SPERRY RAND

# UNIVAC

## 418-III
REAL-TIME SYSTEM

## FH-880
MAGNETIC DRUM
SUBSYSTEM

PROGRAMMER/OPERATOR
REFERENCE MANUAL

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# 1. INTRODUCTION



a. Drum Unit          b. Control Unit

*Figure 1–1. FH-880 Magnetic Drum Subsystem*

This manual contains information for the programming and operation of the FH-880 Magnetic Drum Subsystem for the UNIVAC 418-III Real-Time System.

Referencing the programming information within this manual on a regular basis is unnecessary when an I/O Handler is available as an interface to the FH-880 Magnetic Drum Subsystem.

It is assumed that both the programmer and operator have sufficient background information on the Processor and Storage of the System, and need only to be instructed in the use of the FH-880 Magnetic Drum Subsystem. Therefore, material already covered in the *UNIVAC 418-III Real-Time System Processor and Storage Reference*, UP-7627, will not be duplicated here.

This manual is divided into three basic sections:

* Subsystem Description

* Programming

* Operation

# 2. SUBSYSTEM DESCRIPTION

## 2.1. GENERAL

The FH-880 Magnetic Drum Subsystem provides the UNIVAC 418-III Real-Time System with a large capacity, word-addressable, random access storage medium. The subsystem consists of one Type 7427-03 Control Unit and from one to eight Type 7304-01 FH-880 Magnetic Drums, each drum capable of storing 786,432 computer words of 36 data bits plus parity. The average access time for any word in the subsystem is 17 milliseconds. Performance characteristics are summarized in Table 2-1.

Of the 880 tracks on each drum, 768 are used for storing data, 32 for parity, and the remainder for spares and timing purposes. The 768 tracks of data storage are organized into 128 bands of six tracks each, with each band having a capacity of 6,144 words. Reading and writing are performed in six-bit parallel mode on all six tracks of a band simultaneously, at a maximum transfer rate of 60,000 words or 360,000 characters per second.

Odd parity checking is used to verify the accuracy of data recording. When data is recorded on the drum, the control unit generates one parity bit per word and stores this bit in a predetermined location on one of the parity tracks that is associated with the word being written. When data is read from the drum, the associated parity bit is also read, and parity is checked automatically. Should a parity error occur, the processor is notified by means of an External Interrupt.

| PARAMETER | SPECIFICATION |
|---|---|
| STORAGE CAPACITY (PER DRUM)<br>    WORDS<br>    CHARACTERS | <br>786,432 (1,572,864 18-bit words)<br>4,718,592 |
| ACCESS TIME<br>    MINIMUM<br>    AVERAGE<br>    MAXIMUM | <br>160 microseconds<br>17 milliseconds<br>34 milliseconds |
| DRUM SPEED | 1770 rpm |
| NUMBER OF READ/WRITE DATA HEADS | 880 (one per track) |
| WORD TRANSFER RATE (MAXIMUM) | 60,000 words per second |
| CHARACTER TRANSFER RATE (MAXIMUM) | 360,000 characters per second |
| I/O CHANNELS REQUIRED | 2 |
| NUMBER OF DRUMS PER SUBSYSTEM | 1 to 8 |

*Table 2-1. Performance Characteristics*

SOLID OUTLINE REPRESENTS MINIMUM CONFIGURATION.

DOTTED OUTLINE REPRESENTS OPTIONAL ADDITIONS.
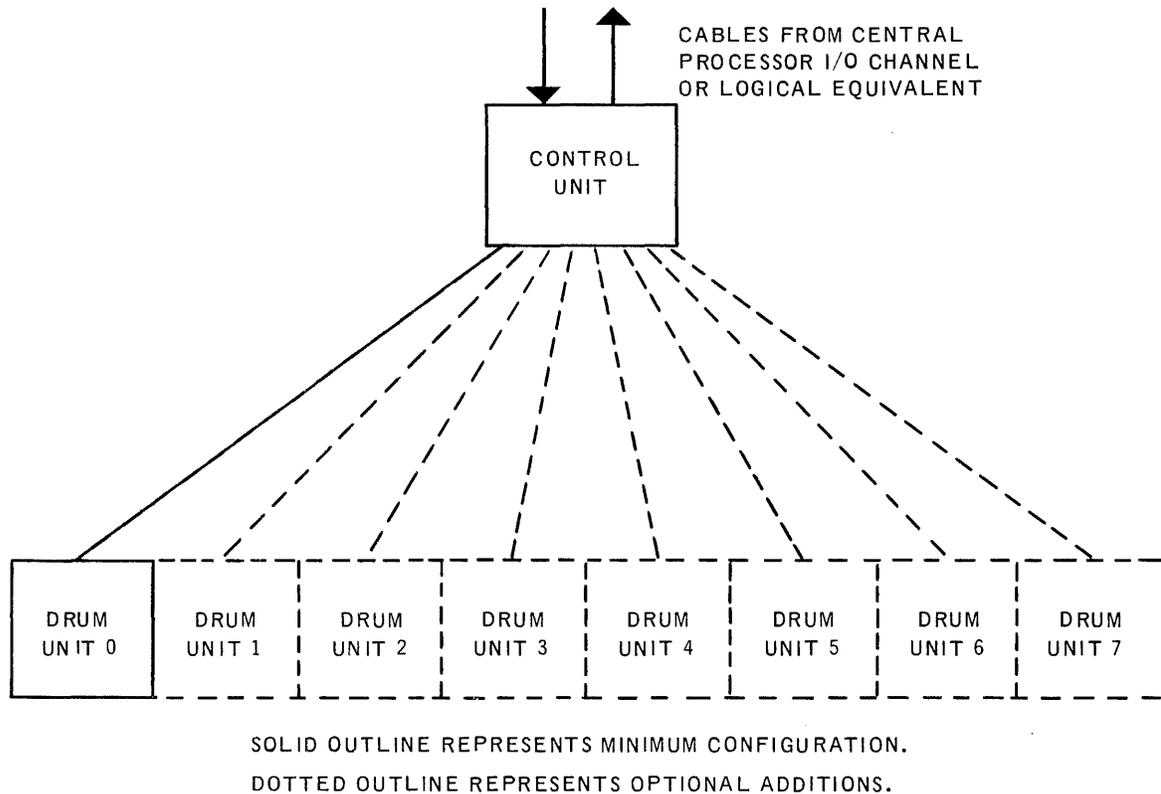
*Figure 2-1. Block Diagram of FH-880 Drum Subsystem*

Once initiated, all functions of the subsystem operate independently of the processor, except for actual data transfers. In addition to the usual functions of reading and writing at known addresses, the FH-880 Drum Subsystem provides the ability to search offline through a drum area of any size. Once a Search function has been initiated and an identifier word transferred, the subsystem performs all required operations without intervention from the processor until the function is completed, or terminated by the program or an External Interrupt caused by a Search Find, End-of-File, or detection of an abnormal condition. The FH-880 Drum Subsystem may be connected to either a Normal or a Compatible Paired I/O (36-bit) channel of the I/O Module.

## 2.2. CONFIGURATIONS

The basic configuration of the FH-880 Drum Subsystem consists of one control cabinet and one FH-880 Magnetic Drum Unit. The storage capacity of the subsystem can be expanded by increasing the number of drum units to not more than eight. Figure 2-1 is a block diagram of the FH-880 Drum Subsystem. Table 2-2 summarizes component requirements for the subsystem.

| SUBSYSTEM COMPONENT | TYPE NUMBER | NUMBER REQUIRED | NUMBER PERMITTED |
|---|---|---|---|
| FH-880 DRUM CONTROL UNIT | 7427-03 | 1 | 1 |
| FH-880 MAGNETIC DRUM UNIT | 7304-01 | 1 | 8 |

*Table 2—2. FH-880 Subsystem Components*

## 2.3. SUBSYSTEM COMPONENTS

Subsystem components, described in the following paragraphs, include the FH-880 Drum Unit and the control unit.

### 2.3.1. FH-880 Drum Unit

The FH-880 Drum Unit contains one FH-880 drum, which is a magnetic-coated cylinder having 880 recording tracks; it contains also 880 read/write heads, one for each track. Of the 880 tracks, 768 are active data tracks, 32 are parity tracks, and the remainder are timing tracks and spares.

Due to the 36-bit interface characteristics of the FH-880 subsystem, all functions performed on the subsystem must employ at least two 18-bit processor words or multiples thereof. A subsystem word has a 36-bit format as opposed to the 18-bit processor word format. All references in this text will be to the subsystem word format (36-bits).

