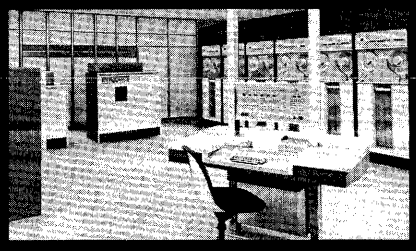
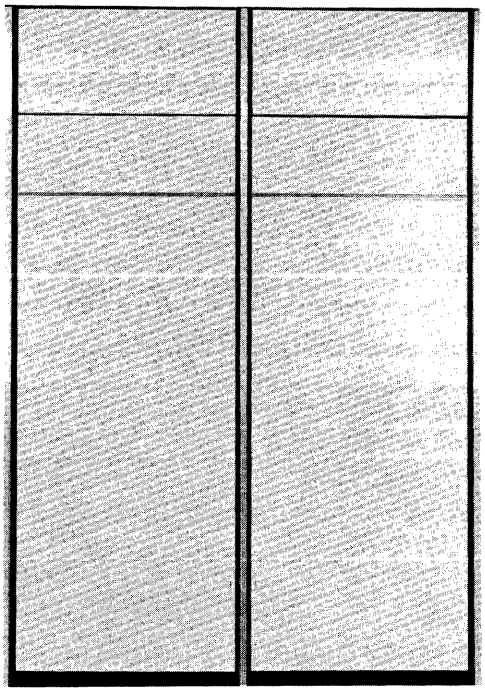
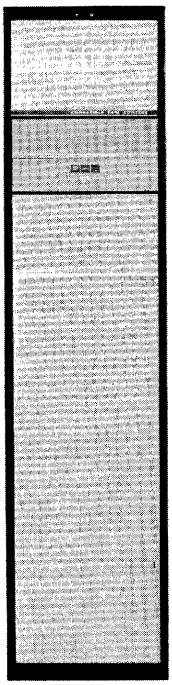


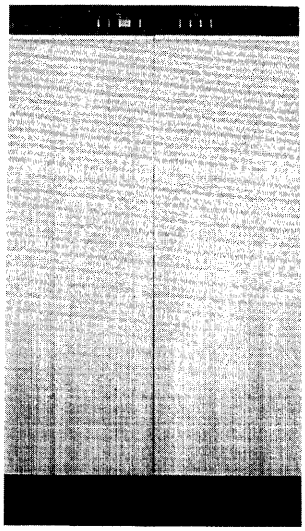
UNIVAC 1107 THIN-FILM MEMORY COMPUTER

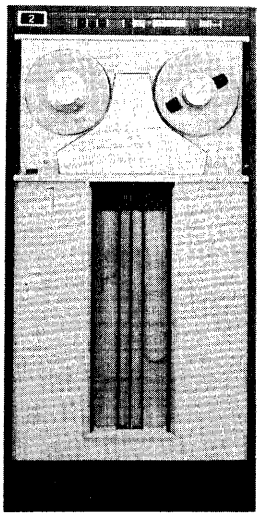
UNISERVO IIIC MAGNETIC TAPE SUBSYSTEM

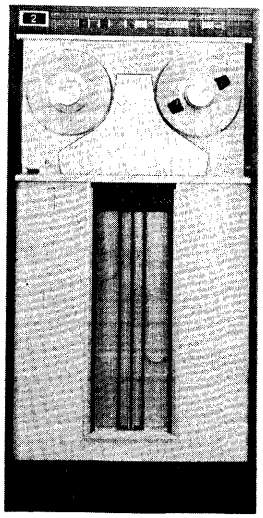
TECHNICAL BULLETIN











The UNISERVO* IIIC Magnetic Tape Subsystem is a large capacity data storage and retrieval system which is compatible with a format used in IBM** tape units. This bulletin introduces you to the subsystem's physical and functional characteristics, its unique features (including format compatibility with other tape systems and ability to perform special functions), and its extensive repertoire of instructions. Also included are basic programming examples and other details to fully acquaint you with the subsystem's capabilities when operating with the UNIVAC® 1107 Thin-Film Memory Computer.

Contents

*UNISERVO: Trademark, Sperry Rand Corp.
**International Business Machine Corp.

FEATURES

Compatibility The UNISERVO IIIC Magnetic Tape Subsystem allows complete compatibility between a UNIVAC 1107 Thin-Film Memory Computer and IBM data-handling equipment without off-line tape conversion (see compatibility illustration). The subsystem read-write operations are designed to function with the IBM tape format described later. The subsystem, therefore, makes possible the use of tapes from a wider variety of sources.

Format Choice The UNISERVO IIIC subsystem can communicate with the computer in either binary or binary-coded decimal format. More details on format are on page 6.

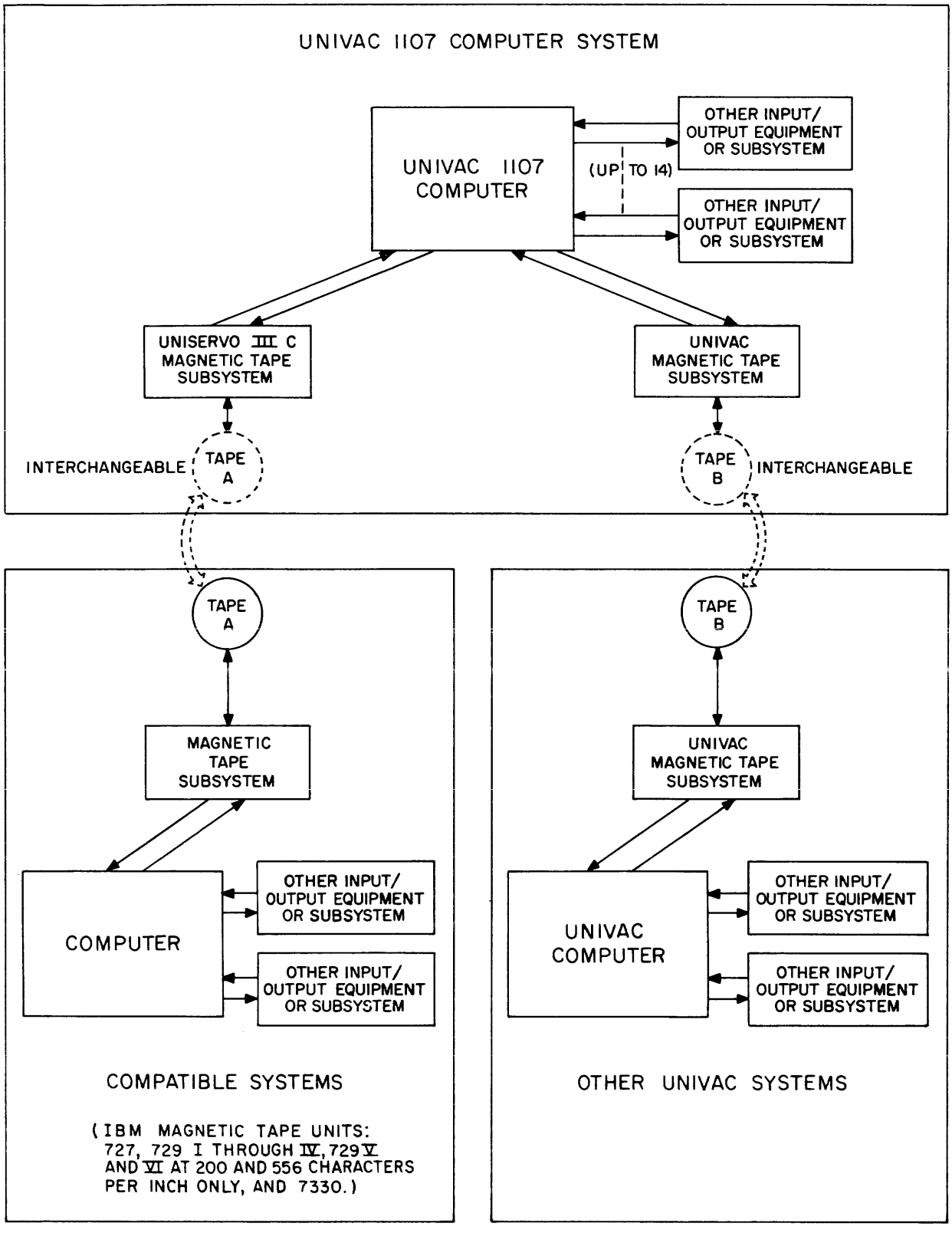
Each UNISERVO tape handler accepts a tape reel containing up to 2400 feet of plastic tape. The tapes can be read or written with a density of either 200 or 556 characters per inch. A UNISERVO tape handler in the high-density binary mode, for example, can record more than 14,000 blocks of data containing 100 words each on one reel of tape. Block length is variable.

