UNIVAC

DATA PROCESSING DIVISION

491
492
494

REAL-TIME SYSTEMS

UNISERVO VI C MAGNETIC TAPE SUBSYSTEM

PROGRAMMER/OPERATOR REFERENCE MANUAL

UP-4101

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1. INTRODUCTION

This manual contains information for the programming and operation of the UNISERVO* VI C Magnetic Tape Subsystem for the UNIVAC 491, 492, and 494 Real-Time Systems. 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 the 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 UNISERVO VI C Magnetic Tape 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.

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2. SUBSYSTEM DESCRIPTION

2.1. GENERAL

A UNISERVO VI C Magnetic Tape Subsystem for a 491, 492, or 494 Real-Time System includes either one or two Type 5008 Control Units (Standard and Auxiliary*) and may include one to 16 Type 0858 UNISERVO VI C Magnetic Tape Units. A control unit may be connected to an I/O channel of a 491 or 492 Central Processor or to either a normal or compatible I/O channel of the 494 Central Processor. A control unit performs the following functions:

- Receives and interprets control information in the form of a function word from the processor
- Directs the activity of the magnetic tape unit selected by the function word
- Accepts data read from the selected magnetic tape unit and makes it available to the processor
- Requests data from the processor and controls writing of this data on the selected magnetic tape unit
- Informs the processor of the results by means of a status word.

A UNISERVO VI C Magnetic Tape Unit performs the following functions:

- Receives control signals from a control unit
- Reports to the control unit on various conditions within the tape unit when it is selected and during the course of an operation
- Accepts data to be written on the tape from the Standard Control Unit
- Sends data read from tape to a control unit.

Table 2–1 summarizes certain capabilities and features present in the UNISERVO VI C Subsystem.

* See 2.3.2. and 2.3.3.

PARAMETER	SPECIFICATION	
Functions	Write, Skip/Write, Read Forward, Read Backward, Bootstrap, Rewind To Load Point, Rewind With Interlock	
Tape Handling Speed	42.7 inches/second for data transfer operations 160 inches/second for rewinding	
Rewind Time	3.0 minutes for a 2400 foot reel of tape	
Recording Densities and Transfer Rates	200 characters per inch 556 characters per inch 800 characters per inch	8,540 characters per second 23,720 characters per second 34,160 characters per second
Inter-Record Gap	.75 inch for the 7-track format	

Table 2–1. Subsystem Capabilities and Features.

2.2. CONFIGURATIONS

There are two basic variations of the UNISERVO VI C Magnetic Tape Subsystem:

- A non-simultaneous operation subsystem.
- A simultaneous operation subsystem.

A non-simultaneous operation subsystem allows sequential performance of reading and writing operations, which can be initiated only when all work required of the control unit for the preceding operation has been completed. Reading and writing operations require use of the control unit throughout their performance; rewind operations, on the other hand, require use of the control unit only to initiate the function. As soon as a rewind operation is initiated and the processor so notified, a new function may be sent to the subsystem for any inactive tape unit and its performance overlapped with that of the previous rewind operation.

A simultaneous operation subsystem provides for initiation and execution of any operation (on any inactive tape unit) via the Standard Control Unit regardless of any activity that may be occurring in the Auxiliary Control Unit. It also provides for the initiation and execution of any operation (except a write operation) on any inactive tape unit via the Auxiliary Control Unit regardless of any activity that may be occurring in the Standard Control Unit. In a simultaneous operation subsystem, the Standard Control Unit and the Auxiliary Control Unit share some of the interface lines leading to the tape units, enabling them to resolve ties and conflicts in case both control units simultaneously desire to reference the same magnetic tape unit.

The block diagrams of the configurations of these two subsystems are shown in Figures 2–1 and 2–2. These figures show the required subsystem components as solid line boxes and the additional UNISERVO VI C Magnetic Tape Units which are permitted (but not required) in each subsystem as dotted line boxes. Additional magnetic tape units are added to a subsystem in the sequence shown from top to bottom in Figures 2–1 and 2–2. Table 2–2 identifies by name and type number the units which make up a non-simultaneous operation subsystem for both 60- and 50-cycle power installations. Table 2–3 does the same for a simultaneous operation subsystem.

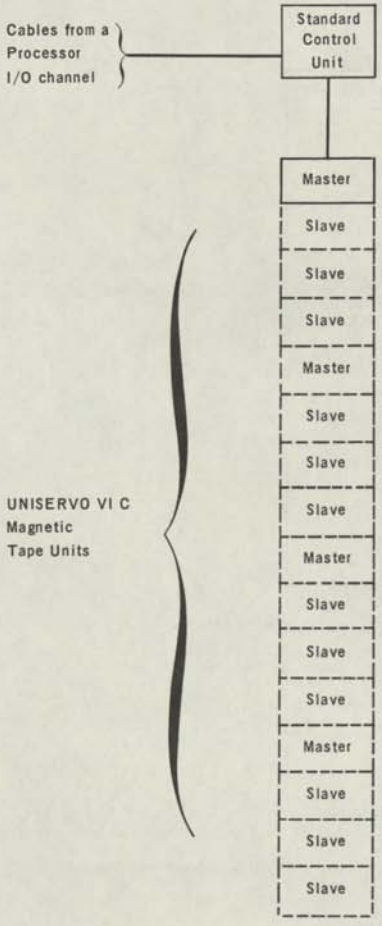


Figure 2–1. Non-Simultaneous Operation Subsystem Configuration, Block Diagram

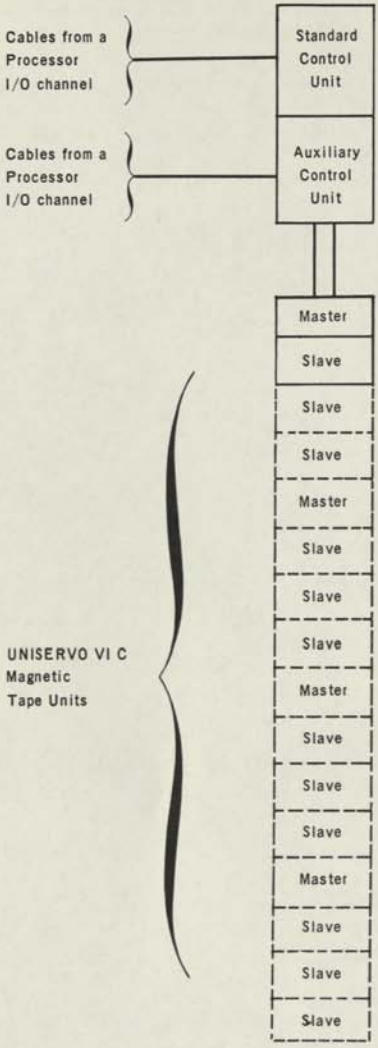


Figure 2–2. Simultaneous Operation Subsystem Configuration, Block Diagram

Subsystem Component Name	Type Number for 60 Cycle Power	Type Number for 50 Cycle Power	Number Required	Number Permitted
Standard Control Unit	5008-04	5008-06	1	1
UNISERVO VI C Master Magnetic Tape Unit	0858-00	0858-02	1	up to 16*
UNISERVO VI C Slave Magnetic Tape Unit	0858-01	0858-03	0	up to 12*

* *Restrictions: The total number of tape units in the subsystem must not exceed 16.*

The number of slave units in a subsystem must not be greater than three times the number of master units.

Table 2–2. Non-Simultaneous Operation Subsystem Components

Subsystem Component Name	Type Number for 60 Cycle Power	Type Number for 50 Cycle Power	Number Required	Number Permitted
Standard Control Unit	5008-04	5008-06	1	1
Auxiliary Control Unit	5008-05	5008-07	1	1
UNISERVO VI C Master Magnetic Tape Unit	0858-08	0858-09	1	up to 16*
UNISERVO VI C Slave Magnetic Tape Unit	0858-01	0858-03	1*	up to 12*

* *Exceptions and Restrictions: No slave units are required if the subsystem includes two master units.*

The total number of tape units in the subsystem must not exceed 16.

The number of slave units in a subsystem must not be greater than three times the number of master units.

Table 2–3. Simultaneous Operation Subsystem Components

2.3. SUBSYSTEM COMPONENTS

2.3.1. UNISERVO VI C Magnetic Tape Units

The UNISERVO VI C Magnetic Tape Unit (see Figure 2–3) operates at 42.7 inches per second for reading and writing operations and at 160 inches per second for rewinding operations. It comes in two basic forms: a *master* unit and a *slave* unit. Both are identical in external appearance. A master unit includes a power supply unit and electronic circuitry which are shared by the master unit and by up to three slave units. A master unit and its associated slave units are referred to as a *quad*.

Figure 2–3. UNISERVO VI C Magnetic Tape Units.

The master unit used in a simultaneous operation subsystem includes more electronic circuit cards than a master unit used in a non-simultaneous operation subsystem. This is necessary since a master unit in a simultaneous operation subsystem must provide sufficient reading and writing capabilities to permit performing a read operation on any tape unit in the quad concurrently with a read or write operation on any other tape unit in the quad. The master unit used in a simultaneous operation subsystem provides for concurrent communication between the two control units in the subsystem and any two tape units in the quad. The slave units used in a non-simultaneous operation subsystem are identical to the slave units used in a simultaneous operation subsystem.

Each UNISERVO VI C Magnetic Tape Unit includes an Operator's Control Panel, a tape supply reel hub, a permanently mounted tape take-up reel, a photoelectric reflective marker detection system, a 7-track read/write head, an erase head, and a write enable/disable facility.

The reel of tape mounted on the supply reel may be normal duty plastic tape (Univac part number 3525145-00 for 2400 foot reels or part number 3525145-01 for 1200 foot reels) when operating at any density. However, heavy duty plastic tape (Univac part number 3525145-02 for 2400 foot reels or part number 3525145-03 for 1200 foot reels) is recommended for longer tape life, greater reliability, and more error free operations at the 800 frames per inch density.

The photoelectric reflective marker detection system detects markers placed on the base (uncoated) side of the tape near the physical beginning and the end of the tape.

Both the photoelectric reflective marker detection hardware and the erase head are in the tape path between the read/write head and the tape supply reel. The marker detection hardware is about 3 inches from the write head. The erase head is about 3.25 inches from the write head.

The write enable/disable facility consists of a spring loaded pin, a groove in the back of each tape reel, and a write enable ring which must be inserted in the groove on the back of any reel of tape to permit writing. When the ring is not in place on a reel of tape mounted on the supply reel hub, the pin can ride in the groove and writing on that reel of tape is inhibited. When the ring is in place, the pin is depressed and writing is permitted.

The 7-track read/write head records the seven bits of each data frame in a straight line across the width of the tape. Each data frame consists of six data bits plus a parity bit which is written as either a zero bit or a one bit to provide even or odd parity as specified by the program. Each computer word written on, or read from, the tape consists of five data frames. A group of consecutive data frames preceded by and followed by an unrecorded area is called a *block*. A longitudinal-check frame is associated with each block of data on tape. It consists of seven bits and is written in the 4th frame position following the last data frame in each block. (It is generated in the master unit of a quad for a write operation performed on any tape unit in the quad.)

The bit written in each track for the longitudinal check frame is written as either a zero or one bit, with the choice made so that the number of one bits in each track (including all the data frames and the longitudinal check frame) is an even number for the block.

The unrecorded area of tape between the longitudinal check frame of a block and the first data frame of the next block is called an interblock gap. The interblock gap size for 7-track format recording is .75 inch nominal. (An interblock gap size any place in the range from .69 inch to .91 inch is considered acceptable.)

The effective tape reversal time is defined as the amount of unproductive time required to initiate tape motion in the opposite direction. The effective tape reversal time is 25 milliseconds starting from the instant that the need for reversing tape motion is recognized by the control unit.

The *start* time for a tape unit on which the tape is at rest begins when it receives a signal calling for motion in the same direction as the most recent tape motion and ends when the tape reaches normal operating speed. The nominal start time is 7 milliseconds. Between .10 and .15 inches of tape moves past the read/write head during this interval.

The *stop* time for a tape unit begins the instant that a tape unit passing tape at normal operating speed receives a stop command and ends when tape motion has ceased. The nominal stop time is 5 milliseconds. Between .09 and .16 inches of tape moves past the read/write head during this interval. It should be noted that these are the *mechanical* start and stop times. Effective start and stop times from a subsystem standpoint are discussed in section 3.4.

Table 2-4 summarizes the general characteristics of the UNISERVO VI C Tape Unit.

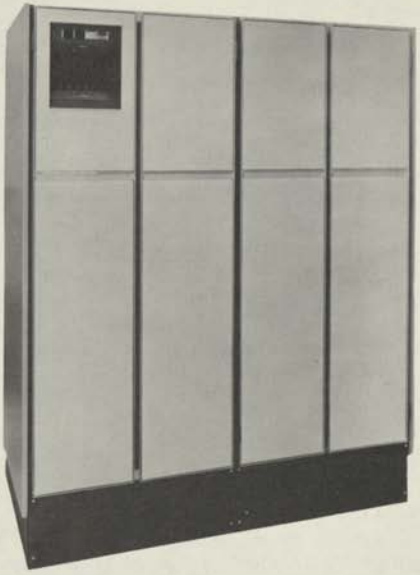
PARAMETER	SPECIFICATION
Tape Handling Speed	42.7 inches per second
Recording Densities	200, 556, or 800 frames/inch
Transfer Rates:	
200 frames/inch	8,540 frames/second
556 frames/inch	23,720 frames/second
800 frames/inch	34,160 frames/second
Effective Tape Reversal Time	25 milliseconds
Rewind Speed	160 inches/second
Rewind Time (2400 foot reel)	3.0 minutes
Interblock Gap Size	.75 inch
Tolerance	+.16 inch, −.06 inch
Start Time	7 milliseconds
Start Distance	.10 to .15 inches
Stop Time	5 milliseconds
Stop Distance	.09 to .16 inches

Table 2–4. UNISERVO VI C General Characteristics

2.3.2. Standard Control Unit

The Standard Control Unit (Type 5008-04 for 60 cycle power; Type 5008-06 for 50 cycle power) is shown in the left half of Figure 2–4. It is used in both the non-simultaneous operation and in the simultaneous operation subsystem. The Standard Control Unit may be connected to an I/O channel of a 491 or 492 or to either a normal or a compatible I/O channel of the 494 processor via cables containing 30 input lines, 30 output lines, and 7 control signal lines. It can control a bank of up to 16 UNISERVO VI C Magnetic Tape Units. Logic and switching for all slave units is performed by the master tape unit.

The Standard Control Unit receives and interprets function words from the processor via the output data lines, initiates tape motion on the selected unit, and handles the data transfer and checking required. At the end of the logical process called for by the function word, the Standard Control Unit sends a status word to the processor to report on the results of the operation.



Note: Only the Standard Control Unit (left-hand unit) is required for non-simultaneous subsystems.

Figure 2–4. Standard and Auxiliary Control Units for Simultaneous Operation Subsystem

During the execution of a Write function, the Standard Control Unit requests 30-bit data words from the processor, disassembles the data words received into 6-bit groups, adds the appropriate parity bit to each group, and sends each resulting 7-bit group to be written on the specified tape unit. It also checks each write operation, via readback from the tape unit's read head, for proper lateral parity and checks to see that the longitudinal check frame for the block provides even parity for each track.

During the execution of a Read function, the Standard Control Unit checks each 7-bit frame read from tape for proper parity, strips off the parity bit, assembles the resulting 6-bit groups into 30-bit words and makes each word available to the processor. It also checks to see that the longitudinal check frame for the block provides even parity for each track.

The Standard Control Unit includes a Control/Indicator Panel, which is discussed in Section 4.2.2.

2.3.3. Auxiliary Control Unit

The Auxiliary Control Unit (Type 5008-05 for 60 cycle power; Type 5008-07 for 50 cycle power) is shown in the right half of Figure 2–4. It is used only in the simultaneous operation subsystem. It may be connected to an I/O channel of a 491 or 492 or to either a normal or a compatible I/O channel of the 494 processor. This interface is identical to the interface between the Standard Control Unit and its processor I/O channel. The Auxiliary Control Unit is connected to the master tape units in the subsystem and from them to the slave units.

The functions of the Auxiliary Control Unit are identical to those of the Standard Control Unit as explained in section 2.3.2. except that the Auxiliary Control Unit does not provide any of the capabilities required exclusively for execution of a Write or Skip/Write function. The Auxiliary Control Unit does not include a Control/Indicator Panel, but rather shares the services of the panel on the Standard Control Unit.

2.4. OPTIONAL FEATURES

2.4.1. Translate Feature

Both the non-simultaneous and the simultaneous operation subsystems have provision for the addition of the Translate Feature which will translate the 6-bit code used in the processor to the 6-bit code used in the tape units and vice-versa. A full description of the Translate Feature is given in Appendix C.

2.4.2. 9-Track Format Option

Both the non-simultaneous and the simultaneous operation subsystems have provisions for the addition of a 9-track format option to the control unit or units and the use of 9-track format tape units in place of some or all of the 7-track tape units, to give the subsystem the ability to operate in a 9-track format compatible with the 800 bytes per inch format of the IBM* 2400 series magnetic tape units. This option is fully described in Appendix B.

* *Registered trademark of International Business Machines Corp.*

3. PROGRAMMING

3.1. SUBSYSTEM/PROCESSOR INTERFACE

Subsystem/processor interface consists of two sets of 30 data lines and a set of seven control signal lines. One set of data lines (output data lines) is used to send both function words and data words from the processor to the subsystem. The other set of data lines (input data lines) is used to send both data words and status words from the subsystem to the processor.

The seven control signal lines are used:

- by the processor to master clear the Standard Control Unit (one line, called the Master Clear line),
- by the Standard Control Unit to inform the processor that it can accept a function word or a data word (one line, called the Output Request line),
- by the processor to inform the Standard Control Unit that the word on the output data lines is a function word or a data word (two lines, called the External Function and Output Acknowledge lines),
- by the Standard Control Unit to inform the processor that the word on the input data lines is a data word or a status word (two lines, called the Input Data Request and External Interrupt lines),
- by the processor to inform the Standard Control Unit that it has accepted the data word or status word on the input data lines (one line, called the Input Acknowledge line).

The Standard Control Unit of both a simultaneous and non-simultaneous operation subsystem interfaces with a processor I/O channel (either a normal or a compatible channel in the case of the 494) in the manner described above. The simultaneous operation subsystem, however, also provides an interface between an Auxiliary Control Unit and a processor I/O channel (either a normal or a compatible channel in the case of the 494). The processor I/O channel interfaced with the Auxiliary Control Unit is identical to the I/O channel interfaced with the Standard Control Unit; however, it has a different channel number. It is permissible to use one normal I/O channel and one compatible I/O channel in the interface between a 494 processor and the simultaneous operation subsystem.

3.2. WORD FORMATS

3.2.1. Function Words

Figure 3-1 shows the function word format in terms of fields; each field is explained in Table 3-1.

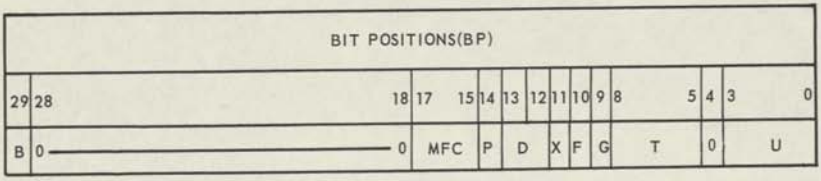


Figure 3-1. Function Word Format

FIELD DESCRIPTOR	BIT POSITIONS	CONTENTS
B (Bootstrap)	29	This bit position should contain a zero for all function words except the Bootstrap function. See section 3.2.1.7 on the Bootstrap function.
–	28–18	These bit positions should always contain zeros.
MFC (Main Function Code)	17–15	These bit positions control the following functions : ▪ Read Backward (1_8) ▪ Rewind With Interlock (2_8) ▪ Rewind To Load Point (3_8) ▪ Bootstrap (4_8) ▪ Write (5_8) ▪ Read Forward (6_8) ▪ Skip/Write (7_8)
P (Parity)	14	A zero bit specifies odd lateral parity; a one bit specifies even lateral parity. Recording with odd lateral parity is defined as being Binary mode. Recording with even lateral parity is defined as being "Binary Coded Decimal" or "BCD" mode.
D (Density)	13–12	The four possible variations of the D field of the Function Word have the following meanings: 00 Operate at the density which corresponds to the setting of the DENSITY switch on the specified magnetic tape unit. 01 Operate at 200 frames/inch. 10 Operate at 556 frames/inch. 11 Operate at 800 frames/inch.

