UNIVAC

DATA PROCESSING DIVISION

494

REAL-TIME SYSTEM

FH-432 MAGNETIC DRUM SUBSYSTEM

PROGRAMMER/OPERATOR REFERENCE MANUAL

UP-4102

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1. INTRODUCTION

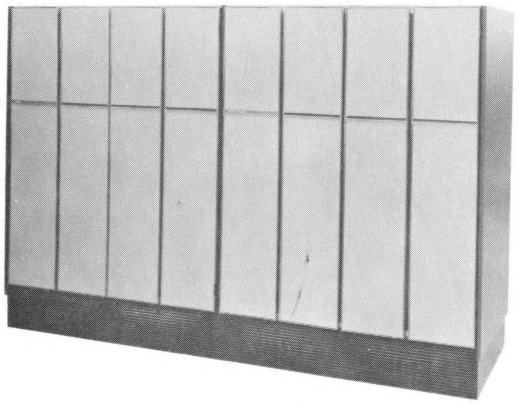


Figure 1–1. FH–432 Magnetic Drum Subsystem

This manual contains information for the programming and operation of the FH-432 Magnetic Drum Subsystem (Figure 1–1) for the UNIVAC 494 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 subsystem.

It is assumed that both the programmer and the operator are already capable on the system level and need only to be instructed in the use of the subsystem. Therefore, material already covered in system manuals will not be duplicated here.

This manual is divided into three basic sections:

- Subsystem Description

  This section will acquaint the reader with the characteristics of the FH-432 Magnetic Drum Subsystem.

- Programming

  This section supplies the user with the information required for programming the subsystem.

- Operation

  This section contains the information necessary for the operation of the subsystem.

2. SUBSYSTEM DESCRIPTION

2.1. GENERAL

The FH-432 Magnetic Drum Subsystem provides the UNIVAC 494 Real-Time System with a high-speed, large-capacity, word-addressable, random-access storage medium. The subsystem consists of one Type 6013 Control Unit and from three to nine Type F0696 FH-432 drums, each drum capable of storing 262,144 computer words of 30 data bits plus parity, or 1,310,720 alphanumeric characters per drum. The average access time for any word in the subsystem is 4.33 milliseconds. Performance characteristics are summarized in Table 2-1.

PARAMETER	SPECIFICATION		
STORAGE CAPACITY	PER DRUM	MINIMUM CONFIGURATION (3 DRUMS)	MAXIMUM CONFIGURATION (9 DRUMS)
WORDS	262,144	786,432	2,359,296
CHARACTERS	1,310,720	3,932,160	11,796,480
ACCESS TIME			
MINIMUM	120 microseconds		
AVERAGE	4.33 milliseconds		
MAXIMUM	8.55 milliseconds		
DRUM SPEED	7120 rpm		
NUMBER OF READ/WRITE DATA HEADS	432 (one per track)		
WORD TRANSFER RATE	240,000 words per second (maximum)		
CHARACTER TRANSFER RATE	1,200,000 characters per second (maximum)		
I/O CHANNELS REQUIRED	1 channel		
NUMBER OF DRUMS PER SUBSYSTEM	Minimum 3 Maximum 9		

Table 2-1. Performance Characteristics

Of the 432 tracks on each drum, 384 are used for storing data; the remaining tracks are used for spares and for timing purposes. Data and parity bits are recorded on 128 three-track bands, each band having a capacity of 2048 words. The functions of reading and writing occur in three-bit-parallel mode on all three tracks of a band simultaneously, at a maximum transfer rate of 240,000 words or 1,200,000 characters per second.

In order to operate efficiently at the maximum transfer rate, the FH-432 Drum Subsystem must be connected to Channel 15, the highest priority channel, on the 494 Central Processor. If the subsystem is connected to a lower-priority channel, it is normally operated at a slower transfer rate by changing the interlace which governs recording sequence on the drums. Section 3.3 contains further information on this subject.

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-432 Drum Subsystem provides the ability to search off-line 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 terminated.

The accuracy of data recording is verified by odd parity checking. When data is recorded on the drum, three parity bits per word are generated by the control unit and stored with the word. When data is read from the drum, parity is checked automatically. Should a parity error occur, an External Interrupt is generated, and the processor is notified of the address of the word in which the error was detected.

2.2. CONFIGURATIONS

The basic configuration of the FH-432 Drum Subsystem consists of one control unit and three FH-432 drums. These elements are housed in two cabinets as follows:

- Drum Control Cabinet containing the control unit and one drum
- Drum Satellite Cabinet containing two drums

A block diagram of this basic configuration is shown in Figure 2–1.

The storage capacity of the subsystem can be expanded by the optional addition of from one to six more drums, housed in additional Drum Satellite Cabinets (maximum of two drums per cabinet). Component requirements for the FH-432 Drum Subsystem are summarized in Table 2–2.

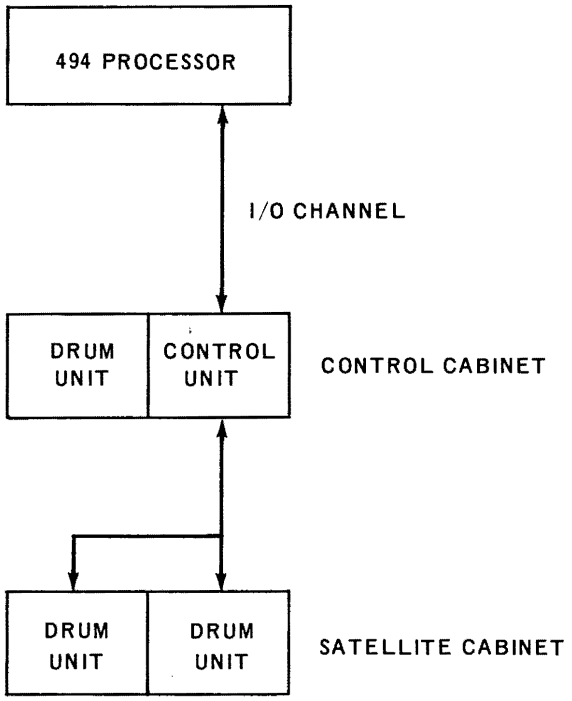


Figure 2–1. Block Diagram of Minimum Configuration FH-432 Subsystem

SUBSYSTEM COMPONENT	TYPE NUMBER FOR 60 CYCLE POWER	TYPE NUMBER FOR 50 CYCLE POWER	NUMBER REQUIRED	NUMBER PERMITTED
FH-432 Drum Control Cabinet containing control unit and one FH-432 drum unit	6013-02	6013-03	1	1
FH-432 Drum Unit	F0696-00	F0696-01	3*	9*

* Number includes the one drum unit contained in the Control Cabinet.