The 768 data tracks are grouped into 128 six-track bands. Each band is divided into 2048 angular addresses, and each angular address is further divided into three angular sections, as illustrated in Figure 2—2. Each angular section (AS) within an angular address (AA) is capable of storing one 36-bit word.
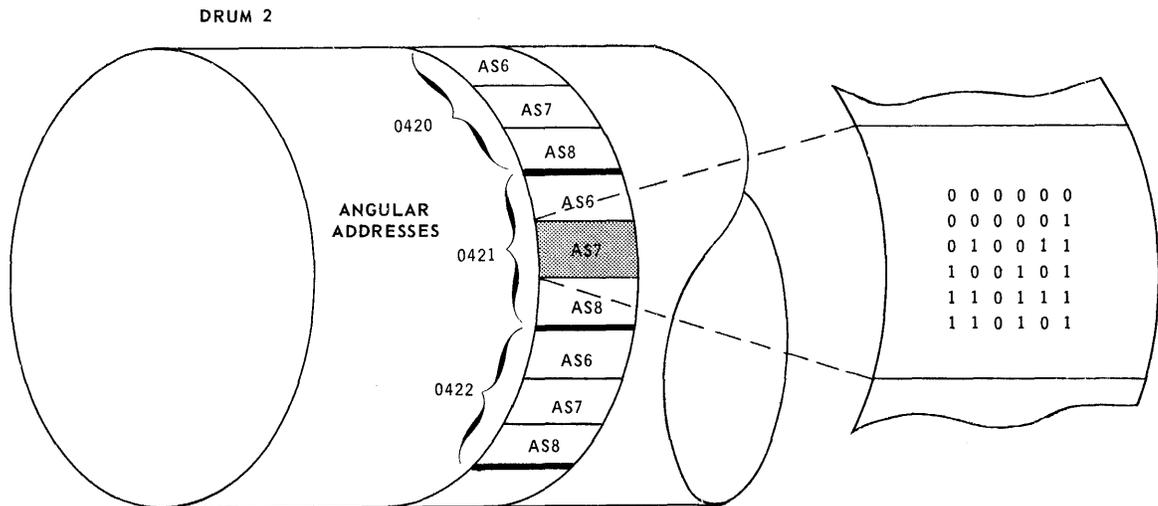


*Figure 2—2. Recording Format of FH-880 Drum*

When a word is written on the drum, it is first divided into six groups of six data bits each. Each group of six data bits is recorded in parallel on the six tracks of a band, starting with bit positions 35 through 30 of the data word, followed by bit positions 29 through 24, and so on. Thus, the data word illustrated in Figure 2–2 represents an octal value of 000123456765. When the data bits are recorded, a parity bit is generated so that the total number of 1 bits recorded (data word plus parity bit is an odd number. This parity bit is recorded in a parity track location internally associated with the data word location.

As a word is read from a drum, groups of six data bits each are read in parallel from the band. Six of these groups are assembled into a 36-bit word, the first group in bit positions 35 through 30, the second in bit positions 29 through 24, and so on. Odd parity is calculated and checked against the recorded parity bit. If it is correct, the assembled data word is made available to the processor.

The angular section number, in addition to specifying a word location within an angular address on a band, also identifies the drum unit on which this word is located. Each drum may be considered to consist of three angular sections which are numbered consecutively from drum to drum: Drum Unit 0 containing AS0, 1, and 2; Drum Unit 1 containing AS3, 4, and 5; and so on up to AS21, 22, and 23 for Drum Unit 7.

Each subsystem word (36-bit) within the FH-880 Drum Subsystem is individually addressable. A complete drum address consists of three address designators: Angular Section, Band, and Angular Address. The range of values for each of these designators is shown in Table 2–3.

| DESIGNATOR | DECIMAL | OCTAL |
|---|---|---|
| ANGULAR SECTION* | 00-23 | 00-27 |
| BAND NUMBER | 000-127 | 000-177 |
| ANGULAR ADDRESS | 0000-2047 | 0000-3777 |

*Angular Section range given is for 8-drum subsystem.

Table 2–3. Range of Values for Address Designators

Drum addresses are internally represented by a combination of 23 bits in the following format:

| ANGULAR SECTION | BAND | ANGULAR ADDRESS |
|---|---|---|
| 22            18 | 17            11 | 10            0 |

This address occupies the 23 low-order bit positions of the function word which initiates drum operations. The actual bit patterns of drum addresses are shown below for the information of the user although they are usually of no concern to him since absolute drum addresses are conventionally represented in octal notation.

The highest angular address on any band is:

$$2047_{10} = 3777_8 = 11\ 111\ 111\ 111_2$$

The highest band number on any drum is:

$$127_{10} = 177_8 = 1\ 111\ 111_2$$

The highest angular section is an 8-drum subsystem is:

$$23_{10} = 27_8 = 10\ 111_2$$

Combining these individual bit patterns and grouping the result in sets of three for octal representation gives:

| ADDRESS DESIGNATOR | ANGULAR SECTION | | BAND | | ANGULAR ADDRESS | | | |
|---|---|---|---|---|---|---|---|---|
| BIT POSITION | 22 | 18 | 17 | 11 | 10 | | | 0 |
| BINARY | 1 0 1 1 1 | | 1 1 1 1 1 1 1 | | 1 1 1 1 1 1 1 1 1 1 1 | | | |
| OCTAL | 2 | 7 | 7 | 7 | 7 | 7 | 7 | 7 |

The range of addresses in octal notation for each drum of a subsystem is given in Table 2—4.

| DRUM UNIT | BEGINNING ADDRESS | ENDING ADDRESS |
|---|---|---|
| 0 | 00 000 000 | 02 777 777 |
| 1 | 03 000 000 | 05 777 777 |
| 2 | 06 000 000 | 10 777 777 |
| 3 | 11 000 000 | 13 777 777 |
| 4 | 14 000 000 | 16 777 777 |
| 5 | 17 000 000 | 21 777 777 |
| 6 | 22 000 000 | 24 777 777 |
| 7 | 25 000 000 | 27 777 777 |

Table 2—4. Range of Drum Addresses (octal)

Most drum operations require reading from or writing into a number of consecutive word locations. In the course of such an operation, the control circuitry automatically increments the drum address following the reading or writing of each word. Storage access is sequential from band to band within an angular section, from angular section to angular section within a drum, and from drum to drum within a subsystem. For example, following AA2047 of Band 51, AS0, the next address to be accessed in sequence is AA0 of Band 52, AS0. Similarly, following access of AA2047 of Band 127, AS0, the next address in sequence is AA0 of Band 0, AS1.

A certain amount of time is required to stabilize all the circuits involved in switching from the last word on one band to the first word on the next without missing a drum revolution. The necessary time is provided by a nonaddressable dead space, equal to 24 words in length, which occurs between AA2047 and AA0 on the drum. Thus, a longer than normal interval occurs between the accessing of these two words. The length of the interval depends on whether the next band is in a different angular section or on a different drum. If the advance is to the next band in the same angular section, the interval is 24 word times (the length of the dead space). If the advance is to the next angular section on the same drum, the interval is 25 word times (24-word dead space plus one word time to pass the corresponding word for the previous angular section). If the advance is to the next drum, the interval may vary from almost nothing to a full drum revolution, depending on the relative angular orientation of the two drums. The average interval will be one-half drum revolution.

Attempting to access an address outside the limits of a specific subsystem configuration, either directly or by incrementation, will result in an External Interrupt and transmission of the appropriate status code.

## 2.3.2. Control Unit

The control cabinet, which is connected to both the I/O channel and the individual drum units, contains two major logic sections, called the synchronizer and the drum control unit. For programming purposes these two sections may be thought of as a single unit. In this manual, they are regarded as one unit called the control unit.

The control unit governs all operations of the FH-880 Drum Subsystem. Its principal functions are:

● To receive function words from the I/O Module and translate them into control signals for the drums,

● to control the orderly addressing of drum locations,

● to assemble and disassemble control words for initiating I/O Module activities (status words), control unit activities (function words), and data words for input to the processor and output to the drums,

● to synchronize the flow of data between the I/O Module and the drums, and

● to interpret signals both normal and abnormal, from the drums and to notify the I/O Module of drum conditions.

# 3. PROGRAMMING

## 3.1. SUBSYSTEM/PROCESSOR INTERFACE

Communication between the processor and the FH-880 Drum Subsystem is accomplished by means of the usual I/O channel cabling, consisting of an input cable and an output cable. Each cable contains 36 data lines and the control signal lines necessary for transmission of data requests, acknowledges, and the like.

Subsystem operations are initiated by transmission of at least one function word from the I/O Module to the control unit, which decodes the function word and establishes the proper control circuits to initiate the requested operation. Once the operation has begun, the subsystem operates offline from the processor except for the actual transfer of data words.

Data transfer operations of the FH-880 Drum Subsystem, like those of other peripheral subsystems, require that the I/O Module respond to an Input Data Request signal with an Input Acknowledge signal or to an Output Data Request signal with an Output Acknowledge signal. Even if the appropriate acknowledge signal is not received within the time limit imposed by the subsystem in order to achieve the maximum data transfer rate, the subsystem remains active until the function is terminated. The I/O Module may fail to respond to a request signal within the time limit imposed by the subsystem, either as a result of all required data having been transferred or as a result of delay caused by conflict with higher priority I/O control activity. In the case of delayed acknowledge, the subsystem remains active and resumes data transfer activity when the acknowledge signal is received, with the only system penalty being that one extra drum revolution (or more if the response is delayed by more than 34 milliseconds) is required to access the next word in the sequence. In either case, once any function other than a Terminate function is initiated, the subsystem remains active until a Terminate function is received or until a condition is detected which leads to generation of a status word and an External Interrupt.

Conditions which generate External Interrupts may be either normal or abnormal. For example, finding the desired word on the drum during a Search operation is a normal condition which causes an External Interrupt. On the other hand, abnormal or error conditions which can cause an External Interrupt include parity errors, End-of-File (attempting to go beyond the last available address in the subsystem), Fault (loss of power or incorrect head selection), and the like. Some functions, by their nature, always conclude with a condition which causes an External Interrupt; those which do not must be terminated by the I/O Module in the absence of an error or abnormal condition.