Table 3-1. Function Word Fields (Sheet 1 of 2)

FIELD DESCRIPTOR	BIT POSITIONS	CONTENTS
X (Translator)	11	This bit position should be zero if the subsystem does not include the Optional Translate Feature. If the subsystem does include the Optional Translate feature, this bit position may contain either a zero or a one bit. See Appendix C for details.
F (Format)	10	This bit position should be a zero if the subsystem does not include the Optional 9-Track Format feature. If the subsystem does include the 9-Track Format feature, this bit position may contain either a zero or a one bit for Read Forward, Read Backward, Write, and Skip/Write function. See Appendix B for details.
G (Gain)	9	A zero specifies normal gain; a one bit specifies low gain. The Gain bit in a function word instructs the control unit how much amplification to perform on signals it receives from the read head during the execution of any function which requires the transfer of data bits from the magnetic tape unit to the control unit. Normal gain should be employed in a Read operation to minimize the possibility of a bit being misread because of an imperfection on the tape. Low gain must be employed in a Write or Skip/Write function. The Gain bit in a Bootstrap function word should always be a zero bit to specify normal gain. If a parity error is detected during execution of either a Read Forward or a Read Backward function, any recovery attempted should include an attempt to perform the function at low gain.
T (Track)	8–5	This field should contain zeros if the subsystem does not include the 9-Track Format feature. If the subsystem does include this feature, this field may contain a mixture of zero bits and one bits for a Read Forward function only, and then only under certain circumstances. See Appendix B for details.
–	4	This bit position must always contain a zero.
U (UNISERVO Unit)	3–0	This field specifies the logical number of the tape unit to which the function word applies.

Table 3-1. Function Word Fields (Sheet 2 of 2)

The following sections present details for each of the 7 main function codes. Details for operating with optional translate and/or 9-Track Format are different in many cases and are explained in the appendices.

3.2.1.1. Write

29 — 18	17 — 15	14	13	12	11	10	9	8 — 4	3 — 0
0 — 0	MFC	P	D	0	0	G	0 — 0		U

Specifications:

MFC = Main Function Code of 101 (Octal 5)

P = Parity
0 for odd parity
1 for even parity

D = Density
00 for manual density selection
01 for 200 frames/inch
10 for 556 frames/inch
11 for 800 frames/inch

G = Gain
1 for low gain

U = Logical Unit Number

The Write function instructs the Standard Control Unit

(1) to select the specified logical magnetic tape unit,

(2) to initiate forward tape motion on that tape unit as soon as tape motion for the most recently completed Write operation on any tape unit in the quad has ceased,

(3) to record the data received from the processor as soon as the tape has reached the proper operating speed and the proper size interblock gap has been created,

(4) to read back from the tape the data it records, checking for proper parity, and

(5) to generate a status word informing the processor of the results of the operation.

The Write function is a legal function only for a Standard Control Unit and can be performed only if the reel of the tape on the magnetic tape unit specified in the function word has a write enable ring in place. It cannot be performed by the Auxiliary Control Unit in a simultaneous operation subsystem.

When the Standard Control Unit receives a Write function, it waits until it receives the first data word to be written and then initiates tape motion.

The first data frame written includes the contents of bit positions 29 through 24 of the first word received from the processor; the second data frame includes the contents of bit positions 23 through 18, and so on down through the fifth data frame which includes the contents of bit positions 5 through 0. Data frames for the second and subsequent computer words are written in the same sequence.

An integral number of words is always written when the P bit of a Write function is zero specifying odd lateral parity. In this case, the Standard Control Unit ceases writing data for a block and enters its end-of-block procedure when it fails to receive the second or a subsequent data word from the processor in time to write the first data frame with the proper frame-to-frame timing required by the specified density.

When the P bit of a Write function is a one bit to specify recording with even lateral parity, the Standard Control Unit ceases writing data in a block either as a result of deciding that the processor has sent all of the data words to be written in the block, or as a result of detecting a "stop" code in the data. When the Standard Control Unit detects that any one of the 6-bit data codes is to be written as 00_8 plus an even parity bit (which would be a zero bit to give even parity for the frame) it does not write that frame or any additional data frames in the block. Instead, it enters its end-of-block procedure, just as if it decided that the processor has sent all of the data words to be written in the block.

If the data word containing the stop code is not the last word in the output data buffer defined by the processor for an even parity Write function, the processor may send up to three additional words (buffer size permitting) to the subsystem. If the terminal address field (for 491 or 492) or the count field (for 494) of the Buffer Control Word permits two or more words to be sent to the subsystem after the word containing the stop code is sent, two words will be sent to the subsystem (and ignored) before the status word is generated. If the terminal address field or the count field permits three or more words to be sent, a third word will be sent as soon as the receipt of a status word is acknowledged as a result of executing the Store Channel (17_8) instruction, provided the output buffer has not been terminated by the program.

If the first data word sent for an even parity Write function contains a stop code in the most significant character position, tape motion will be initiated in the normal manner. Instead of writing data when the tape has reached proper operating speed, the Standard Control Unit will signal the tape unit to halt tape motion. In this case, the length of the interblock gap following the previously recorded block will be increased by about .5 inch.

The Write function may be used to simulate a Write End-of-File process when writing a tape to be read by a subsystem not requiring an extended interblock gap preceding an End-of-File record (as required in some 704 installations). In order to do this, the Write function should instruct the Standard Control Unit to write with even parity (at the desired density) with low gain on the desired tape unit. The first data word sent to the Standard Control Unit following the sending of the Write function should consist of $1700XXXXXX_8$. The first six bits of this data word (17_8) will cause one data frame (which is the End-of-File code) to be written on the selected magnetic tape unit. The next six bits of this data word (00_8) will be interpreted by the Standard Control Unit as a stop code; the remaining 18 bits of the data word will be discarded by the Standard Control Unit following detection of the stop code.

3.2.1.2. Read Forward

29 — 18	17 — 15	14	13	12	11	10	9	8 — 4	3 — 0
0 — 0	MFC	P	D	0	0	G	0 — 0		U

Specifications:

MFC = Main Function Code of 110 (Octal 6)

P = Parity
0 for odd parity
1 for even parity

D = Density
00 for manual density selection
01 for 200 frames/inch
10 for 556 frames/inch
11 for 800 frames/inch

G = Gain
0 for normal gain
1 for low gain

U = Logical Unit Number

The Read Forward function instructs the control unit

(1) to select the specified logical tape unit,

(2) to initiate forward tape motion on that tape unit,*

(3) to assemble into data words the six data bits from each data frame,

(4) to make each data word available to the processor as soon as it has been assembled,

(5) to generate a status word informing the processor of the results of the operation when the control unit determines that an interblock gap has been encountered after it has detected at least one apparent data frame.

When reading in the forward direction on a properly formatted tape, the assembly of data words proceeds as follows.

The six data bits from the first data frame encountered will be placed in the control unit word assembly register in bit positions which correspond to bits 29 through 24 of a computer word; the six data bits from the second data frame will be placed in bit positions 23 through 18, and so on until the six data bits from the fifth data frame are placed in bit positions 5 through 0 of the word assembly register. At this point the data word is made available to the processor and assembly of the second (and subsequent) data words proceed in the same sequence.

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* *If the tape is still moving as a result of a previous completed Read Forward or Bootstrap function, the interblock gap passing time is less than it would be for stop/start operation.*

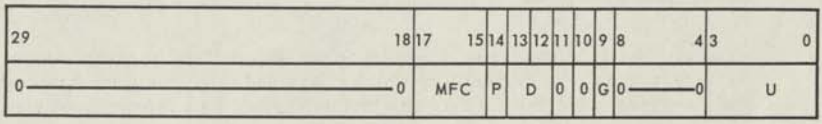
If the processor fails to accept a data word within the proper time (see Table 3-5), the control unit continues to assemble data words and makes them available to the processor. However, one or more data words may be discarded and one or more meaningless data words may be received in the process. Further details are given in section 3.2.2.7.

If the number of data frames in a block being read is not a multiple of five, the last data word assembled will contain zeros in the unused low order bit positions of the assembly register. This word will be made available to the processor as if it were a full data word.

To obtain the data in the first 5n data frames of a block containing more than 5n data frames, an n-word input data buffer is defined.

The Read Forward function can be used by the programmer to simulate a "Move Forward One Block" function. The recommended method of doing this is to initiate a Read Forward function after defining an input buffer which is greater than the "noise constant" * for the installation, and ignore the Abnormal Frame Count, Parity Error, and Late Acknowledge status indicators (provided the number of words received exceeds the noise constant for the installation) which may be generated at the conclusion of the Read Forward function.

3.2.1.3. Read Backward



Specifications:

MFC = Main Function Code of 001 (Octal 1)

P = Parity
0 for odd parity
1 for even parity

D = Density
00 for manual density selection
01 for 200 frames/inch
10 for 556 frames/inch
11 for 800 frames/inch

G = Gain
0 for normal gain
1 for low gain

U = Logical Unit Number

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* *That value which is established to determine whether or not legitimate data has been read. If a value x is established, then any transmittal of data less than or equal to x is considered meaningless "noise" if a parity error is reported.*

The Read Backward function instructs the control unit

(1) to select the logical tape unit specified in the function word,

(2) to initiate tape motion in a backward direction on that tape unit,*

(3) to assemble into data words the six data bits from each data frame,

(4) to make each assembled data word available to the processor,

(5) to generate a status word informing the processor of the results of the operation when the control unit determines that an interblock gap has been encountered after it has detected at least one apparent data frame.

Meaningful data will be assembled and made available to the processor during the execution of a Read Backward function provided the tape being read was originally written on a UNISERVO VI C or UNISERVO VIII C Magnetic Tape Unit via a Type 5008 Control Unit because such tapes are recorded with what is called a "statically deskewed longitudinal check frame." The recording produced on many IBM compatible magnetic tape subsystems including IBM magnetic tape subsystems which utilize the 727, 7330, and 729 magnetic tape units does not have such a check frame. As a consequence, meaningful data words may not be assembled because the control unit may treat some of the bits in the longitudinal check frame as data frames and the first data word assembled may include up to four false data characters.

When reading in the backward direction on a properly formatted tape, the assembly of words to be made available to the processor proceeds as follows:

The six data bits from the first data frame encountered will be placed in the word assembly register in bit positions which correspond to bit positions 5 through 0 of a computer word; the six data bits from the second data frame encountered will be placed in bit positions 11 through 6, and so on until the six data bits from the fifth data frame encountered are in bit positions 29 through 24. At this point, the data word is made available to the processor and assembly of the second (and subsequent) data words proceeds in the same sequence.

If the processor fails to accept a data word within the proper time (see Table 3–5), the control unit continues to assemble data words, making them available to the processor. However, one or more data words may be discarded and one or more meaningless data words may be received in the process. Further details are given in section 3.2.2.7.

If the number of data frames in a block being read is not a multiple of five, the last data word assembled will contain zeros in the unused high order bit positions of the word assembly register. This word will be made available to the processor as if it were a full data word.

To obtain the data in the last 5n data frames of a block containing more than 5n data frames, an n-word input buffer is defined.

** If the tape is still moving as a result of a previously completed Read Backward function, the interblock gap passing time is less than it would be for stop/start operation.*

The Read Backward function can be used by the programmer to simulate a Backspace Block function. The recommended method of doing this is to initiate the Read Backward function, after having defined an input buffer which is one word greater than the "noise constant" for the installation, ignore the Abnormal Frame Count status indicator, the Parity Error and Late Acknowledge status indicators, provided the number of words received exceeds the "noise constant."

Normal uses for a Read Backward function are:

- To read data in the backward direction as required by some sorting algorithms.
- To perform the repositioning required as part of the procedure for recovering from an error which is reported at the completion of a Write, Skip/Write, or Read Forward function.

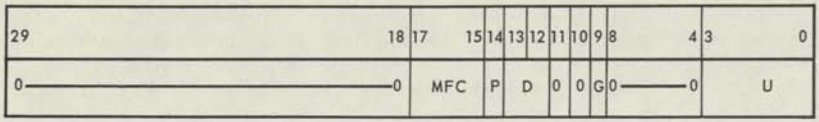
It should be noted that when reading a block which does not contain an integral number of data words, the format of the data stored in memory when executing a Read Backward function will always differ from the format of the data stored in memory when executing a Read Forward function for the same block. For example, if a Read Forward function is used to read a block containing 13 data frames, and if the Buffer Control Word specifies a starting address of 2000, the data would be stored in the following manner:

(2000) =	D_1	D_2	D_3	D_4	D_5
(2001) =	D_6	D_7	D_8	D_9	D_{10}
(2002) =	D_{11}	D_{12}	D_{13}	ZERO BITS	

If, however, a Read Backward function is used to read the same block, and if the Buffer Control Word specifies a starting address of 2000, the data would then be stored in the following manner:

(2000) =	D_9	D_{10}	D_{11}	D_{12}	D_{13}
(2001) =	D_4	D_5	D_6	D_7	D_8
(2002) =	ZERO BITS		D_1	D_2	D_3

3.2.1.4. Skip/Write



Specifications:

MFC = Main Function Code of 111 (Octal 7)

P = Parity
0 for odd parity
1 for even parity

D = Density
00 for manual density selection
01 for 200 frames/inch
10 for 556 frames/inch
11 for 800 frames/inch

G = Gain
1 for low gain

U = Logical Unit Number

The Skip/Write function instructs the Standard Control Unit:

(1) to select the logical tape unit specified in the function word

(2) to initiate forward tape motion on that magnetic tape unit as soon as tape motion resulting from the most recently completed Write operation on any tape unit in the quad including the selected tape unit has ceased

(3) to erase tape for about three inches after normal operating speed is attained

(4) to proceed from this point as if a Write function had been received.

A Skip/Write function is performed in exactly the same manner as a Write function except that it creates an interblock gap following the preceding block which is about 3 inches greater than would be created by a Write function.

All of the rules, restrictions, and comments which apply to a Write function (see section 3.2.1.1) also apply to a Skip/Write function except for interblock gap size, timing details, and the Main Function Code used.

The Skip/Write function is used in the recovery procedure when a tape defect (which causes either a parity error or tape hash error) is encountered during execution of a Write function. The recommended recovery procedure when a parity error is reported is:

(1) to execute a Read Backwards function (to move backward one block),

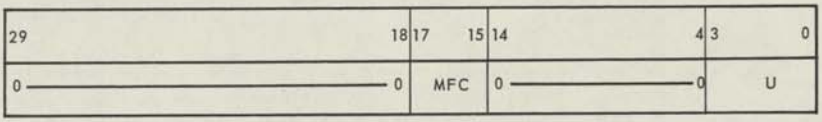
(2) to execute a Skip/Write function to skip over the defective area on tape (erasing the previously recorded block during the "skip" portion of the Skip/Write function) and to write the desired data.

The recommended procedure for dealing with a tape hash error is described in 3.3.4.

The Skip/Write function can be used as a Skip Only (no write) function by specifying even parity in the function word and including a stop code (00_8) in the six most-significant bit positions of the first word of the output data buffer. Such a Skip/Write function has the effect of moving the tape about 3.5 inches and erasing it. No writing is done.

The Skip/Write function should be used to simulate a Write End-of-File function when writing a tape which will be read by a subsystem which requires an extended (3.75 inch nominal) interblock gap preceding an End-of-File record.

3.2.1.5. Rewind With Interlock



Specifications:

MFC = Main Function Code of 010 (Octal 2)

U = Logical Unit Number

The Rewind With Interlock function instructs the control unit:

(1) to select the logical tape unit specified in the function word,

(2) to initiate a high-speed rewinding operation,

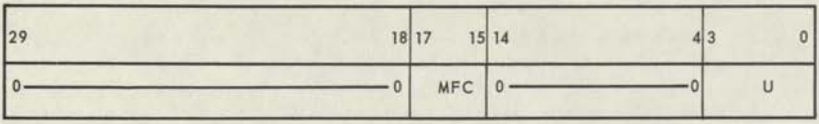
(3) to set an interlock condition in the tape unit,

(4) to inform the processor of the results of the operation as soon as the rewinding process has been successfully initiated, or the control unit detects a condition which prevents the successful initiation of the rewinding process.

If a control unit receives a legitimate function word which specifies a tape unit on which a Rewind With Interlock function has been previously initiated, and if either the rewinding process has not been completed, or the interlock condition has not been removed (by depression of the LOAD POINT switch on the tape unit's Control/Indicator Panel), then the control unit will generate a status word which includes an Interlock status indicator in response to that function word.

Rewinding time for a full 2,400 foot reel of magnetic tape is 180 seconds. The rewinding speed is 160 inches per second.

3.2.1.6. Rewind To Load Point



Specifications:

MFC = Main Function Code of 011 (Octal 3)

U = Logical Unit Number

The Rewind To Load Point function instructs the control unit:

(1) to select the logical tape unit specified in the function word,

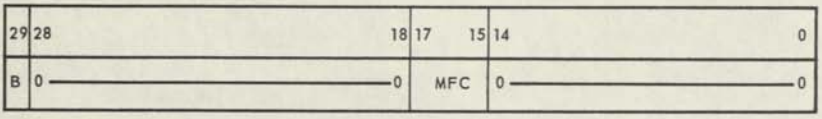
(2) to initiate a high-speed rewinding operation,

(3) to inform the processor that the rewinding process has been successfully initiated (including the case of the tape already positioned at Load Point), or that the control unit has detected a condition which prevents the successful initiation of the rewinding process.

The tape unit on which a Rewind To Load Point function is initiated automatically becomes available for subsequent operations as soon as the rewinding process has been completed and the tape is positioned with the Load Point Marker under the marker detector.

Rewinding time for a full 2,400 foot reel of magnetic tape is 180 seconds. The rewinding speed is 160 inches per second.

3.2.1.7. Bootstrap



Specifications:

MFC = Main Function Code of 100 (Octal 4) if B = 0. Otherwise MFC = 000

B = Bootstrap bit set to 1 if MFC = 000. If MFC = 100 then B = 0.

Note that either MFC or B may be set but not both.

The Bootstrap function instructs the control unit:

(1) to select logical tape unit zero,

(2) to rewind the reel of tape on that tape unit to load point if the tape is not already positioned at load point,

(3) to perform a Read Forward function at the density which has been manually selected for logical unit zero checking for odd lateral parity,

(4) to generate a status word to inform the processor of the results of the operation when the control unit determines that the interblock gap which follows the first block on the reel of tape has been encountered.

NOTE: The 7CH/9CH two position toggle switch on the Control/Indicator Panel of the Standard Control Unit (see section 4.2.2) must be in the 7CH (up) position when the Bootstrap function is initiated on a subsystem which includes only 7-track format tape units. See Appendix B for details on the use of this switch when a subsystem includes the Optional 9-Track Format Feature.

3.2.1.8. Function Codes - Summary

Table 3-2 summarizes the legitimate bit combinations in positions 17 through 9 of a function word when operating in the 7-track format without the optional Translate Feature. The use of bit combinations not in this table will lead to erratic operation.

3.2.2. Status Words

When a control unit receives a function word, it performs (or attempts to perform) the specified function. It then generates a status word, makes it available to the processor, and turns on the External Interrupt signal. The External Interrupt signal is acknowledged when the processor executes the Store Input Channel (17_8) instruction. The control unit is ready to receive a new function word within one microsecond from the time it receives the Input Acknowledge signal in response to an External Interrupt signal.

A status word is generated in response to every function word. No function word has an *inhibit interrupt* specification.