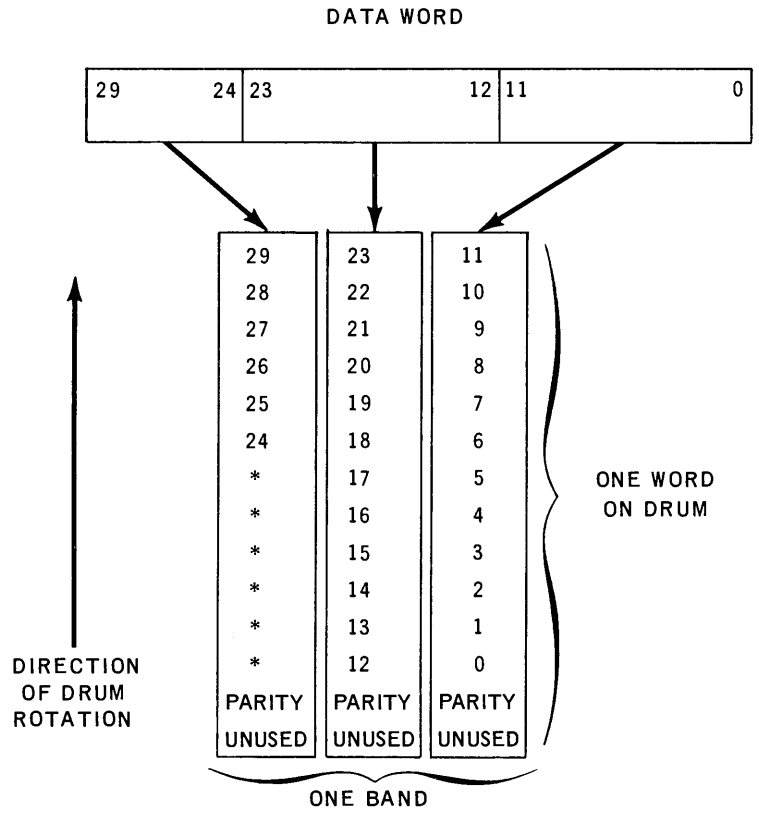
Table 2–2. FH-432 Subsystem Components

2.3. SUBSYSTEM COMPONENTS

2.3.1. FH-432 Drum Unit

The FH-432 drum is a magnetic-coated cylinder containing 432 recording tracks, each equipped with a read/write head. Of the 432 tracks, 384 are active data tracks and the remainder are timing tracks and spares. The 384 data tracks are organized into 128 bands of three tracks each, with each band having a capacity of 2048 computer words.

When a word is written on the drum, three bits are recorded in parallel on the three tracks of a band. Although a data word consists of 30 bits, it occupies 36 bit positions on the drum, 12 on each of the three tracks of a band. Bits 0 through 11 are recorded on the first track, bits 12 through 23 on the second track, and bits 24 through 29 on the third track. The six remaining bit positions on the third track always contain 1-bits. Following the 12 bits recorded in each track is a parity bit, calculated by the control circuitry, and one unused bit position between words which provides a margin for slight word placement shifts because of temperature variation, etc. When a word is read from the drum, data bits are read in parallel from the three tracks of a band, parity is checked, and the three parts are assembled into a 30-bit data word for transmission to the processor. Figure 2–2 illustrates the recording format of one word on three tracks of a band.



* 1-bits are always padded in when recording in these bit positions.

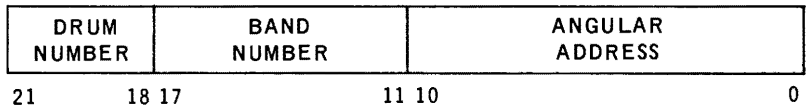
Figure 2–2. Recording Format of One Word

Each word within the FH-432 Drum Subsystem is individually addressable. A complete drum address consists of three parts:

- Drum number (0-8) within the subsystem
- Band number (0-127) on the specified drum
- Angular address (0-2047) – the number of the word on the specified band.

The first two portions of the address cause the proper drum and heads to be selected by the control circuitry. The last portion, the angular address (AA), is compared with the contents of two of the timing tracks which indicate the present rotational angle of the drum; that is, which word within the band is currently at the read/write head. When the angular address read from the AA timing tracks exactly matches that specified in the function word, the requested operation is started.

Drum addresses are internally represented by a combination of 22 bits in the following format:



This address occupies the 22 low-order bit positions of the function word which initiates drum operations. The actual bit patterns of drum addresses are given here for the convenience of the user although they normally are 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 drum number in a 9-drum subsystem is:

$$8_{10} = 10_8 = 1\ 000_2$$

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

BIT POSITION	21 18	17 11	10 0
ADDRESS PORTION	DRUM	BAND	ANGULAR ADDRESS
BINARY	1 0 0 0	1 1 1 1 1 1 1	1 1 1 1 1 1 1 1 1 1 1
OCTAL	1 0	7 7	7 7 7 7

The range of addresses in octal for each drum of a subsystem is given in Table 2–3.

DRUM UNIT NUMBER$_{10}$	BEGINNING ADDRESS$_8$	ENDING ADDRESS$_8$
0	00 000 000	00 777 777
1	01 000 000	01 777 777
2	02 000 000	02 777 777
3	03 000 000	03 777 777
4	04 000 000	04 777 777
5	05 000 000	05 777 777
6	06 000 000	06 777 777
7	07 000 000	07 777 777
8	10 000 000	10 777 777

Table 2–3. Range of Drum Addresses

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 and from drum to drum. Following AA-2047 of Band 51, for example, the next address to be accessed in sequence is AA-0 of Band 52. (To insure sufficient time 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, a non-addressable dead space equal to 48 words in length occurs between AA-2047 and AA-0 on the drum.) Similarly, following access of AA-2047 on Band 127 of Drum 1, the next address in sequence is AA-0 on Band 0 of Drum 2.

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 unit governs all the operations of the FH-432 Drum Subsystem. Its principal functions are:

- to receive function words from the processor and translate them into control signals for the drums
- to control the orderly addressing of drum locations
- to assemble and disassemble data and control words for acceptance by the processor and the drums
- to synchronize the flow of data between the processor and the drums
- to interpret signals, both normal and abnormal, from the drums and to notify the processor of drum conditions.

3. PROGRAMMING

3.1. SUBSYSTEM/PROCESSOR INTERFACE

Communication between the processor and the FH-432 Drum Subsystem is accomplished by means of the usual I/O Channel cabling, which consists of an input cable and an output cable, each containing 30 data lines and the various control 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 processor to the control unit which decodes the function word and establishes the proper control circuits for the requested operation. Once the operation has begun, the subsystem operates off-line from the processor except for the actual transfer of data words.

Data transfer operations of the FH-432 Drum Subsystem, like those of other peripheral subsystems, require that the processor respond to an Input Data Request signal with an Input Acknowledge signal and 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 processor may fail to respond to a request signal within the subsystem-imposed time limit 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 over 8.43 milliseconds) is required to access the next word in the sequence. In either case, once a data transfer operation (or 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 signal.

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 conditions which cause External Interrupts include parity errors, End of File (attempting to go beyond the highest 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 processor in the absence of an error or abnormal condition.