Writing Non-Stop Another feature of the subsystem is the ability to write data "non-stop." Circuitry and programming techniques allow consecutive blocks of data to be written on a tape without stopping the tape transport. When a number of blocks are to be consecutively written on one tape, the ability to write "non-stop" allows appreciable time saving by eliminating tape unit start and stop times.

Check While Writing The check-while-writing method employed in the subsystem assures later readability of data. A just-recorded character is read approximately 2.2 milliseconds after it is written. This "simultaneous" reading while writing enables read check circuitry to assure the readability of the data while it is being written. Bad spots on the tape are automatically detected by this method.

High-Speed Rewind and Automatic Positioning Tape rewind speed for a UNISERVO IIIC Unit is approximately 360 inches per second.

Automatic load point positioning is another feature of the tape handlers in the IIIC subsystem. When a reel of tape is inserted for operation, closing the door on the front of the UNISERVO unit automatically positions the tape at its load point.



SYSTEM COMPATIBILITY

SUBSYSTEM

Physical Description The UNISERVO IIIC Magnetic Tape Subsystem consists of: a UNISERVO IIIC Control Cabinet, a Tape Adapter Cabinet, a UNISERVO Power Supply Cabinet, and from two to twelve UNISERVO cabinets. The subsystem cabinets are designed to match the appearance of existing cabinets used with the UNIVAC 1107 Thin-Film Memory Computer. The physical characteristics of the subsystem are listed in Appendix A.

The tape transport mechanism, mounted on the front of the UNISERVO cabinet, is manufactured independent from the main cabinet frame. This provides exceptional alignment accuracy in the tape path. Vacuum applied to the slotted periphery of the vacuum capstan "clutches" the tape to move it as necessary. The tape loop vacuum chambers assure proper tension of the tape passing over the capstan. Acceleration and deceleration time at normal tape speed (112.5 inches per second) is 3 milliseconds or less. Rewind speed is approximately 360 inches per second.

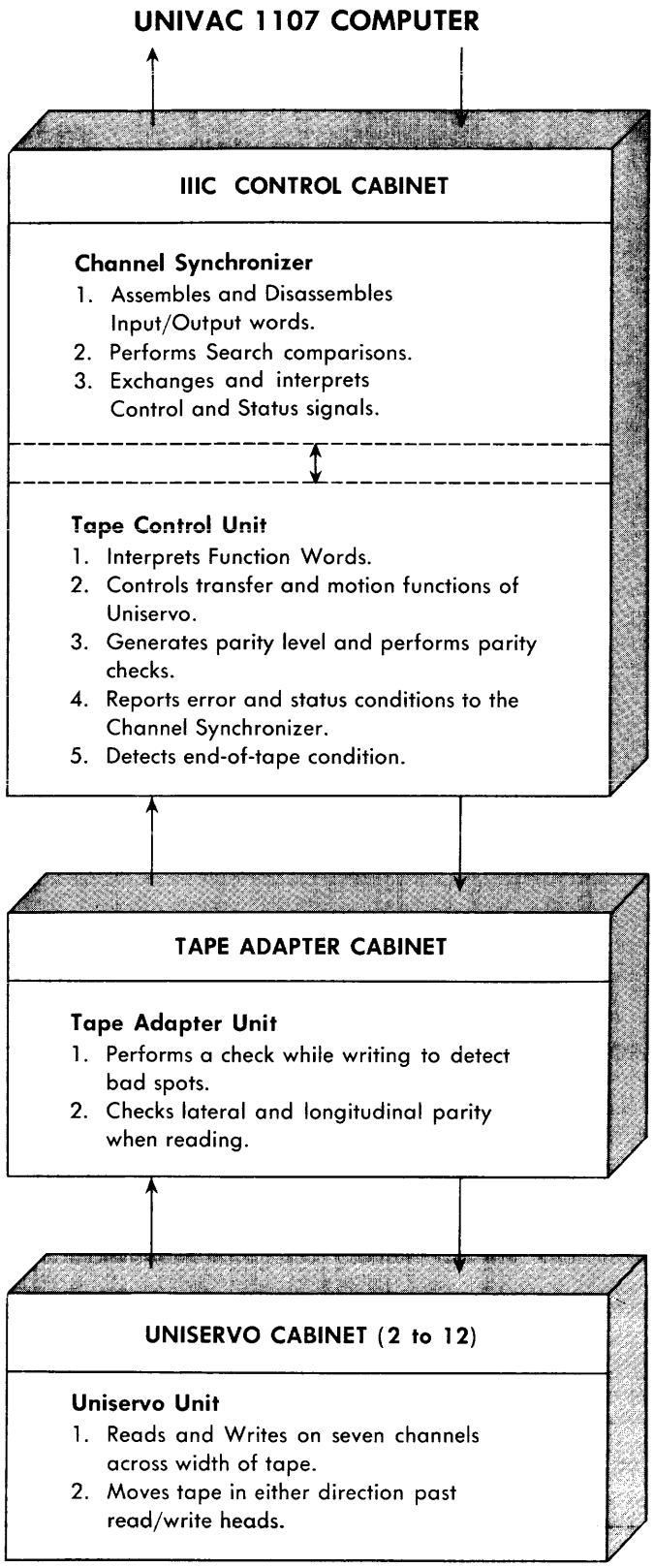
Tape threading details are illustrated in Appendix B.

Functional Description The subsystem is capable of reading or writing at either high or low density (556 or 200 characters per inch, respectively). Each word is recorded or read in 96 microseconds (62,500 frames per second) at high density or 267 microseconds (22,500 frames per second) at low density. The subsystem is also capable of performing computer-commanded "housekeeping" functions such as *Rewind, Erase, Backspace, Write End of File.* These functions are explained in greater detail later.

Bad spots on the tape are detected by a check-while-writing method. This method of reading back the data being written ensures later readability of recorded data. Destruction of recorded data by accidental "write-over" is prevented by automatic lockout of the *Write* Instruction unless a *Write Permit* Ring is physically attached to the tape reel.

The subsystem diagram shows the logical location of each subsystem unit and the unit's function within the subsystem. The instruction repertoire is listed in Appendix C. Each instruction listed may be coded for execution with or without a computer interrupt after completion of the instruction.