FUNCTION	PARITY	NORMAL GAIN				LOW GAIN			
		DENSITY				DENSITY			
		MANUAL	200	556	800	MANUAL	200	556	800
READ FORWARD	ODD	600	610	620	630	601	611	621	631
	EVEN	640	650	660	670	641	651	661	671
READ BACKWARD	ODD	100	110	120	130	101	111	121	131
	EVEN	140	150	160	170	141	151	161	171
WRITE	ODD	LOW GAIN SHOULD				501	511	521	531
	EVEN	ALWAYS BE SPECIFIED				541	551	561	571
SKIP/WRITE	ODD	FOR WRITE AND SKIP/				701	711	721	731
	EVEN	WRITE FUNCTIONS.				741	751	761	771
BOOTSTRAP	ODD	400 or 000*	*WHEN 000_8 IS USED AS THE FUNCTION CODE FOR BOOTSTRAP, THE BOOTSTRAP FUNCTION WORD MUST BE 4000000000_8.						
REWIND WITH INTERLOCK	200								
REWIND TO LOAD POINT	300								

Table 3–2. Function Codes (Bit Positions 17 thru 9 in octal notation) for operating in the 7-Track Format Without Translation.

Figure 3-2 shows the status word format. Table 3-3 lists the names assigned to the various status detail master bits, and the other single and multiple bit position fields which make up a status word.

BIT POSITION (BP)										
29	18	17	9	8	5	4	3	0		
NOT USED		STATUS DETAIL MASTER BITS		T		1	M			

Figure 3–2. Status Word Format

BIT POSITION(S)	IDENTIFYING NAME
29 – 18	NOT USED
17	ABNORMAL FRAME COUNT
16	(POSSIBLE) END OF FILE
15	END OF TAPE WARNING/LOAD POINT
14	INTERLOCK
13	BUSY
12	PARITY ERROR
11	LATE ACKNOWLEDGE ERROR
10	TAPE HASH
9	INVALID FUNCTION
8 – 5	BAD TRACK
4	ALWAYS A 1-BIT
3 – 0	FRAME COUNT/MODULO 5

Table 3-3. Status Word Fields.

The following explains the status word indicators generated in response to function words.

3.2.2.1. Abnormal Frame Count (BP 17)

The Abnormal Frame Count indicator is set to one if the block involved in a Read Forward, a Read Backward, or a Bootstrap operation is regarded by the subsystem as not having a multiple of five data frames. The reading of an End-of-File record will also cause this indicator to be set to one.

This bit position is interpreted differently when generated in response to a 9-track format Read Forward, Read Backward, or Bootstrap function (see Appendix B).

3.2.2.2. End-of-File (BP 16)

The End-of-File indicator will be set to one if either of the two following conditions exist:

- The detection of a block containing a single data frame of 001111 (Octal 17) with a zero lateral parity bit during a Read Forward or Bootstrap operation.
- The detection of a block which appears to contain fewer than five data frames during a Read Backward operation.

3.2.2.3. End-of-Tape/Load Point (BP 15)

Bit position 15 of a status word will be set to one if:

- the End-of-Tape warning marker is detected during the execution of a Write or Skip/Write function, or is beyond the photocell at the time the status word is generated in response to these functions.
- the Load Point marker is sensed during initiation or execution of a Read Backward function.
- Power is dropped during execution of a Read Forward, Read Backward, Write, or Skip/Write function or during the Read phase of a Bootstrap function. In this case, the Busy indicator (BP 13) is also set to one.

3.2.2.4. Interlock (BP 14)

Bit position 14 of the status word will be set to one if:

- the reel of tape on the unit specified in a Write or Skip/Write function word does not contain a write enable ring.
- the wiring of the control panel on the Standard Control Unit is incorrect and the logical tape unit specified by the function word indicates a physical tape unit which does not exist.
- the tape unit specified in any function word is logically non-existent as a result of "Power Off" status, "Local" status, or a prior initiation of a Rewind-with-Interlock function without manual removal of the interlock condition.
- power is dropped during the rewinding phase of a Bootstrap function.

3.2.2.5. Busy (BP 13)

Bit position 13 of the status word will be set to one if:

- the selected tape unit is performing a previously initiated Rewind-to-Load-Point operation.
- the subsystem involved is a simultaneous operation subsystem and a function word received by either control unit specifies a tape unit under the control of the other.
- Tape motion is initiated for a Read Backward function and is halted by detection of the Load Point Marker.
- Power is dropped during execution of a Read Forward, Read Backward, Write or Skip/Write function or during the Read phase of a Bootstrap function. In this case, the End of Tape/Load Point indicator (BP 15) is also set to one.

3.2.2.6. Parity Error (BP 12)

Bit position 12 of the status word generated in response to a Read Forward, Read Backward, Bootstrap, Write, or Skip/Write function word will be set to one if:

- the number of 1-bits read from tape for any data frame in the block being read (or written) does not agree with the parity (odd or even) specified in the function word.
- the number of 1-bits read from tape in each of the seven tracks for the total block being read or written (including all the data frames plus the longitudinal check frame) is not an even number.

3.2.2.7. Late Acknowledge (BP 11)

Two conditions will set bit position 11. They are as follows:

- the contents of bit position 11 of the status word generated in response to a Read Forward, Read Backward, or Bootstrap function will be a 1-bit if the processor acknowledges that it has accepted an input data word after the data buffering capacity of the subsystem has been exceeded.

  If there is a word in the input register of the control unit and assembly of another word is completed, there is a critical interval of about one frame time less 10 microseconds for acknowledgment by the processor of its acceptance of the data in the input register. The Late Acknowledge status indicator will be set if the processor acknowledges receipt of the input word after expiration of this critical interval. If the processor does not acknowledge receipt of the input word before the expiration of this critical interval, the control unit will start assembling the next data word over the previously assembled word with "inclusive OR" of previous and new 1-bits.

  This assembly continues until the end of the block is reached or until the input register is cleared by an Input Acknowledge signal from the processor. If an Input Acknowledge signal is received from the processor after the critical interval is exceeded, the Late Acknowledge status indicator will

be set. The word built up by the "inclusive OR" operation in the assembly register will be transferred as it stands from the assembly register to the input register. If the transfer of the contents of the assembly register to the input register is performed in the midst of a word assembly cycle, the cycle will be completed and then the assembly register is considered to be loaded again, and its contents are available for transfer to the input register when the input register is next cleared.

- Bit position 11 of the status word generated in response to a Write or Skip/Write operation will be set to one if an Output Acknowledge signal is detected after the control unit prepares to end the recording cycle.

  When a Standard Control Unit receives a Write or Skip/Write function, it waits until the first data word for the block has been received and then initiates tape motion. When tape is up to operating speed and the proper interblock gap has been created, the first data frame is written. From that point on the control unit should receive each of the consecutive data words to be written soon enough to write consecutive data frames with uniform frame-to-frame timing. If it does not receive another data word soon enough to write a data frame with uniform frame-to-frame timing, it assumes that it has received the last data word for the block and enters its End-of-Block procedure. However, if the control unit receives a data word between the time it enters its End-of-Block procedure and the time the status word for the block is generated (this interval is about 9 milliseconds; see Table 3–7), the status word will include the Late Acknowledge status indication.

  If writing is stopped because of a stop code, the Late Acknowledge indicator will be zero.

3.2.2.8. Tape Hash (BP 10)

Bit position 10 of the status word generated in response to a Write or Skip/Write function will be set to 1 only if the subsystem detects apparent recording in what is supposed to be an area without any recording. This area extends from the point under the read head when the tape starts forward motion for a Write or Skip/Write function to a point about .10 inches before the point at which the first data frame for the block is recorded.

3.2.2.9. Invalid Function (BP 9)

Bit position 9 of the status word will be set to one if:

- the function word received by the subsystem contains a 1-bit in bit position 4.
- the subsystem is a simultaneous operation subsystem and the Main Function Code field of a function word received by the Auxiliary Control Unit in the subsystem is 5_8 or 7_8 to specify Write or Skip/Write, or if the MFC field of the function word is 0_8 and the contents of bit position 29 is a 0-bit (this combination should not be used with a subsystem having only 7-track format capabilities).
- a subsystem which does not include the Optional 9-Track Format Feature receives a Read Forward, Read Backward, Write, or Skip/Write function word containing a 1-bit in bit position 10 (this specifies 9-track operation).

- a Bootstrap function is received by a subsystem which does not include the Optional 9-Track Format Feature when the 7CH/9CH switch on the Standard Control Unit is in the 9CH (down) position.

3.2.2.10. Bad Track (BP 8-5)

Bit positions 8 through 5 will always contain zeros in the status word generated in response to any function word which specifies 7-track format operations.

3.2.2.11. Fixed Indicator (BP 4)

Bit position 4 of the status word generated in response to any function word will always be a 1-bit.

3.2.2.12. Frame Count/Modulo 5 (BP 3-0)

If the Abnormal Frame Count indicator (BP 17) is set to one and all data words in a block have been accepted by the processor, then bit positions 2 through 0 of the status word generated in response to a Read Forward, Read Backward or Bootstrap function will contain the count of the number of data frames contained in the last input data word.

Bit position 3 of the status word generated in response to any function which specifies the 7-track format will always be zero.

3.3. ERROR RECOVERY PROCEDURES

Table 3–4 shows the status conditions which may be reported in response to each of the valid function words.

This section details the various status conditions with regard to the functions which cause them to occur and includes error recovery procedures from these conditions.

MFC	BASIC FUNCTIONS	Abnormal Frame Count 17	(Possible) End of File 16	End of Tape Warning/ Load Point 15	Interlock 14	Busy 13	Parity Error 12	Late Acknowledge 11	Tape Hash 10	Invalid Function 9	Frame Count, Modulo 5 3*–0
1_8	Read Backward	1/0	1/0	1/0	1/0	1/0	1/0	1/0	0	1/0	1/0
2_8	Rewind with Interlock	0	0	0	1/0	1/0	0	0	0	1/0	0
3_8	Rewind to Load Point	0	0	0	1/0	1/0	0	0	0	1/0	0
4_8	Bootstrap	1/0	1/0	1/0	1/0	1/0	1/0	1/0	0	1/0	1/0
5_8	Write	0	0	1/0	1/0	1/0	1/0	1/0	1/0	1/0	0
6_8	Read Forward	1/0	1/0	1/0	1/0	1/0	1/0	1/0	0	1/0	1/0
7_8	Skip/Write	0	0	1/0	1/0	1/0	1/0	1/0	1/0	1/0	0

* *BP 3 is always zero.*

Table 3–4. Possible Status Indicators, 7-Track Format

3.3.1. General Recovery Procedures

The following paragraphs cover general error recovery procedures for status indicators that may be set in response to any function code.

- Interlock Indication

  When the Interlock indicator is a 1-bit in the status word generated in response to any function, it will be the only indicator set. Tape will not have moved as a result of the receipt of the function by the subsystem. It indicates that either an operator or a program error has occurred (or that there has been a tape unit malfunction). In either case, manual intervention is required.

- Busy Indication

  When the busy indicator is the only indicator set in the status word generated in response to any function, the handling of the function by the subsystem will have no effect on the tape unit specified by the function word.

  If the Busy condition is reported because the specified tape unit has not completed the rewinding process initiated by a previous Rewind-to-Load-Point function, the recommended recovery procedure is to send the function word to the subsystem again after an interval to allow for the completion of the rewinding process.

  If the Busy condition is reported by one of the control units of a simultaneous operation subsystem because the specified tape unit is under the control of the other control unit, it indicates a program error.

- Busy plus End of Tape/Load Point Indication

  When the Busy indicator is set in combination with the End of Tape/Load Point indicator, it is the result of power dropping on the tape unit or manual intervention at the tape unit during execution of a function other than a Rewind function, or the result of detection of the Load Point Marker while tape is moving backward during execution of a Read Backward function.

  If both indicators are set as the result of power dropping or manual intervention, the program using that tape unit should usually be terminated because position on tape may be lost by as much as 18 inches. However, if the program has sufficient information to reposition tape to the position it had at the time the failing function was initiated, it may do so (after the operator properly conditions the tape unit) and then repeat the desired function.

- Invalid Function Indication

  When the Invalid Function indicator is a 1-bit in the status word generated in response to any function, it will be the only indicator set. Tape will not move on any tape unit as a result of the receipt of the function.

If the Invalid Function indicator is set as a result of sending a Write or Skip/Write function to the Auxiliary Control Unit, or as a result of the program sending any function word containing a 1-bit in bit position 4 to either type of control unit, it is a program error. If it is set as a result of the receipt of a function including a 1-bit in bit position 10 by a subsystem which does not include the Optional 9-Track Format Feature, it is a program error. If it is set as a result of receipt of a Bootstrap function by a subsystem which does not include the Optional 9-Track Format Feature when the 7CH/9CH switch is in the 9CH (down) position, it is an operator error.

3.3.2. Read Backward Function

If reading data is the immediate objective and more than one error or abnormal condition is reported, the recommended procedure is to recover from the highest priority error or abnormal condition according to the following priority sequence: Load Point plus Busy, Load Point without Busy, Possible End-of-File, Late Acknowledge, Parity Error, Frame Count Mod 5, and Abnormal Frame Count.

If moving backward one block is the immediate objective and more than one error or abnormal condition is reported, the recommended procedure is to recover from the highest priority error or condition according to the following priority sequence: Load Point plus Busy, Load Point without Busy, Possible End-of-File, Parity Error, and Late Acknowledge. Frame Count/Mod 5 and Abnormal Frame Count status indicators may be ignored when received in a status word generated in response to a Read Backward function used to move backward one block.

Suggested error recovery procedures are as follows:

- Load Point Indication (With and Without Busy Indication)

  If both the Load Point and Busy indicators are set in the status word generated in response to a Read Backward function, the Read Backward function should be sent to the subsystem a second time to determine which of two possible situations led to the dual indication.

  (1) If the response to the second Read Backward function is Interlock, it means that power was dropped on the tape unit during the attempt to execute the first Read Backward function. This situation is explained in 3.3.1.

  (2) If the response to the second Read Backward function is Load Point, it means that tape was positioned between the first block and the Load Point Marker when the first Read Backward function was initiated and that the dual indication was the result of tape moving backward until Load Point was detected.

  Whenever Load Point is the only indicator generated in response to a Read Backward function, it means that the function was received when tape was positioned at Load Point and that there was no tape motion as a result of the receipt of that function.

- End-of-File Indication

  If the End-of-File indicator is a 1-bit in the status word received in response to a Read Backward function, it means that the block contained four or fewer data frames. If the End-of-File indicator is a 1-bit, the Abnormal Frame Count indicator will also be a 1-bit. If the Read Backward function word specified even parity without translation, if the data word contains 001111 in the six low-order bit positions, and if the status word contains 0001 in the Frame Count/Mod 5 field and does not indicate detection of a parity error, then true End-of-File has been detected. If these conditions are not met, the program should determine whether or not an End-of-File record was detected by performing a Read Forward function and examining the End-of-File indicator of the resultant status word.

- Late Acknowledge Indication

  When the Late Acknowledge indicator is a 1-bit in the status word received in response to a Read Backward function, it means that the processor failed to accept an input data word within the appropriate timing limitation and then accepted one or more data words before the status word was generated.

  If the primary objective of the Read Backward function was to read data, the recommended recovery procedure is to execute a Read Forward function to move forward one block and then repeat the Read Backward function to read the desired data.

  If the primary objective of the Read Backward function was to move backward one block, the Late Acknowledge indicator may usually be ignored. However, if the status word includes a parity error indication and the number of words acknowledged by the processor does not exceed the noise constant, the program is usually unable to determine whether or not the block length exceeds the noise constant. If this is the case, the recommended procedure is to execute a Read Forward function for repositioning purposes, and then repeat the Read Backward function.

- Parity Error Indication

  When the Parity Error indicator is a 1-bit in the status word generated in response to a Read Backward function, it means that a lateral parity error was detected in one or more of the data frames read and/or a longitudinal parity error was detected in one or more of the tracks on tape.

  If the number of data words read was less than or equal to the "noise constant" software convention for the installation, then the system software convention should be followed.

  If the number of words read was greater than the noise constant and the primary objective of the Read Backward function was to read data, the following recovery procedure is recommended: read forward to position tape so the read head is over the interblock gap following (in the forward direction) the longitudinal check frame, and then attempt to read the desired data by executing a Read Backward function.

Repeated attempts to read the block should alternate between normal gain and low gain.

If the number of data words read was greater than the "noise constant" and the primary objective of the Read Backward function was to move backward one block, then the parity error should be ignored.

- Frame Count/Mod 5

  If the Frame Count/Mod 5 field of the status word received in response to a Read Forward or Read Backward function does not contain all 0-bits, the last word accepted by the processor contained some data characters and some "padded zero" characters. The field contains a binary count of the number of data characters in the word. The contents of the field are normally of interest only to the application program.

- Abnormal Frame Count

  If the Abnormal Frame Count indicator is a 1-bit in the status word received in response to a Read Forward or Read Backward function, then the block just read did not appear to contain an exact multiple of 5 data frames. If the primary objective of performing the Read was to obtain data rather than to position tape, then the fact that an abnormal frame count was detected should be made known to the application program. If the primary objective was to position the tape rather than read data, then the status indicator may be ignored.

3.3.3. Bootstrap Function

The various indicators in the status word received in response to the Bootstrap function have the same general meaning as the status bits generated in response to a Rewind-to-Load-Point function (in the case of the Interlock, Busy without End of Tape/Load Point, or Invalid Function indicators) and the status bits generated in response to a Read Forward function initiated when tape is positioned at load point (for all other indicators including the combination of Busy and End of Tape/Load Point). However, the normal software conventions dictate that the only recovery procedure which should be attempted in case an error or abnormal condition is reported is to re-initiate the Bootstrap function.

3.3.4. Write and Skip/Write Functions

If the status word generated in response to a Write or Skip/Write function reports the detection of more than one error or abnormal condition, the recommended procedure is to recover from the highest priority error according to the following priority sequence: Tape Hash, Late Acknowledge, Parity Error, and End-of-Tape Warning without Busy.

Suggested error recovery procedures are as follows:

- Tape Hash Indication

  If a Tape Hash error is detected, the program utilizing the suspect tape should be terminated and the tape removed for visual inspection. If the error persists, the tape should be permanently removed from operation.

  If any recovery procedure is attempted to recover from the Tape Hash error, the goal should be to make certain either that (a) no noise is left on the tape between the end of the previously written block and the first frame of the block to be recorded, or (b) that if noise is left on the tape, it will be in a tape area which is isolated from the preceding and following data block by a .75 inch erased tape gap and will not appear to be a block with a length greater than the "noise constant" software convention during a subsequent reading pass.

- Late Acknowledge Indication

  When the Late Acknowledge indicator is a 1-bit in the status word received in response to a Write or Skip/Write function, it means that the processor failed to supply the second or a subsequent data word for the block within the appropriate timing limitation and then sent a data word to the subsystem before the status word was generated. The procedure recommended to recover from this error is to use the Read Backward function to position tape with the write head over the interblock gap preceding the block and then write the desired data by executing a Write function.

- Parity Error Indication

  When the Parity Error indicator is a 1-bit in the status word received in response to a Write or Skip/Write function, it means that a lateral parity error was detected in one or more data frames and/or a longitudinal parity error was detected in one or more of the tape tracks during the read check. The recovery procedure for this error requires execution of a Read Backward function to position tape with the write head over the interblock gap preceding the error block, and then another attempt to write the desired data by executing a Write or Skip/Write function. A series of Skip/Write functions may also be used to erase tape and then write the desired data.

- End-of-Tape Warning Indication without Busy Indication

  When the End-of-Tape Warning indicator is a 1-bit and the Busy indicator a 0-bit in the status word generated in response to a Write or Skip/Write function, it means that the End-of-Tape Warning marker has passed the photocell. The 1-bit serves as a warning to the program that it must exercise care in continuing forward tape motion on that tape unit.

Even though the End-of-Tape Warning indicator is listed as lowest priority, it should not be ignored by the program when a higher priority error is indicated. To ignore it could lead to writing off the end of the tape, if for example, a parity error is indicated and the recovery from this error requires the use of many Skip/Write functions in order to pass over defective tape near the end of the reel.