3.2. WORD FORMAT

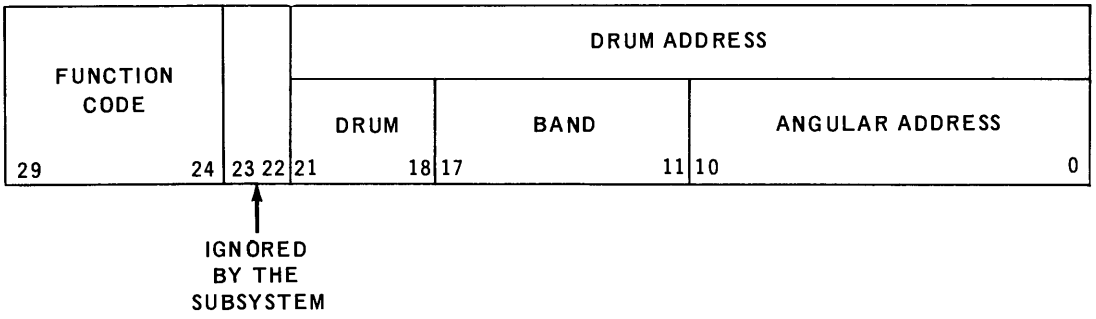
The FH-432 Drum Subsystem accommodates six types of computer input/output words. The various types of words are:

- 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 processor. 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 types of 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 22 low-order bits specify the drum address at which the operation is to begin. The format of the function word is as follows:



The function repertoire of the FH-432 Drum Subsystem consists of the eleven 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 processor and to record them in consecutive drum locations beginning at the address specified in the function word and continuing until concluded by one of the following:

Terminate function

End of File

Illegal Address error

Fault condition

Illegal Address and Fault are both error conditions; End of File is treated as an error condition. If any of these conditions occurs the writing operation is stopped, and an External Interrupt signal is generated. After the External Interrupt signal is acknowledged by the processor, the subsystem is free to accept a new function.

In the absence of detection of an error condition, the writing operation continues until the output buffer has been exhausted. At this point, the subsystem is still conditioned for writing, so that the buffer may be extended if desired. After all required data words have been transferred, a Terminate With Interrupt function should be sent to the subsystem so that the processor will be informed when the writing operation has been successfully 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 the receipt of a Write function word. After the first data word is received, the nominal transfer rate can be achieved only if the processor responds to each Output Data Request signal by sending another data word to the subsystem within the timing limitations specified in Section 3.3. Whenever the processor 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 Band 0 of Drum 0 (called the bootstrap area) by setting the Write Lockout switch on the control unit. If an attempt is made to write in the bootstrap area when the Write Lockout switch is on, the function is not performed, and a status word containing an Illegal Address status code is generated along with an External Interrupt signal.

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 transfer to the processor, beginning at the drum address specified in the function word and continuing until concluded by one of the following:

Terminate function

End of File

Parity error

Illegal Address error

Fault condition

As in the case of the Write function, the Continuous Read function must be concluded by a Terminate function unless a condition occurs which causes an External Interrupt. 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 processor. The buffer area may of course be extended if more words are required than are provided for in the original buffer area.

If a parity error is detected during a Continuous Read operation, the processor is notified of the error by an External Interrupt and a status code of 64, after all preceding words have been accepted by the processor. After the interrupt is acknowledged, the error word, which has been held in the control unit, is presented to the processor with an Input Data Request signal, asking the processor to accept the error word as if it were a normal data word. When the processor acknowledges receipt of the error word, the subsystem is cleared and is ready to receive another function. If the processor does not accept the error word, the subsystem must receive a Terminate function (either form) before it can properly accept and act on any other function word.

The Continuous Read operation 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 Continuous Read 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 processor.

After the first data word has been transferred in a reading operation, the processor must respond to each successive Input Data Request signal within the timing limitations specified in Section 3.3, in order to maintain the nominal transfer rate of the equipment. If the processor fails to respond in time, the input data word and the next two data words 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 transfer, 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 processor as the last word to enter the input buffer. When the processor 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 24 low-order bits of the overflow word for presentation to the processor along with an External Interrupt signal. The Block Read function may be concluded by one of the following:

End of Block

Terminate function

End of File

Parity error

Illegal Address error

Fault condition

If the input buffer is filled before an End of Block word is detected, data transfer ceases, but the subsystem is still in an active condition. 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.

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 compare 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 identical comparison is achieved between a word on the drum and the identifier word, the control unit changes from a searching operation to a reading operation, and input data transfer is performed, starting with the word that matches the identifier word. When the input buffer has been filled, data transfer ceases, but the subsystem is still in an active condition. At this point, the buffer may be extended if additional words are to be read; otherwise a Terminate function (either form) must be sent to the subsystem to clear the subsystem 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 searching operation continues until End of File is reached unless previously concluded by a Terminate function or the occurrence of an error. The Search Read function may be concluded by one of the following:

Terminate function

End of File

Parity error

Illegal Address error

Fault condition

It should be noted that the control unit, after receiving a Search Read function word, 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 searching operation. In such a case, a second Terminate function word would be required to clear the subsystem.

The conditions stated in the preceding paragraph are true of all Search functions (Search, Search Read, Block Search, Block Search Read). It is therefore preferable, when the Function mode is established by the processor for any Search function, to use a Buffer Control Word with a word-count of two: 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 with the drum address specified in the function word, and compare 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 generates an External Interrupt signal and assembles a status word containing the End of Block (04) status code and the 24 low-order bits of the overflow word.

- A condition is detected which causes an External Interrupt. Possible conditions are End of File, parity error, Illegal Address error, and Fault condition.

- Identical comparison is achieved between a word read from the drum and 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 Section 3.2.1.3, apply equally to a Block Search Read after a find has been made.

If the identifier word for 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 24 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 Section 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 Search function word, and compare 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 the identifier word and a word on the drum. When this condition occurs, an External Interrupt is generated, and the control unit assembles a status word containing the Search Find (05) status code and the address of the found word. The Search function may be concluded by one of the following:

Search Find

Terminate function

End of File

Parity error

Illegal Address error

Fault 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 Section 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 Block Search function word, and compare 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 identical comparison is achieved between the identifier word and a word on the drum before an End of Block word is detected, the control unit generates an External Interrupt signal and assembles a status word containing the Search Find (05) status code and the address of the found word. If an End of Block word is detected before a find is made, the control unit generates an External Interrupt signal and assembles a status word containing the End of Block (04) status code and the 24 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 assembled will contain the 05 rather than the 04 status code, and the low-order bit positions of the status word will contain the address of the End of Block word rather than the 24 low-order bits of the overflow word. The Block Search function may be concluded by one of the following:

Search Find

End of Block

Terminate function

End of File

Parity error

Illegal Address error

Fault 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 Section 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 (identical with function code 42) starting with AA-0 of Band 0 on Drum 0. The address portion of a Bootstrap Without Interrupt function word is ignored by the subsystem. All methods of termination which apply to the Continuous Read function apply to the Bootstrap Without Interrupt function as well.

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 programmed before the Bootstrap function. 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 (identical with function code 52) starting with AA-0 of Band 0 on Drum 0. The address portion of a Bootstrap with Interrupt function word is ignored by the subsystem. All methods of termination which apply to the Block Read function apply to the Bootstrap With Interrupt function as well.

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 upon receipt of the Terminate function by the control unit; output operations continue until all of the data words previously received by the subsystem have been written on the drum before the termination becomes effective.