Following acknowledgment of an External Interrupt generated under normal conditions (EOB, Search Find, etc.) and which are in response to any of the Block functions (including Bootstrap With Interrupt) or a Terminate With Interrupt function, the subsystem is automatically cleared to accept a new function. However, if any of the other functions is concluded by detection of a condition which causes an External Interrupt, a Terminate function must be sent to clear the subsystem after the interrupt is acknowledged.

## 3.2. WORD FORMATS

The FH-880 Drum Subsystem accommodates six types of input/output words. The various types of words are:

- Function words

  The function word specifies the operation to be performed and the starting drum address.

- Identifier words

  The identifier word is used in search operations to specify the bit configuration of the word being sought. It is transferred to the subsystem after the function word.

- End-of-Block words

  The End-of-Block word is used to separate files or groups of records on the drum.

- Overflow words

  The overflow word is the word stored in the location immediately following an End-of-Block word. It may be used to indicate the drum address of a group of related records.

- Status words

  The status word is generated by the control unit and transferred to the I/O Module. It indicates the subsystem condition which caused an External Interrupt.

- Data words

  The data word contains the information to be written on or read from the drum.

These words are described in detail in the following sections of this manual.

### 3.2.1. Function Word

The function word instructs the control unit to initiate a subsystem operation. The six high-order bits specify the operation to be performed, while the 23 low-order bits specify the drum address at which the operation is to begin. The format of the function word is as follows:

| Function Code | | Ignored by the Subsystem | | Address Designators | | |
|---|---|---|---|---|---|---|
| | | | | Angular Section | Band | Angular Address |
| 35 | 30 | 29 | 23 | 22  18 | 17  11 | 10  0 |

The function repertoire of the FH-880 Drum Subsystem consists of the 11 functions listed in Table 3—1. Each of these functions is described in detail in the following paragraphs.

| FUNCTIONS | FUNCTION CODES | |
|---|---|---|
| | OCTAL | BINARY |
| WRITE | 02 | 000 010 |
| TERMINATE WITHOUT INTERRUPT | 23 | 010 011 |
| TERMINATE WITH INTERRUPT | 33 | 011 011 |
| BOOTSTRAP WITHOUT INTERRUPT | 40 | 100 000 |
| CONTINUOUS READ | 42 | 100 010 |
| SEARCH | 45 | 100 101 |
| SEARCH READ | 46 | 100 110 |
| BOOTSTRAP WITH INTERRUPT | 50 | 101 000 |
| BLOCK READ | 52 | 101 010 |
| BLOCK SEARCH | 55 | 101 101 |
| BLOCK SEARCH READ | 56 | 101 110 |

*Table 3—1. Summary of Function Repertoire*

## 3.2.1.1.   Write

Function Code:  02

The Write function is the only function which causes output data to be transferred from the processor to the subsystem. The Write function instructs the subsystem to accept output data words from the I/O Module and records them in consecutive drum locations, beginning at the address specified in the function word and continuing until concluded by a Terminate function or by the detection of an error or abnormal condition which causes an External Interrupt. If any of these conditions (further described in 3.2.5) is detected, the write operation is stopped, the appropriate status word is assembled, and the External Interrupt signal is turned on. After the interrupt is acknowledged by the I/O Module, a Terminate function must be sent to clear the subsystem so that it can accept a new function.

In the absence of detection of an error or abnormal condition, the writing operation continues until the output buffer has been exhausted. At this point, the subsystem is still conditioned for writing, so the buffer can be extended if desired. After all required data words have been transferred, a Terminate With Interrupt function must be sent to the subsystem so that the I/O Module will be informed when the writing operation has been completed and the subsystem is ready to accept another function.

The process of writing is not initiated until a data word is received by the subsystem following receipt of a Write function word. After the first data word is received, the nominal transfer rate can be achieved only if the I/O Module responds to each Output Data Request signal by sending another data word to the subsystem within the timing limitations specified in 3.4. Whenever the I/O Module fails to respond in time, an extra drum revolution is required to reach the proper angular address for writing the late word.

It is possible to prevent writing in AS0, Band 0, (called the Bootstrap area) by setting the BOOTSTRAP WRITE switch to the OFF position. If an attempt is made to write in the Bootstrap area when this switch is off, the function is not performed, a status word containing the illegal Address status code is generated, and the External Interrupt signal is turned on.

### 3.2.1.2.    Continuous Read

Function Code:  42

The Continuous Read function instructs the subsystem to read data words from the drum and perform input data transfers to the I/O Module address specified in the function word and continuing until concluded by a Terminate function or by detection of a condition causing an External Interrupt.

If no abnormal condition is detected, the Continuous Read function must be concluded by a Terminate function to clear the subsystem so that it can accept another function. The Terminate Without Interrupt function is commonly programmed as the response to a Monitor Interrupt indicating that the input buffer has been filled, provided all required data words have been received by the I/O Module. The buffer area may be extended if more words are required than were provided for in the original buffer area.

When an abnormal condition is detected, the read operation is stopped, a status word containing the appropriate status code is generated, and the External Interrupt signal is turned on. Regardless of what condition caused the interrupt, a Terminate function must be sent to clear the subsystem after the interrupt has been acknowledged.

If a parity error is detected during execution of a Continuous Read function, the External Interrupt signal is turned on after the I/O Module has accepted all preceding parity-correct words. After the interrupt is acknowledged, the error word, which has been held in the control unit, is presented to the I/O Module with an Input Data Request signal, asking the I/O Module to accept the error word as if it were a normal data word. If the input buffer is active, the word containing the parity error is transferred to the I/O Module and data transfer stops. Whether or not the I/O Module accepts the error word, a Terminate function must be programmed to restore the control unit to a ready condition.

If the last parity correct word preceding a parity error word is stored in the last location in the input buffer, it will trigger an Input Monitor Interrupt. When this occurs, I/O interrupts are locked out until enabled by the program. The program can turn off the External Interrupt signal and clear the subsystem to accept the next function word by sending a Terminate Without Interrupt function to the subsystem before enabling I/O interrupts. (See 3.2.5.12.)

The Continous Read function is the only drum function which permits a word with bad parity to be entered into the buffer area. It should be noted that the External Interrupt accompanying a parity error status code must be acknowledged before the error word can be transferred to main storage. As a consequence, there is no possibility of honoring a Monitor Interrupt at a time when a known error word is in memory without first having been warned of the impending arrival of the error word by means of the status code received with the External Interrupt signal. If the

Monitor Interrupt is honored before an External Interrupt is honored, it means that the subsystem did not detect a parity error in any of the data words it sent to the I/O Module.

After the first data word has been transferred in a read operation, the I/O Module must respond to each successive Input Data Request signal within the timing limitations specified in 3.4, in order to maintain the nominal transfer rate of the equipment. If the I/O Module fails to respond in time, the input data word plus the next data word remain available in the subsystem, but an extra drum revolution will be required to reach the proper angular address for reading the following data word from the drum.

### 3.2.1.3. Block Read

Function Code: 52

The Block Read function instructs the subsystem to read data words from the drum and perform input data transfers, starting at the drum address specified in the function word and continuing until an End-of-Block word (defined as a word of all 1 bits) and the word following it (called the overflow word) have been read. Following the transfer of all preceding data words, the End-of-Block word is transferred to the I/O Module as the last word to enter the input buffer. When the I/O Module acknowledges receipt of the End-of-Block word, the control unit assembles a status word consisting of the End-of-Block (04) status code and the 30 low-order bits of the overflow word for presentation to the I/O Module along with the External Interrupt signal. When the interrupt is acknowledged, the subsystem is cleared to a ready condition.

If the input buffer is filled before an End-of-Block word is detected, data transfer ceases, but the subsystem is still conditioned for reading. If more data words are required by the processor, the input buffer may be extended; otherwise, it is necessary to program a Terminate function to clear the subsystem before a new function can be initiated.

In addition to the normal conclusion of detecting an End-of-Block word, the Block Read function may also be concluded by the detection of a number of other conditions which cause an External Interrupt. These conditions include parity errors, character count errors, End-of-File, Fault, Illegal Address, and sequence errors. If any of these conditions is detected, the read operation is halted, a status word containing the appropriate status code is generated, and the External Interrupt signal is turned on. Following acknowledgment of the interrupt, the subsystem is cleared to a ready condition.

### 3.2.1.4. Search Read

Function Code: 46

The Search Read function instructs the subsystem to read data words from the drum, starting at the drum address specified in the function word, and compares each word with the identifier word, which contains the bit pattern being sought. The identifier word is supplied to the control unit as a second function word following the Search Read function word. When a word read from the drum and the identifier are found to be identical, the control unit changes from a search operation to a read

operation, and input data transfer is initiated, starting with the word that matches the identifier word.

When the input buffer is filled, data transfer ceases, but the subsystem is still conditioned for reading. At this point, the buffer may be extended if additional words are to be read; otherwise, a Terminate function must be sent to the subsystem to restore it to a ready condition before a new function can be initiated.

If, in the course of the Search, no word is found on the drum which matches the identifier word, the search operation continues until an End-of-File is reached unless previously concluded by a Terminate function or by the detection of an abnormal condition which causes an External Interrupt, such as Fault, Illegal Address, parity error, character count error, or sequence error. After the interrupt is acknowledged, a Terminate function must be sent to the subsystem to restore it to a ready condition.