In the case of programs which perform a Read Forward function followed by a Write or Skip/Write function (on the same tape), the programmer must remember that the End-of-Tape Warning status indicator is not set in the status word generated in response to a Read Forward function. The repetitive adding of one or more blocks to the end of a previously written tape in this manner may eventually cause the tape to be pulled off the supply reel.

3.3.5. Read Forward Function

If reading data is the immediate objective and more than one error or abnormal condition is reported, the recommended procedure is to recover from the highest priority error or condition according to the following priority sequence: End-of-File, Late Acknowledge, Parity Error, Frame Count/Mod 5, and Abnormal Frame Count.

If moving forward one block is the immediate objective and more than one error or abnormal condition is reported, the recommended procedure is to recover from the highest priority error or condition according to the following priority sequence: End-of-File, Parity Error, and Late Acknowledge. The Frame Count/Mod 5 and Abnormal Frame Count status indicators may be ignored in a status word generated in response to a Read Forward function used to move forward one block.

Suggested error recovery procedures are as follows:

- End-of-File Indication

  Detection of End-of-File should be made known to the application program.

- Late Acknowledge Indication

  When the Late Acknowledge indicator is a 1-bit in the status word received in response to a Read Forward function, it means that the processor failed to accept an input data word within the appropriate timing limitations and then accepted one or more data words before the status word was generated.

  If the primary objective of the Read Forward function was to read data, the recommended recovery procedure is to execute a Read Backward function to move backward one block and then repeat the Read Forward function to read the desired data.

  If the primary objective of the Read Forward function was to move forward one block, the Late Acknowledge indicator may usually be ignored. However, if the status word includes a parity error indication and the number of words acknowledged by the processor does not exceed the

"noise constant," the program is usually unable to determine whether or not the block length exceeds the noise constant. If this is the case, the recommended procedure is to execute a Read Backward function for repositioning purposes, and then repeat the Read Forward function.

- Parity Error Indication

  If the Parity Error indicator is a 1-bit in the status word received in response to a Read Forward function, it means that a lateral parity error was detected in one or more of the data frames and/or a longitudinal parity error was detected in one or more of the tracks on tape.

  If the number of data words read was less than or equal to the "noise constant" for the system, then the system software convention should be followed.

  If the number of data words read was greater than the "noise constant" and the primary objective of the Read Forward function was to read data, then the recommended recovery procedure is to execute a Read Backward function to position tape with the read head in the interblock gap preceding the data block, and then repeat the Read Forward function in order to read the data.

  Repeated attempts to read the block should alternate between normal gain and low gain.

  If the number of data words read is greater than the "noise constant" and the primary objective of the Read Forward function was to move forward one block, then the parity error should be ignored.

- Frame Count/Modulo 5

  See paragraph 3.3.2.

- Abnormal Frame Count

  See paragraph 3.3.2.

3.4. TIMING

When data is being handled (either reading or writing), magnetic tape moves past the read/write head at 42.7 inches per second. To reach this operating speed from a stopped position and move in either direction takes about 7 milliseconds. In preparation for initiating tape motion for a data handling function, the control unit determines the direction of the most recent motion on the tape unit. If the desired motion is in the opposite direction from the most recent motion on the specified tape unit, the control unit instructs the tape unit to prepare for motion in the desired direction, delays for 25 milliseconds and then initiates motion. The response time plus the deceleration time required to halt tape motion is about 5 milliseconds.

The control unit bypasses the "last motion direction" checking sequence when it initiates either form of Rewind function. The time required to reach the nominal 160 inches/second rewinding speed is about 10 seconds. Rewind time for a full 2400 foot reel of tape is 3.0 minutes.

The density sensitive operating characteristics of the subsystem are shown in Table 3–5. The permitted processor response times shown in each of the operating density columns must not be exceeded to insure that a Late Acknowledge indicator will not be set in the status word generated in response to a data transfer function. For reading functions (Read Forward, Read Backward, or Bootstrap), the entries indicate the maximum permitted interval between the time a control unit makes a data word available to the processor and the time the subsystem receives an Input Acknowledge signal from the processor indicating the data word has been accepted. For writing functions (Write and Skip/Write) the entries indicate the maximum permitted interval between the time the subsystem requests the processor to send the third or subsequent data word for a block and the time the subsystem must receive the word in order to write that word in the block.

	OPERATING DENSITY		
	200 FRAMES/INCH	556 FRAMES/INCH	800 FRAMES/INCH
FRAME TIME (microseconds)	117.1	42.1	29.3
WORD TIME (microseconds)	585.5	210.6	146.4
TRANSFER RATE:			
FRAMES PER SECOND	8,540	23,720	34,160
WORDS PER SECOND	1,708	4,744	6,832
PERMITTED PROCESSOR RESPONSE TIMES (microseconds) READ:			
REPETITIVE MAXIMUM	579	204	139
1 TIME MAXIMUM	686	236	159
WRITE:			
REPETITIVE MAXIMUM	580	205	140
1 TIME MAXIMUM	682	232	155

Table 3-5. Density Sensitive Characteristics

Table 3-6 shows function initiation timing. The times listed for functions which lead to data handling are based on the assumption that:

(1) the most recent tape motion on the unit specified in the function word was in the same direction (forward or backward) as required to perform the function,

(2) the tape is at rest at the starting reference time,

(3) the erased tape gap between blocks on a tape being read is .75 inch.

If the first assumption is not correct, 25 milliseconds must be added to the times shown. If the second assumption is not correct, Table 3–8 should be consulted.

FUNCTION	STARTING REFERENCE TIME	ENDING REFERENCE TIME	ELAPSED TIME
Read Forward	Function Received	First data frame read	18.7 ms
Read Backward	Function Received	First data frame read	11.0 ms
Write	First Data Word Received	First data frame written	12.8 ms
Skip Write	First Data Word Received	First data frame written	89.9 ms
Any Function	Function Received	EI signal turned on with Interlock indicated in status word.	0.1 ms

Table 3-6. Function Initiation Timing

Table 3-7 shows function ending timing. The times listed are for the interval from the time:

(a) the last data frame is read for a Read Forward or Read Backward function,

(b) the last data frame is written for a Write or Skip/Write function, or

(c) the function word is received for a Rewind-with-Interlock or Rewind-to-Load Point function

to the time the status word is generated in response to the function and made available to the processor with an External Interrupt (EI) signal. The information in Tables 3-6 and 3-7 plus the appropriate word transfer time in Table 3-5 may be used to determine the interval from the time a function word, with a tape at rest, is received by the subsystem until the status word reporting on the result of the operation is made available to the processor.

Table 3-8 provides information on inter-function timing. This is the time between the turning on of the External Interrupt signal which indicates to the processor that the status word is available, and the reading or writing of the first data frame as required by the next function. The inter-function interval between any two sequential functions is dependent on three elements:

(1) what the two functions are,

(2) whether they reference the same or different tape units (in a sequence of two Write functions whether the two tape units referenced are in the same quad or different quads),

(3) the interval between the turning on of the EI signal in response to the first function and the receipt of either the second function or the first data word to be written for the second function.

Table 3-8 may be used in conjunction with Table 3-7 to determine the interblock gap passing time.

FUNCTION	STARTING REFERENCE POINT	TIME TO EI SIGNAL TURNED ON
Read Forward	Read last data frame in the block	2.2 ms
Read Backward	Read first data frame in the block (the last frame read)	9.6 ms
Write and Skip Write	Write last data frame in the block	9.0 ms
Rewind (either form)	Function word received	0.1 ms

Table 3–7. Function Ending Timing

FUNCTION SEQUENCE	INTERVAL BETWEEN EXTERNAL INTERRUPT SIGNAL AND FIRST DATA FRAME (ms)	
	SAME TAPE UNIT	DIFFERENT TAPE UNIT*
Read Forward, then Read Forward	16.6 (note 1) 23.7+W (note 2)	18.7+X* (note 3)
Read Backward, then Read Forward	43.7+X (note 3)	18.7+X* (note 3)
Write, then Read Forward	(note 4)	18.7+X* (note 3)
Read Forward, then Read Backward	36.0+X (note 3)	11.0+X* (note 3)
Read Backward, then Read Backward	8.4 (note 1) 16.0+W (note 2)	11.0+X* (note 3)
Write then Read Backward	36.0+X (note 3)	11.0+X* (note 3)
Read Forward then Write	12.8+Y (note 5)	12.8+Y* (note 5)
Read Backward, then Write	37.8+Y (note 5)	12.8+Y* (note 5)
Write, then Write (same quad)	17.8 (note 6) 17.8+Z (note 7)	17.8* (note 6) 17.8+Z* (note 7)
Write, then Write (different quad)		12.8+Y* (note 5)

* If the second function in the sequence calls for motion in the opposite direction from the last motion on the specified tape unit, then 25 ms must be added to the time indicated. (See notes below).

Table 3–8. Inter-Function Timing

NOTES FOR TABLE 3–8

Note 1: This time is based on the assumption that the second function in the sequence is received within 2.0 milliseconds of the EI signal turned on in response to the first function.

Note 2: This time is based on the assumption that the second function is received at least 4.5 milliseconds after the EI signal turned on in response to the first function. "W" is the elapsed time between the end of the 4.5 milliseconds interval and the receipt of the function. If the second function is received between 2.0 and 4.5 milliseconds after the EI signal is turned on, the interval between the EI signal and the first data frame will be between the two values shown.

Note 3: "X" is the interval between the time the EI signal is turned on in response to the first function and the time the second function is received.

Note 4: Write, then Read Forward on the same tape unit is not a logical sequence and should not be used.

Note 5: "Y" is the interval between the time the EI signal is turned on in response to the first function and the time the first data word for the second function in the sequence is received.

Note 6: This time is based on the assumption that both the second Write function in the sequence and the first data word are received within 4.5 milliseconds of the EI signal turned on in response to the first Write function.

Note 7: This time is based on the assumption that the first data word for the second function is received at least 4.5 milliseconds after the EI signal is turned on in response to the first function. "Z" is the elapsed time between the end of the 4.5 milliseconds and the time the first data word is received.

4. OPERATION

4.1. OPERATOR RESPONSIBILITIES

The operator is responsible for turning on and turning off power to the various components of the UNISERVO VI C Magnetic Tape Subsystem, tape loading and unloading as required for operation, and responding to inquiries and instructions via the system console.

4.2. CONTROLS AND INDICATORS

4.2.1. UNISERVO VI C Magnetic Tape Units

Each UNISERVO VI C Magnetic Tape Unit includes a Control/Indicator Panel for the operator located across the front top of the unit as shown in Figure 4-1. This panel includes four switches, two indicators, and five switch/indicators labeled as follows, from left to right: A numerical indicator, LOCAL, REMOTE, FORWARD, UNLOAD, WRITE ENABLE, REWIND, LOAD POINT, ON, OFF, and DENSITY. None of the indicators on any tape unit in a quad will be lit and none of the switches will be effective if AC power is not being received by the power supply unit in the UNISERVO VI C Master Magnetic Tape Unit of the quad. Table 4-1 details their usage.

Figure 4-1. UNISERVO VI C Control/Indicator Panel

Control and/or Indicator	Function and/or Indication
Numerical Indicator 0 through 15	This is a translucent plastic insert engraved with one of the numbers from 0 through 15. It identifies the logical or "PROGRAM" number assigned to the physical magnetic tape unit by the wiring on the PHYSICAL/PROGRAM plugboard portion of the Control/Indicator Panel on the Standard Control Unit. It is the operator's responsibility to change the numerical indicator on a magnetic tape unit whenever he changes the PHYSICAL/PROGRAM wiring and assigns a different logical number to that physical magnetic tape unit. The numeral is lit if the ON indicator is depressed or when any rewinding process is completed. The numeral is turned off when the OFF switch is depressed, when any rewinding process (either manual or program) is initiated, whenever tape is pulled out of either of the two vacuum columns, or whenever tape enters either vacuum column so far that it is between the innermost end of the column and the 4th pressure sensing port.
LOCAL	When this white switch/indicator is lit, it means that a control unit will not send any motion or conditioning signals to the tape unit. If the control unit receives a valid function for a tape unit on which the LOCAL indicator is lit, an Interlock condition will be indicated in the status word generated in response to the function. If the LOCAL indicator is not lit, only the LOCAL, ON, and OFF switches are operational. If the LOCAL indicator alone is lit, only the ON switch is operational. If both the LOCAL and ON indicators are lit then all switches are operational. The LOCAL indicator will be turned on when: (1) AC power is first applied to the power supply for the quad, (2) the LOCAL, ON, or OFF switch is depressed, (3) the tape unit receives a Rewind-with-Interlock signal from a control unit, (4) tape is pulled out of either vacuum column or extends too far into either vacuum column as a result of a malfunction. The LOCAL indicator is turned off when: (1) the Load Point Marker reaches the marker detector after the LOAD POINT switch is depressed, (2) the REMOTE switch is operational and depressed, (3) power is removed from the power supply for the quad. When the Local switch is depressed the REMOTE indicator, if lit, will be turned off. If the LOCAL switch is depressed while a Rewind-to-Load-Point process is active, the process is converted to a Rewind-with-Interlock process.

Table 4–1. UNISERVO VI C Controls and Indicators (Sheet 1 of 7)

Control and/or Indicator	Function and/or Indication
REMOTE	When this green switch/indicator is lit it means that the tape unit is conditioned to accept signals from a control unit, provided the ON indicator is lit. Except for a Write function specifying a tape unit on which there is a reel of tape without a write enable ring, no Interlock condition will occur if the REMOTE indicator on the tape unit specified by the function is lit at the time the control unit receives the function word. When the REMOTE indicator is lit, only the LOCAL, ON, and OFF switches are operational. A prerequisite for the REMOTE indicator being lit is that the ON indicator be lit. The only exception to this rule is that the REMOTE indicator is lit and the ON indicator is not lit during a Rewind-to-Load Point process. The REMOTE switch is operational only if both the LOCAL and ON indicators are lit. The REMOTE indicator is turned on when: (1) the Load Point Marker reaches the marker detector after the LOAD POINT switch is depressed, (2) the REMOTE switch is depressed when it is operational. Depression of the REMOTE switch in this case extinguishes the LOCAL indicator. The REMOTE indicator is extinguished when: (1) the LOCAL, ON or OFF switches are depressed, (2) a Rewind-with-Interlock process is initiated by a control unit. (3) tape is pulled out of either vacuum column or extends too far into either vacuum column.

Table 4–1. UNISERVO VI C Controls and Indicators (Sheet 2 of 7)

Control and/or Indicator	Function and/or Indication
FORWARD	When this green switch/indicator is lit it means that the tape unit is conditioned for forward motion. The control unit therefore need not delay 25 ms before signalling the tape unit to move tape forward for a Write, Skip/Write, Read Forward, or the read phase of a Bootstrap function. The FORWARD indicator is never lit unless the ON indicator is lit. The FORWARD indicator is turned on when: (1) the FORWARD switch is depressed, (2) the control unit sends a Forward signal to the tape unit, (3) forward tape motion is initiated as a result of depressing the LOAD POINT switch, (4) tape halts and starts to move forward to Load Point near the end of a Rewind-to-Load-Point process, (5) the ON switch is depressed. The FORWARD indicator is extinguished when: (1) the control unit sends a Backward signal to the tape unit, (2) either form of Rewind process is initiated by a control unit, (3) the UNLOAD, OFF, or REWIND switch is depressed. The FORWARD switch is operational only when both the LOCAL and ON indicators are lit. Depression of the FORWARD switch when it is operational initiates tape motion in the forward direction at 42.7 inches per second. Releasing the switch halts tape motion. If the LOAD POINT indicator is lit, depression of the FORWARD switch will extinguish the LOAD POINT indicator if the switch is depressed long enough to move the Load Point Marker away from the marker detector.
UNLOAD	The primary purpose of this red switch is to move tape in a backward direction following a Rewind-with-Interlock function so that all tape will be removed from the takeup reel as part of the tape unloading procedure. The UNLOAD switch is operational only when both the LOCAL and ON indicators are lit. Depressing the UNLOAD switch when it is operational extinguishes the FORWARD indicator and initiates tape motion in the backward direction at 42.7 inches per second. Tape motion is halted when the UNLOAD switch is released or when tape extends too far into the lower vacuum column. If the LOAD POINT indicator is lit, depression of the UNLOAD switch will extinguish the Load Point indicator when the switch is held down long enough to move the Load Point Marker away from the marker detector. If the UNLOAD switch is held down until motion is halted as a result of tape extending too far into the lower vacuum column, all indicators except the LOCAL indicator will be extinguished.

Table 4–1. UNISERVO VI C Controls and Indicators (Sheet 3 of 7)

Control and/or Indicator	Function and/or Indication
WRITE ENABLE	When this yellow indicator is lit it signifies that the mounted reel of tape has a write enable ring in place. Writing and erasing can take place on that tape. The WRITE ENABLE indicator will light only when the ring is in place and the ON switch is pressed or a rewind operation is completed. The WRITE ENABLE indicator is turned off when: (1) a rewinding process is initiated either by the control unit or manually, (2) the OFF switch is depressed, (3) tape is pulled out of either vacuum column or extends too far into either vacuum column.
REWIND	This white switch manually initiates a Rewind-with-Interlock function. Tape will be pulled from the vacuum columns and rewound at high speed. The REWIND switch is operational only when both the LOCAL and ON indicators are lit. When the REWIND switch is depressed the FORWARD indicator will be turned off. The tape will move in a backward direction until the Load-Point Marker is detected, at which time tape motion halts. If the LOAD POINT switch is depressed between the time the REWIND switch is depressed and tape motion halts, the manually initiated Rewind-with-Interlock process is converted to a Rewind-to-Load-Point process. In this case, the LOCAL indicator will be extinguished and the REMOTE indicator will be turned on when tape comes to rest with the Load Point Marker under the marker detector. Depression of the REWIND switch when the LOAD POINT indicator is lit is not recommended. Repetitive depression of the REWIND switch when tape is positioned at load point will pull the tape out of the upper vacuum column thereby having the same effect as depressing the OFF switch.
LOAD POINT	When this white switch/indicator is lit, tape is positioned at Load Point. The LOAD POINT indicator can be lit only if the ON indicator is lit. The LOAD POINT indicator is turned on when the Load Point Marker is under the detector. This can be as a result of: (1) depressing the LOAD POINT switch, (2) completing a Rewind-to-Load Point process, (3) attempting execution of a Read Backward function when tape is positioned with the read head between the first block and the Load Point marker.