All input and output functions that are not concluded by an External Interrupt must be concluded by a Terminate function, either With or Without Interrupt, in order to free the subsystem to perform another function. Therefore, in the absence of an error causing an External Interrupt, a Terminate function must be sent to the subsystem following completion of the functions of Write, Bootstrap Without Interrupt, Continuous Read, and Search Read, since none of these functions normally result in an External Interrupt. On the other hand, the Block functions which involve input data transfer (Block Read, Bootstrap With Interrupt, and Block Search Read) may or may not require a Terminate function. If the function is concluded by an End of Block interrupt, the subsystem is cleared following acknowledgment of the interrupt. However, if the input buffer is filled before End of Block is detected, a Terminate function is necessary to clear the subsystem unless the buffer is to be extended.

The Terminate Without Interrupt function is commonly used to conclude all operations except writing operations. The Terminate With Interrupt function should be used to conclude a Write operation.

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; output operations continue until all of the data words previously received by the subsystem have been written on the drum 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 status code of 40, Normal Completion.

The Terminate With Interrupt is required for the purpose of concluding a Write operation, so that the processor is informed when the Write function has been completed. As noted previously, the termination of a Write function becomes effective only after all data words received by the subsystem have been written on the drum. It is therefore possible for an error condition to occur between the time the Terminate With Interrupt function is received by the control unit and the time the Write function is effectively concluded. If such an error occurs, the status code in the status word accompanying the External Interrupt is governed by the nature of the error. A Fault or Illegal Address condition occurring during this interval will take precedence over Normal Completion and present to the processor a status word containing the Fault (14) or Illegal Address (54) status code. On the other hand, Normal Completion will take precedence over End of File, and the status word presented to the processor will contain the Normal Completion (40) status code.

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 remains inactive until the identifier word is received. The subsystem 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 30-bit computer word containing all binary 1's, 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 End of Block has occurred. The External Interrupt following reading of an End of Block word in the highest address in the subsystem will be accompanied by a status word containing the End of File (34) status code rather than End of Block (04) because of failure to read an overflow word.

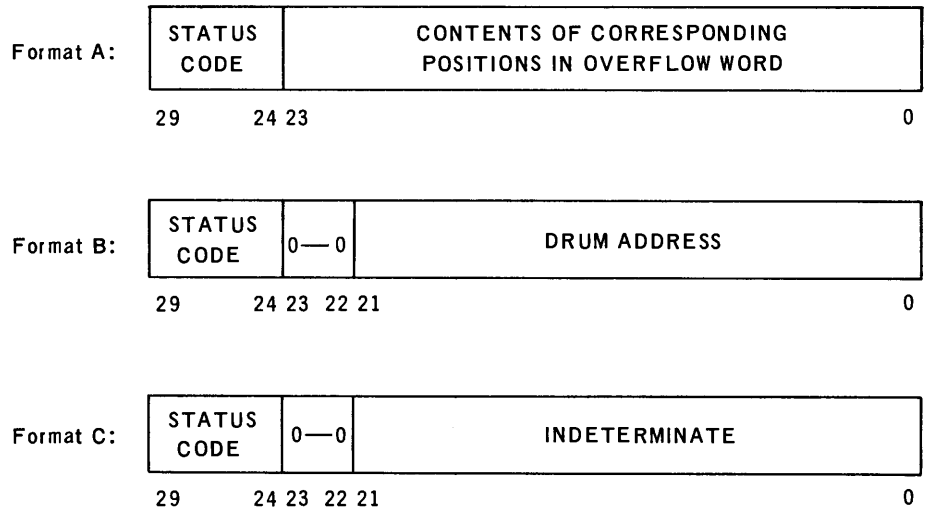
3.2.4. Overflow Word

The overflow word is the designation given to whatever word is recorded in the address immediately following an End of Block word. The 24 low-order bits of the overflow word are presented to the processor as part of the status word, along with a status code of 04, at the normal conclusion of all Block functions except when a Search Find occurs in a Block Search operation. The 22 low-order bits of the overflow word may be programmed to indicate the starting address of the next portion of a non-consecutive file.

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 processor over the 30 input data lines, accompanied by a signal on the External Interrupt line to inform the processor that a status word rather than a data word is on the lines.

The status code always occupies the six most-significant bit positions of the status word; the remainder of the status word may or may not contain significant information. The status word may take one of three possible formats depending upon the nature of the condition being indicated. The three formats of the status word are as follows:



The FH-432 Drum Subsystem can generate any of the ten status codes listed in Table 3–2.

STATUS WORD	STATUS CODE	
	OCTAL	BINARY
End of Block	04	000 100
Search Find	05	000 101
Overflow Parity Error	06	000 110
Non-Continuous Read Parity Error	07	000 111
Fault	14	001 100
End of File	34	011 100
Normal Completion	40	100 000
Illegal Function	50	101 000
Illegal Address	54	101 100
Continuous Read Parity Error	64	110 100

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 indications logically suggest that one or more attempts be made to re-read 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, so the use made of this information depends entirely on the nature of the program.

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 in the subsystem repertoire.

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

During execution of a Bootstrap with Interrupt or Block Read function or during execution of a Block Search Read function for which a find has been made, the End of Block word is made available to and accepted by the processor provided the input buffer is sufficiently large. However, no more data words are made available to the processor after the End of Block word. If the processor acknowledges receipt of the End of Block word in the above case, or if a find is not made for a Block Search or Block Search Read Function before the overflow word is read, the control unit assembles a status word consisting of the status code 04 and the 24 low-order bits of the overflow word, makes the status word available to the processor and turns on the External Interrupt signal.

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 one of the Block functions, an End of File rather than End of Block status word will be generated.

3.2.5.2. Search Find

Status Code: 05 Status Word Format: B

The Search Find status code indicates to the processor that during a Search (45) or Block Search (55) function, a word has been found on the drum which is identical to the identifier word. The 22 low-order bits of the status word contain the drum address of the found word.

3.2.5.3. Overflow Parity Error

Status Code: 06 Status Word Format: B

The Overflow Parity Error status code informs the processor that a parity error was detected by the control unit during reading of the overflow word at the conclusion of a Block function. The 22 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. Non-Continuous Read Parity Error

Status Code: 07 Status Word Format: B

The Non-Continuous Read Parity Error status code indicates to the processor that a parity error was detected by the control unit during an input function other than Continuous Read or Bootstrap Without Interrupt; that is, during a Search, Search Read, or any of the Block functions, including Bootstrap With Interrupt. The 22 low-order bits of the status word contain the drum address of the word in which the parity error was detected.

When a Non-Continuous Read Parity Error occurs, the External Interrupt signal is turned on only after the processor has accepted all parity-correct data words read before the error was detected. The error word itself is not made available to the processor.

3.2.5.5. Fault

Status Code: 14 Status Word Format: C

The Fault status code informs the processor that a hardware malfunction has occured in the subsystem. Conditions which can cause a Fault indication are:

- More than one read/write head has been selected
- Power to the drum units has been dropped.

The contents of the 22 low-order bits of the status word are indeterminate and should be ignored.

3.2.5.6. 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 (54) status code rather than End of File.

The contents of the 22 low-order bits of the status word are indeterminate and should be ignored.

3.2.5.7. 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 (33) function and indicates to the processor that the previous function was successfully concluded. The contents of the 22 low-order bits of the status word are indeterminate and should be ignored.

If an Illegal Address or Fault condition occurs in the interval between receipt of a Terminate With Interrupt function and the actual conclusion of a Write operation, the error condition takes precedence over Normal Completion. However, Normal Completion takes precedence over End of File, should it occur.

