN or space after logical length suppression for DISPLAY and PRINT. |
| *+ | W | Turn on space compression during WRITE. |
| *- | KDP | Turn off Keyin Continuous (turned off at the end of the statement) or the space after logical length suppression. |
| *- | W | Turn off space compression during WRITE. |
| *<n> | P | Causes a horizontal tab on the printer to the column indicated by the number <n>. |

| | | |
|---|---|---|
| | | No action occurs if the carriage is past the column indicated by <n>. |
| *<n><br>*<nvar> | RW | Tab specification for READ or WRITAB operations; the logical file pointers are moved to that character position relative to the current physical record. |
| ; | KDP | Suppress a new line function when occurring at the end of a list. |
| " | KDP | Any characters appearing between quotes are displayed or printed when encountered (note that a quote itself cannot be quoted). |
| *F | P | Causes the printer to be positioned to the top of form. |
| *L | KDP | Causes a linefeed to be displayed or printed. |
| *C | KDP | Causes a carriage return to be displayed or printed. |
| *T | K | Time out after 2 seconds for KEYIN statement. |
| *W | KD | Pause for one second. |
| *JL | K | Left-justify numeric variable and zero-fill at right if there is no decimal point. |
| *JR | K | Right-justify string variable and blank-fill at left. |
| *ZF | KDPW | Left zero-fill string variable. |
| *DE | K | Restrict string input to digits (0-9) only. |
| *IT | K | Turn-on Text Mode (invert alphabetic input). |
| *IN | K | Turn-off Text Mode. |

| | | |
|---|---|---|
| *MP | W | Convert numeric variable to "Minus-overpunch" format. |

# APPENDIX C. COMPILER ERROR CODES

When an E code is given by the compiler at the left of a line of code containing an error, the very next line will contain an asterisk followed by an E code number and another asterisk under the error line at the position of the scanning pointer when the error was detected. The E code number refers to the number in the left column of the following table and the corresponding error explination in the right column.

00001 The first operand of a CMATCH or CMOVE instruction was not an octal number, a quoted character, or a string variable.

00002 The second operand of a CMATCH instruction was not an octal number, a quoted character, or a string variable.

00003 The second operand of a MATCH or APPEND instruction was not a string variable.

00004 The first operand of a MATCH or APPEND instruction was not a string variable or a literal.

00005 The first operand of a RESET instruction was not a string variable.

00006 The second operand of a RESET instruction was followed by a character that was not a space, implying that there were other operands following the second operand. RESET may have only one or two operands.

00007 The first operand of a BUMP instruction was not a string variable.

00010 The second operand of a BUMP instruction was not terminated by a space, or had an absolute value of greater than 127.

00011 The operand of a CHAIN or ROLLOUT instruction was not a string variable or a literal.

00012 The first operand of a STORE instruction was not a string variable or numeric variable or literal. The first operand of a LOAD instruction was not a string variable or

numeric variable.

00013 The second operand of a STORE or LOAD instruction was not a numeric variable.

00014 The second operand of a STORE or LOAD instruction was not followed by either a space or a comma.

00015 One of the third thru Nth operands of a STORE or LOAD instruction was not the same data type as the first operand. If the first operand is a string or numeric variable, then all operands after and including the third operand must be a string or numeric variable, respectively.

00016 The second operand of a MOVE instruction was not a string variable or a numeric variable.

00017 The second operand of a MOVE instruction was not a string variable or a numeric variable.

00020 The first operand of a MOVE instruction was not a string variable or a numeric variable or a literal.

00021 The second operand of a COMPARE, ADD, SUBTRACT, MULTIPLY, or DIVIDE instruction was not a numeric variable.

00022 The second operand of a CMATCH, CMOVE, MATCH, APPEND, CHAIN, ROLLOUT, COMPARE, ADD, SUBTRACT, MULTIPLY, or DIVIDE instruction was not followed by a space (indicating no more operands follow).