After receiving a Search Read function word, the control unit always interprets the next function word it receives as the identifier word. Thus, if a Search Read function word is immediately followed by a Terminate function word, the control unit will not recognize the Terminate function word as such, but rather will interpret it as an identifier word and begin the search operation. In such a case, a second Terminate function word would be required to restore the subsystem to a ready condition.

The conditions stated in the preceding paragraph are true of all Search functions (Search, Search Read, Block Search, and Block Search Read). Therefore, it is preferable, when the function mode is established by the I/O Module for any Search function, to use Buffer Control Words and the size (or length) of the Function Buffer Area; the first word for the Search function itself, and the second for the identifier word.

### 3.2.1.5. Block Search Read

Function Code: 56

The Block Search Read function instructs the subsystem to read data words from the drum, starting at the drum address specified in the function word, and compares each word with the identifier word which contains the bit pattern being sought. The identifier word is supplied to the control unit as a second function word following the Block Search Read function word. This searching operation continues until one of the following occurs:

- An End-of-Block word is detected. One more word, the overflow word, is read from the drum. The control unit assembles a status word containing the End-of-Block (04) status code and the 30 low-order bits of the overflow word, and turns on the External Interrupt signal.

- A condition is detected which causes an External Interrupt. Possible conditions include Fault, End-of-File, parity error, character count error, and sequence error.

- A word read from the drum matches the identifier word. When this condition occurs, the control unit changes from a searching operation to a reading and data

transferring operation identical with the Block Read function. All conditions relating to the Block Read function, described in 3.2.1.3, apply equally to a Block Search Read function after a find has been made.

If the identifier word in a Block Search Read function is an End-of-Block word, the search find condition will cause the End-of-Block word to be the only word transferred to the input buffer. The status word accompanying the External Interrupt will contain the End-of-Block (04) status code and the 30 low-order bits of the overflow word.

The same principle governs the function transfer of the identifier word as previously described in connection with the Search Read function (see 3.2.1.4).

### 3.2.1.6. Search

Function Code: 45

The Search function instructs the subsystem to read data words from the drum, starting at the drum address specified in the function word, and compares them with the identifier word, which contains the bit pattern being sought. The identifier word is supplied to the control unit as a second function word following the Search function word. The normal ending of a search operation is a search find condition when identical comparison is achieved between a word read from the drum and the identifier word. When this condition occurs, the control unit assembles a status word containing the Search Find (05) status code and the address of the found word, and the External Interrupt signal is turned on.

If, in the course of the search, no word is found which matches the identifier word, the search operation continues until an End-of-File is reached unless previously concluded by a Terminate function or by detection of an abnormal condition which causes an External Interrupt. Abnormal conditions include fault, parity error, character count error, and sequence error.

Following the acknowledgment of an External Interrupt (whether caused by a Search Find, by an End-of-File, or by detection of an abnormal condition), a Terminate function must be sent to the subsystem to restore it to a ready condition.

Since no input data transfers are associated with this function, no input buffer area need be specified.

As is true of other search type functions, the control unit interprets the next function word received after the Search function word as the identifier word. This subject was previously discussed in 3.2.1.4.

### 3.2.1.7. Block Search

Function Code: 55

The Block Search function instructs the subsystem to read data words from the drum, starting at the drum address specified in the function word, and compares them with the identifier word which contains the bit pattern being sought. The identifier word is supplied to the control unit as a second function word following the Block Search function word. If a Search Find (that is, identical comparison

between a word read from the drum and the identifier word) occurs before an End-of-Block word is detected, a status word is generated which contains the Search Find (05) status code and the address of the found word, and the External Interrupt signal is turned on. If an End-of-Block word is detected before a find is made, a status word is generated containing the End-of-Block (04) status code and the 30 low-order bits of the overflow word. (It should be noted that if the identifier word is an End-of-Block word, then when an End-of-Block word is read from the drum, the status word will follow the Search Find format rather than the End-of-Block format.)

If neither a search find condition nor End-of-Block is detected, the search continues until an End-of-File is reached unless previously concluded by a Terminate function or by the detection of an abnormal condition which causes an External Interrupt. Abnormal conditions include Fault, parity error, character count error, and sequence error.

Following acknowledgment of any External Interrupt which occurs in response to the Block Search function, the subsystem is automatically cleared to a ready condition.

Since no input data transfers are associated with this function, no input buffer area need be specified.

As is true of other search type functions, the control unit interprets the next function word it receives after the Block Search function word as the identifier word. This subject was previously discussed in 3.2.1.4.

### 3.2.1.8. Bootstrap Without Interrupt

Function Code: 40

The Bootstrap Without Interrupt function instructs the subsystem to perform a Continuous Read operation starting at AA0 of Band 0 of AS0 (Drum 0). The address portion of a Bootstrap Without Interrupt function word is ignored by the subsystem. In all other respects, this function is identical to the Continuous Read function, described in 3.2.1.2.

The subsystem must be in a cleared condition (no other function in progress) before the Bootstrap function can be initiated. If Bootstrap is used as an automatic recovery device, in a situation where the current condition of the subsystem is unknown to the recovery program, two consecutive Terminate functions should be sent to the subsystem to clear it before the Bootstrap function is sent. If this precaution is neglected and a Bootstrap function is given when the subsystem is not in a cleared condition, the result will be unpredictable.

### 3.2.1.9. Bootstrap With Interrupt

Function Code: 50

The Bootstrap With Interrupt function instructs the subsystem to perform a Block Read operation starting at AA0 of Band 0 of AS0 (Drum 0). The address portion of a Bootstrap With Interrupt function word is ignored by the subsystem. In all other respects, this function is identical to the Block Read function, described in 3.2.1.3.

If the Bootstrap With Interrupt function is used in a recovery procedure when the condition of the subsystem is unknown to the recovery program, it should be handled in the same manner as Bootstrap Without Interrupt; that is, preceded by two consecutive Terminate functions to insure that the subsystem is cleared to receive a new function.

The use of the Bootstrap With Interrupt function is not recommended unless the portion of the program read in from the first block includes provision for handling an End-of-Block status word.

### 3.2.1.10. Terminate Without Interrupt

Function Code: 23

The Terminate Without Interrupt function instructs the subsystem to conclude the function currently being performed by the subsystem. Input operations are terminated immediately on receipt of the Terminate function by the control unit. If the control unit receives a Terminate Without Interrupt function following an input operation, it must wait approximately 600 nanoseconds before accepting the next function word. An output operation (write) continues until it is completed before the termination becomes effective.

The Terminate Without Interrupt function is commonly used as the programmed response to an Input Monitor Interrupt when all desired input data has been received, or as the programmed response to a Continuous Read Parity Error status code $(64_8)$ when the error word is unacceptable as an input word. (Refer to 3.2.5.12.) The use of the Terminate Without Interrupt function is not restricted to these instances, since it can be used to conclude any drum function. However, the use of the Terminate With Interrupt function is recommended as a programmed response to an Output Monitor Interrupt when all of the data to be written has been sent to the subsystem.

Whenever the condition of the subsystem is in doubt, two consecutive Terminate functions should be sent to the subsystem in order to cover the special case for all Search functions as explained in 3.2.1.4 before a new function is initiated. The attempt to initiate a function while a previous function is still active will produce unpredictable results.

### 3.2.1.11. Terminate With Interrupt

Function Code: 33

The Terminate With Interrupt function instructs the subsystem to conclude the function currently being performed by the subsystem and to inform the processor of its conclusion by means of an External Interrupt. Input operations are terminated immediately upon receipt of the Terminate function by the control unit; an output operation (write) continues until it is completed before the termination becomes effective. When the previous function has been successfully terminated, the status word presented to the processor along with the External Interrupt contains a Normal Completion (40) status code. When the interrupt is acknowledged by the processor, the subsystem is cleared to a ready condition.

The Terminate With Interrupt function should be used to conclude a write operation so that the processor is informed when the Write function has been completed and the subsystem can accept the next function. As noted previously, the temination of a Write function becomes effective only when it is completed. Therefore, the use of the Terminate With Interrupt function makes it unnecessary for the programmer to time out the interval required to insure completion of the Write function.

### 3.2.2. Identifier Word

The identifier word is transferred from the processor to the subsystem as a second function word following the transfer of any of the search functions (Search, Search Read, Block Search, Block Search Read). There is no fixed format for the identifier word, which may contain any bit configuration representing the data word being sought.

After a search function word is received and decoded, the subsystem waits until the identifier word is received. The subsystem normally will request the identifier word about 600 nanoseconds after the search function word is received.

### 3.2.3. End-of-Block Word

The End-of-Block word is a full 36-bit word containing all 1 bits, which is used to separate files or groups of records stored on the drum. It is recognized as an End-of-Block word by the control unit only during block operations (Block Read, Block Search, Block Search Read, and Bootstrap With Interrupt). In those block operations involving input data transfers, no data words are transferred to the input buffer following the transfer of the End-of-Block word.

If an End-of-Block word is stored at the highest address in the subsystem, the processor will not be informed that an End-of-Block has occurred when this word is read. The External Interrupt which follows the reading of an End-of-Block word from the highest address in the subsystem during a Block operation will be accompanied by a status word containing the End-of-File status code rather than End-of-Block.