Table 4–1. UNISERVO VI C Controls and Indicators (Sheet 4 of 7)

Control and/or Indicator	Function and/or Indication
LOAD POINT (Continued)	The LOAD POINT indicator is extinguished when the Load Point Marker moves out from under the detector. This can be the result of a forward tape motion signal received from a control unit when tape is at Load Point at the start of the execution of a Read Forward, Write, Skip/Write, or Bootstrap function. It can also be the result of depressing either the FORWARD or UNLOAD switch when tape is at Load Point. The LOAD POINT indicator will also be extinguished if the OFF switch is depressed or if the tape is pulled out of either vacuum column or extends too far into either vacuum column. The LOAD POINT indicator will blink on and then off if the Load Point Marker passes under the marker detector while the FORWARD or UNLOAD switch is depressed. Depression of the LOAD POINT switch when both the LOCAL and ON indicators are lit turns on the FORWARD indicator and initiates tape motion in the forward direction at 42.7 inches/second. When the Load Point Marker is detected, tape motion halts, the LOCAL indicator is extinguished, and the REMOTE indicator is turned on. The tape motion initiated by depressing the LOAD POINT switch is also halted if either the ON or the OFF switch is depressed, or if tape is pulled out of either vacuum column or extends too far into either vacuum column. Depression of the LOAD POINT switch when tape is positioned at Load Point does not initiate tape motion, but it does extinguish the LOCAL indicator and turn on the REMOTE indicator. Depression of the LOAD POINT switch when tape is moving backwards as a result of a Rewind-with-Interlock process initiated manually or by the program, converts the Rewind-with-Interlock process to a Rewind-to-Load-Point process.
ON	When this green switch/indicator is lit it means that both of the reel motors and the vacuum motor are on, tape is properly loaded in both vacuum columns, and the tape unit is conditioned for either manual or program control. The ON indicator is turned on when tape is loaded in both vacuum columns and positioned within the normal operating range. This occurs when: (1) the ON switch is depressed as part of the tape-loading procedure,

Table 4–1. UNISERVO VI C Controls and Indicators
(Sheet 5 of 7)

Control and/or Indicator	Function and/or Indication
ON (Continued)	(2) backward motion stops near the end of a Rewind-to-Load-Point process, (3) a Rewind-with-Interlock process is completed. The ON indicator is extinguished when: (1) the OFF switch is depressed, (2) tape extends too far into either vacuum column (3) tape is pulled out of either vacuum column as it is during a rewinding process initiated manually or by program. The effect of depressing the ON switch is dependent on the conditions existing at the time it is depressed: ■ If it is depressed when no indicators are lit on the operator's panel, there will be no effect since power is not reaching the power supply for the quad. ■ If it is depressed when the LOCAL indicator is lit and tape has been threaded and wound onto the take up reel as part of the tape loading procedure: the Numerical Indicator, FORWARD, WRITE ENABLE (if appropriate), and ON indicators are immediately turned on; both reel motors and the vacuum motor are turned on; tape is loaded into the proper position in both vacuum columns (provided the ON switch is held down for about two seconds); and the tape unit is conditioned for further manual operation. ■ If the ON switch/indicator is depressed when it is lit or when a rewinding process is active, tape motion is halted; the tape unit is master cleared; the REMOTE indicator is extinguished if it is lit; the LOCAL and FORWARD indicators are turned on; and, if a rewinding process is occuring, tape is loaded into the vacuum columns. ■ Whenever the ON switch is depressed, the tape unit's memory of the position of the End-of-Tape warning marker with respect to the detector is cleared so that the tape unit will not report to the control unit that the End-of-Tape warning marker is on the take-up reel side of the marker detector. Pressing the ON switch during a computer run involving that tape unit should be avoided.
OFF	This red switch is used to turn off power to the tape unit. Depression of the OFF switch turns off the reel and vacuum motors, and extinguishes all indicators except the LOCAL indicator. The LOCAL indicator will be turned on if it is not lit at the time the OFF switch is depressed.

Table 4–1. UNISERVO VI C Controls and Indicators
(Sheet 6 of 7)

Control and/or Indicator	Function and/or Indication
DENSITY	This three-position rotary switch is used by the operator to specify the operating density for Read Forward, Read Backward, Write, Skip/Write, and Bootstrap functions. If both bits of the Density field (bit positions 13 and 12) of any of these function words are zero, the control unit probes the setting of the DENSITY switch on the specified tape unit at the time the function is initiated and proceeds accordingly. If either or both of the bits in the Density field of a function word are 1-bits, the control unit ignores the setting of the DENSITY switch and operates at the density specified by the function word.

Table 4–1. UNISERVO VI C Controls and Indicators (Sheet 7 of 7)

4.2.2. Standard Control Unit

The Control/Indicator Panel on the upper portion of the left hand front door of the Standard Control Unit is shown in Figure 4-2. It contains three switch/indicators plus a dual indicator across the top, 16 physical jacks and 16 program plugs, and a two-position toggle switch behind the program/physical wiring. The three switch/indicators and the dual indicator near the top of the panel are labelled as follows from left to right: ON, OFF, CLEAR, and TEMP/TEST. Their usage is given in Table 4-2.

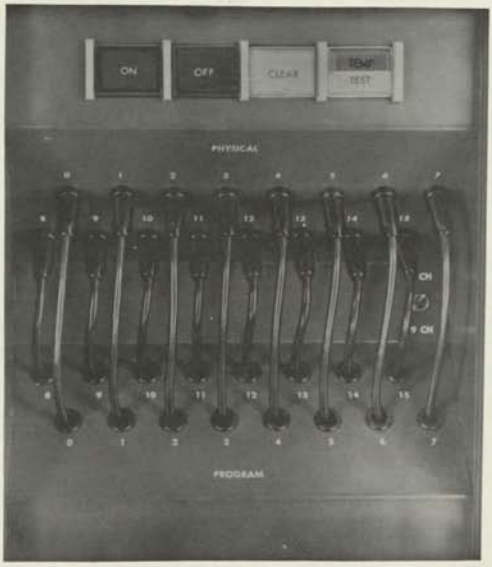


Figure 4–2. Standard Control Unit Control and Indicator Panel

Control and/or Indicator	Function and/or Indication
ON	This green switch/indicator is used to turn on DC power to the Standard Control Unit in a non-simultaneous operation subsystem and to both the Standard Control Unit and the Auxiliary Control Unit in a simultaneous operation subsystem. When the ON indicator is lit it means that power is distributed throughout the control unit circuitry. The ON indicator is lit when the ON switch is depressed. The ON indicator is extinguished when the OFF switch is depressed. Depression of the ON switch for up to two seconds when the OFF indicator is lit: (1) turns on the ON indicator, (2) turns on the cooling blower motor in each control unit, (3) turns on DC power to all control unit circuitry, (4) clears all control unit circuitry to the master clear state, and (5) conditions the control unit (or units) to receive a function word from the processor. Depression of the ON switch when the ON indicator is lit or when the OFF indicator is not lit has no effect.
OFF	This red switch/indicator is used to turn off DC power to the control unit (or units). The OFF indicator is turned on when AC power reaches the power supply unit in the base of the Standard Control Unit. The OFF indicator is extinguished when the ON switch is depressed and vice versa. Depression of the OFF switch when the ON indicator is not lit has no effect.
CLEAR	This white switch/indicator is used to master clear all control unit circuitry and condition the control unit (or units) to receive a function word from the processor. The CLEAR switch/indicator is turned on when depressed provided the ON indicator is lit. The CLEAR indicator is extinguished when the switch is released. Depression of the CLEAR switch when the ON indicator is not lit has no effect.

Table 4–2. Standard Control Unit Controls and Indicators
(Sheet 1 of 2)

Control and/or Indicator	Function and/or Indication
TEMP / TEST	This dual indicator is a split indicator. The top is red and labelled TEMP; the bottom is yellow and labelled TEST. The red TEMP indicator is used to warn the operator and maintenance personnel that a sensor in the control unit detects a high temperature condition. A buzzer in the Standard Control Unit is also turned on when the TEMP indicator is turned on. When this buzzer sounds, it can be disabled by setting to Off position a 2-position toggle switch on the Standard Control Unit. This switch is located behind the lower portion of the left front door below the jack outlet labelled "–4.5". The yellow TEST indicator is used to indicate that the subsystem is not conditioned to react to function words, data words, or control signals which may be received from the processor. The TEST indicator is turned on when the ON indicator is lit and any of five 2-position toggle switches labelled RUN, TEST, REPEAT, LIGHTS ON, and DISC EI are in up position. These toggle switches are located on the maintenance panel behind the right front door of the Standard Control Unit (and Auxiliary Control Unit).
7CH / 9CH	This 2-position toggle switch is used to specify whether the control unit should read a tape as a 7- or 9-track format tape when executing the read portion of a Bootstrap function. "Up" position is used for 7-track format; "down" for 9-track format. The switch should always be in the up position for a subsystem which does not include the Optional 9-Track Format Feature. See Appendix B for details on the use of this switch in a subsystem which includes the 9-Track Format Feature.

Table 4–2. Standard Control Unit Controls and Indicators (Sheet 2 of 2)

4.2.2.1. Physical/Program Tape Unit Association

The 16 physical jacks and the 16 program plugs on the sloping surfaces of the panel are used to associate the program or logical tape unit with a physical tape unit. The wiring from a numbered program plug to a numbered physical jack assigns that logical tape unit number to the physical tape unit. The connections between the physical tape units and the physical jacks are set when the subsystem is installed.

Normal plugging on this plugboard is from Program plug 0 to Physical jack 0, from Program plug 1 to Physical jack 1, etc. When wiring is changed, it is the operator's responsibility to change the numerical indicators on the UNISERVO VI C Control/Indicator Panels to agree with the Program/Physical wiring.

4.2.3. Auxiliary Control Unit

The Auxiliary Control Unit contains no operator controls.

4.3. SUBSYSTEM OPERATION

4.3.1. Turn-On Procedure

In order for the subsystem to be considered "turned on," the ON indicator on the Control/Indicator Panel of the Standard Control Unit and the LOCAL indicator on the Control/Indicator Panel of each UNISERVO VI C Magnetic Tape Unit to be utilized must be lit. When the subsystem is to be turned on after a system shutdown, the main circuit breaker for the system should be checked to make certain that AC power is available to the components of the subsystem. Set the ON/OFF switch (located on the master tape unit Power Panel*) to the ON position in each quad to be used. This will turn on the LOCAL indicators. Finally, the ON switch on the Standard Control Unit's Control/Indicator Panel should be pressed.

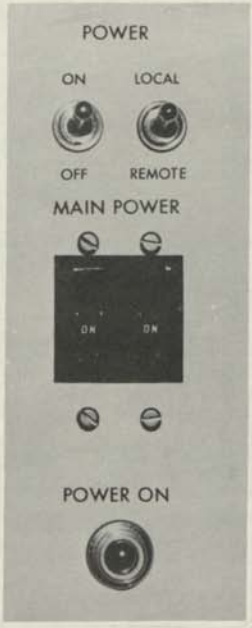


Figure 4–3. UNISERVO VI C Master Tape Unit Power Panel

* *The Power Panel (see Figure 4–3) is inside the rear door of the master tape unit.*

4.3.2. Tape Loading

When tape is not properly loaded on the tape unit, all motors in the unit will be turned off. The following procedure is then used to install (load) a reel of tape:

(1) Before proceeding to install the reel, check to see if it contains a write enable ring:

- If the tape is to be written on, the write enable ring must be inserted in the slot in the back of that reel.

  Figure 4–4 shows the back side of a reel of tape and a write enable ring. The ring fits into the slot around the core of the reel.

- If no writing is to be done on the tape, it must not contain a write enable ring. Without the ring, no inadvertent writing or erasing can take place.

  During a rewinding operation, the write enable ring is disabled to prevent any inadvertent erasing.

(2) If the program calls for manual density selection, set the Density switch accordingly.

(3) Open the glass door on the upper front of the unit.

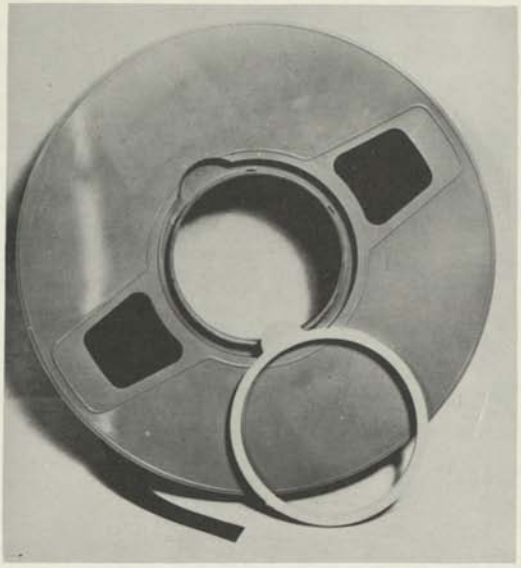


Figure 4–4. Reel of Tape and Write Enable Ring

(4) Place the core of the reel on the supply reel hub so that the leading end of the tape is to the right. Press in the reel to lock in place. Figure 4-5 shows the tape transport panel with a reel of tape mounted on the supply reel hub. Figure 4-6 shows a close-up view of the head unit with the cover open and identifies items referenced below.

(5) While using the left hand to control tape movement from the supply reel so that excessive tape is not unreeled, thread the leading end of the tape under the pulley at the lower left hand corner of the upper vacuum column, between the capstan and the pressure roller at the top of the head unit, then down between erase head and the Load Point and End of Tape Warning Marker Detector, and over the read/write head as shown in Figure 4-7.

(6) Bring the leading edge between the lower capstan and pressure roller, around the pulley between the pressure roller and the lower vacuum column, and over the lower vacuum column and the pulley near the upper left hand corner of the lower vacuum column as shown in Figure 4-8.

(7) Draw the leading edge of the tape around the under side of the core of the take-up reel in a clockwise direction until there is enough slack for the end of the tape to fall against the top side of the core of the take-up reel. Hold the leading edge of the tape against the core by inserting a finger through one of the openings in the reel and turn the take-up reel clockwise so that the leading edge of the tape is held in place against the core of the reel by an additional turn of tape. Rotate the take-up reel clockwise three or four turns so that the tape is held securely on the take-up reel (see Figure 4–9).

(8) Close the glass door.

(9) Depress the ON switch and hold (for 2 seconds or so) until tape has been loaded into both the upper and lower vacuum columns and both reels are at rest.

(10) Depress the LOAD POINT switch. Tape will move in a forward direction (from the supply reel to the take-up reel) until the Load Point Marker is under the marker detector, at which time the LOCAL indicator will turn off and the LOAD POINT and REMOTE indicators will turn on. The tape unit is now ready for remote operation under control of the processor via a control unit.

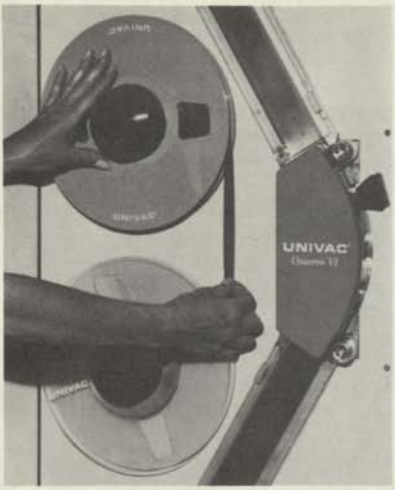
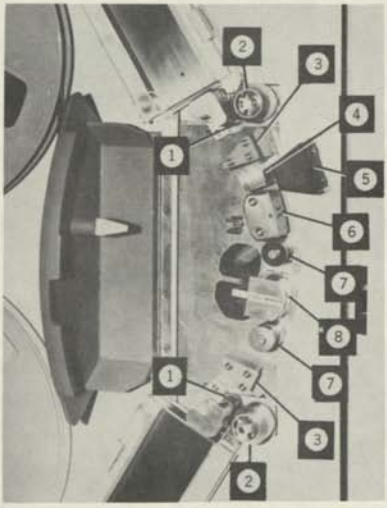


Figure 4–5. Tape Reel Mounted on Supply Reel Hub

Figure 4–7. Tape Threaded Down Over Read/Write Head



In this close-up of the Head Unit, the following are indicated:

1. Pressure Rollers
2. Capstans
3. Chute Guides
4. Erase Head
5. Load Point and End of Tape Warning Marker Detector
6. Tape Cleaner
7. Edge Guides
8. Read/Write Head

Figure 4–6. Head Unit With Cover Open

Figure 4–8. Tape Threaded Over Lower Vacuum Column

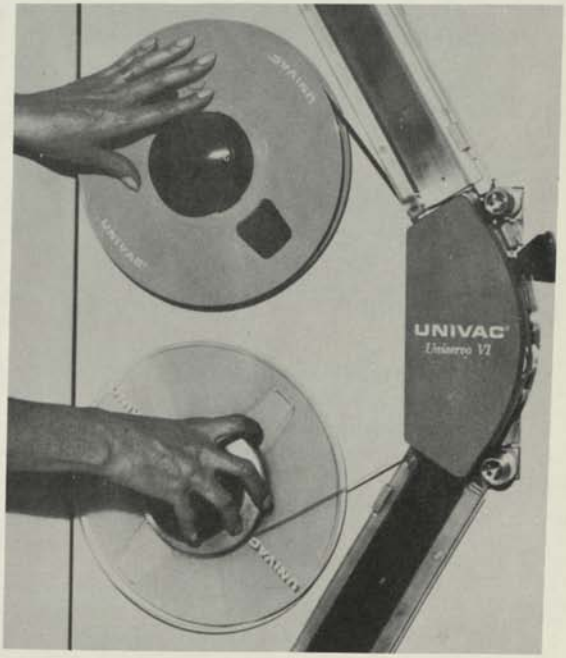


Figure 4–9. Tape Securely On Take-Up Reel

4.3.3. Tape Unloading

When operations on a reel of tape have been completed, the program will normally have issued a Rewind-with-Interlock function in preparation for unloading tape. If a Rewind operation is in progress when it is desired to unload tape, the operator should wait until the operation is complete. (If it is desired to unload tape when tape is not positioned at or near load point, a Rewind-with-Interlock operation should be initiated manually by depressing the LOCAL switch when tape is not moving, and then depressing the REWIND switch).

The REWIND switch should not be depressed when tape is positioned with the Load-Point Marker on the supply reel side of the marker detector because this may damage the leading end of the tape when it is released from the take-up reel.

To unload tape when tape is at rest with the Load Point Marker near the marker detector:

(1) Make sure the LOCAL indicator is lit (if not, depress the LOCAL switch) and then depress and hold the UNLOAD switch until the trailing end of the tape feeds off the take-up reel.

(2) Open the glass door.

(3) Rotate the supply reel counterclockwise to wind the leading edge of the tape onto that reel.

(4) Depress the supply reel hub to unlock the tape reel.

(5) Remove the tape reel from its hub. The tape unit is now ready to receive a new reel of tape.

4.4. OPERATOR-PERFORMED MAINTENANCE

4.4.1. Tape Markers

The magnetic tape must include the Load Point marker and the End of Tape Warning Marker Detector as shown in Figure 4-10.

These two markers are light-reflective, aluminum strips measuring 1 x 3/16 inches with a pressure-sensitive adhesive on the reverse side (Univac part number 3011819-00). These strips are mounted on the shiny side of the tape (the outside, as the tape is wound on the reel). The inside of the tape contains the iron oxide coating.

The Load Point marker is placed 1/32 inch from the outside edge of the tape, at least 10 feet from the leading end. When the tape is mounted in the unit, the outside edge is the edge nearest the operator.

The End-of-Tape Warning marker is placed 1/32 inch from the inside edge of the tape, at least 14 feet from the trailing end.

Should the tape not contain these markers or should either end of the tape become damaged, these markers must be applied or re-applied according to the above specifications.

Successful tape operation cannot be obtained unless the tape contains both of these markers, properly placed on the tape.

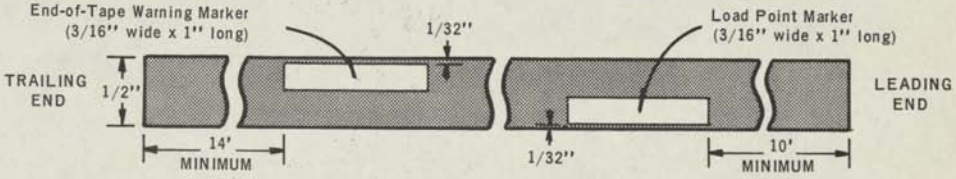


Figure 4–10. Tape Markers

4.4.2. Cleaning Instructions

Foreign matter on the tape can interfere with successful operation. For this reason, the tape and the areas contacted by the tape must be kept as clean as possible.

When tape is not in use, it should be kept in the containers designed for its protection. When a reel of tape is to be installed, no more tape should be unreeled than is necessary to load the transport.

Because of the speed of movement and the friction generated when the tape contacts the various surfaces in the tape unit, a certain amount of dirt and tape material will be deposited on these surfaces. The action of the vacuum columns will cause small amounts of dust to be deposited on the surfaces of these chambers.

To prevent a decrease in reliability due to dirt and dust accumulations, the operator must maintain a regular cleaning schedule based on the number of hours of operation. There should be no tape in the transport at the time of cleaning.