00023 The first operand of a COMPARE, ADD, SUBTRACT, MULTIPLY, or DIVIDE instruction was not a numeric variable or a literal.

00024 The first operand of an instruction which may be followed by a comma or a preposition was not immediately followed by a comma or a space. If a comma follows the operand a preposition is not looked for. If a space does follow the operand then a preposition must be there.

00025 The first operand of a GOTO, CALL, or TRAP instruction was not followed by a space.

00026 The first operand of a TRAP instruction was not followed by " IF ".

00027 The conditional operand ([NOT] EOS, EQUAL, ZERO, etc.) of a GOTO, CALL, or TRAP instruction was not followed by a space.

00030 The conditional operand of a GOTO or CALL instruction was not [NOT] EOS, EQUAL, ZERO, LESS, or OVER; or the conditional operand of a TRAP instruction was not PARITY, RANGE, FORMAT, CFAIL, or IO.

00031 The first operand of the TRAPCLR instruction was not followed by a space.

00032 The first operand of the TRAPCLR instruction was not PARITY, RANGE, FORMAT, CFAIL, or IO.

00033 An operand in a KEYIN or DISPLAY instruction was not a string variable or a numeric variable. It was an EQU, FILE, or IFILE variable.

00034 A control code (letter or letters following an asterisk) in a KEYIN or DISPLAY instruction was not *C, *L, *N, *T, *R, *P, *EL, *EF, *ES, *W, *EON, or *EOFF.

00035 A variable <N> in the *P<N>:<N> control code of a KEYIN or DISPLAY instruction was not a number (did not have a first character of 0-9) nor a numeric variable.

00036 A variable <N> in the *P<N>:<N> control code of a KEYIN or DISPLAY instruction was a numeric literal with a value for the first (horizontal position) <N> that was not 1 =< <N> =< 80, or with a value for the second (vertical position) <N> that was not 1 =< <N> =< 24.

00037 A literal in a KEYIN or DISPLAY instruction was not followed by a comma, space, semicolon, or full colon.

00040 The last character in the operand string of a KEYIN, DISPLAY, PRINT, READ, WRITE, or WRITAB instruction was not a space, colon, or semicolon.

00041 The end-of-line was encountered before an operand string terminator was encountered for a KEYIN, DISPLAY, PRINT, READ, WRITE, WRITAB, WEOF, READKS, UPDATE, OPEN, PREPARE, INSERT, or DELETE instruction, or

The character following the first <N> in the *P<N>:<N> control code of a KEYIN or DISPLAY instruction was not a

colon, or

A quoted string or octal number was specified in the operand string of a READ instruction.

00042 An EQUATE, FILE, or IFILE name was specified in the operand list of a PRINT instruction.

00043 A character following an asterisk indicating a control code in a PRINT instruction was not +, -, L, F, C, N, or a number 0-9.

00044 The first operand of a READ, WRITE, WRITAB, or WEOF instruction was not a FILE or IFILE name.

00045 The character following the first operand of a READ, WRITE, WRITAB, or WEOF instruction was not a comma.

00046 The second operand of a READ, WRITE, WRITAB, or WEOF instruction having an IFILE name as the first operand was not a string variable name nor a numeric variable name.

00047 The second operand of a READ, WRITE, WRITAB, or WEOF instruction having a FILE name as the first operand was not a numeric variable.

00050 The character following the first operand of a READKS instruction or the second operand of a READ instruction was not a semicolon.

00051 The character following the first opernad of an UPDATE instruction or the second operand of a WRITE instruction was not a space or semicolon.

00052 An operand in the operand string of a READ or READKS instruction was not a tab (*<number> or *<nvar> or *<EQUname>) nor numeric variable nor string variable, or

An oprand in the operand string of a WRITE or UPDATE instruction was not a space compression control (*+ or *-) or a quoted string or numeric variable or string variable, or

An operand in the operand string of a WRITAB or UPDATE instruction was not a tab (*<number> or *<EQUname>) or space compression control (*+ or *-) or quoted string or numeric variable or string varible.