### 3.2.4. Overflow Word

The overflow word is the designation given to whatever word is recorded in the address immediately following an End-of-Block word. The 30 low-order bits of the overflow word are presented to the processor as part of the status word, along with the End-of-Block (04) status code, at the normal conclusion of all Block functions except when a search find occurs in a block search operation. The 23 low-order bits of the overflow word may be programmed to indicate the starting address of the next portion of a nonconsecutive file.

It should be noted that there is no overflow word following an End-of-Block word stored in the highest address of the subsystem.
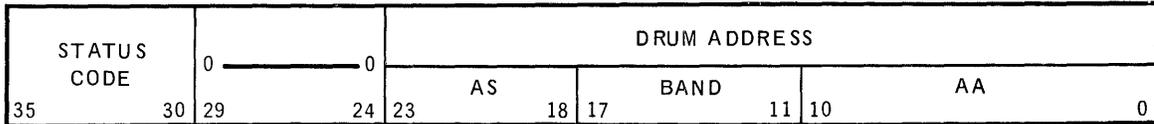
### 3.2.5. Status Word

The status word is generated by the control unit to indicate conditions within the subsystem. The status word is made available to the I/O Module over the 36 input data lines, accompanied by a signal on the External Interrupt line to inform the I/O Module that a status word rather than a data word is on the lines.

The status code can occupy either the four or six most significant bit positions of the status word. The six-bit codes are accompanied by other meaningful information in the remainder of the status word. In the case of the four-bit codes, the rest of the status word is indeterminate and should be ignored. The status word may take one of three possible formats depending on the nature of the condition being indicated. The three formats of the status word are as follows:

FORMAT A:

| STATUS<br>CODE<br>35　　　30 | CONTENTS OF CORRESPONDING BIT POSITIONS OF OVERFLOW WORD<br>29　　　　　　　　　　　　　　　　　　　　　　　　　　0 |
|---|---|

FORMAT B:

| STATUS<br>CODE<br>35　　　30 | 0 ———— 0<br>29　　24 | DRUM ADDRESS | | |
|---|---|---|---|---|
| | | AS<br>23　　18 | BAND<br>17　　11 | AA<br>10　　　　　0 |

FORMAT C:

| STATUS<br>CODE<br>35　　32 | INDETERMINATE<br>31　　　　　　　　　　　　　　　　　　　　　　　　　　0 |
|---|---|

The FH-880 Drum Subsystem can generate any of the 13 status codes listed in Table 3—2. It should be noted that the octal designations given for the four-bit codes are nominal since bits 31 and 30 of the status word may contain either 0 or 1 bits.

| STATUS WORD | STATUS CODE | |
|---|---|---|
| | OCTAL | BINARY |
| End-of-Block | 04 | 000 100 |
| Search Find | 05 | 000 101 |
| Overflow Parity Error | 06 | 000 110 |
| Noncontinuous Read Parity Error or Character Count Error | 07 | 000 111 |
| Fault | 14 | 001 1xx* |
| Synchronizer Character Count Error | 30 | 011 0xx* |
| End-of-File | 34 | 011 1xx* |
| Normal Completion | 40 | 100 0xx* |
| Illegal Function | 50 | 101 0xx* |
| Illegal Address | 54 | 101 1xx* |
| Control Sequence Error | 60 | 110 0xx* |
| Continuous Read Parity Error | 64 | 110 1xx* |
| Write Character Count Error | 70 | 111 0xx* |

\* Only the four high-order bits of these codes are significant. The bits shown as xx are meaningless and may be either 0 or 1 bits.

*Table 3—2. Summary of Status Codes*

Some of the status codes represent error conditions while others simply represent the normal conclusion of subsystem operations. In general, error conditions take precedence over normal conditions if the two should occur simultaneously. The action to be taken by the program on the occurrence of the External Interrupt depends on the function being executed and the nature of the condition which caused the interrupt. For example, parity error indicators logically suggest that one or more attempts should be made to reread the error word, as a recovery procedure. On the other hand, a search find is a normal condition indicating to the program that the desired information has been located on the drum; the response to this status code is therefore dependent on the nature of the program itself.

Not all status codes can occur in response to all function codes. Table 3–3 indicates the possible status code responses to each of the function codes and the priority sequence which applies in each case. If two or more of the possible conditions are detected at the same time, only the highest priority status code is generated.

The status codes and their significance are discussed in detail in the following paragraphs.

3.2.5.1.   End-of-Block

Status Code:  04                    Status Word Format:  A

The End-of-Block status code indicates to the processor that the control unit has detected an End-of-Block word in the course of performing a Block function. If End-of-Block is detected during a search operation (Block Search or Block Search Read), it indicates that no word matching the identifier word was found within that block. If End-of-Block is detected during the input data transfer sequence for a Block Read, Bootstrap With Interrupt, or Block Search read function, the End-of-Block word is transferred to the processor as the last data word to enter the input buffer. Regardless of when the End-of-Block word is detected, one more word, the overflow word, is read from the drum. The control unit then assembles a status word containing the status code 04 and the 30 low-order bits of the overflow word and turns on the External Interrupt signal. In the case of the data transfer functions noted above, the External Interrupt (EI) signal is turned on only after the processor has acknowledged receipt of the End-of-Block word.

It should be noted that there is no overflow word following an End-of-Block word which appears in the highest address in the subsystem. If an End-of-Block word is read from the highest address in the subsystem during any of the Block functions, End-of-File rather than End-of-Block will be indicated in the status word.

3.2.5.2.   Search Find

Status Code:  05              Status Word Format:  B

The Search Find status code indicates to the I/O Module that, during a Search or Block Search function, a word was found on the drum which is identical with the identifier word. The 23 low-order bits of the status word contain the drum address of the found word.

| STATUS CODES | | STATUS WORD FORMAT* | FUNCTION CODES | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 02 WRITE | 23 TERMINATE WITHOUT INTERRUPT | 33 TERMINATE WITH INTERRUPT | 40 BOOTSTRAP WITHOUT INTERRUPT | 42 CONTINUOUS READ | 45 SEARCH | 46 SEARCH READ | 50 BOOTSTRAP WITH INTERRUPT | 52 BLOCK READ | 55 BLOCK SEARCH | 56 BLOCK SEARCH READ | OTHER (ILLEGAL) |
| 04 | END-OF-BLOCK | A | | | | | | | | 5 | 6 | 7 | 6 | |
| 05 | SEARCH FIND | B | | | | | | 5 | | | | 5 | | |
| 06 | OVERFLOW PARITY ERROR | B | | | | | | | | 4 | 4 | 4 | 4 | |
| 07 | NONCONTINUOUS READ PARITY ERROR OR CHARACTER COUNT ERROR | B | | | | $4^\dagger$ | $4^\dagger$ | $4^\dagger$ | $4^\ddagger$ | 6 | 7 | 8 | 7 | |
| 14 | FAULT | C | 2 | | | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | |
| 30 | SYNCHRONIZER CHARACTER COUNT ERROR | C | 5 | | | 6 | 7 | 7 | 6 | 7 | 8 | 9 | 8 | |
| 34 | END-OF-FILE | C | 4 | | | | 6 | 6 | 5 | | 5 | 6 | 5 | |
| 40 | NORMAL COMPLETION | C | | | 1 | | | | | | | | | |
| 50 | ILLEGAL FUNCTION | C | | | | | | | | | | | | 1 |
| 54 | ILLEGAL ADDRESS | C | 1 | | | 1** | 1 | 1 | 1 | 1** | 1 | 1 | 1 | |
| 60 | CONTROL SEQUENCE ERROR | C | $3^{\dagger\dagger}$ | | | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | |
| 64 | CONTINUOUS READ PARITY ERROR | C | | | | 5 | 5 | | | | | | | |
| 70 | WRITE CHARACTER COUNT ERROR | C | $3^{\dagger\dagger}$ | | | | | | | | | | | |

\* FORMAT A – INCLUDES LOW-ORDER 30 BITS OF OVERFLOW WORD
FORMAT B – DRUM ADDRESS IN LOW-ORDER 23 BITS
FORMAT C – LOW-ORDER 32 BITS ARE INDETERMINATE

\*\* ONLY IF DRUM 0 IS INOPERATIVE

† ONLY IF CHARACTER COUNT ERROR

†† SINCE THESE CONDITIONS CANNOT OCCUR SIMULTANEOUSLY, THEY SHARE THE SAME PRIORITY LEVEL.

Table 3-3. Possible Status Code Responses to Function Codes (in Priority Sequence)

### 3.2.5.3. Overflow Parity Error

Status Code: 06          Status Word Format: B

The Overflow Parity Error status code informs the I/O Module that a parity error was detected by the control unit during reading of the overflow word at the conclusion of a Block function. The 23 low-order bits of the status word contain the drum address of the overflow word in which the error was detected.

### 3.2.5.4. Noncontinuous Read Parity Error or Character Count Error

Status Code: 07          Status Word Format: B

This code informs the I/O Module that one of the following conditions occurred:

- a parity error was detected during any search or read function except Continuous Read or Bootstrap Without Interrupt, or

- a character count error was detected during any search or read function.

The 23 low-order bits of the status word contain the drum address of the word that led to detection of the error.

The Character Count Error (07) status code denotes a hardware malfunction, indicating that an internal signal within the control unit was not received in time for the next character to be read from the drum.

If a Parity Error (07) status code is reported, the External Interrupt signal is turned on only after the processor has accepted all parity-correct data words read from the drum before the error was detected. The error word itself is not made available to the processor. (NOTE: A parity error detected during a Continuous Read or Bootstrap Without Interrupt function is reported by a 64 status code.)