3.2.5.8. Illegal Function

Status Code: 50 Status Word Format: C

The Illegal Function status code informs the processor 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 presented to the processor immediately. The contents of the 22 low-order bits of the status word are indeterminate and should be ignored.

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

3.2.5.9. Illegal Address

Status Code: 54 Status Word Format: C

The Illegal Address status code informs the processor that either the drum address in the function word is invalid, or an apparent error has been detected in the Angular Address timing tracks by a checking circuit.

In the first case, an invalid address is defined as one that is beyond the limits of the subsystem configuration, or is on an inoperable drum, or is on Band 0 of Drum 0 for a Write function when the Write Lockout switch is on. If the function word specifies an invalid address, the function is not initiated, and the External Interrupt signal is presented to the processor immediately.

In the second case, the circuit that checks the validity of recording in the Angular Address timing tracks has detected noise or some condition other than normal. This type of Illegal Address error can occur while the subsystem is in the process of performing any input or output function.

			FUNCTION CODES											
		Status Word Format*	02 Write	23 Terminate	33 Terminate w/Interrupt	40 Bootstrap	42 Continuous Read	45 Search	46 Search Read	50 Bootstrap w/Interrupt	52 Block Read	55 Block Search	56 Block Search Read	Other (Illegal)
STATUS CODES	04 End of Block	A								■ 6	■ 6	■ 7	■ 6	
	05 Search Find	B						■ 4				■ 5		
	06 Overflow Parity Error	B								■ 3	■ 3	■ 3	■ 3	
	07 Non-Continuous Read Parity Error	B						■ 3	■ 3	■ 4	■ 4	■ 4	■ 4	
	14 Fault	C	■ 2		■ 2	■ 2	■ 2	■ 2	■ 2	■ 2	■ 2	■ 2	■ 2	
	34 End of File	C	■ 3			■ 4	■ 4	■ 5	■ 4	■ 5	■ 5	■ 6	■ 5	
	40 Normal Completion	C			■ 3									
	50 Illegal Function	C												■ 1
	54 Illegal Address	C	■ 1		■ 1	■ 1	■ 1	■ 1	■ 1	■ 1	■ 1	■ 1	■ 1	
	64 Continuous Read Parity Error	B				■ 3	■ 3							

■ Indicates possible response. The numeral indicates priority sequence of status codes. If conditions which could lead to generation of two or more status codes are detected during execution of a function, only the status code with the lowest "priority number" will be generated.

* Format A = Includes low-order 24 bits of overflow word
Format B = Includes drum address in low-order 22 bits
Format C = Low-order 22 bits are indeterminate.

Table 3–3. Possible Status Code Responses to Function Codes

In both cases, the contents of the 22 low-order bits of the status word are indeterminate and should be ignored.

3.2.5.10. Continuous Read Parity Error

Status Code: 64 Status Word Format: B

The Continuous Read Parity Error status code informs the processor that the control unit detected a parity error while performing either a Continuous Read (42) or Bootstrap Without Interrupt (40) function. (Parity errors detected while performing other input functions are indicated by a Non-Continuous Read Parity Error status code, described in Section 3.2.5.4.) The 22 low-order bits of the status word contain the drum address of the word in which the error was detected.

When a Continuous Read Parity Error occurs, the External Interrupt signal is turned on only after the processor has accepted all parity-correct data words read before the error was detected. The word containing the error is held in the control unit and is presented to the processor along with an Input Data Request signal as soon as the interrupt has been acknowledged. Data transfer stops after the error word is accepted by the processor, and the subsystem is cleared to receive a new function.

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 processor and the subsystem. The data word is a 30-bit computer word with no fixed format. No data words are transferred when either form of Terminate function, a Search (45) function, or a Block Search (55) function is sent to the subsystem.

3.3. TIMING

The basic element in timing of drum operations is the speed of the drum, The FH-432 drum revolves at a speed of 7120 rpm, giving a time of 8.43 milliseconds for one drum 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 consists of a "get-ready" time plus the time required to reach the angular address at which the function is to begin. The get-ready time for the FH-432 drum is 120 microseconds required for drum and head selection after the function word has been decoded. This 120 microsecond delay must elapse before address coincidence can occur; that is, before the control unit can detect that the address specified in the function word is at the read/write head. Therefore, the minimum access time of 120 microseconds will be achieved if the specified angular address reaches the read/write head immediately after the delay has run out. On the other hand, the maximum access time of 8.55 milliseconds (8.43 milliseconds for one full drum revolution plus .120 millisecond delay) will be required if the specified angular address passes the read/write head just before the delay runs out. The average access time for the first word is considered to be 4.33 milliseconds (4.21 milliseconds for one-half drum revolution plus .120 millisecond 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 4.02 microseconds, when the subsystem is operating at the maximum transfer rate of 240,000 words per second. The time of 4.02 microseconds is determined by dividing the time for one revolution, 8.43 milliseconds, by the number of word locations per band, 2096 locations (2048 data words plus 48-word dead space).

This rate of data transfer can be maintained only if the processor responds to each Input or Output Data Request within a required interval. A certain amount of buffering capacity is provided by a series of registers in the control unit, but there are critical time intervals which must be observed, on both a one-time and a cumulative basis, in order to maintain the rated speed of the subsystem. If the processor fails to respond to an Input or Output Data Request within the maximum one-time interval, or if the cumulative lag in response finally exceeds the buffering capacity of the subsystem, an extra drum revolution will be required because the desired sequential angular address will have passed the read/write head by the time the appropriate control unit register can accept another word from the drum. The critical intervals vary according to whether an output or an input function is being performed.

For an output function, the response interval is defined as the time interval between the arrival of an Output Data Request signal at the processor end of the I/O cable and the initiation of an Output Acknowledge at the same end of the cable. The critical output response time is 2.5 microseconds; that is, if the processor responds to each Output Data Request with an Output Acknowledge within 2.5 microseconds, data transfer will proceed at rated speed. The maximum output response time is 6.0 microseconds as a one-time excess. A cumulative lag in response of up to 3.5 microseconds can be tolerated without loss of a drum revolution.

For an input function, the response interval is defined as the time interval between the arrival of an Input Data Request signal at the processor end of the I/O cable and the initiation of an Input Acknowledge at the same end of the cable. The critical input response time is 3.1 microseconds; that is, if the processor responds to each Input Data Request with an Input Acknowledge within 3.1 microseconds, data transfer will proceed at rated speed. The maximum input response time is 6.2 microseconds as a one-time excess. A cumulative lag in response of up to 3.1 microseconds can be tolerated without loss of a drum revolution.

The response times stated above are based on the maximum transfer rate of 240,000 words per second. It is also possible to operate the FH-432 Drum Subsystem at any of several slower transfer rates. The slower rates are all submultiples of the maximum and are implemented merely by changing the locations of several circuit cards in the control unit which govern the interlace (the physical sequence of recording words on the drums). The maximum transfer rate of 240,000 words per second is called Interlace 1 and consists of recording each consecutively numbered word in consecutive locations on each band. When the slower transfer rates are employed, the sequence of recording words on a band is non-consecutive, thereby providing longer intervals between the accessing of successive words and increasing the available response time. For example, if Interlace 2 is used, consecutively numbered words are recorded in every second location around the drum. Thus, two drum revolutions are required to access all words in a band, and the maximum transfer rate for Interlace 2 is therefore 120,000 words per second. The various interlaces, and the transfer rates and response times associated with each, are given in Table 3–4.