00053 A tab operand (*<number> or *<EQUname> or *<nvar>) was used in a READ instruction that had an IFILE name as operand one and an NVAR name as operand two.

00054 The character following the * control-indicator character in a WRITE instruction was not a + or -. The compiler will recognize only the *+ or *- control for the WRITE instruction, use the WRITAB instruction to use tab control (*<number> or *<nvar> or *<EQU'd label>) for output to a disk file. For an Index-Sequential file, to use tab control to update a record in the file, use the UPDATE instruction.

00055 The operand following an * control-indicator character was a quoted item. Numeric literals may be used but they may not be enclosed in double-quote " symbols. Numeric literals, numeric variable names, or equated names may be used to specify tab values in KEYIN, DISPLAY, CONSOLE, READ, WRITAB, READKS, or UPDATE instructions.

00056 The operand following an * control-indicator character was not an unquoted numeric literal, a numeric variable name, or an equated name.

00057 The first operand of a READKS or UPDATE instruction was not an IFILE name.

00060 A tab in a READ, WRITAB, READKS, or UPDATE instruction was greater than 249.

00061 A tab in a READ, WRITAB, READKS, or UPDATE instruction was zero. Note that if the value of an EQU'd tab is incorrectly specified the compiler generates a value of zero for the tab, and each use of that tab will generate this error.

00062 A character following an operand in the operand string of a READ, WRITE, WRITAB, READKS, or UPDATE instruction was not a space, comma, semicolon, or colon. If the instruction is a WRITAB or UPDATE instruction a semicolon is assumed.

00063 The character following the second operand of a WEOF instruction was not a space.

00064 The character following the second operand of a WRITAB instruction was not a semicolon.

00065 The first operand of an OPEN instruction was not a FILE or IFILE name or the first operand of a PREPARE instruction was not a FILE name.

00066 The first operand of a PREPARE instruction was an IFILE name.

There is no provision within the DATABUS 1100 INTERPRETER for the creation of an indexed-sequential file. The file must first exist and be indexed by means of the INDEX program before the file may be opened by the OPEN instruction and accessed, increased, or decreased by means of the READ, WRITE, WRITAB, WEOF, READKS, UPDATE, and DELETE instructions.

00067 The character following the first operand of an OPEN or PREPARE instruction was not a comma.

00070 The character following the second operand of an OPEN or PREPARE instruction was not a space.

00071 The second operand of an OPEN or PREPARE instruction was not a string variable name or a literal.

00072 The end-of-line was encountered before a first operand was encountered in a CLOSE instruction.

00073 The first operand of a CLOSE instruction was not a FILE or IFILE name.

00074 The character following the operand of a CLOSE instruction was not a space.

00075 A character following an operand in a STORE, LOAD, or BRANCH instruction was not a comma, colon, or space.

00076 The first operand of a CLOCK instruction was not TIME, DAY, or YEAR.

00077 A comma or the preposition TO was not used between the first and second operands of the CLOCK instruction.

00100 The second operand of a CLOCK instruction was not a string variable.

00101 The character following the second operand of a CLOCK instruction was not a space.

00102 The first operand of an INSERT or DELETE instruction was not an IFILE name.

00103 The character following the first operand of an INSERT or DELETE instruction was not a comma.

00104 The second operand of an INSERT or DELETE instruction was not a string variable name.

00105 The character following the second operand of an INSERT or DELETE instruction was not a space.

00106 An alphabetic character string where a preposition should have been was not recognized as a preposition: BY, TO, OF, FROM, or INTO, or

A numeric literal was used but was not enclosed in double quote " symbols.

00107 An EQUATE directive was given after an executable instruction was specified.

00110 An EQUATE directive was given but no label was specified.

00111 The first character of the operand of an EQUATE directive was not 1 thru 9. A first character of 0 implies an octal number which is not allowed in the EQUATE directive.