Data Transfer Sequence The Computer initiates the transfer sequence by sending an External Function signal and a Function Word to the subsystem.


UNIVAC 1107 COMPUTER
IIIC CONTROL CABINET
Channel Synchronizer
1. Assembles and Disassembles Input/Output words.
2. Performs Search comparisons.
3. Exchanges and interprets Control and Status signals.
Tape Control Unit
1. Interprets Function Words.
2. Controls transfer and motion functions of Uniservo.
3. Generates parity level and performs parity checks.
4. Reports error and status conditions to the Channel Synchronizer.
5. Detects end-of-tape condition.
TAPE ADAPTER CABINET
Tape Adapter Unit
1. Performs a check while writing to detect bad spots.
2. Checks lateral and longitudinal parity when reading.
UNISERVO CABINET (2 to 12)
Uniservo Unit
1. Reads and Writes on seven channels across width of tape.
2. Moves tape in either direction past read/write heads.

When the function has been interpreted by the subsystem, the appropriate tape unit in the subsystem is conditioned to communicate with the Computer. The data transfer sequences between the subsystem and the UNIVAC 1107 Thin-Film Memory Computer are as follows:

INPUT SEQUENCE

Subsystem presents an *Input Data Request* signal and Data Word:
Computer accepts the word and returns an *Input Acknowledge* signal.

OUTPUT SEQUENCE

Subsystem presents an *Output Data Request* signal;
Computer returns a Data Word and an *Output Acknowledge* signal.

TAPE FORMAT

Parity Level Each 6-bit character appears across the width of the tape with its parity bit in the 2^6-bit position. The parity bit, not passed to the Computer, is read by the parity checking circuits to determine the lateral parity status of each character. When writing, the subsystem adds a parity bit to each 6-bit data character to be written on the tape.

Data can be written or read in blocks with a density of 556 or 200 characters per inch. The length of a data block is variable under program control and is restricted only by computer memory size. The tape width accommodates seven channels or bit positions.

The UNISERVO IIIC subsystem can communicate with the computer in either a "binary" or a "binary-coded decimal" format. The choice of data format, in either high or low density, is Computer-programmed; the Function Word specifies which format is to be used. The binary format may be an exclusively numeric code or any UNIVAC binary-coded decimal coding. The binary-coded decimal format normally is IBM binary-coded decimal code. Both formats are physically handled in the same manner by the subsystem; however, the subsystem distinguishes between the tape formats by means of odd or even parity. Odd parity is used for the binary format and even parity for the IBM binary-coded decimal format. Parity check functions, as performed by the subsystem, are detailed later.

Translation between computer code and the IBM binary-coded decimal code can be accomplished either by computer programming or by means of an optional translator device installed as part of the Channel Synchronizer/Control Unit. Determination of the specific code formats involved in automatic translation is made by the user when the device is ordered. When the translator is included in the subsystem, it is activated by a "1" bit in position 18 of those function words which specify operations in the BCD mode. When these function words contain a "0" in position 18, and for all non-BCD functions, the translator is bypassed.

On page 7 are the binary-coded decimal codes, and examples of how they appear on tape and in the registers of the subsystem and the Computer.

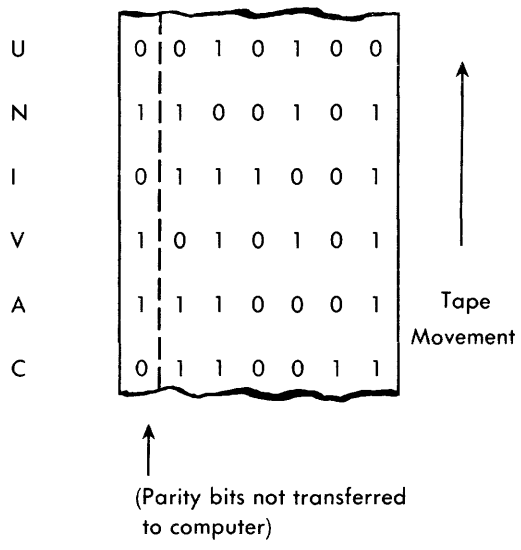
CHARACTER	CODE	CHARACTER	CODE	CHARACTER	CODE
A	110001	R	101001	0	001010
B	110010	S	010010	1	000001
C	110011	T	010011	2	000010
D	110100	U	010100	3	000011
E	110101	V	010101	4	000100
F	110110	W	010110	5	000101
G	110111	X	010111	6	000110
H	111000	Y	011000	7	000111
I	111001	Z	011001	8	001000
J	100001			9	001001
K	100010			.	111011
L	100011			-	100000
M	100100			$	101011
N	100101			*	101100
O	100110			/	010001
P	100111			'	011011
Q	101000				

REGISTER

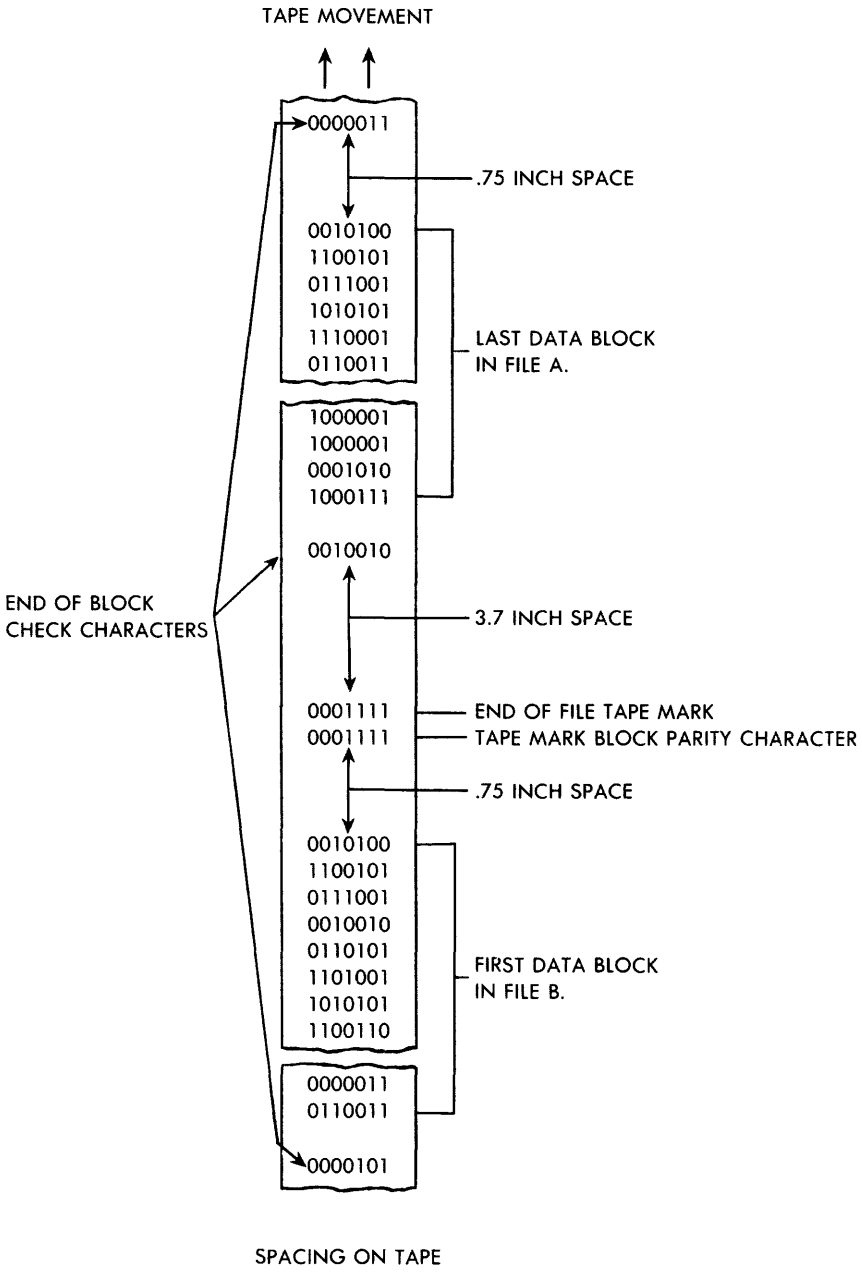
U	N	I	V	A	C
010100	100101	111001	010101	110001	110011

35 Bit Position 0

TAPE



Odd parity checking (odd number of 1's in each character) is used for the "binary" format. That is, a parity bit is added to maintain an odd number of 1's across the width of the tape. When the "binary-coded-decimal" format is used, the subsystem utilizes even parity checking.