### 3.2.5.5. Fault

Status Code: 14          Status Word Format: C

The Fault status code indicates to the I/O Module that one of the following malfunctions has occurred in the subsystem:

- More than one set of read/write heads has been selected or no read/write head has been selected

- Temperature in the addressed drum unit is too high or too low

- Power to the addressed drum unit has been dropped

- Write voltage has failed or has been turned off.

### 3.2.5.6. Synchronizer Character Count Error

Status Code: 30          Status Word Format: C

This code indicates to the processor that a malfunction has occurred in the character counter which governs assembly and disassembly of words by the synchronizer portion of the control unit. This counter normally starts at zero, counts up to five, and recycles to zero. If, at any time, this counter registers a count greater than five, the function in process is aborted, and the condition is reported to the I/O Module by generating a 30 status code and turning on the External Interrupt signal.

### 3.2.5.7. End-of-File

Status Code: 34          Status Word Format: C

The End-of-File status code informs the processor that the next sequential address is either beyond the limits of the particular subsystem or is on an inoperable drum. This status code is generated only through incrementation of the drum address during the performance of a function; specifying such an address in the function word would cause an External Interrupt accompanied by an Illegal Address status code rather an End-of-File.

The specific time at which the End-of-File status code is generated in response to the various functions is as follows:

● for a Write function, after a word has been written in the last available address, regardless of whether an extra data word has been sent to the subsystem,

● for any function performing input data transfers, after the I/O Module has acknowledged receipt of the word read from the last available address, or

● for a search function, after the identifier word has been compared with the word read from the last available address and the two are found not identical.

### 3.2.5.8. Normal Completion

Status Code: 40          Status Word Format: C

The Normal Completion status code is possible only as a response to a Terminate With Interrupt function. It indicates to the I/O Module that the control unit has completed the previous function.

### 3.2.5.9. Illegal Function

Status Code: 50          Status Word Format: C

The Illegal Function status code informs the I/O Module that the function word supplied to the control unit specifies a function code that is not included in the

subsystem repertoire. No function is initiated in this case, and the External Interrupt signal is turned on immediately. It is recommended that a Terminate function be sent to the subsystem following receipt of this status code.

If both an illegal function code and an illegal address are specified in the same function word, the Illegal Function status code takes precedence.

3.2.5.10.   Illegal Address

Status Code:  54          Status Word Format:  C

The Illegal Address status code informs the processor that the drum address specified in the function word is invalid. An invalid address is defined as one that is beyond the limits of the subsystem configuration, or is on an inoperable drum, or is in AS0, Band 0, for a Write function when the BOOTSTRAP WRITE switch (see 4.2.2) is off. If the function word specifies an invalid address, the function is not initiated, the status word is generated, and the External Interrupt signal is turned on immediately.

3.2.5.11.   Control Sequence Error

Status Code:  60          Status Word Format:  C

This status code informs the I/O Module that a timing error has occurred in the control section of the control unit. Character timing pulses generated in the control unit are checked against signals from timing tracks on the drum. If the two appear to be out of synchronism, the sequence error condition is indicated to the I/O Module.

3.2.5.12.   Continuous Read Parity Error

Status Code:  64          Status Word Format:  C

This status code informs the I/O Module that the control unit detected a parity error while performing either a Continuous Read or Bootstrap Without Interrupt function. (Parity errors detected during other reading functions are indicated by a Noncontinuous Read Parity Error status code, described in 3.2.5.4.)

When a Continuous Read Parity Error is detected, the External Interrupt signal is turned on only after the I/O Module has accepted all parity-correct data words from the drum before the error was detected. The word containing the error is held in the control unit and is presented to the I/O Module along with an Input Data Request signal as soon as the interrupt has been acknowledged. If the input buffer is active, the error word is transferred to the I/O Module, and data transfer then stops. A Terminate function must be sent to the subsystem to restore it to a ready condition.

### 3.2.5.13. Write Character Count Error

Status Code: 70          Status Word Format: C

This status code is possible only as a response to a Write function. It indicates a timing problem in the control unit; specifically, that an internal transfer of data within the control unit was not made in time to write the character on the drum successfully.

### 3.2.6. Data Word

Data words contain the information which is read from or written on the drum. After the function word or words have been received and acted upon by the control unit, data words are transferred between the I/O Module and the subsystem. The data word is a 36-bit word with no fixed format. No data words are transferred when either form of a Terminate (23 or 33) function, a Search (45) function, or a Block Search (55) function is sent to the subsystem.

## 3.3. ERROR RECOVERY PROCEDURES

The action to be taken by the program on the occurrence of an External Interrupt depends on whether the interrupt represents a subsystem malfunction or a normal or abnormal program condition. End-of-Block, Search Find, and Normal Completion all indicate the normal expected conclusion of a program operation, while End-of-File may be either an expected conclusion or the result of an abnormal condition in the program. The response to all of these conditions must be determined by the nature of the program.

The remaining status codes all represent errors or malfunctions in the subsystem. Of these, the most serious is the Fault (14) status code. If a Fault condition is indicated, the recommended procedure is to suspend operation on the subsystem and notify the Univac Field Engineer of the condition.

If Illegal Function or Illegal Address errors occur, it should first be established that the condition is not the result of a program error. If it is not, then the I/O Module described in the following paragraph should be followed.

The remaining status codes are parity error, character count error, or sequence error indications, all of which may result from transient conditions in the subsystem. Therefore, the recommended procedure in these cases is to attempt to perform the function one or two more times. If the error persists after several attempts, the Univac Field Engineer should be notified.

## 3.4. TIMING

The basic element in timing of drum operations is the speed of the drum. The FH-880 Drum revolves at a nominal speed of 1770 rpm (1765 rpm minimum, 1800 rpm maximum), with a maximum time of 34 milliseconds for one revolution. This drum speed affects both the time required to access the first drum location for a function and the rate at which subsequent words are transferred.

The time required to access the first drum location for any function is the ''get-ready'' time plus the time required to reach the angular address at which the function is to begin. The get-ready time required for drum and head selection is 160 microseconds after the function word has been decoded. This 160-microsecond delay must occur before the control unit can detect that the address specified in the function word is at the read/write head. Therefore, access time will be minimum if the specified angular address reaches the read/write head immediately following the expiration of the 160-microsecond delay. On the other hand, the maximum access time of 34.16 milliseconds (one drum revolution plus delay) will be required if the specified angular address passes the read/write head just before the end of the delay. The average access time for the first word is considered to be 17.16 milliseconds (one-half drum revolution plus delay).

After the first word has been accessed for a function, subsequent data transfers between the processor and the drum can occur at the rate of one word every 16.5 microseconds. This rate of data transfer can be maintained only if the I/O Module responds to each Input or Output Data Request within a required interval.

For any input or output function, the response interval is defined as the time between the arrival of the Data Request signal at the processor and the initiation of the corresponding Acknowledge. The safe average response interval is 13.0 microseconds; that is, if the I/O Module responds to each Input or Output Data Request with the corresponding Acknowledge within 13.0 microseconds, data transfer will proceed at rated speed. The two critical response intervals, to avoid missing a drum revolution, are 25.5 microseconds as a one-time maximum and 12.5 microseconds as a cumulative lag in response.

A certain amount of buffering capacity is provided by two fullword registers in the control unit, but the critical intervals stated above must be observed to maintain the rated speed of the equipment. If either of them is exceeded, an extra drum revolution will be required because the desired angular address will have passed the read/write head by the time the next data word can be accepted by or supplied from the appropriate control unit register.

The response times stated above are based on the maximum transfer rate of 60,000 words per second. It is also possible to operate the FH-880 Drum Subsystem at any of several slower transfer rates. These slower rates are all submultiples of the maximum and are implemented by changing the locations of several circuit cards in the control unit. These cards govern the physical sequence of records on the drums, which is called the interlace. If consecutively numbered words are recorded in consecutively numbered addresses, the recording sequence is called Interlace 1; this is the normal sequence, and it permits the maximum transfer rate of 60,000 words per second. If every second angular address is used (Interlace 2), the transfer rate is reduced because each word requires a longer access time. Because two drum revolutions are required to access all words within an angular section on a band, the maximum transfer rate for Interlace 2 is 30,000 words per second. The various interlaces, and the transfer rates and permitted response times for each, are given in Table 3-4.

| INTERLACE | TRANSFER RATE (words/sec) | AVERAGE TIME BETWEEN WORDS (microseconds) | PERMITTED RESPONSE TIME* (microseconds) | |
|---|---|---|---|---|
| | | | ONE-TIME MAXIMUM | SAFE AVERAGE MAXIMUM |
| 1 | 60,000 | 16.5 | 25.5 | 13.0 |
| 2 | 30,000 | 33.0 | 58.5 | 29.5 |
| 4 | 15,000 | 66.0 | 124.5 | 62.5 |
| 8 | 7,500 | 132.0 | 256.5 | 128.5 |
| 16 | 3,750 | 264.5 | 521.0 | 261.0 |

\* Permitted response time equals the time interval between the arrival of an IDR or ODR
at the I/O Module and the initiation of the corresponding acknowledge.