00113 The value specified for an EQUATE directive was not from 1 thru 249.

00114 The file specified in an INCLUDE directive was not found on disk.

00115 The character after the first operand of a DIM instruction was not a space.

00116 The operand value of a DIM instruction was greater than 127.

00117 For an INIT instruction or an instruction using a string literal:

No operand was found, or

A character after a quoted string was not comma or space, or

The end-of-line was encountered before the ending quote of a quoted operand was encountered, or

The end-of-line was encountered immediately after a forcing character # was given, or

A character following a comma following a quoted string or an octal number was not a double-qoute symbol or a zero, or

A quoted string of greater than 127 characters was specified.

00120 For an INIT instruction or an instruction using a string literal:

The character following the ending double-quote symbol of a quoted string was not a comma or a space.

00121 For an instruction using a string literal: the literal was over 40 characters long.

00122 The end-of-line was encountered before the first operand (data item length specification) was encountered for the DIM instruction.

00123 The end-of-line was encountered before the first operand (numeric data format specification) was encountered, or the numeric data was specified to be more than 22 characters long, for the FORM instruction.

00124 A closing double-quote symbol was not found for the operand (numeric data format specification) of a FORM instruction, or

A numeric literal was used but was not enclosed in double quote " symbols.

00125 For the operand (numeric data format specification) of a FORM instruction or for a numeric literal operand:

The following applies for the FORM instruction if a integer-decimal length was specified:

The character after the first numeric string (specifying the integer part length) was not a space or a decimal point, or

The character after the first numeric string was a decimal point but no numeric string specifying the decimal part length was found.

The following applies if a quoted string was specified:

There were more than 127 characters in the number specification, or

There were no digits specified, or

There was a decimal point specified but no digits followed it, or

The numeric literal was not enclosed in double quote " symbols.

00126 For the DIM, INIT, or FORM instructions: the end-of-line was encountered before an operand was encountered.

00127 An operand was not a quoted item, a number, or a label.

00130 The second character after the opening double-quote symbol in the operand of a CMOVE or CMATCH instruction was not a double-quote symbol. The forcing character does not apply in these two instructions because it is not necessary.

00131 For an instruction using a literal: the character after the ending double-quote symbol was not a space or comma.

00132 An octal number was specified but the number was not in the range 0 thru 037 inclusive.

00141 The operand of a PI instruction was not an unquoted numeric literal with a value of 1 through 20.

00142 The operand of a WEOF instruction was not an NVAR name.

# APPENDIX D. INTERPRETER I/O TRAP CODES

A - an access sequentially by key was attempted before any indexed sequential access was made using the logical file.
B - the READ mechanism ran off the end of a sector without encountering a physical end of record character (003).
C - an operation on a closed logical file was attempted.
D - a non-READ non-DELETE indexed sequential operation was attempted where the specified key already exists in the index.
E - an EOF mark without at least four zero's was encountered.
I - the index file specified in an OPEN statement does not exist on the specified drive(s).
J - the index file found by the OPEN statement does not reside in the correct physical location on the disk (index files may never be moved, they must always be re-created).
K - a null key was supplied in an operation where the key may not be null.
M - the data file specified in the OPEN statement does not exist on the specified drive(s).
N - the data file name specified in the OPEN or PREPARE statement was null.
O - the index file name specified in the OPEN statement was null.
P - the file specified in the PREPARE statement had some type of DOS protection (either write, delete, or both).
T - the tab value in the READ or WRITAB statement was off the end of the sector.
U - an EOF mark was encountered while a record was being deleted in the indexed sequential file.
V - one of the indexed sequential access overlays (DB11/OV1, DB11/OV2, or DB11/OV3) could not be loaded by the DOS loader.
W - an index file pointer sector could not be read.
X - an index file header sector could not be read.
Y - the R.I.B. of the data file pointed to by the index file could not be read. (VWXY errors can be caused by parity errors, the drive being switched off line, or the disk cartridge being swapped with another while an operation is taking place.)