SPACING ON TAPE

The subsystem also checks longitudinal or block parity. This is accomplished by "counting" the number of 1's in each channel of a block and adding a special character after the end of the block to assure an even number of 1's in each channel.

If either lateral or longitudinal parity errors are detected during a read, the Computer is notified by an external interrupt and a unique Status Word at the end of the block being read. The Computer program can then order a repeat of the function.

Spacing Spacing on tape is automatically provided by the UNISERVO IIIC subsystem when recording data. At the end of each block of data the subsystem records an end of block check character. A 0.75 inch space will occur between the check character and the first character of the next block.

When the last block of data in a file (related group of blocks) and its end of block parity character are recorded, the tape advances 3.7 inches before writing the end-of-file or tape mark character. The tape mark character (for longitudinal check purposes) is considered a block of data by the subsystem; therefore, the tape mark is followed by its own end of block parity character. A space of 0.75 inch will occur to provide the normal block space between an end of block character and the first character of a new block.

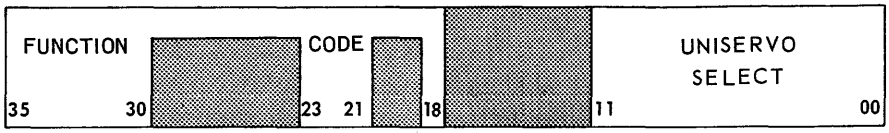
PROGRAMMING

There are four basic word transfers which may occur during an input/output sequence between a UNISERVO IIIC subsystem and a UNIVAC 1107 Computer: Function Word, Identifier Word, Data Word and Status Word. These words are transferred on the 36 data lines between the two equipments. Specific control signals accompany each of these words to make them readily distinguishable.

Function Words A Function Word is sent by the Computer to initiate each specific operation in the subsystem. An External Function signal is sent with each Function Word to identify it as a Function Word rather than an output Data Word. A complete repertoire of Function Words is listed in Appendix C. The functions may be summarized as follows: (each function may be executed with or without external interrupt; normal usage is with interrupt).

- *Write* with choice of density, format, and single or multi-block mode;
- *Read* forward, with choice of density, and format;
- *Search-Read* forward, with choice of density, and format;
- *Rewind* with or without interlock;
- *Backspace* file or block;
- *Skip while erasing;*
- *Terminate;* and
- *Bootstrap.*

The subsystem requires 10 bits of the 36-bit Function Word to define the requested operation and 12 bits to determine which of the possible twelve tape handlers is to perform the requested function. The Function Word format is:



"1" in position 18 activates the translator

Identifier Words An Identifier Word follows a *Search-Read* Function Word; it is also accompanied by an External Function signal. In effect, this full-length Computer Word is used to define the specific data to be read. That is, the first word of each block is compared with the Identifier Word until a block is reached with a first word identical to the Identifier Word. The subsystem then reads the block containing the desired first word.

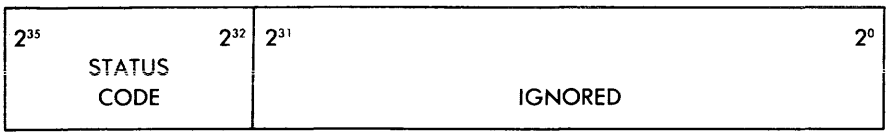
Data Words Information is read from or recorded on tape in the form of 6-bit characters (plus a parity bit). A group of six characters make up the 36-bit Data Word. The transfer of Data Words to and from the tape must always be preceded by the appropriate Function Word (and Identifier Word for *Search-Read* functions). Data Words may be in either the binary or binary-coded decimal format depending on the Computer program.

Status Words If requested by the Function Word an External Interrupt signal accompanied by a Status Word is sent by the subsystem to notify the Computer of normal completion of a function. In case of an error, the subsystem sends an External Interrupt and Status Word regardless of the Function Word. The status code is contained in the four most significant bits of the Status Word.

The function code is transmitted to circuitry within the tape control unit; this circuitry translates the 9-bit binary (three-digit octal) number to define the function and directs the subsystem to carry out the instruction.

The 12-bit UNISERVO select number is not coded. A master bit appears in only one bit position, and the position of this bit determines which UNISERVO unit is selected. This master bit signal logically selects the UNISERVO unit; the physical selection is completed by patching a plugboard on the Tape Adapter Cabinet prior to operation.

If a Function Word is received which is not in the subsystem repertoire or which errs in selecting a UNISERVO unit, or there is an error detected in transmitting the Function Word, the tape control unit circuitry signals this fact. The subsystem notifies the Computer of the condition with a Status Word.



A Normal Completion status code is sent only if the Computer Function Word requested the function with interrupt and no errors occurred during the function. This status code is not automatically generated. It must be requested when the Function Word is sent.

An *End-of-File* status code is sent when the tape mark is read at the end of a file.

The abnormal Status Words may be summarized as follows:

1. Circuitry or Program Malfunctions

Function Word Error: The subsystem decodes a Function Word which is not in the subsystem's repertoire, or there is a UNISERVO select error (more than one UNISERVO unit specified, or none specified when one should be).

Control Unit Sequence Error: The Computer delays in issuing an Input Acknowledge signal in time to remove a word from the subsystem register before the subsystem begins to put the next word in the register; or the Computer delays in issuing an Output Acknowledge signal and data so the subsystem begins to write and verify the Longitudinal Parity Check Frame.

Repeat Operation: A parity error, either lateral or longitudinal, has been detected during the read or search process or a comparison, parity, skew, or echo-check error has been detected during the write-check process. (An echo-check error occurs when the tape writing amplifiers fail to write at least one "1" bit for each frame.)

Abnormal Frame Count: A block contains a total number of significant frames which is not a multiple of six. During a *Write* function or the search portion of a *Search-Read* function only the status code is transferred. When reading, the final 3-bit positions of the last Data Word read indicate how many frames in the last word were significant.

Channel Synchronizer Sequence Error: The Channel Synchronizer in the subsystem has received an *End-of-Block* signal when its character counter is not at zero.

Channel Synchronizer Character Count Error: The Channel Synchronizer character counter contains a count greater than five. Tape movement stops at the end of the block.

2. Tape-Handling Conditions

Requested UNISERVO Unit is Rewinding: The Function Word has called for a UNISERVO unit which is in the process of Rewind Without Interlock.

Interlock Fault: The UNISERVO unit requested is interlocked, is rewinding with interlock, is inoperative, or (if writing is requested) does not have a Write Permit Ring installed on the tape reel. Power may be off, or a non-existent unit selected. Manual intervention is required.