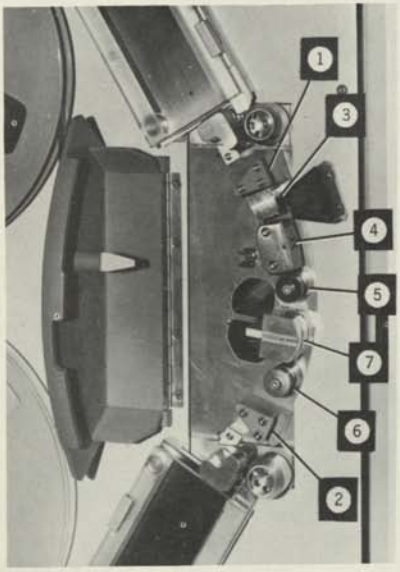
- Every two hours: clean the chute guides, edge guides, erase head, read/write head, and the tape cleaner in the head unit (see Figure 4-11).
- Every eight hours: clean the vacuum columns and the capstans and pressure rollers (see Figure 4-12).

If this schedule is not observed, accumulations of oxide and dirt can make the cleaning operation quite difficult.

To perform these operations, an initial supply of the following materials is furnished:

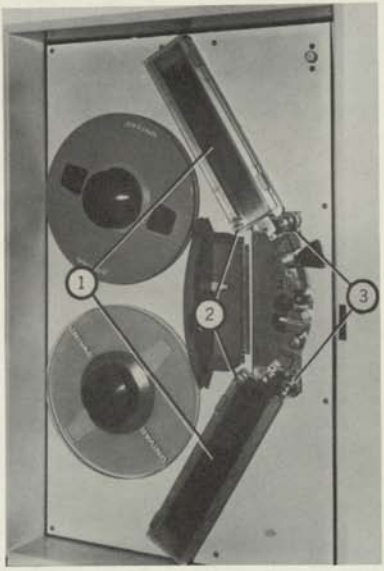
- A can of Freon TF Solvent. It is the only cleaning solvent warranted for use with this equipment. It is a neutral fluid that will not damage the tape nor elements of the tape unit. Residual traces of some solvents can cause tape damage.
- Swabs, tissues, and a bristle brush.

Additional quantities of the Freon TF Solvent are supplied by the Univac Field Engineer. Additional supplies of the swabs, tissues, and brushes are maintained by the customer.



1. Upper Chute Guide
2. Lower Chute Guide
3. Erase Head
4. Tape Cleaner
5. Upper Edge Guide
6. Lower Edge Guide
7. Read/Write Head

Figure 4–11. Items for Two-Hour Cleaning



1. Vacuum Columns
2. Vacuum Column Pulleys
3. Capstans and Pressure Rollers

Figure 4–12. Items for Eight-Hour Cleaning

4.4.2.1. Two-Hour Cleaning

(1) Swing open the cover of the *Head Unit*. This cover is hinged at the left and pulled open from the right.

(2) With the bristle brush soaked with the cleaning solvent, clean all surfaces of both the upper and lower *Chute* and *Edge Guides*. Spin the *Edge Guides* to be assured they are free to rotate.

(3) With a portion of a full tissue dampened with the cleaning solvent, clean the full surface of the *Read/Write Head*. Clean the *Erase Head* and the *Tape Cleaner*.

(4) With the dry portion of the tissue, wipe the *Chute* and *Edge Guides*, *Read/Write Head*, and the *Tape Cleaner*.

(5) Close the *Head Unit* cover. This cover is held in place by a spring clip inside the *Head Unit*.

4.4.2.2. Eight-Hour Cleaning

The above procedure should be performed in addition to the following procedure for the balance of the tape unit.

(1) Open the *Head Unit* cover.

(2) Open and remove the glass vacuum column covers. The cover for the upper vacuum column is hinged at the right. The cover for the lower vacuum column is hinged at the left. After a cover is opened, it is removed by lifting it off its hinges.

(3) With a tissue dampened with cleaning solvent, clean all surfaces of both *vacuum columns*. Pay particular attention to see that the areas around the vacuum openings are free of any foreign matter.

(4) Clean the pulley at the lower left corner of the upper column and the pulley at the upper left corner of the lower column. Also clean the pulleys in the metal blocks at the top and bottom of the *Head Unit*. Spin these pulleys to be assured they will rotate freely.

(5) Clean the inside of the vacuum column covers and replace them.

(6) With a tissue dampened with cleaning solvent, wipe each *pressure roller* from one end to the other while rotating the roller with a finger held against the outer edge.

(7) Clean the capstans with a tissue dampened with the solvent.

(8) Close the *Head Unit* cover.

(9) Before closing the glass door, dust the interior of the Tape Transport area with a dampened tissue.

APPENDIX A. SUMMARY OF PHYSICAL CHARACTERISTICS AND OPERATIONAL REQUIREMENTS

Table A-1 lists permissible temperature and humidity ranges and cabling restrictions for the subsystem.

Table A-2 lists physical dimensions and weight for each of the cabinets in a subsystem.

Table A-3 lists heat dissipation, cooling blower thruput, permitted primary power inputs, and power consumption for each of the cabinets in a subsystem.

PARAMETER	SPECIFICATION
Environment:	
Ambient Temperature	60-80°F
Optimum	72°F
Relative Humidity	30-70%
Optimum	50%
Distances:	
Processor to Control Unit	200 ft maximum cable length
Standard Control Unit to most distant Master Tape Unit	140 ft maximum total cable length
Individual Cable Lengths:	
Control Unit to first UNISERVO VI C Master Unit:	
Non-Simultaneous Operation Subsystem	15 ft minimum
Simultaneous Operation Subsystem	20 ft minimum
UNISERVO VI C Master to UNISERVO VI C Master	20 ft minimum

Table A-1. Subsystem Requirements

Cabinet	Height (in.)	Width (in.)	Depth (in.)	Weight (lbs)
Standard Control Unit	63.38	24	24	600
Auxiliary Control Unit	63.38	24	24	450
UNISERVO VI C Master Magnetic Tape Unit	63.38	24*	28.63	700
UNISERVO VI C Slave Magnetic Tape Unit	63.38	24*	28.63	375

* *Add 1.94 inches for casework where needed.*

Table A–2. Subsystem Component Dimensions and Weights

CABINET	HEAT DISSIPATION (BTU/hr)	COOLING BLOWER THRUPUT (cfm)	PRIMARY POWER INPUT	POWER CONSUMPTION
Standard Control Unit	2170	350	115(±15) vac line-to-neutral single phase 60(±0.5) cps *or* 230(+30, −40) vac line-to-neutral single phase 50(±1) cps	15 amps maximum *or* 8 amps maximum
Auxiliary Control Unit	1970	300	none (from Standard Control Unit)	from Standard Control Unit
UNISERVO VI C Master Magnetic Tape Unit	3680	230	230(+30, −40) vac line-to-line, single phase, 60(±0.5) cps *or* line-to-neutral, single phase, 50(±1) cps	1075 Watts
UNISERVO VI C Slave Magnetic Tape Unit	2210	230	none (from UNISERVO VI C Master Unit)	650 Watts

Table A–3. Heating, Cooling, and Electrical Characteristics

APPENDIX B. OPTIONAL 9-TRACK FORMAT FEATURE FOR UNISERVO VI C MAGNETIC TAPE SUBSYSTEMS

Appendix B contains information for programming and operation of UNISERVO VI C Magnetic Tape Subsystems which include the Optional 9-Track Format Feature. Only the information which is uniquely associated with the Optional 9-Track Format Feature is included in Appendix B. Details which apply equally well whether operating with or without the feature are not repeated. References are included to permit quickly locating these details.

B1. DESCRIPTION

B1.1. GENERAL

The Optional 9-Track Format Feature for UNISERVO VI C Subsystems provides the ability to read tapes prepared on IBM 2400 series magnetic tape configurations at 800 bytes per inch and to write tapes which can be read on such equipment. It also provides for increased data transfer rates. It permits a configuration which includes both 9-track tape units and 7-track tape units.

The addition of the Optional 9-Track Format Feature to a non-simultaneous operation subsystem requires that Feature 0706-00 be installed in the Standard Control Unit, and that the subsystem include at least one UNISERVO VI C Master Magnetic Tape Unit with 9-track format capabilities.

The addition of the 9-Track Format Feature to a simultaneous operation subsystem requires that Feature 0706-00 be installed in both the Standard and Auxiliary Control Units, and that the subsystem include at least one UNISERVO VI C Master Magnetic Tape Unit with 9-track format capabilities. It is not permissible to install Feature 0706-00 in only one of the control units in a simultaneous operation subsystem.

B1.2. CONFIGURATIONS

Tables B-1 and B-2 identify by name and type or feature number, the units which make up both a non-simultaneous and simultaneous operation 9-track format subsystem for both 60 cycle and 50 cycle power installations. It should be noted that the Optional Translate Feature is useful in a 9-track format system only if the subsystem includes one or more 7-track format magnetic tape units. The Optional Translate Feature should not be employed for data transfers with a 9-track format tape unit.

The main difference between a 7-track format tape unit and a 9-track format tape unit is in the read/write head. The 7-track unit writes seven bits in each frame, whereas the 9-track unit writes nine bits in each frame. The nine bits in each data frame normally consist of eight data bits plus a parity bit which provides odd lateral parity for the frame. The assembly and disassembly of words performed in the control unit when reading and writing tape makes four data words correspond to 15 data frames. When writing tape, a special 9-bit diagonal check frame is calculated in

the Standard Control Unit as each data frame is written. This check frame is written in the 4th frame position following the last data frame of the block. A 9-bit longitudinal check frame is written in the 8th frame position following the last data frame. Both the diagonal check frame and the longitudinal check frame are recalculated during a Read Forward function, and a parity error reported if both do not check properly. All 9-track format data handling operations are performed at 800 frames per inch density with odd parity. Interblock gap spacing is 0.6 inches.

SUBSYSTEM COMPONENT NAME	TYPE NUMBER FOR 60 CYCLE POWER	TYPE NUMBER FOR 50 CYCLE POWER	NUMBER REQUIRED	NUMBER PERMITTED
Standard Control Unit	5008-04	5008-06	1	1
Optional 9-Track Format Feature No.	0706-00	0706-00	1	1
UNISERVO VI C Master Magnetic Tape Unit, 9-Track Format	0858-10	0858-11	1	up to 16 *
UNISERVO VI C Slave Magnetic Tape Unit, 9-Track Format	0858-14	0858-15	0	up to 12 *
UNISERVO VI C Master Magnetic Tape Unit, 7-Track Format	0858-00	0858-02	0	up to 15 *
UNISERVO VI C Slave Magnetic Tape Unit, 7-Track Format	0858-01	0858-03	0	up to 12 *

* ***Restrictions:*** *The total number of tape units in the subsystem must not exceed 16. The number of slave units (9-Track Format) must not exceed three times the number of master tape units (9-Track Format). The total number of slave units (7- and 9-track format combined) in a subsystem must not exceed three times the total number of master units in the subsystem.*

Table B–1. Non-Simultaneous Operation 9-Track Format Subsystem Components.

SUBSYSTEM COMPONENT NAME	TYPE NUMBER FOR 60 CYCLE POWER	TYPE NUMBER FOR 50 CYCLE POWER	NUMBER REQUIRED	NUMBER PERMITTED
Standard Control Unit	5008-04	5008-06	1	1
Auxiliary Control Unit	5008-05	5008-07	1	1
Optional 9-Track Format Feature No.	0706-00	0706-00	2	2
UNISERVO VI C Master Magnetic Tape Unit, 9-Track Format	0858-12	0858-13	1*	up to 16**
UNISERVO VI C Slave Magnetic Tape Unit, 9-Track Format	0858-14	0858-15	0*	up to 12**
UNISERVO VI C Master Magnetic Tape Unit, 7-Track Format	0858-08	0858-09	0*	up to 15**
UNISERVO VI C Slave Magnetic Tape Unit, 7-Track Format	0858-01	0858-03	0*	up to 12**

* ***Restrictions:*** *The minimum simultaneous operation subsystem must include two tape units. One of these must be a master unit (9-Track Format). The second may be either a master unit or a slave unit, a 7-track format unit, or a 9-track format unit.*

** ***Restrictions:*** *The total number of tape units in the subsystem must not exceed 16. The number of 9-track format slave units must not exceed three times the number of 9-track format master units. The total number of slave units (7- and 9-track format combined) in a subsystem must not exceed three times the total number of master units in the subsystem.*

Table B–2. Simultaneous Operation 9-Track Format Subsystem Components.

B2. PROGRAMMING

B2.1. SUBSYSTEM/PROCESSOR INTERFACE

The subsystem/processor interface described in section 3.1 is identical to the interface provided when the Optional 9-Track Format Feature is included in the subsystem.

B2.2. WORD FORMATS

B2.2.1. Function Words

The function word specifying 9-track format operations is basically the same as explained in section 3.2.1. for 7-track format operations. Data transfer operations should always specify odd parity (except for 9-track format Skip Only functions) and a density of 800 frames per inch either manually or program selected. 9-track format is specified by including a 1-bit in bit position 10 of all function words specifying data transfer operations with the exception of Bootstrap function words. (The setting of the 7CH/9CH toggle switch on the Standard Control Unit governs the format employed in a Bootstrap operation.) The following paragraphs explain function word differences between 9-track and 7-track format operations.

B2.2.1.1. Write End-of-File

A Write End-of-File function is required for 9-track format operation. The Main Function Code is 0_8. The function word should specify:

- odd parity
- 800 frames per inch density
- no translation
- 9-track format
- low gain
- all zero bits in the "T" field
- the logical tape unit number of a 9-track format tape unit.

It should be sent only to a Standard Control Unit, not to an Auxiliary Control Unit.

When a Standard Control Unit with the Optional 9 Track Format Feature receives a Write End-of-File function word, it waits until it receives a data word, initiates tape motion, and writes a single 9-bit data frame plus the 9-bit longitudinal check frame (which in this case is identical to the data frame) in the 8th frame position following the data frame. It does not write a 9-bit special diagonal check frame. The eight most significant bits of the data word sent to the subsystem should be 00010011. The low order 22 bits of the data word received by the subsystem are ignored. A control unit will recognize the block which results as an End-of-File record when the block is read in either the forward or backward direction in a subsequent run.

This function should not be used when operating with a 7-track format tape unit.

B2.2.1.2. Write

When a 9-track format Write function is received by the Standard Control Unit, no tape motion is initiated until the first data word is received. Each group of four consecutive data words received by the control unit corresponds to 15 data frames. Figure B–1 illustrates the relationship between a group of four data words and the data content of the associated data frames. It should be noted that the fourth data frame contains the six least significant bits of the first data word plus the two most significant bits of the second data word, the eighth data frame contains the four least significant bits of the second data word plus the four most significant bits of the third data word, and the twelfth data frame contains the two least significant bits of the third data word plus the six most significant bits of the fourth data word.

If the Buffer Control Word used to define the data buffer for a Write function does not specify an integral multiple of four words, the last data frame written will include two, four, or six 0-bits padded in by the Standard Control Unit to fill out the frame. The exact number of 0-bits padded in is dependent on whether the number of words sent to the subsystem exceeds an integral multiple of four by one, two, or three. In a subsequent reading operation, the subsystem is unable to tell whether the 0-bits padded in during the writing operation are padded bits or data bits, so an extra word will be assembled.

Stop code capability is *not* available when performing a 9-track format Write function. The proposed industry standard for the 9-track format is that a minimum of 18 data frames should be written in every block (excluding the special End-of-File block). This means that in order to comply with the proposed industry standard, the Buffer Control Word defining the output data buffer for a Write function should provide for at least five words of output data. This will provide for writing at least 19 data frames. It is recommended that the Buffer Control Word should provide for a minimum of eight output data words, and that it should always provide for an integral multiple of four output data words.

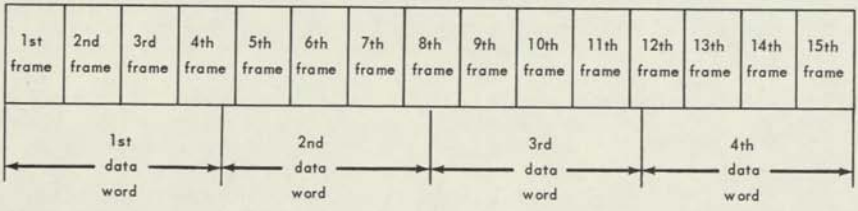


Figure B–1. Data Word/Data Frame Relationships Forward Motion – 9 Track Format

B2.2.1.3. Read Forward

The 9-track format Read Forward function assembles 15 consecutive data frames into four data words as shown in Figure B-1. In case the number of data frames in a block is not an integral multiple of 15, 0-bits will be padded into the least significant bit positions of the partial data word assembled to complete the word. For

example, a block containing 90 data frames will produce exactly 24 words of input. A block containing 91 data frames will yield 25 words of input, with the 25th word consisting of the eight data bits from the 91st data frame in bit positions 29 through 22 and 0-bits padded in bit positions 21 through 0. A block containing 94 data frames will produce 26 data words. The 25th word will contain the data bits from the 91st through the 93rd data frame plus six bits from the 94th data frame. The 26th data word will contain the remaining two bits from the 94th data frame in bit positions 29 and 28 and 0-bits padded in bit positions 27 through 0.

It should be noted that when a 9-track format Read Forward function is used to read a block which was written using a Buffer Control Word for data which did not specify an integral multiple of four words, one more word will be made available as input than was sent out to be written. For example, if the count when writing was 21, the first 20 words would yield 75 data frames, the most significant 24 bits of the 21st word would yield three more data frames, and the six least significant bits of the 21st word would have two padded 0-bits added to give a full frame and be written as the 79th data frame for the block. When the block is read using a Read Forward Function, 21 words will be assembled which are identical to the data words sent to the subsystem to be written. A 22nd word will be assembled which consists of two 0-bits in bit position 29 and 28 (these are the 0-bits which were padded in at the time the block was written) and 28 more 0-bits padded into bit position 27 through 0 of the 22nd data word by the control unit to fill out the word.

Bit positions 8 through 5 of the Read Forward function word should always contain 0-bits when the first attempt is made to read a block. If a parity error is reported in the status word generated in response to the first attempt to read a block in the forward direction, and if the purpose of the Read Forward function was to actually read the data (as distinguished from merely moving tape forward one block), then the contents of bit positions 8 through 5 of the status word should be saved. After execution of a Read Backward function to move backward one block, the saved contents of bit positions 8 through 5 of the status word should be inserted in bit positions 8 through 5 of the Read Forward function word used for the second attempt to read the block. This procedure will permit successful reading of the troublesome block in those cases in which defective or marginal magnetic tape led to bit dropping or bit pickup in only one of the 9-recording tracks on the tape. When a bad track is identified in a Read Forward function word, if a lateral parity error is detected in any data frame, the control unit uses the complement of the bit read from the identified track as the proper bit.

B2.2.1.4. Read Backward

The assembly of data words for the 9-track format Read Backward function proceeds as shown in Figure B-2. The notation "1st frame" refers to the first data frame encountered when moving in the backward direction. This is actually the last data frame which was written in the block. If the number of data frames in a block is not an integral multiple of 15, then the bit positions at the most significant end of the partial data word assembled will be padded with 0-bits to fill out the word before it is made available to the processor.

Bit positions 8 through 5 of a Read Backward function word should always contain 0-bits. Data reconstruction is not provided during execution of the Read Backward function.

It should be noted that if a block is written using a Buffer Control Word which does not specify an integral multiple of four data words, when this block is read in the backward direction, the first input data word made available to the processor will contain 0-bits in the two, four, or six low-order bit positions. All data bits will be shifted left by the same number of bit positions from their position in the original output data words and an extra input data word (one more than the number of output data words) will be made available to the processor. The last input data word will contain 0-bits in the 28, 26, or 24 high order bit positions, and the contents of the two, four, or six high-order bit positions of the first output data word will occupy the two, four, or six low-order bit positions of the last input data word.

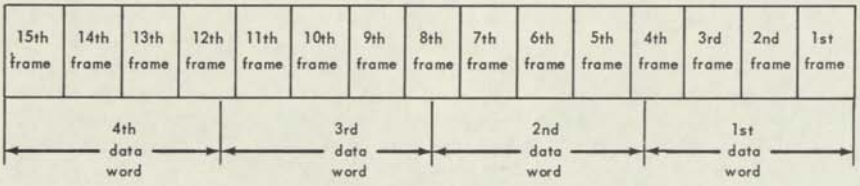


Figure B–2. Data Word/Data Frame Relationships Read Backward – 9 Track Format

B2.2.1.5. Skip/Write

The 9- and 7-track format Skip/Write functions are similar. The only difference is that the Write portion of the 9-track format Skip/Write function follows all the rules and variations applicable to the 9-track format Write function.