*Table 3–4. Response Times Required to Avoid Extra Drum Revolutions*

# 4. OPERATION

## 4.1. OPERATOR'S RESPONSIBILITIES

The operator is responsible for turning on and turning off power to the various components of the FH-880 Drum Subsystem and for responding to inquiries and instructions by way of the system console.

## 4.2. CONTROLS AND INDICATORS

Controls and indicators on the FH-880 Drum Unit and the control unit are described in the following paragraphs.

### 4.2.1. FH-880 Drum Unit

Each FH-880 Drum in a subsystem includes a Drum Unit Control Panel, which gives the operator a visual display of drum conditions. It also allows him to exercise control over AC and DC power distribution to the drum. This panel, shown in Figure 4-1, is located inside the front doors of the cabinet just below the transparent housing of the drum. A description of panel components is given in Table 4-1.

In addition, one switch and one indicator light are located inside the right-hand door on the back of the cabinet. The WRITE VOLTAGE switch is a two-position toggle switch, labeled ON and OFF, which is primarily of significance to the Univac Field Engineer. The associated indicator light is labeled POWER SUPPLY ON.
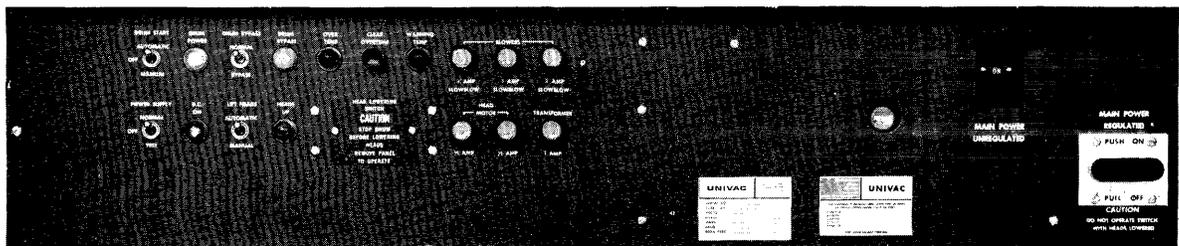


Figure 4-1. FH-880 Drum Unit Control Panel

| NAME OF COMPONENT | TYPE | DESCRIPTION |
|---|---|---|
| DRUM START | 3-position toggle switch | Controls application of power to drum drive motor, as follows:<br>*AUTOMATIC: Power applied to drum drive motor is under control of automatic sequencing which is initiated by control unit.<br>OFF: No power applied to drum drive motor.<br>MANUAL: Control of power to drum drive motor independent of control unit. DRUM BYPASS switch must be in BYPASS position to apply power. |
| DRUM POWER | Indicator | Light on indicates power is being applied to drum drive motor. |
| DRUM BYPASS | 2-position toggle switch | Controls automatic sequencing of power application initiated by control unit, as follows:<br>*NORMAL: Power is applied to this drum in its normal sequence.<br>BYPASS: This drum is removed from the normal sequence, and manual control is permitted in conjunction with MANUAL setting of DRUM START switch. |
| DRUM BYPASS | Indicator | Light on indicates this drum is offline; i.e., DRUM BYPASS switch is set to BYPASS position. |
| OVER TEMP | Indicator | Light on indicates temperature in drum housing has reached 115° F. All power in drum unit is dropped except power to the blowers. |
| CLEAR OVER-TEMP | Pushbutton | Pressing this button clears the overtemp indicator and restores power to the drum unit when temperature returns to below 115° F. |
| WARNING TEMP | Indicator | Light on indicates temperature in drum housing is below 95° F or above 105° F. Fault status code is generated and EI signal turned on in response to any function except Terminate. |

* Represents position of the toggle switch under normal operating condition.

*Table 4-1. FH-880 Drum Unit Control Panel Controls and Indicators (Sheet 1 of 2)*

| NAME OF COMPONENT | TYPE | DESCRIPTION |
|---|---|---|
| POWER SUPPLY | 3-position toggle switch | Controls the application of DC voltages to drum logic circuits as follows:<br>*NORMAL: Application of DC voltage governed by head position (heads up — no power; heads down — power).<br>OFF: Removes power from logic circuits.<br>TEST: Power is applied to logic circuits regardless of head position. |
| DC ON | Indicator | Light on indicates DC power is being applied to drum logic circuits. |
| LIFT HEADS | 2-position toggle switch | Controls positioning of heads as follows:<br>*AUTOMATIC: This setting allows for automatic lowering or raising of heads during normal operation.<br>MANUAL: This setting results in manual head lifting for maintenance purposes. |
| HEADS UP | Indicator | Light on indicates heads are out of the flying position while power is being applied to the drum unit. |
| FUSES | Indicators | Light on indicates a blown fuse. Call Univac Field Engineer. |
| RESET | Pushbutton | Pressing this button restores drum operation if drum power was interrupted by a drum motor overload. |
| MAIN POWER UNREGULATED | Circuit breaker | Controls application of unregulated power to the drum unit and provides overcurrent protection for the drum drive motor. |
| MAIN POWER REGULATED | Circuit breaker | Controls application of regulated power to the DC power supplies. Also provides overcurrent protection for the DC power supplies. |

* Represents position of the toggle switch under normal operating conditions.

Table 4-1. FH-880 Drum Unit Control Panel Controls
and Indicators (Sheet 2 of 2)

### 4.2.2. Control Unit

The Control Unit Operator's Panel displays operating conditions and permits some control of the subsystem. This panel, shown in Figure 4–2, is located on the front of the control unit near the top of the cabinet. A description of panel components is given in Table 4–2.
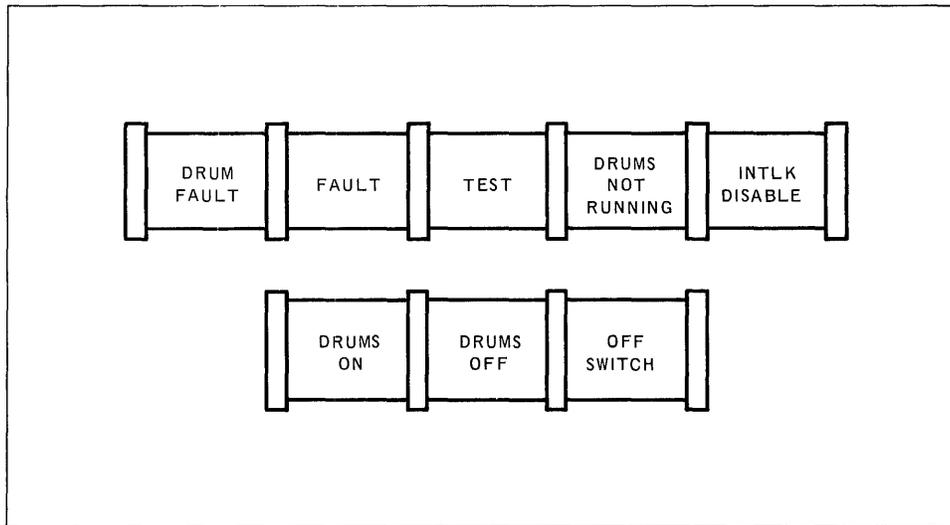


Figure 4–2. Control Unit Operator's Panel

The BOOTSTRAP WRITE switch is located inside the front door of the control unit, below and to the right of the Operator's Panel. When this switch is ON, both reading and writing are permitted in the Bootstrap area (Drum 0, AS0, Band 0, AA0 through AA2047). When this switch is OFF, only reading is permitted in the Bootstrap area; an attempt to perform a Write function produces an External Interrupt accompanied by an Illegal Address status code.

Two maintenance panels, primarily for the use of the Univac Field Engineer, are located inside the doors on the back of the control unit. At the bottom of each panel there is a group of toggle switches which may be of significance to the operator. During normal operations, all of these switches, with the exception of INTLK DISABLE, should be ineffective (DOWN). If any of them is in the UP position, the TEST indicator on the Control Unit Operator's Panel is turned on, and the subsystem will not properly respond to function words sent by the processor.

| NAME OF COMPONENT | TYPE | DESCRIPTION |
|---|---|---|
| DRUM FAULT | Indicator | Lights under any of the following conditions:<br>■ Temperature in a drum unit is below 95°F or above 105°F.<br>■ A voltage fault occurs in a drum unit.<br>■ Any drum becomes inoperative after all drums have reached operating speed. |
| FAULT | Indicator | Lights whenever the DRUM FAULT light is on or when one of the following faults is detected in the control unit:<br>■ Low voltage<br>■ High current<br>■ High temperature<br>■ Loss of air. |
| TEST | Indicator | Lights when any test toggle switch (except INTLK DISABLE) in the subsystem is in its test (UP) position. |
| DRUMS NOT RUNNING | Indicator | Lights under any of the following conditions:<br>■ Any drum is not in the automatic mode of operation.<br>■ Any drum is not up to full speed during the power-on sequence.<br>■ Power in a drum unit is off.<br>■ Write voltage in a drum unit is off. |
| INTLK DISABLE | Indicator | Lights when the BOOTSTRAP WRITE switch is in the ON position, or when the control unit cabinet interlocks are bypassed. |
| DRUMS ON | Switch-indicator | Pressing this switch-indicator starts sequential operation of the drums. Drum Unit 0 is started first and, once it is up to speed, the sequence continues until all drums are running. This indicator lights immediately; however, the DRUMS NOT RUNNING light remains on until all drums are up to speed. |
| DRUMS OFF | Switch-indicator | Pressing this switch-indicator removes power from the drums and lights the indicator. This switch must be held until the DRUMS ON indicator goes off. Power to the control unit is not affected. |
| OFF SWITCH | Switch-indicator | Pressing this switch-indicator removes power from the control unit. Power on is indicated by green light; power off by red light. |

*Table 4–2. Control Unit Operator's Panel Controls and Indicators*

## 4.3. SUBSYSTEM OPERATION

Elements of subsystem operation described in the following paragraphs include:

■ turn-on procedure,

■ stand-by procedures, and

■ turn-off procedure.