Tape Limit Reached: The read, search, or write is normal, but during the block, the UNISERVO unit detected the reflective end-of-tape spot near the end of the tape.

If two or more Status Words are generated at the same time by conditions within the subsystem, one must take priority over the others. The order of priority is as follows:

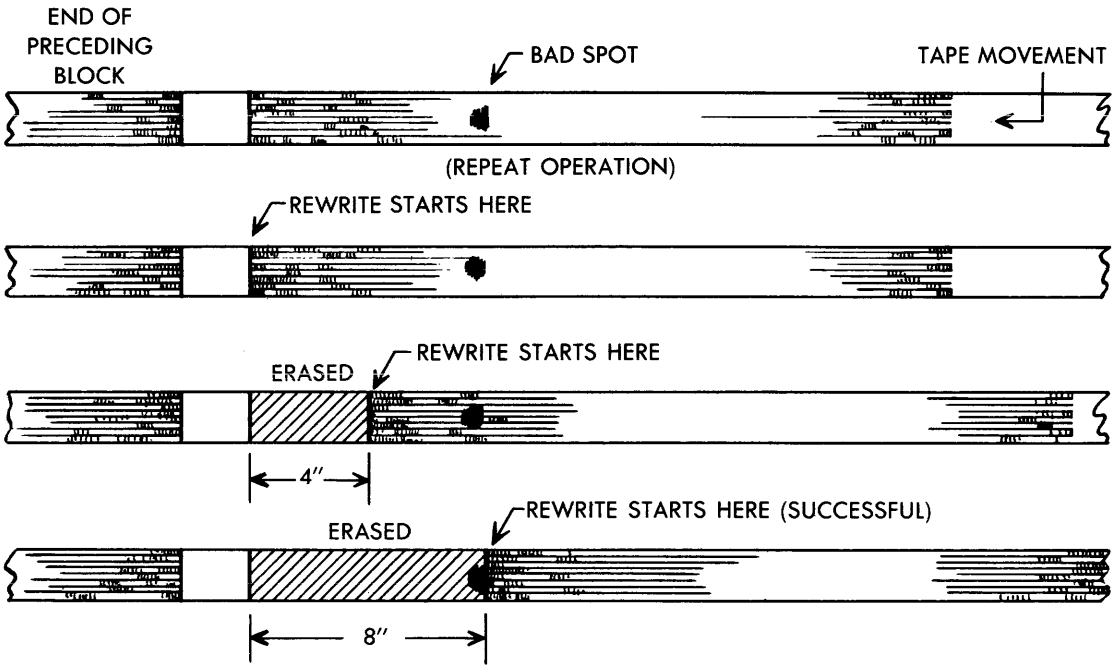
NOMENCLATURE	CODE (OCTAL)
Channel Synchronizer Character Count Error	(30)
Function Word Error	(34)
Requested UNISERVO Unit is Rewinding	(24)
End-of-File	(54)
Control Unit Sequence Error	(50)
Interlock Fault	(74)
Repeat Operation	(44)
Abnormal Frame Count	(70)
Tape Limit Reached	(60)
Channel Synchronizer Sequence Error	(20)
Normal Completion	(40)

This means that a Normal Completion interrupt, when requested, cannot be transmitted unless there is no other interrupt status generated. The status codes that can result from each basic function are contained in Appendix E.

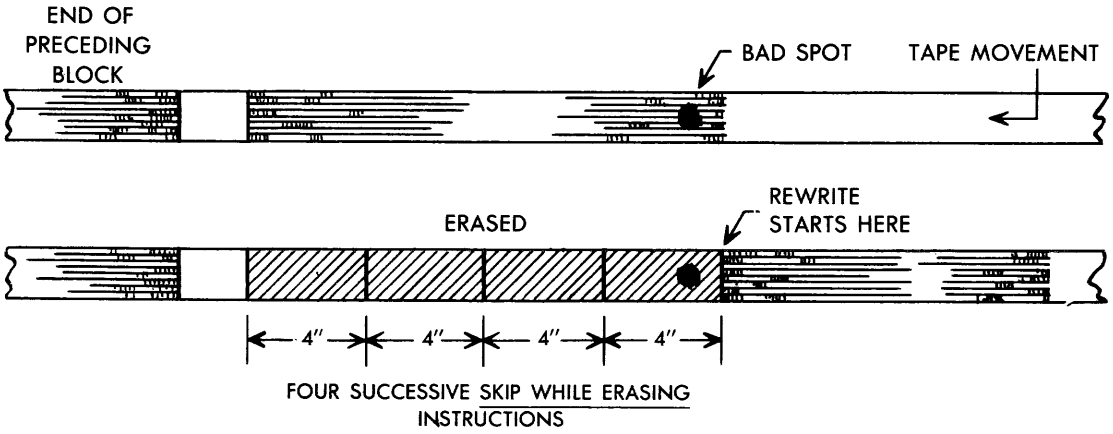
Multi-block Write Multi-block writing allows recording several blocks of data without the necessity of the tape transport coming to a complete stop between each block. Because of the greater speed of the Computer, compared to the subsystem, this type writing is feasible. Multi-block writing can be achieved by issuing successive *Multi-block Write* instructions or one or more *Multi-block* instructions followed by a normal *Write* instruction.

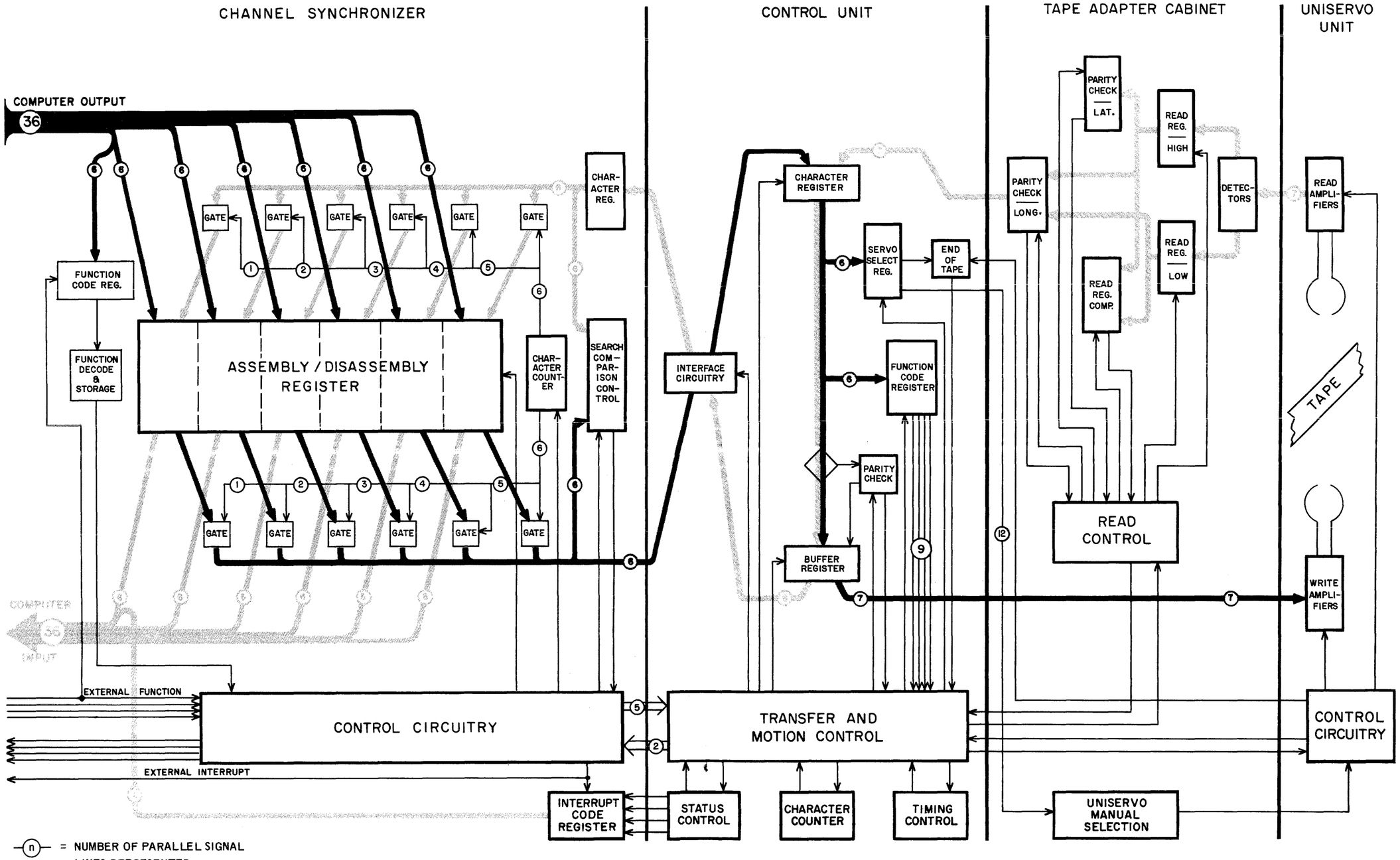
Recording, during a Multi-block function, is exactly the same as for a normal *Write* function. However, after the data block is recorded, tape motion continues if a new *Write* instruction and the first Data Word are received before the tape advances 0.75 inch. If the instruction and data are not received within the normal interblock space and the last instruction was a *Multi-block Write,* the interblock space will be increased by 0.50 inch. The multi-block method is advantageous when the program requires writing many consecutive blocks on the same tape unit.