B2.2.1.6. Skip Only

The Skip Only function can be used to erase tape on a 9-track format tape unit as part of the recovery procedure from a Write or Skip/Write function which resulted in reporting of a Parity Error or Tape Hash error. It should be used when it is desired to erase more than 3 inches of tape before attempting to write the desired block.

The Skip Only function word should specify:

- Main Function Code of 7_8
- even parity
- 800 frames per inch density
- no translation
- 9-track format
- low gain
- all 0-bits in the T field
- the logical tape unit number of a 9-track tape unit.

The Skip Only function is the only 9-track format function which should specify even parity (to distinguish it from the Skip/Write function). It should be sent only to a Standard Control Unit, not to an Auxiliary Control Unit.

Following the sending of the Skip Only function word to the subsystem, a one word output data buffer should be defined. When the output data word is received by the subsystem, forward tape motion is initiated on the tape unit specified in the function word, and tape is erased for about three inches after normal operating speed is attained. After three inches of forward motion at normal operating speed, the control unit ignores the contents of the data word which initiated tape motion, generates a status word indicating the result of the operation, and turns on the External Interrupt signal.

The effect of the Skip Only function specifying a 9-track tape unit and followed by any output data word is identical to the effect of an even parity Skip/Write function specifying a 7-track tape unit and followed by an output data word containing a stop code in the most significant character position.

B2.2.1.7. Bootstrap

When performing a Bootstrap function on a 9-track format tape unit, the 7CH/9CH switch on the Control/Indicator Panel of the Standard Control Unit must be in the "9CH" (down) position.

B2.2.1.8. Summary:

Table B-3 lists the function codes which are used for operating with 9-track format magnetic tape units.

<table>
<tr><th rowspan="3">FUNCTION</th><th colspan="2">NORMAL GAIN</th><th colspan="2">LOW GAIN</th></tr>
<tr><th colspan="2">DENSITY</th><th colspan="2">DENSITY</th></tr>
<tr><th>MANUAL</th><th>800</th><th>MANUAL</th><th>800</th></tr>
<tr><td>Read Forward</td><td>602</td><td>632</td><td>603</td><td>633</td></tr>
<tr><td>Read Backward</td><td>102</td><td>132</td><td>103</td><td>133</td></tr>
<tr><td>Write</td><td colspan="2" rowspan="4">Low Gain should always be specified for Write, Skip/Write, Skip Only, and Write-End-of-File functions.</td><td>503</td><td>533</td></tr>
<tr><td>Skip/Write</td><td>703</td><td>733</td></tr>
<tr><td>Skip Only</td><td>743</td><td>773</td></tr>
<tr><td>Write-End-of-File</td><td>003</td><td>033</td></tr>
<tr><td>Bootstrap</td><td colspan="4">400 or 000*</td></tr>
<tr><td>Rewind with Interlock</td><td colspan="4">200</td></tr>
<tr><td>Rewind to Load Point</td><td colspan="4">300</td></tr>
</table>

* *When 000_8 is used as the function code, the Bootstrap function word must be 4000000000_8.*

Table B–3. Function Codes (Bit Positions 17 through 9 in Octal Notation) For Operating with 9-Track Format Tape Units.

B2.2.2. Status Words

The format of the status word received in response to a function word specifying either 9- or 7-track format operation is identical. In most cases, a 1-bit in any bit position of a status word has the same meaning. However, bit positions 17, 16, 12, 9, 8 through 5, and 3 through 0 have slightly different uses and meanings for 9-track format operations. The following discusses these bit positions.

B2.2.2.1. Abnormal Frame Count (BP 17)

The contents of bit position 17 of the status word generated in response to Read Forward, Read Backward, or Bootstrap function, will be a 1-bit when the block does not contain an integral multiple of 15 data frames.

B2.2.2.2. End-of-File (BP 16)

The contents of bit position 16 of the status word generated in response to a Read Forward or Bootstrap function will be a 1-bit if a data frame consisting of 000010011 is detected as the first frame of a block followed by two frame positions with no recording. If End-of-File is indicated in the status word a parity error will also be indicated.

The contents of bit position 16 of the status word generated in response to a Read Backward function will be a 1-bit if the block read includes a single data frame containing 000010011 which is seven to nine frame positions from the longitudinal check frame. The presence or absence of a diagonal check frame, positioned about midway between the longitudinal check frame and the data frame, will not affect the End-of-File status indicator in the status word. When the End-of-File indicator is set in the status word generated in response to a 9-track format Read Backward function, it means "End of File" rather than "Possible End of File."

If the End-of-File indicator is a 1-bit in the status word generated in response to a Read Forward, Read Backward, or Bootstrap function, the Abnormal Frame Count indicator will also be set.

B2.2.2.3. Parity Error (BP 12)

Bit position 12 of the status word generated in response to a Read Forward or Bootstrap function will contain a 1-bit if the control unit's analysis of the recorded bits shows that there is a lateral parity error in a data frame or a longitudinal parity error in a track, or that the special diagonal check frame read from the tape is not identical to the value calculated from the data frames read from tape.

Bit position 12 of the status word generated in response to a Write-End-of-File, Write, or Skip/Write function will contain a 1-bit if the Standard Control Unit's analysis of recorded bits shows that there is a lateral parity error in any data frame or a longitudinal parity error in any track for the block. A parity error is not reported solely as a result of the fact that the special diagonal check frame is not written when executing a Write-End-of-File function.

Bit position 12 of the status word generated in response to a Read Backward function will contain a 1-bit when a lateral parity error is detected in any data frame or if a longitudinal parity error is detected in any track for the block.

B2.2.2.4. Invalid Function (BP 9)

Bit position 9 of the status word will be set to one if:

- the function word received by the subsystem contains a 1-bit in bit position 4.
- the subsystem is a simultaneous operation subsystem and a Write, Skip/Write, Skip Only, or Write End-of-File function is received by the Auxiliary Control Unit.
- a Read Forward, Read Backward, Write, Skip/Write, Skip Only, or Write End-of-File function indicates 9-track operation but specifies a 7-track tape unit, or indicates 7-track operation but specifies a 9-track tape unit.
- a Bootstrap function is received by the subsystem when the setting of the 7CH/9CH switch on the Standard Control Unit does not correspond to the read/write head capabilities of the physical tape unit that has been assigned Program unit number zero.

B2.2.2.5. Bad Track (BP 8-5)

Bit Positions 8 through 5 of the status word generated in response to a Read Forward or Bootstrap function will contain a value of from 0001 through 1001 if the Parity Error status indicator is a 1-bit and if the control unit is able to identify a probable bad track through its manipulation of the bits it receives for each data frame and for the special diagonal check frame.

In most cases where the parity error results from dropping or adding one or more 1-bits in a single track, the Bad Track field will identify the track which led to the parity error. If the parity error occurs within a span of eight or fewer consecutive frames, the Bad Track field will always identify the error track (except for the case in which a dropped 1-bit is the only 1-bit in a frame). There are cases in which certain sequences of dropped and/or picked up bits in a single track,over a span of nine or more consecutive frames,will not permit identifying the error track.

The contents of bit positions 8 through 5 of the status word received in response to a Read Forward function will be of no value if the Read Forward function word did not contain all 0-bits in bit positions 8 through 5.

If the control unit is unable to identify a probable bad track during the execution of a Read Forward or Bootstrap function, then bit positions 8 through 5 of the status word will contain zeros.

Bit positions 8 through 5 of the status word generated in response to a Read Backward, Write, Skip/Write, Skip Only, Write-End-of-File, or either form of Rewind function will always contain zeros.

B2.2.2.6. Frame Count/Modulo 15 (BP 3-0)

Bit positions 3 through 0 of the status word generated in response to a Read Forward, Read Backward, or Bootstrap function will contain one of the values 0001 through 1110 if the number of data frames in block read is not an integral multiple of 15 and if the processor accepts the last partial data word assembled. In this case, the bits in this field will be a binary representation of the number of data frames in the block, modulo 15. The relationship between the various possible non zero values in this field and the number of data bits in the last input data word received by the processor is shown in Table B-4.

Bit positions 3 through 0 of the status word generated in response to a Read Forward, Read Backward, or Bootstrap function will all contain 0-bits if the number of data frames in the block is an integral multiple of 15 or if the processor does not accept the partial data word assembled as the last word of input from the block.

Bit positions 3 through 0 of the status word generated in response to a Write, Skip/Write, Skip Only, Write-End-of-File, or either form of Rewind function will always contain zeros.

CONTENTS OF FRAME COUNT/ MOD 15 FIELD	NUMBER OF WORDS ASSEMBLED FROM THE BLOCK (MODULO 4)	NUMBER OF DATA BITS IN THE LAST WORD ASSEMBLED
0001_2	1	8
0010_2	1	16
0011_2	1	24
0100_2	2	2
0101_2	2	10
0110_2	2	18
0111_2	2	26
1000_2	3	4
1001_2	3	12
1010_2	3	20
1011_2	3	28
1100_2	0	6
1101_2	0	14
1110_2	0	22

Table B–4. Meaning of Frame Count/Mod 15 Field Contents

B2.2.3. Error Recovery Procedures

Table B-5 shows the status conditions which may be reported in response to each of the valid function words when operating with 9-track format. This section details the various status conditions with regard to the functions which cause them to occur and includes error recovery procedures from these conditions.

MFC	BASIC FUNCTIONS	Abnormal Frame Count	End-of-File	End-of-Tape Warning/ Load Point	Interlock	Busy	Parity Error	Late Acknowledge	Tape Hash	Invalid Function	Bad Track	Frame Count/Modulo 15
		17	16	15	14	13	12	11	10	9	8 – 5	3 – 0
0_8	Write End-of-File	0	0	1/0	1/0	1/0	1/0	1/0	1/0	1/0	0	0
1_8	Read Backward	1/0	1/0	1/0	1*/0	1*/0	1/0	1*/0	0	1*/0	0	1/0
2_8	Rewind With Interlock	0	0	0	1*/0	1*/0	0	0	0	1*/0	0	0
3_8	Rewind To Load Point	0	0	0	1*/0	1*/0	0	0	0	1*/0	0	0
4_8	Bootstrap	1*/0	1*/0	1*/0	1*/0	1*/0	1*/0	1*/0	0	1*/0	1*/0	1*/0
5_8	Write	0	0	1*/0	1*/0	1*/0	1/0	1*/0	1/0	1*/0	0	0
6_8	Read Forward	1/0	1/0	1*/0	1*/0	1*/0	1/0	1*/0	0	1*/0	1/0	1/0
7_8	Skip/Write	0	0	1*/0	1*/0	1*/0	1/0	1*/0	1/0	1*/0	0	0
7_8	Skip Only	0	0	1*/0	1*/0	1*/0	0	0	1/0	1*/0	0	0

* Same recovery procedure as for 7-track format.

Table B–5. Possible Status Indicators, 9-Track Format

B2.2.3.1. General Error Recovery Procedures

The following paragraphs cover general error recovery procedures for indications generated in response to any function.

- Tape Hash Indication

  When the Tape Hash indicator is a 1-bit in the status word generated in response to a Write End-of-File, Write, Skip/Write, or Skip Only function, it means that data appears to have been detected in a supposedly unrecorded area on tape. Any attempt to recover from this error involves the risk that position on tape may be lost or that apparent recording may be left on the tape, leading to either an unrecoverable error or a skipped data block on a subsequent reading pass of the tape.

  If a Tape Hash error is detected, the program utilizing the tape should be terminated and the tape removed for visual inspection. If the error persists, the tape should be permanently removed from operation.

  If any recovery procedure is attempted to recover from the Tape Hash error, the user should ascertain that either:

  (a) no noise is left on the tape between the end of the previously written error-free block and the first frame of the block to be written, or

  (b) if noise is left on the tape, it is in a tape area isolated from the preceding and following data blocks by a 0.6 inch erased tape gap and will not appear to be a block of 12 or more data frames.

- Invalid Function Indication

  When the Invalid Function indicator is a 1-bit in the status word generated in response to any function, it will be the only indicator set. Tape will not have moved as a result of the receipt of the function.

  If the Invalid Function indicator is set as a result of sending a Write End-of-File, Write, Skip/Write, or Skip Only function to the Auxiliary Control Unit or as a result of sending a function word containing a 1-bit in bit position 4 to either type of control unit, it is a program error. If this indicator is set in response to a function word which specifies a 9-track format operation on a 7-track tape unit or a 7-track format operation on a 9-track tape unit, it may be the result of either a program error or an operator error. If it is set as a result of the lack of compatibility between the setting of the 7CH/9CH switch and the type of tape unit assigned logical unit number zero when a Bootstrap function is received, it is an operator error.

- Interlock Indication

  When the interlock indicator is a 1-bit in the status word generated in response to any function, it will be the only indicator set. Tape will not have moved as a result of receipt of the function by the subsystem. It indicates either that an operator error or a program error has occurred or that there has been a tape unit malfunction. In either case, manual intervention by the operator is required.

- Busy Indication

  When the Busy indicator is the only indicator set in the status word generated in response to any function, the handling of the function by the subsystem will have no effect on the tape unit specified by the function word.

  If the Busy condition is reported because the specified tape unit has not completed the rewinding process initiated by a previous Rewind-to-Load-Point function, the recommended recovery procedure is to send the function word to the subsystem again after an interval to allow for completion of the rewinding process.

  If the Busy condition is reported by one of the control units of a simultaneous operation subsystem because the specified tape unit is under the control of the other control unit, it indicates a program error.

- Busy plus End of Tape/Load Point Indication

  When the Busy indicator is set in combination with the End of Tape/Load Point indicator in response to any function other than a Rewind function, it is usually the result of power dropping at the tape unit during execution of the function. If both of these indicators are set in response to a Read Backward function, it is the result either of power dropping or of tape moving backward until Load Point is detected. See 3.3.1 and 3.3.2 for further details.

B2.2.3.2. Write End-of-File

If the status word generated in response to a Write End-of-File function reports detection of more than one error or abnormal condition, the recommended procedure is to recover from the highest priority error according to the following priority: Busy plus End-of-Tape Warning, Tape Hash, Parity Error, End-of-Tape Warning without Busy, and Late Acknowledge. The End-of-Tape Warning indicator should not be completely ignored in case Tape Hash or Parity Error is reported. To ignore the End-of-Tape Warning indicator could lead to writing off the end of the tape if, for example, a parity error is indicated and the recovery from this error requires the use of many Skip Only functions.

Error recovery procedures are as follows:

- Busy plus End-of-Tape Warning Indication
  (See B2.2.3.1 General Procedures)

- Tape Hash Indication

  (See B2.2.3.1 General Procedures)

- Parity Error Indication

  When the Parity Error indicator is a 1-bit in the status word generated in response to a Write End-of-File function, it means either that a lateral parity error has been detected in the data frame or that a longitudinal parity error has been detected in one or more tape tracks.

The recovery procedure requires the execution of a Read Backward function to position tape with the write head over the interblock gap preceding the End-of-File block, and then execution of the Write End-of-File function. If the error persists, the execution of a Read Backward function for positioning purposes should be followed by a Skip Only function. This will move the apparent defective area on tape past the write head. A Write End-of-File function should then be initiated.

- End-of-Tape Warning Without Busy Indication

  When the End-of-Tape Warning indicator is a 1-bit in the status word generated in response to a Write End-of-File function and the Busy indicator is not set, it means that the End-of-Tape Warning marker is on the take-up reel side of the marker detector. The 1-bit serves as a warning to the program that it must exercise care in continuing forward tape motion on that tape unit.

- Late Acknowledge Indication

  When the Late Acknowledge indicator is a 1-bit in the status word generated in response to a Write End-of-File function, it means that a data word was received by the Standard Control Unit during the interval starting about 29 microseconds after the single data frame for the End-of-File block was written and ending when the status word is generated in response to the Write End-of-File function. The error can only occur if a multiple word output data buffer is set up or if a second or third output data buffer is set up after the Write End-of-File function is sent to the Standard Control Unit before the status word is generated. In any case, it is a program error.

B2.2.3.3. Read Backward

The Read Backward function may be used to read data to supply needed input data to the processor or to move tape backward one block (simulating a Backspace Block function) in cases in which positioning of tape is the immediate objective rather than reading data to supply input data. If reading data is the immediate objective and more than one error or abnormal condition is reported, the recommended procedure is to recover from the highest priority error or abnormal condition according to the following priority sequence: Load Point, End-of-File, Late Acknowledge, Parity Error, Frame Count/Mod 15, and Abnormal Frame Count.

If moving backward one block is the immediate objective and more than one error or abnormal condition is reported, the recommended procedure is to recover from the highest priority error or condition according to the following priority sequence: Load Point, End-of-File, Parity Error, and Late Acknowledge. Frame Count/Mod 15 and Abnormal Frame Count status indicators should be considered by the program only if their contents are needed to determine whether or not the block contained at least 12 data frames.

A late acknowledge error should usually be ignored when using a Read Backward function for positioning purposes only. A block which does not contain at least 12 data frames and which leads to the reporting of a parity error when it is read

should normally be considered a noise block and ignored. When the status word generated in response to a Read Backward function includes the Late Acknowledge indicator it is impossible for the program to tell with certainty the length of the block just read. As a consequence, when the status word generated in response to a Read Backward function executed for positioning purposes indicates both a parity error and a late acknowledge error, and the number of words accepted by the processor is three or fewer, the program may be unable to tell whether the block should be ignored as a noise block or should be considered a true data block. If the program is unable to determine the block length, a Read Forward function and then a Read Backward function should normally be executed to recover from this combination of errors.

Error recovery procedures are as follows:

- Load Point Indication

  (See error recovery procedures for 7 track format in 3.3.2.)

- End-of-File Indication

  When the End-of-File indicator is a 1-bit in the status word generated in response to a Read Forward or Read Backward function, it means that a block which includes exactly one data frame consisting of 000010011 has been read. This fact should be made known to the program which requested the reading operation.

  It is normal for a parity error to be indicated in the status word generated in response to a Read Forward function if End-of-File is also indicated because the End-of-File block does not include the special diagonal check frame. In this case the parity error should be ignored. It is also normal for an abnormal frame count to be indicated in the status word generated in response to a Read Forward or Read Backward function along with the End-of-File indication.

- Late Acknowledge Indication

  (See error recovery procedures for 7-track format in 3.3.2.)

- Parity Error Indication

  When the Parity Error indicator is a 1-bit in the status word generated in response to a Read Backward function, it means that a lateral parity error was detected in one or more of the data frames and/or a longitudinal parity error was detected in one or more of the tape tracks.

If repeated attempts to read a block result in the reporting of a parity error and if the block appears to contain less than 12 data frames, the block should be considered to be noise rather than a legitimate data block. The program can decide whether or not a block contains at least 12 data frames by:

(1) providing an input data buffer to allow for at least three input words,

(2) determining the number of data words accepted by the processor from the change to the count field of the Input Buffer Control Word,

(3) examining the Frame Count/Mod 15 field in case exactly three words of input data are accepted by the processor.

Table B-6 tabulates the rules for determining the number of data words in a block.

If the block contains 12 or more data frames and the primary objective of the Read Backward function was to read data, then the procedure recommended to recover from the parity error is to execute a Read Forward function to position tape with the read head over the interblock gap which follows the longitudinal check frame for the block and then attempt to read the desired data by executing a Read Backward function.

If the block contains 12 or more data frames and the primary objective of the Read Backward function was to move backward one block, then the parity error may be ignored.

If the block contains less than 12 data frames, then "recovery" from the parity error requires that the apparent data be assumed to be noise and ignored. The Read Backward function should be initiated again to perform the desired function.

A special case of the use of a Read Backward function for positioning purposes arises in the use of the Read Backward function as part of the recovery from a Parity Error indication in response to a Write End-of-File function or recovery from a Late Acknowledge indication caused by a Write or Skip/Write function. In cases in which it is known that the block being moved over contains less than 12 data frames and a parity error is indicated in response to a Read Backward function, then it is the Parity Error indication rather than the block which should be ignored.