INTERLACE	TRANSFER RATE (words/sec)	AVERAGE TIME BETWEEN WORDS (us)	*OUTPUT PERMITTED RESPONSE TIME (us)		**INPUT PERMITTED RESPONSE TIME (us)	
			ONE TIME MAXIMUM	SAFE AVERAGE MAXIMUM	ONE TIME MAXIMUM	SAFE AVERAGE MAXIMUM
1	240,000	4.1	6.0	2.5	6.2	3.1
2	120,000	8.2	14.2	6.6	14.4	7.2
4	60,000	16.4	30.6	14.8	30.8	15.4
8	30,000	32.8	63.4	31.2	63.6	31.8
16	15,000	65.6	129.0	64.0	129.2	64.6

* Output Response Time = The time interval between the arrival of an ODR at the processor end of a 50 foot cable and the initiation of an OA at the processor end of the cable.

** Input Response Time = The time interval between the arrival of an IDR at the processor end of a 50 foot cable and the initiation of an IA at the processor end of the cable.

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

When the FH-432 Drum Subsystem is connected to Channel 15 on the 494 Central Processor, Interlace 1 is commonly used. However, if the subsystem is connected to a lower-priority channel, priority conflicts may reduce the available response time of the processor. With such a configuration, it is preferable from the standpoint of total system efficiency to operate at an interlace of 2 rather than periodically to miss a drum revolution at an interlace of 1. If the subsystem is connected to a Compatible I/O Channel of the 494 Central Processor, operating with an interlace of 4 (or greater) is recommended.

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-432 subsystem and for responding to inquiries and instructions via the 494 system console.

4.2. CONTROLS AND INDICATORS

4.2.1. FH-432 Drum Unit

Each FH-432 drum in a subsystem includes a Drum Power Distribution Panel, shown in Figure 4–1, which gives the operator a visual display of drum conditions. It also allows him to exercise control over the AC and DC power distribution to the drum. This panel is located on the front of each drum unit at the top of the cabinet. A description of panel components is given in Table 4–1.

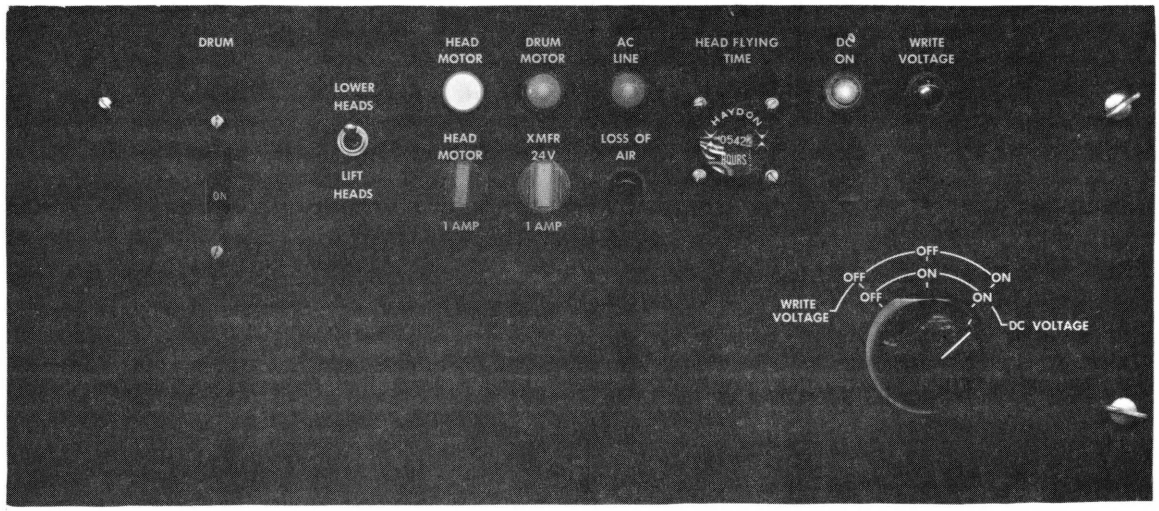


Figure 4–1. Drum Power Distribution Panel

4.2.2. Control Unit

The control unit contains three panels which permit the operator and/or the UNIVAC Field Engineer to exercise off-line and limited on-line control of the subsystem. Of these three, the most significant to the operator is the Control Cabinet Power Distribution Panel. The other two are the Maintenance Panel and the DC Power Supply Panel.

NAME OF COMPONENT	TYPE	DESCRIPTION
DRUM	Thermal circuit breaker switch	Allows the operator to apply AC power to the drum drive motor. In the event the circuit breaker trips, the operator must push this switch toward the OFF position as far as it will go to reset the circuit breaker before turning it ON again.
LOWER HEADS/ LIFT HEADS	Toggle switch	Controls the positioning of the read/write heads. In normal operation, this switch is left in the LOWER HEADS position. When placed in the LIFT HEADS position, AC power is removed from the head motor and the heads remain up.
HEAD MOTOR	Light	Light on indicates AC power has been applied to the head motor.
DRUM MOTOR	Light	Light on indicates AC power has been applied to the drum drive motor. (DRUM switch has been closed).
AC LINE	Light	Light on indicates AC power has been applied to the drum unit.
DC ON	Light	Light on indicates all DC voltages except Write voltage are on.
WRITE VOLTAGE	Light	Light on indicates that Write voltage is on.
WRITE VOLTAGE/ DC VOLTAGE	Rotary switch	A three-position switch which controls the Write voltage and DC voltages to the drum electronics, as follows: OFF-OFF position: Both Write voltage and DC voltages are off. OFF-ON position: Write voltage is off. DC voltages are on. ON-ON position: Both Write voltage and DC voltages are on.
HEAD MOTOR/ 1 AMP	Fuse	Fuse for head motor.
XMFR 24V/ 1 AMP	Fuse	Fuse for transformer which powers the head motor and time delay relays.
LOSS OF AIR	Light	Light on indicates a loss of air flow over the drum or incorrect blower rotation.
HEAD FLYING TIME	Meter	A running-time meter indicating the number of hours the heads are in the "flying" position.

Table 4–1. Drum Power Distribution Panel Indicators and Switches

4.2.2.1. Control Cabinet Power Distribution Panel

The Control Cabinet Power Distribution Panel, shown in Figure 4–2, gives the operator a means of turning on the DC power supplies, controlling the Write voltage to the drums, and observing certain physical conditions within the control cabinet. This panel is located on the upper right-hand side on the front of the control cabinet. A description of panel components is given in Table 4–2.