Bad Spot Detection Tape bad spots, where recording and readback are impossible, are detected by reading back the data as recorded. The high-gain and low-gain outputs of the tape are compared and checked for parity; when there is disagreement or a parity error, the Status Word *Repeat Operation* is transmitted to the Computer. The Computer then may command the tape to backspace to the beginning of the block and try writing again. If the second attempt also shows an error, the Computer may command a backspace again; this time, instead of writing at the same place, the Computer may command *Skip While Erasing*, which moves the tape approximately four inches. Then another attempt to write may be made. This sequence may continue for as many times as necessary to get past the bad spot; obviously, the number of times depends upon the position of the bad spot as related to the beginning of the block. One possible sequence is illustrated below:



Another possible program sequence might not attempt a rewrite until several *Skip While Erasing* instructions have been issued:




CHANNEL SYNCHRONIZER
CONTROL UNIT
TAPE ADAPTER CABINET
UNISERVO UNIT
COMPUTER OUTPUT
36
GATE
CHAR-ACTER REG.
FUNCTION CODE REG.
FUNCTION DECODE & STORAGE
ASSEMBLY / DISASSEMBLY REGISTER
CHAR-ACTER COUNT-ER
SEARCH COM-PAR-ISON CON-TROL
CHARACTER REGISTER
INTERFACE CIRCUITRY
SERVO SELECT REG.
END OF TAPE
FUNCTION CODE REGISTER
PARITY CHECK
BUFFER REGISTER
PARITY CHECK — LAT.
PARITY CHECK — LONG.
READ REG. — HIGH
READ REG. — LOW
READ REG. COMP.
DETEC-TORS
READ CONTROL
READ AMPLI-FIERS
TAPE
WRITE AMPLI-FIERS
COMPUTER INPUT
55
EXTERNAL FUNCTION
EXTERNAL INTERRUPT
CONTROL CIRCUITRY
TRANSFER AND MOTION CONTROL
CONTROL CIRCUITRY
INTERRUPT CODE REGISTER
STATUS CONTROL
CHARACTER COUNTER
TIMING CONTROL
UNISERVO MANUAL SELECTION
(n) = NUMBER OF PARALLEL SIGNAL LINES REPRESENTED
= READ CIRCUITRY
= WRITE CIRCUITRY
BLACK = CONTROL CIRCUITRY

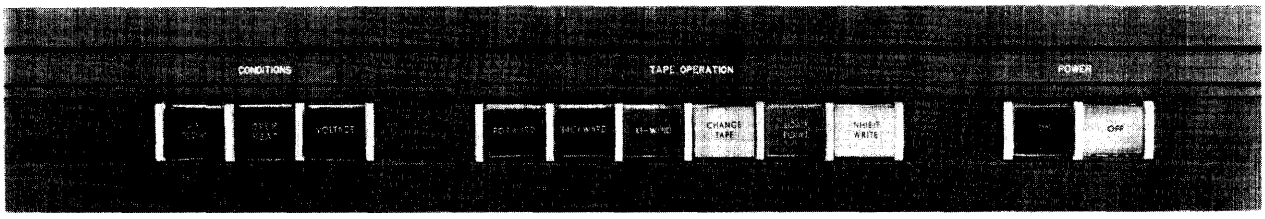
A programmer has a varied choice in dealing with bad spots; the choice of method depends upon block length, density, and other factors.

Bootstrap The subsystem's *Bootstrap* function commands a read from the beginning of a tape especially designated for bootstrap use. If the bootstrap tape is not at its load point, the tape is rewound and one block of data is read. The tape then comes to a stop.

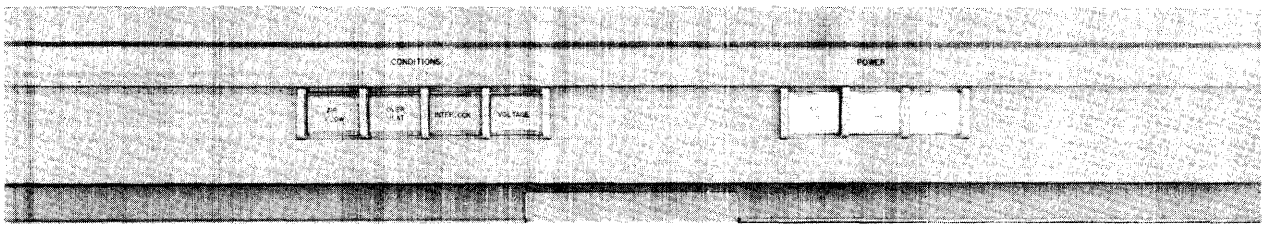
The *Bootstrap* Function Word need not program a specific UNISERVO unit; this designation has been made by setting the BOOTSTRAP SERVO dial on the IIIC Control Cabinet lower panel.

Typical Programming Examples of some basic programming are given in Appendix D. These show the format of Instruction Words, Access-Control Words and Function Words within the Computer.