### 4.3.1. Turn-On Procedure

The procedure for turning on the subsystem from a complete stop involves supplying power to each drum unit and then initiating the automatic drum-starting sequence from the Operator's Panel on the control unit. The recommended procedure follows:

(1) Close all circuit breakers on the external power supply panels.

(2) Perform the following procedure for each drum:

    (a) Before applying power, check to see that the following switches are set as indicated:

| SWITCH | SETTING |
|---|---|
| MAIN POWER UNREGULATED | OFF |
| MAIN POWER REGULATED | OFF |
| DRUM START | OFF |
| DRUM BYPASS | NORMAL |
| POWER SUPPLY | NORMAL |
| LIFT HEADS | AUTOMATIC |

    (b) Set the MAIN POWER UNREGULATED switch to the ON position. This starts the blowers for the drum and the power supplies. The HEADS UP indicator will light.

    (c) Set the MAIN POWER REGULATED switch to the ON position.

    (d) Set the DRUM START switch to the AUTOMATIC position. This conditions the drum for the automatic turn-on sequence initiated from the control unit.

(3) Press the DRUMS ON switch on the Control Unit Operator's Panel. This causes the drums to be turned on sequentially at 120-second intervals to avoid circuit overloads. Starting with Drum 0, the following sequence of events occurs:

    (a) The drum motor starts, and the DRUM POWER indicator is turned on. The WARNING TEMP indicator will also be turned on if the temperature in the drum unit is below 95 °F or above 105°F.

(b) A time delay relay causes a 120-second delay to allow the drum to get up to speed before proceeding.

(c) The head motor starts and lowers the heads to the flying position. The HEADS UP indicator is turned off.

(d) The DC ON indicator is turned on.

After the 120-second delay (see (3)(b) above) has elapsed, the motor of the next drum is started, and the same sequence occurs for each drum until all have been started. When all drums are up to speed, the DRUMS NOT RUNNING indicator on the Control Unit Operator's Panel is automatically turned off.

(4) Before proceeding, allow the internal temperature of the drums to reach 98 °F with the heads flying during the entire warm-up period. Drum temperature is indicated by a thermometer located inside the upper right-hand corner of the transparent housing around the drum. Several hours of warm-up may be required if the drums have been shut down long enough to cool to room temperature.

(5) On the left-hand maintenance panel located on the back of the control unit, press the toggle switch labeled DRUM WRITERS down to the ON position and hold it down until the DRUM WRITERS indicator, above and to the right of the switch, goes off. (The switch is spring-loaded and will return to the center position when released.) The subsystem should now be operational.

When the subsystem is operational, the following indicators should be lighted:

● On the Control Unit Operator's Panel:

DRUMS ON
OFF SWITCH (green)

● On the Control Panel of each drum unit:

DRUM POWER
DC ON

## 4.3.2. Standby Procedures

Once the subsystem has been turned on, it is usually left in a standby condition (rather than shut down completely) if the drums are not to be used for a period of time such as a weekend. In the stand-by condition, the drums continue to rotate with the heads lifted out of the flying position and with power removed from the control unit. Leaving the drums on standby significantly reduces the amount of warm-up time required when the drums are again to be used.

> **NOTE:** If a complete shutdown of the subsystem is necessary, the turn-off procedure described in 4.3.3 should be followed.

To place the drums on stand-by, the recommended procedure is as follows:

(1)   Perform the following procedure for each drum:

    (a)   Set the LIFT HEADS switch to the MANUAL position. This causes the heads to be lifted and the HEADS UP indicator to light. The DC ON indicator should go out after approximately 15 seconds.

    (b)   Set the POWER SUPPLY switch to the OFF position.

(2)   On the Control Unit Operator's Panel, press and hold the OFF SWITCH until it lights red. This removes power from the control unit.

To restore the subsystem to operational status after being on standby the procedure is as follows:

(1)   On the larger (leftmost) of the two maintenance panels inside the back doors of the control unit:

    (a)   Press and hold the green POWER ON pushbutton for about 15 seconds. Several indicators on the maintenance panel will light.

    (b)   Press the DRUM WRITERS switch at the bottom of the panel down to the ON position, and hold it down until the DRUM WRITERS indicator, above and to the right of the switch, goes off. The switch is spring-loaded and will return to the center position when released.

(2)   On each drum in the subsystem, perform the following operations:

    (a)   Set the POWER SUPPLY switch to the NORMAL position.

    (b)   Set the LIFT HEADS switch to the AUTOMATIC position. The HEADS UP indicator should go off, and the DC ON indicator should light after about 15 seconds.

(3)   Allow from 30 to 45 minutes of warm-up time to elapse before proceeding.

## 4.3.3.   Turn-Off Procedure

If it is necessary to shut down the subsystem completely, the following procedure should be employed:

(1)   On each drum unit, set the following switches to the indicated setting in the order specified:

| SWITCH | SETTING |
|---|---|
| LIFT HEADS | MANUAL |
| POWER SUPPLY | OFF |
| DRUM START | OFF |
| MAIN POWER REGULATED | OFF |
| MAIN POWER UNREGULATED | OFF |

(2) On the Control Unit Operator's Panel:

   (a) Press and hold the DRUMS OFF switch until the DRUMS ON indicator goes off.

   (b) Press and hold the OFF SWITCH until it lights red.

(3) Open all circuit breakers on the external power supply panel.

## 4.4. ERROR CONDITIONS AND CORRECTIONS

When an error or abnormal condition is detected in the subsystem, a status word is generated and made available to the processor, and the External Interrupt signal is turned on. The status codes related to these conditions are described in 3.2.5.

In an operating environment, error conditions requiring the intervention of the operator are normally signaled by an error message on the console. The precise nature of error messages and the permitted responses to each are functions of the software being employed. The appropriate publication on system software should be consulted for information on this subject.

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UNIVAC 418-III
FH-880 MAGNETIC DRUM SUBSYSTEM

Appendix A
SECTION:

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# APPENDIX A. SUMMARY OF PHYSICAL CHARACTERISTICS AND OPERATIONAL REQUIREMENTS

| VARIABLE | OPTIMUM CONDITION | ALLOWABLE RANGE | |
| --- | --- | --- | --- |
| | | MINIMUM | MAXIMUM |
| AMBIENT TEMPERATURE | 65°F | 60°F | 80°F |
| RELATIVE HUMIDITY | 50% | 40% | 70% |

*Table A-1. Environmental Operating Requirements*

| CABLE CONNECTION | MAXIMUM CABLE LENGTH |
| --- | --- |
| I/O MODULE TO CONTROL UNIT | 200 feet |
| CONTROL UNIT TO DRUM UNIT | 60 feet |

*Table A-2. Cabling Requirements*

| CABINET | HEIGHT (in.) | WIDTH (in.) | DEPTH (in.) | WEIGHT (lbs.) |
| --- | --- | --- | --- | --- |
| CONTROL UNIT | 63 3/8* | 36 | 36 | 880 |
| DRUM UNIT | 63 3/8* | 66 | 36 | 2100 |

* Height given is frame height. Jackpads provide additional 2 inches of adjustment.

*Table A-3. Subsystem Component Dimensions and Weights*

| CABINET | HEAT DISSIPATION (BTU/hr) | COOLING REQUIREMENT (cfm) | PRIMARY POWER INPUT |
| --- | --- | --- | --- |
| CONTROL UNIT | 3000 | 390 | regulated 208 VAC±1%, 3-phase, 4-wire, 50-400 cps |
| DRUM UNIT | 3600 | 300 | unregulated 208 VAC±10% 3-phase, 4-wire, 60 cps |

*Table A-4. Heat, Cooling, and Electrical Characteristics*
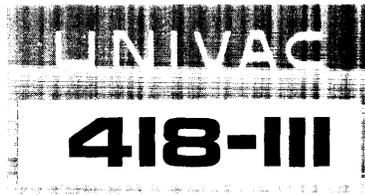
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*UNIVAC 418-III Real-Time System Library Memo 6 announces the release and availability of "UNIVAC 418-III Real-Time System FH-880 Magnetic Drum Subsystem Programmer/Operator Reference Manual," UP-7666, covers and 39 pages. This is a Standard Library Item (SLI).*

UP-7666 describes the UNIVAC FH-880 Magnetic Drum Subsystem. This subsystem provides the UNIVAC 418-III Real-Time System with a large capacity, word-addressable, random access storage medium.

This manual is one of a series describing peripheral subsystems used with the UNIVAC 418-III Real-Time System. It explains machine language programming and operating procedures of the FH-880 Magnetic Drum Subsystem.

It is assumed that both the programmer and the operator are already competent on a system level and need to be instructed only regarding the subsystem.

Major headings of the Table of Contents are:

   1.  INTRODUCTION
   2.  SUBSYSTEM DESCRIPTION
   3.  PROGRAMMING
   4.  OPERATION

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