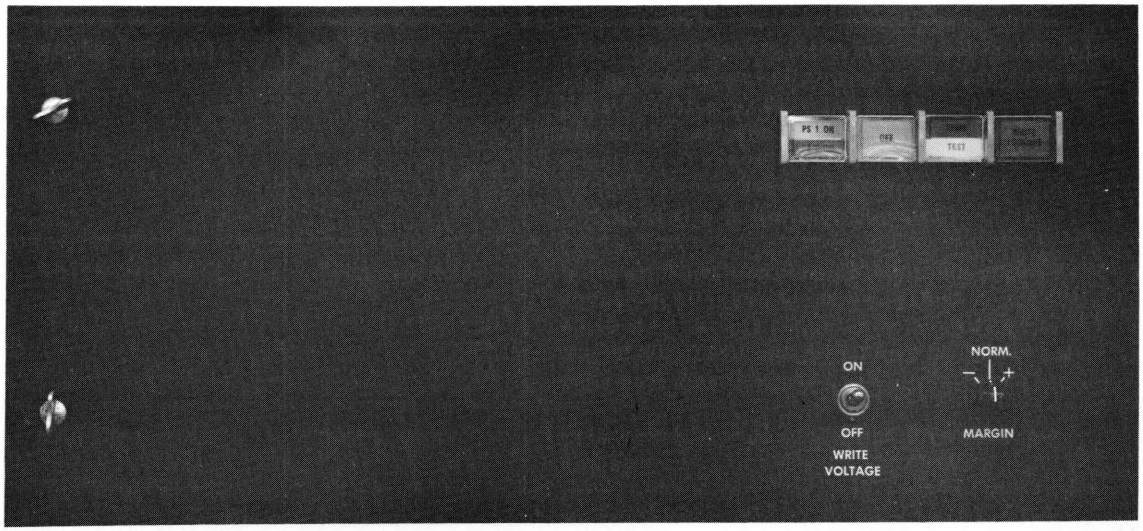


Figure 4–2. Control Cabinet Power Distribution Panel

NAME OF COMPONENT	TYPE	DESCRIPTION
PS 1 ON/PS 2 ON	Switch-indicator	Pressing this switch turns on subsystem power supplies. The upper section of the indicator, labeled PS 1 ON, is associated with the power supply for the control unit; the lower section, labeled PS 2 ON, associated with the power supply for the drums. When the light is on in either half of the indicator, the associated power supply is turned on.
OFF	Switch	Pressing this switch turns off both power supplies (PS 1 and PS 2).
TEMP/TEST	Indicator light	This is a dual indicator. The upper half, labeled TEMP, lights when the air temperature in the Control cabinet is above 95^{o}F or when a card deck blower fault is detected. The lower half, labeled TEST, lights when any of the six toggle switches on the left side of the Maintenance Panel is in the UP position. Both indicators should be off in normal operation.
WRITE LOCKOUT	Switch-indicator	This switch controls the Write Lockout feature which can be used to prevent writing in the Bootstrap area, Band 0 of Drum 0. Pressing this switch initially causes the indicator to light and Write Lockout to be effective. Pressing the switch a second time turns off the indicator and disables Write Lockout, permitting writing in the Bootstrap area.
WRITE VOLTAGE	Toggle switch	In the OFF position, this switch shuts off the Write voltage in all drums of the subsystem. In the ON position, it permits control of Write voltages by the WRITE VOLTAGE/DC VOLTAGE switch on each individual drum unit.
MARGIN	Rotary switch	This switch is used only by the UNIVAC Field Engineer.

Table 4–2. Control Cabinet Power Distribution Panel Indicators and Switches

4.2.2.2. Maintenance Panel

The Maintenance Panel, shown in Figure 4–3, is primarily of significance to the UNIVAC Field Engineer, permitting him to control and observe certain subsystem operations. This panel is located in the back of the control cabinet.

The group of six toggle switches at the left side of this panel may be of significance to the operator. During normal operation, all these switches should be ineffective (DOWN). If any of them is in the UP position, the TEST indicator on the Control Cabinet Power Distribution Panel is turned on, and the subsystem will not properly respond to function words sent by the processor.

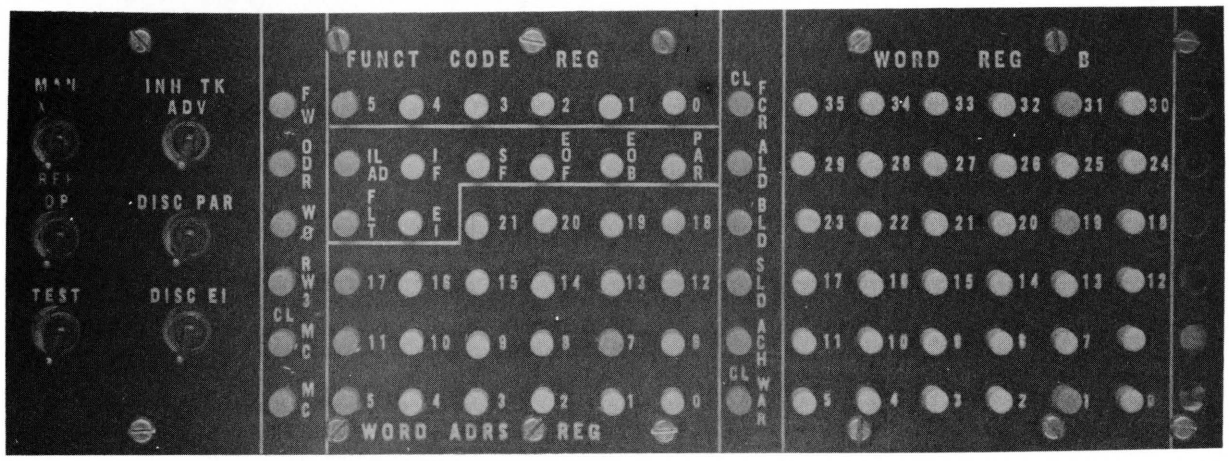


Figure 4–3. Maintenance Panel

4.2.2.3. DC Power Supply Panel

The DC Power Supply Panel, shown in Figure 4–4, is primarily of significance to the UNIVAC Field Engineer. Two of these panels are located in the back of the control cabinet, one above the other. The botton panel is associated with the control unit. The top panel is associated with the drums.

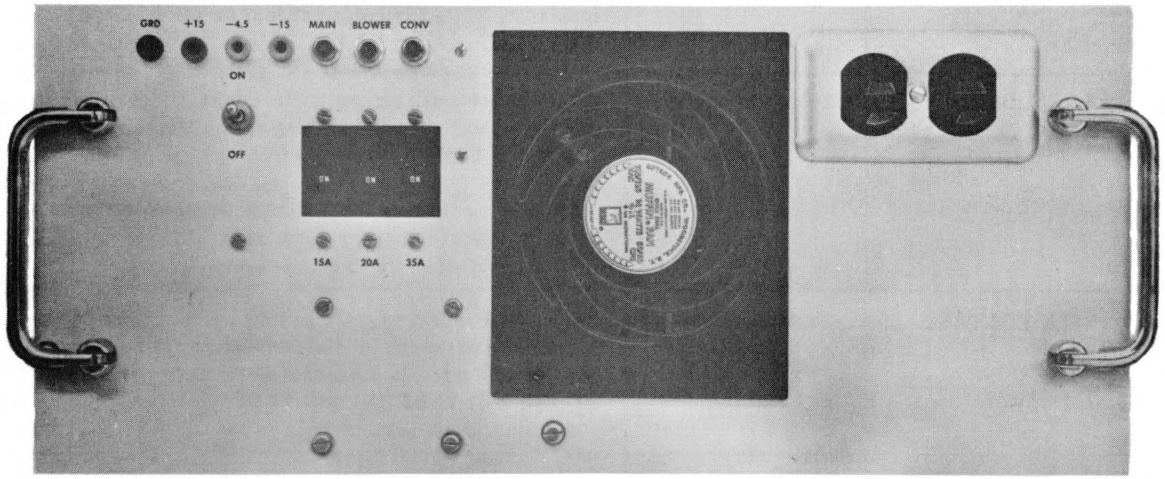


Figure 4–4. DC Power Supply Panel

The one switch on this panel likely to be of significance to the operator is a toggle switch labeled ON/OFF, located on the upper left side of the panel. This switch allows the operator to turn off the fault alarm buzzer (which sounds in the event of an over-temperature condition or loss of air to the drums) permitting operation to continue until the arrival of the UNIVAC Field Engineer. Should the temperature climb excessively during this time, the control unit will automatically shut down.