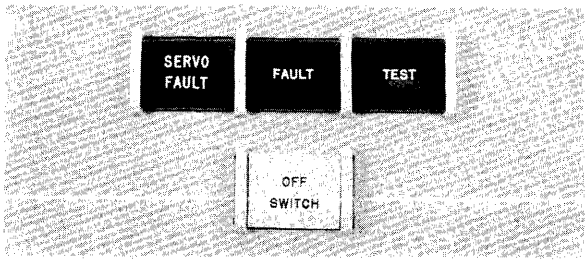
Control Panels When the subsystem is in operation, only the upper panels on the front of the UNISERVO unit, Tape Adapter Cabinet, and the IIIC Control Cabinet are visible to the operator. These panels identify the particular UNISERVO unit's logic designation number, warn of abnormal conditions, allow manual operation, and show normal status conditions. The UNISERVO panel is pictured below:



The Tape Adapter Cabinet panel is pictured below:



The IIIC Control Cabinet panel is pictured below:



The specific function of each indicator and switch is as follows:

UNISERVO Unit

AIRFLOW	:	power is off because air flow fails.
OVERHEAT	:	power is off because cabinet temperature exceeds allowable limits.
VOLTAGE	:	circuit breaker has opened in the UNISERVO unit.
FORWARD	:	command is for forward tape motion; pressing button conditions unit for motion independent of Computer control.
BACKWARD	:	command is for backward tape motion; pressing button conditions unit for motion independent of Computer control.
REWIND	:	tape is rewinding; pressing button allows rewinding with interlock independent of Computer control.
CHANGE TAPE	:	tape has been or is being rewound with interlock; pressing button moves tape to load point and removes interlock.
LOAD POINT	:	tape is positioned at its beginning point, ready for reading or writing.
INHIBIT WRITE	:	supply reel has no *Write Permit* Ring attached to it, preventing erasure of existing data and writing of new data.
POWER ON	:	all power is applied to the tape unit; pressing button applies power.
POWER OFF	:	power is not applied to all tape unit circuitry; pressing button removes power.

Tape Adapter Cabinet

AIR FLOW	:	power is off because air flow fails.
OVERHEAT	:	power is off because cabinet temperature exceeds allowable limit.
INTERLOCK	:	the cabinet power supply door is not completely closed.
VOLTAGE	:	cabinet voltage supply has failed due to power supply or interlock failures.
AC ON	:	AC power is applied to circuitry.
DC ON	:	DC power is applied to circuitry; pushbutton is ON-OFF switch.
READY	:	all power is applied within tolerances to all circuitry.

IIIC Control Cabinet

SERVO FAULT	:	a subsystem fault is within a UNISERVO unit or power supply, rather than control circuitry.
TEST	:	the subsystem is not working with the computer but is isolated for test or maintenance purposes.
FAULT	:	a subsystem power fault occurs. Pressing button clears out the fault if the error has been corrected.
OFF	:	red when pushed, to remove power from the subsystem. (Power is turned ON by other means; then indicator is green.)

The panel accessible from the front of the IIIC Control Cabinet (when a door is opened) allows manual designation of the specific UNISERVO unit for *Bootstrap* operation and permits monitoring of certain UNISERVO unit signals. On the back of the same cabinet, another door allows access to the Channel Synchronizer and Tape Control Unit maintenance panels for maintenance and test purposes.

The panel accessible from the front of the Tape Adapter Cabinet contains a plugboard to connect logical unit designations to specific UNISERVO units.

LOGICAL CHARACTERISTICS

Logic A simplified diagram of the IIIC subsystem is shown on page 14. The data paths show the assembly and disassembly of 36-bit words in the Channel Synchronizer, and the routing within the Tape Control Unit and Tape Adapter Cabinet to and from a UNISERVO unit.

Output — A 36-bit Function Word, Identifier Word, or Data Word is transmitted from the Computer to the Channel Synchronizer disassembly register. Then, as the character counter transmits control signals, each six-bit character is routed to the tape control circuitry.

The character is stored in the character register of the control unit. From the character register, the routing varies: If a Function Word is being transmitted, the function code bits are routed to the function code register and then the servo select bits are routed to the servo select register; if a Data Word is being transmitted, all characters are routed to the buffer register. While moving from character register to buffer, each character is checked for lateral parity; if necessary, a "1" bit is generated and written in the seventh channel by parity circuitry to insure odd parity (binary mode) or even parity (binary-coded-decimal mode).

From this point on, each character consists of seven bits. From the buffer, each character is transmitted to the UNISERVO unit write amplifiers to be written on tape.

If the function ordered is *Search*, Identifier Word characters stored in the disassembly register in the Channel Synchronizer are routed, one by one, to the search comparison control, to be compared with characters read from the tape during the search.

Status-detecting registers (function code, servo select, parity check, etc.) notify control circuitry if an abnormal status is in effect.

Input—Each seven-bit frame read by the UNISERVO unit Read Head is amplified and routed through detector circuitry to the parallel read registers (high-gain and low-gain). The output of the high-gain register is parity-checked (laterally); if no error is detected, the character is transmitted from the high-gain register through the longitudinal parity check circuitry to the character register in the tape control unit. If the output of the high-gain register shows a parity error, then the output of the low-gain register is transmitted through the longitudinal parity check circuitry to the character register. The longitudinal parity check circuitry cannot register an error, if one exists, until an entire block has been read.

In the tape control unit, a character is transmitted successively through the character register, the buffer register, and interface circuitry. As each character leaves the character register, it is parity-checked (laterally) and the parity bit is deleted. At this point, each character is composed of six bits.

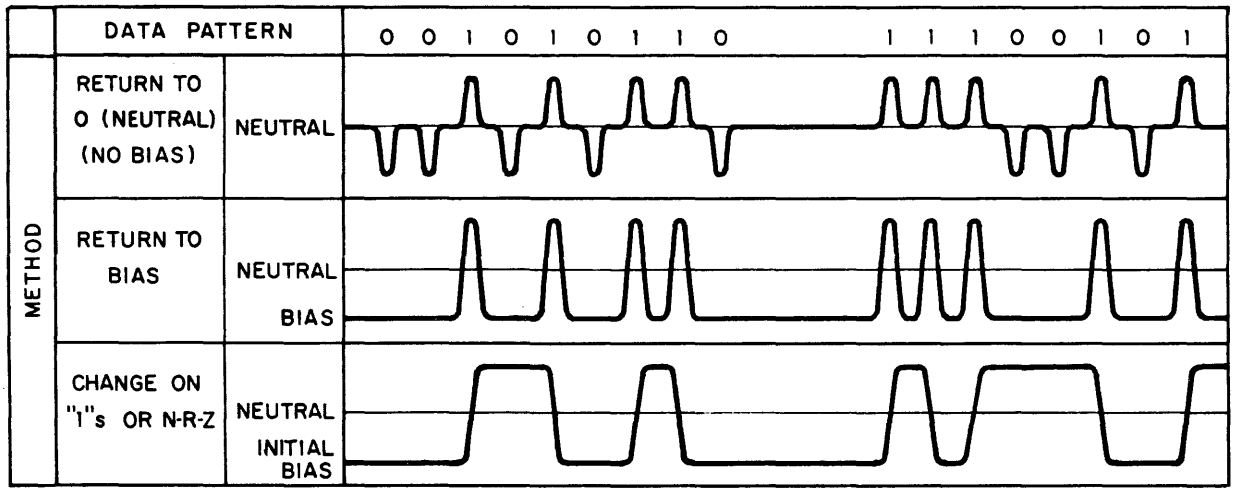
In the Channel Synchronizer, each character is stored in the character register until the character counter gates it into the proper portion of the 36-bit assembly register. From there, it is transmitted to the computer as commanded.

If the function ordered is *Search*, each character (of the first word in each block searched) is routed to the Search Compare Control circuitry for comparison with the corresponding character of the Identifier Word stored in the disassembly register. In this mode, of course, the words read from tape are not routed through the assembly and disassembly registers until after a "find" has been detected as a result of the search.