If apparent recording is detected during execution of a Read Backward function, and this apparent recording appears to be a single frame without any other apparent recording within ten frame times, the frame should be considered to be noise. Tape motion will halt as if the noise frame were a valid data block. No data will be made available to the processor. A status word indicating a parity error will be made available to the processor.

- Frame Count/Mod 15

  When the Frame Count/Mod 15 field of the status word generated is response to a Read Forward or Read Backward function and contains one or more 1-bits, it means that the number of data frames in the block was not an integral multiple of 15 and that the processor accepted the last data word assembled. This in turn means that the last data word accepted by the processor was not a full data word. It included both data bits from tape and 0-bits which were padded in to fill out the last word.

Input Data Buffer Size in Words	Number of Data Words Accepted by the Processor	Frame Count/Mod 15 Field of the Status Word	Data Frames in the Block
4 or more	4 or more	ignore	12 or more
3	3	0000	12 or more
3 or more	3	≠ 0000	8 to 11
3 or more	2 or less	ignore	7 or less

Table B–6. Critical Block Size Determination, 9-Track Format Read Function

- Abnormal Frame Count

  If the Abnormal Frame Count indicator is a 1-bit in the status word received in response to a Read Forward or Read Backward function, the block just read did not appear to contain an exact multiple of 15 data frames. If the primary objective of performing the read was to obtain data rather than to position tape, then the fact that an abnormal frame count was detected should be made known to the application program. If the primary objective was to position the tape rather than read data, then the status indicator may be ignored.

B2.2.3.4. Rewind with Interlock

(See error recovery procedures for 7-track format in 3.3.1.)

B2.2.3.5. Rewind to Load Point

(See error recovery procedures for 7-track format in 3.3.1.)

B2.2.3.6. Bootstrap

The various indicators in the status word received in response to the Bootstrap function have the same general meaning as the status bits generated in response to a Rewind-to-Load Point function (in the case of the Interlock, Busy without End of Tape Warning, or Invalid Function indicators) and the status bits generated in response to a Read Forward function initiated when tape is positioned at load point (for all other indicators including Busy with End-of-Tape Warning). However, the normal software conventions dictate that the only programmed recovery procedure which should be attempted in case an error or abnormal condition is reported is to re-initiate the Bootstrap function.

B2.2.3.7. Write, Skip/Write, and Skip Only

If the status word generated in response to a Write, Skip/Write, or Skip Only function reports the detection of more than one error or abnormal condition, the recommended procedure is to recover from the highest priority error according to the following priority sequence: Tape Hash, Late Acknowledge, Parity Error, and End-of-Tape Warning without Busy. Even though End-of-Tape Warning without the Busy indicator is listed as the lowest priority indicator, it should not be ignored by the program in case a higher priority error is indicated. To ignore it could lead to writing off the end of the tape if, for example, a parity error is indicated and the recovery from this error requires the use of many Skip/Write or Skip Only functions in order to pass over defective tape near the end of the reel.

Error recovery procedures are as follows:

- Tape Hash Indication

  (See B2.2.3.1, General Recovery Procedures.)

- Late Acknowledge Indication

  (See error recovery procedures for 7-track format in 3.3.4.)

- Parity Error Indication

  When the Parity Error indicator is a 1-bit in the status word generated in response to a Write or Skip/Write function, it means that a lateral parity error was detected in one or more data frames, a longitudinal parity error was detected in one or more tape tracks, and/or an error was detected in the special diagonal check frame. The recovery procedure for this error requires execution of a Read Backward function to position tape with the write head over the interblock gap preceding the error block, and then another attempt to write the desired data by executing a Write or Skip/Write function or by executing a sequence of one or more Skip Only functions, followed by a Write or Skip/Write function to write the desired data.

- End-of-Tape Warning

  (See error recovery procedures for 7-track format in 3.3.4.)

B2.2.3.8. Read Forward

If reading data is the immediate objective and more than one error or abnormal condition is reported, the recommended procedure is to recover from the highest priority error or condition according to the following priority sequence: End-of-File, Late Acknowledge, Parity Error, Frame Count/Mod 15, and Abnormal Frame Count.

If moving forward one block is the immediate objective and more than one error or abnormal condition is reported, the recommended procedure is to recover from the highest priority error or condition according to the following priority sequence: End-of-File, Parity Error, and Late Acknowledge. The Frame Count/Mod 15 and Abnormal Frame Count status indicators should be considered by the program only if their contents are needed to determine whether or not the block contained at least 12 data frames.

A late acknowledge error should usually be ignored when using a Read Forward function for positioning purposes only. A block which does not contain at least 12 data frames and which leads to the reporting of a parity error when it is read should normally be considered a noise block and ignored. When the Late Acknowledge indicator is a 1-bit in the status word generated in response to a Read Forward function, it is impossible to tell with certainty the length of the block. As a consequence, when the status word generated in response to a Read Forward function executed for positioning purposes indicates both a parity error and a late acknowledge error, and the number of words accepted by the processor is three or fewer, the program may be unable to tell whether the block should be ignored as a noise block or should be considered a true data block. If the program is unable to determine the block length, a Read Backward function and then a Read Forward function should be executed to recover from this combination of errors.

Error recovery procedures are as follows:

- End-of-File Indication

  (See B2.2.3.3 Read Backward for error recovery procedures.)

- Late Acknowledge

  (See error recovery procedures for 7-track format in 3.3.2.)

- Parity Error Indication

  When the Parity Error indicator is a 1-bit in the status word generated in response to a Read Forward function, it means that a lateral parity error was detected in one or more data frames, a longitudinal parity error was detected in one or more tape tracks, and/or an error was detected in the special diagonal check frame.

  If repeated attempts to read a block result in the reporting of a parity error but not a late acknowledge error and if the block appears to contain less than 12 data frames, the block should be considered to be noise rather than a legitimate data block. The Read Forward function should be initiated again to perform the desired function. Table B–6 tabulates the rules for determining the number of data frames in a block when performing a 9-track format Read function.

  If the block contains 12 or more data frames and the primary objective of the Read Forward function was to read data, the Bad Track field of the status word (bit positions 8 through 5) should be saved for future use, a Read Backward function should be initiated to position tape with the read head over the interblock gap preceding the desired block, and then the Read Forward function should be initiated as explained below to read the desired block.

  (1) If the Track field (bit positions 8 through 5) of the previous Read Forward function which led to parity error detection contained all 0-bits, then the saved contents of the Bad Track field of the status word generated in response to that function word should be included in the Track field of the new Read Forward function.

  (2) If the Track field of the previous Read Forward function did not contain all 0-bits, then the Track field of the new Read Forward function should contain all zeros.

  If the block contains 12 or more data frames and the primary objective of the Read Forward function was to move forward one block, then the Parity Error indicator should be ignored.

- Bad Track Indication

  When the Bad Track field of the status word generated in response to a Read Forward function does not contain all 0-bits, the Parity Error indicator will be a 1-bit. The contents of the Bad Track field may be used as part of the recovery procedure from the parity error as explained in *Parity Error Indication* above.

- Frame Count/Mod 15

  (See B2.2.3.3 Read Backward for procedures.)

- Abnormal Frame Count Indication

  (See B2.2.3.3 Read Backward for error recovery procedures.)

B2.2.4. Timing

With the exception of the 9-track read/write head, the mechanical characteristics of the 9-track format UNISERVO VI C Magnetic Tape Unit are identical to those for the 7-track. This includes 7 milliseconds start time, 42.7 inches per second reading and writing operating speed, 5 milliseconds stop time, 25 milliseconds reversal delay, and 160 inches per second rewinding speed.

Table B-7 lists the data handling characteristics of the subsystem. The Permitted Processor Response Times shown are the times which must not be exceeded in order to avoid a Late Acknowledge indicator in the status word generated in response to a data transfer function. For reading functions (Read Forward, Read Backward, and Bootstrap) the entries indicate the maximum permitted interval between the time a control unit makes a data word available to the processor and the time the control unit receives an Input Acknowledge signal from the processor indicating the data word has been accepted. For writing functions (Write, Skip/Write, and the program error case of specifying 3 or more output data words for a Write End-of-File function) the entries indicate the maximum permitted interval between the time the subsystem requests the processor to send the third or subsequent data word for the block and the time the subsystem must receive the word in order to write that word in the block.

PARAMETER	SPECIFICATION
Interblock Gap Size (inches)	.6
Frame Time (microseconds)	29.3
Word Time – Average (microseconds)	109.8
Transfer Rate:	
Frames per second	34,160
Characters per second	45,547
Words per second	9,109
Permitted Processor Response Times (microseconds)	
Read:	
repetitive maximum	96
1 time maximum	104
Write:	
repetitive maximum	97
1 time maximum	104

Table B–7. Data Timing Characteristics, 9-Track Format

Table B-8 shows function initiation timing for 9-track format operations. The times listed for functions which lead to data handling are based on the assumption that:

(1) the most recent tape motion on the unit specified in the function word was in the same direction (forward or backward) as required to perform the function

(2) the tape is at rest at the starting reference time

(3) the tape gap between blocks on a tape being read is 0.6 inches

If the first assumption is not correct, 25 milliseconds must be added to the times shown. If the second assumption is not correct, Table B–10 should be consulted.

Table B–9 shows function ending timing. The times listed are for the interval from the time

(1) the last data frame is read for a Read Forward or Read Backward function,

(2) the last data frame is written in a block for a Write or Skip/Write function,

(3) the data frame is written for a Write End-of-File function,

to the time the status word is generated in response to the function and made available to the processor with an External Interrupt (EI) signal. Tables B-8 and B–9 plus the 109.8 microseconds word time in Table B-7 provide the detail necessary to determine the length of the interval from the time a function word specifying a tape at rest is received by the subsystem until the status word reporting on the result of the operation is made available to the processor.

Table B–10 provides information on inter-function timing. This is the time between the generation of the External Interrupt signal which indicates to the processor that the status word generated in response to a function is available, and the reading or writing of the first data frame as required by the next function. The length of the inter-function interval between any two functions in a sequence is dependent on what the two functions are, whether they reference the same or different tape units (in the case of two sequential Write functions whether the two tape units referenced are in the same quad or different quads), and the length of the interval between the generation of the EI signal in response to the first function and the receipt of the second function or the first data word to be written for the second function. Table B-9 should be used in conjunction with Table B-10 if it is desired to determine the data to data interblock gap passing time.

Function	Starting Reference Time	Ending Reference Time	Elapsed Time
Read Forward	Function Received	First data frame read	15.2 ms
Read Backward	Function Received	First data frame read (last data frame in the block)	11.0 ms
Write or Write End-of-File	First Data Word Received	First data frame written	11.6 ms
Skip/Write	First Data Word Received	First data frame written	89.9 ms
Any Function	Function Received	EI signal turned on with Interlock indicated in status word.	0.1 ms

Table B–8. Function Initiation Timing, 9-Track Format

Function	Starting Reference Point	Time to EI Signal Turned On
Read Forward	Read last data frame in the block	2.2 ms
Read Backward	Read first data frame in block (The last frame read)	6.5 ms
Write and Skip/ Write	Write last data frame in the block	6.7 ms
Write End-of-File	Write the data frame	6.7 ms

Table B–9. Function Ending Timing, 9-Track Format

Function Sequence	Interval between External Interrupt Signal and First Data Frame (ms)	
	Same Tape Unit	Different Tape Unit*
Read Forward Then Read Forward	13.1 (note 1) 20.2+W (note 2)	15.2+X* (note 3)
Read Backward Then Read Forward	40.2+X (note 3)	15.2+X* (note 3)
Write Then Read Forward	(note 4)	15.2+X* (note 3)
Read Forward Then Read Backward	36.0+X (note 3)	11.0+X* (note 3)
Read Backward Then Read Backward	8.4 (note 1) 16.0+W (note 2)	11.0+X* (note 3)
Write Then Read Backward	36.0+X (note 3)	11.0+X* (note 3)
Read Forward Then Write	11.6+Y (note 5)	11.6+Y* (note 5)
Read Backward Then Write	36.6+Y (note 5)	11.6+Y* (note 5)
Write Then Write (same quad)	16.6 (note 6) 16.6+Z (note 7)	16.6* (note 6) 16.6+Z* (note 7)
Write, then Write (different quad)		11.6+Y* (note 5)

* *If the second function in the sequence calls for motion in the opposite direction from the last motion on the specified tape unit, then 25 ms must be added to the time indicated. (See notes.)*

Table B–10. Inter-Function Timing, 9-Track Format

NOTES FOR TABLE B–10

Note 1: This time is based on the assumption that the second function in the sequence is received within 2.0 milliseconds of the time EI signal is turned on in response to the first function.

Note 2: This time is based on the assumption that the second function is received at least 4.5 milliseconds after the EI signal is turned on in response to the first function. "W" is the elapsed time between the end of the 4.5 milliseconds interval and the receipt of the function. If the second function is received between 2.0 and 4.5 milliseconds after the EI signal is turned on, the EI signal to first data frame interval will be between the two values shown.

Note 3: "X" is the interval between the time the EI signal is turned on in response to the first function and the time the second function is received.

Note 4: Write, then Read Forward on the same tape unit is not a logical sequence and should not be used.

Note 5: "Y" is the interval between the time the EI signal is turned on in response to the first function and the time the first data word following the second function in the sequence is received.

Note 6: This time is based on the assumption that both the second Write function in the sequence and the first data word are received within 4.5 milliseconds of the time the EI signal is turned on in response to the first Write function.

Note 7: This time is based on the assumption that the first data word following second function in the sequence is received at least 4.5 milliseconds after the EI signal is turned on in response to the first function. "Z" is the elapsed time between the end of the 4.5 milliseconds interval and the time the first data word is receive

B2.3. OPERATION

All of the information given in Section 4 of this manual is applicable to operation of a subsystem which includes the Optional 9-Track Format Feature, with the following exception:

In a subsystem which includes the Optional 9-Track Format feature and does not include any 7-track format tape units, the 7CH/9CH toggle switch behind the Program/Physical wiring on the Standard Control Unit's Control/Indicator Panel should always be in the "9CH" (down) position. If the subsystem includes both 9-track and 7-track format tape units, the switch should be in the position which corresponds to the read/write head capabilities of the physical tape unit which is assigned program or logical tape unit number "0".

APPENDIX C. OPTIONAL TRANSLATE FEATURE

The Optional Translate Feature can be included in the non-simultaneous operation UNISERVO VI C subsystem by adding Feature 0627-04 to the Standard Control Unit (Type 5008-04 or 5008-06).

The Optional Translate Feature can be included in the simultaneous operation UNISERVO VI C Subsystem by adding Feature 0627-04 to the Standard Control Unit (Type 5008-04 or 5008-06) and adding Feature 0627-03 to the Auxiliary Control Unit (Type 5008-05 or 5008-07). Both Feature 0627-04 and Feature 0627-03 must be added to the subsystem if the translation capability is to be available in a simultaneous operation subsystem.

Feature 0627-04 provides hardware which relieves the program of the time-consuming task of translating from 6-bit processor code to a tape code for equipment which utilizes different 6-bit codes to represent the various symbols. It also provides hardware translation from tape code to internal code.

Feature 0627-03 provides the hardware which relieves the program of the task of translating from the six data bits in each data frame read from tape to the corresponding 6-bit processor code.

When the Translate Feature is available, and is to be utilized, bit position 11 of the initiating function word is set to 1. Table C–1 contains the function codes to be used when utilizing the translator. When the Translate Feature is delivered to the field it will be wired to provide the translations shown in Table C–2. Feature 0627-04 for the Standard Control Unit will include all wiring. Feature 0627-03 for the Auxiliary Control Unit will include only the wiring to provide the Tape-to-Processor translation capability for Read functions shown in the left half of Table C–2. It will not include the wiring to provide the Processor-to-Tape translation capability for Write functions since the Auxiliary Control Unit cannot perform Write functions.

If specified, the Translate Feature wiring will be modified as part of the installation and checkout procedure to suit the user's requirements. The Translate Feature provides considerable flexibility but there are limitations as follows:

(1) For both Tape-to-Processor translation and Processor-to-Tape translation, any number of codes may be translated to 00_8.

(2) For Processor-to-Tape translation, any two codes may be translated to 20_8.

(3) With the exception of the above two special cases, there must be one-to-one correspondence between tape codes and processor codes when performing Tape-to-Processor translation for Read functions, and one-to-one correspondence between processor codes and tape codes when performing Processor-to-Tape translation for Write functions. The translate feature does not provide the capability of translating two or more different tape codes to the same processor code when performing a Read function, nor does it provide for translating two or more different processor codes to the same tape code when performing a Write function (except as noted in items 1 and 2 above).

(4) The Translate Feature wiring may be changed as needed to reflect any required change in code/symbol relationships. However, repeated changes must be avoided because this leads to unreliable translate operation.

FUNCTION	PARITY	NORMAL GAIN				LOW GAIN			
		DENSITY				DENSITY			
		MANUAL	200	556	800	MANUAL	200	556	800
Read Forward	odd	604	614	624	634	605	615	625	635
	even	644	654	664	674	645	655	665	675
Read Backward	odd	104	114	124	134	105	115	125	135
	even	144	154	164	174	145	155	165	175
Write	odd	Low Gain should always be specified for Write and Skip/ Write functions.				505	515	525	535
	even					545	555	565	575
Skip/Write	odd					705	715	725	735
	even					745	755	765	775

Table C–1. Function Codes (Bit Positions 17 – 9 in octal notation) for operating in the 7-Track Format with Translation.

TAPE TO PROCESSOR (Read Functions)						PROCESSOR TO TAPE (Write Functions)					
Tape Code	System Code	HSP Symbol	Tape Code	System Code	HSP Symbol	HSP Symbol	System Code	Tape Code	HSP Symbol	System Code	Tape Code
00*	46	&	40	41	–	@	00	17	)	40	74
01	61	1	41	17	J	[	01	75	–	41	40
02	62	2	42	20	K	]	02	55	+	42	60
03	63	3	43	21	L	#	03	77	<	43	76
04	64	4	44	22	M	Δ	04	57	=	44	13
05	65	5	45	23	N	(space)	05	20	>	45	16
06	66	6	46	24	O	A	06	61	&	46	00*
07	67	7	47	25	P	B	07	62	$	47	53
10	70	8	50	26	Q	C	10	63	*	50	54
11	71	9	51	27	R	D	11	64	(	51	34
12	60	0	52	55	!	E	12	65	%	52	35
13	44	=	53	47	$	F	13	66	:	53	15
14	72	'	54	50	*	G	14	67	?	54	72
15	53	:	55	02	]	H	15	70	!	55	52
16	45	>	56	73	;	I	16	71	,	56	33
17	00	@	57	04	Δ	J	17	41	\	57	36
20	05	(space)	60	42	+	K	20	42	0	60	12
21	74	/	61	06	A	L	21	43	1	61	01
22	30	S	62	07	B	M	22	44	2	62	02
23	31	T	63	10	C	N	23	45	3	63	03
24	32	U	64	11	D	O	24	46	4	64	04
25	33	V	65	12	E	P	25	47	5	65	05
26	34	W	66	13	F	Q	26	50	6	66	06
27	35	X	67	14	G	R	27	51	7	67	07
30	36	Y	70	15	H	S	30	22	8	70	10
31	37	Z	71	16	I	T	31	23	9	71	11
32	77	≠	72	54	?	U	32	24	'	72	14
33	56	,	73	75	.	V	33	25	;	73	56
34	51	(	74	40	)	W	34	26	/	74	21
35	52	%	75	01	[	X	35	27	.	75	73
36	57	\	76	43	<	Y	36	30	□	76	37
37	76	□	77	03	#	Z	37	31	≠	77	32

* *NOTE: The data code 00_8 will never be read from an even parity (BCD) tape unless a parity error is detected in the block. When writing even parity tapes, the system code which translates to 00_8 tape code will act as a stop code.*

Table C–2. Standard Translation Table (Octal Notation)

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