In addition, this panel contains circuit breakers for various control voltages, which do not normally concern the operator, and 115 vac convenience outlets for the field engineer.

4.3. SUBSYSTEM OPERATION

4.3.1. Turn-on Procedure

The procedure for turning on the subsystem from a complete stop involves supplying power to the subsystem, turning on the control unit, which supplies DC power to all drums, and then turning on each of the drums individually. The recommended procedure is as follows:

1. Close all circuit breakers on the external power supply panels.
2. Turn on the control unit according to the following procedure:
   a. Observe the TEMP indicator, which should be off, indicating that no over-temperature condition exists.
   b. Observe the TEST indicator, which should be off, indicating that the subsystem is not in Test mode. If the TEST indicator is on, check the six toggle switches on the left side of the Maintenance panel. All switches should be set to the DOWN position, and the TEST indicator should go off.
   c. Press and hold the PS 1 ON/PS 2 ON switch. The TEMP indicator and the alarm buzzer will be activated momentarily until the air flow switch is opened by the blower. The ON indicator for both power supplies should light and stay on when the switch is released.
   d. Check to see that the WRITE VOLTAGE switch is in the ON position. If it is not, set it to the ON position. The control unit is now ready.
3. Turn on each drum unit in turn, according to the following procedure.
   NOTE: An interval of at least one minute must be provided between turning on drum motors (step b. below) of successive drums in the subsystem to avoid circuit overloads.
   a. Observe the AC LINE light, which should be on, indicating that AC power has been supplied to the drum cabinet.
   b. Set the DRUM switch to the ON position. The DRUM MOTOR light will come on.
   c. Allow approximately two minutes for the drum to get up to speed before proceeding. A protective circuit containing a time-delay relay will prevent power from being applied to the head motor until drum motor power has been on for two minutes.

d. Set the LOWER HEADS/LIFT HEADS switch to the LOWER HEADS position. The HEAD MOTOR light will come on provided the delay mentioned in the preceding paragraph has elapsed.

e. Allow the required warm-up period to elapse before proceeding. If the drum is at room temperature following a complete shutdown, at least one hour of warm-up must be allowed with the heads flying during the entire period. If the drum has not cooled to room temperature during shutdown, the warm-up time may be proportionately shortened at the discretion of the operator. If the drum has been left rotating but the heads have been lifted, at least 30 minutes of warm-up should be allowed after the heads have been lowered. (The UNIVAC Field Engineer can test for sufficient warm-up by reading only off-line on high and low margins.)

f. Set the WRITE VOLTAGE/DC VOLTAGE switch to the ON-ON position. The DC ON light will come on. The drum is now ready for use.

The entire warm-up period noted in paragraph 3.e. above can be eliminated by leaving the drum rotating with the heads flying at all times. This practice is in fact recommended because, while the subsystem is fully protected against power failure or over-temperature conditions, repeated raising and lowering of the heads may cause minor damage to the surface of the drum.

4.3.2. Turn-off Procedure

As noted before, it is recommended that the subsystem be left in a stand-by condition when not in use; that is, with the drums rotating and the heads flying. This stand-by condition is achieved simply by setting the WRITE VOLTAGE/DC VOLTAGE switch on each drum unit to the OFF-OFF position.

However, if it is necessary to shut down the subsystem completely, the recommended procedure is as follows:

1. On each drum unit in turn:

   a. Set the WRITE VOLTAGE/DC VOLTAGE switch to the OFF-OFF position. The DC ON light will go off.

   b. Set the LOWER HEADS/LIFT HEADS switch to the LIFT HEADS position. The HEAD MOTOR light will go off.

   c. Set the DRUM switch to the OFF position. The DRUM MOTOR light will go off.

2. On the control unit, press the OFF switch. The PS 1 ON/PS 2 ON light will go off.

3. Open the circuit breakers on the external power supply panels.

4.4. ERROR CONDITIONS AND CORRECTIONS

Error conditions in the subsystem consist of those conditions reflected in the status codes which accompany external interrupts. These codes are described in section 3.2.5 of this manual.

In an operating environment, error conditions requiring the intervention of the operator are normally signaled by the type-out of 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--Executive Routine, I/O Handlers, and the like. The appropriate publication on 494 System software should be consulted for information on this subject.

APPENDIX A. SUMMARY OF PHYSICAL CHARACTERISTICS AND OPERATIONAL REQUIREMENTS

Table A–1 lists temperature and humidity requirements.
Table A–2 lists cabling requirements.
Table A–3 lists physical dimensions and weight for each of the cabinets in a subsystem.
Table A–4 lists heat, cooling, and power requirements for each cabinet in a subsystem.

VARIABLE	OPTIMUM CONDITION	ALLOWABLE RANGE	
		MINIMUM	MAXIMUM
AMBIENT TEMPERATURE	70°F	62°F	82°F
RELATIVE HUMIDITY	50%	10%	85%

Table A–1. Environmental Operating Requirements

CABLE CONNECTION	MAXIMUM CABLE LENGTH
PROCESSOR TO CONTROL CABINET	50 FEET INCLUDING INTERNAL ROUTING
CONTROL CABINET TO DRUM UNIT	30 FEET INCLUDING INTERNAL ROUTING

Table A–2. Cabling Requirements

CABINET	HEIGHT (in.)	WIDTH (in.)	DEPTH (in.)	WEIGHT (lbs.)
CONTROL CABINET CONTAINING CONTROL UNIT AND ONE DRUM	64*	48	24	1300
DRUM SATELLITE CABINET CONTAINING TWO DRUMS	64*	48	24	1080
DRUM SATELLITE CABINET CONTAINING ONE DRUM	64*	48	24	765

* Frame height is 64 inches, with jackpads providing additional 2 inch adjustability.

Table A–3. Subsystem Component Dimensions and Weights

CABINET	HEAT DISSIPATION (BTU/hr)	COOLING REQUIREMENT (cfm)	PRIMARY POWER INPUT
CONTROL CABINET CONTAINING CONTROL UNIT AND ONE DRUM	2000	400-600	208/220 vac, 3 Φ, 4–wire, 50 or 60 cps
DRUM SATELLITE CABINET CONTAINING TWO DRUMS	1200	800	
DRUM SATELLITE CABINET CONTAINING ONE DRUM	600	400	

Table A–4. Heat, Cooling, and Electrical Characteristics

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