The four high-order bits sent to the Computer may also be supplied by the Channel Synchronizer interrupt code register when an External Interrupt signals that a Status Word is to be sent to the Computer. Since only these four bits (2^{35}-2^{32}) are significant in the Status Word, the other bits are not supplied by the interrupt code register.

Recording Mode The UNISERVO IIIC subsystem reads and writes tape in the "change on 1's mode"; this is also known as the "non-return-to-zero" mode. With some magnetic tape systems, the lack of magnetic polarization represents "neutral", and "1's" and "0's" are indicated by intense magnetic spots of opposite polarity. In other systems, the magnetic condition is "biased" or held in one polarized state for "0's" and then driven to the other polarized state to write "1's." In either case, when the writing signal is not present, the magnetic field of the tape returns to neutral or the bias condition.

With the IIIC subsystem, however, the magnetic polarization changes only when a "1" is to be written. If a "1" is followed by a "0" in the same channel, there is no change of polarization; the next time there is a "1", however, the polarization changes to the opposite extreme. This is illustrated below:



In order to read "0's" there must be a probing signal to sample all seven channels of a given frame. This signal causes the status of all channels to be registered; those registering no change of polarization are known to be reading a "0." The source of this probing signal is the collective sensing of the entire frame; when there is no parity error, there must be a "1" in at least one channel, and the existence of any "1" will serve as a probe to check for "0's" in the entire frame.

Write-Check Bad Spot Detection The *Read-Write* Head assembly contains seven separate magnetic *Read-Write* heads, one for each channel on the tape. Each is actually a duplex head, capable of reading and writing "simultaneously." The *Read* gap is positioned 0.25 inch after the *Write* gap, so it reads the just-written data approximately 2.2 milliseconds later. The data as read goes to the high-gain and low-gain registers of the tape adapter cabinet circuitry, where a comparison is made of the two outputs. If they do not compare exactly or there is a parity error, an interrupt signal is sent to the Computer after the block has been written. The Computer can then command a *Backspace Block* followed by a Rewrite attempt or a *Skip While Erasing* function.

Test Mode The subsystem can be isolated from the Computer for testing by positioning a switch on the Channel Synchronizer. When the subsystem is in the test mode, the red TEST indicator on the IIIC Control Cabinet is on.

APPENDIX A.
UNISERVO IIIC SUBSYSTEM PHYSICAL CHARACTERISTICS

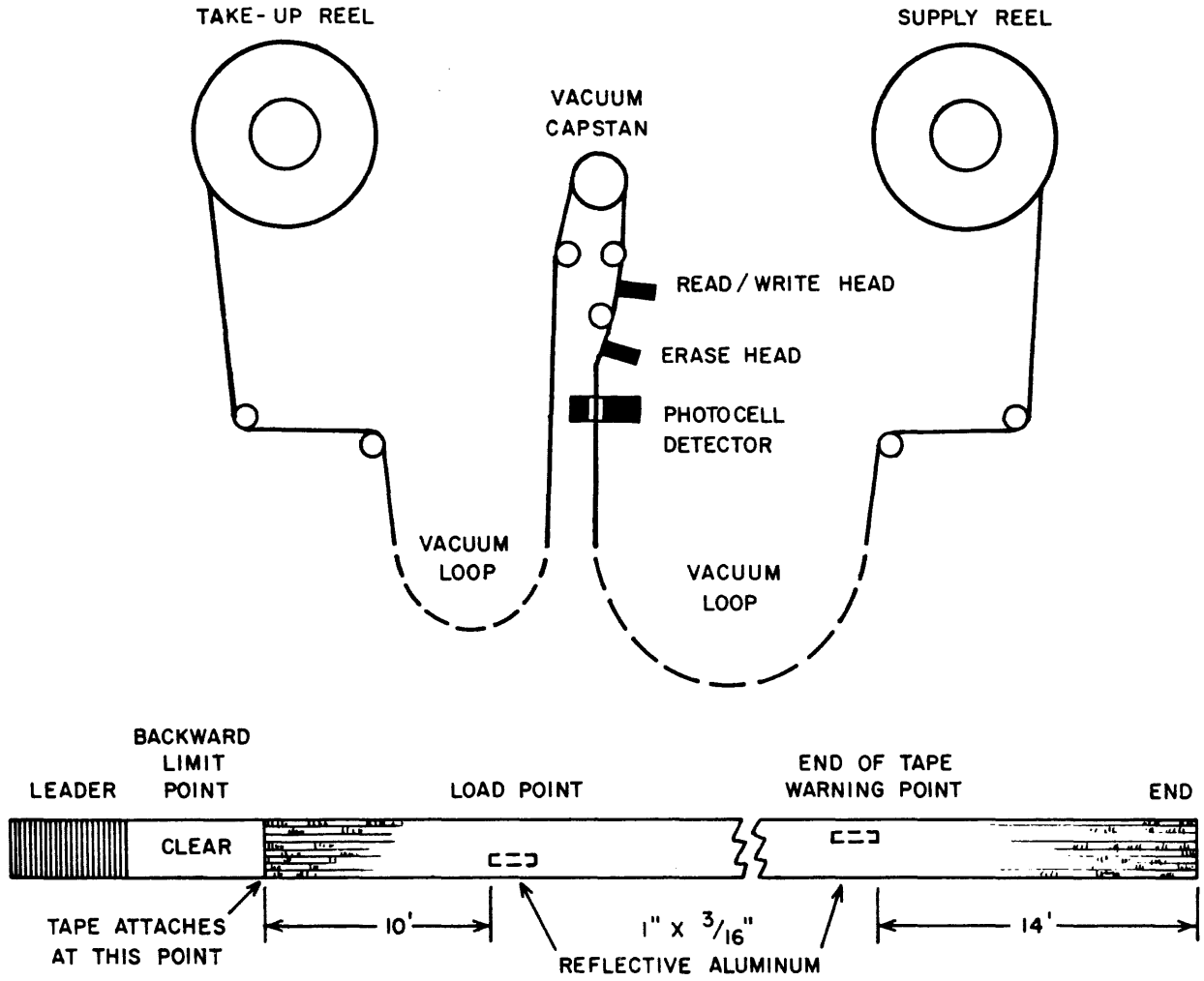
	UNISERVO CABINET	UNISERVO POWER SUPPLY	IIIC CONTROL CABINET	TAPE ADAPTER CABINET
HEIGHT (inches)	64	96	96	64
WIDTH (inches)	31	66	20	36
DEPTH (inches)	30	35	34	30
WEIGHT (approximate lbs.)	750	2200	310	800
TEMPERATURE RANGE	60° - 80°F (15° - 27°C) all units			
HUMIDITY RANGE	40% - 70% all units			
HEAT DISSIPATION (BTU/hr)	7500	10200	598	1360
AIR FLOW (cu. ft./min.)	350	2300	390	600
POWER REQUIREMENTS	Supplied by UNISERVO Power Supply	208 VAC 60 cps 3 phase 43.7 kw	208 VAC ± 1.0% 400 cps 3 phase 0.6 kw	Supplied by UNISERVO Power Supply

CABLING RESTRICTIONS*

1. Tape Adapter Cabinet must be adjacent to left side of first UNISERVO cabinet.
2. Power Supply to Tape Adapter Cabinet: 60 feet of cabling maximum.
3. IIIC Control Cabinet to Tape Adapter Cabinet: 80 feet of cabling maximum.
4. Computer to IIIC Control Cabinet: 300 feet of cabling maximum.

* These are general restrictions; individually-engineered locations may require less or allow more cable length.

APPENDIX B. UNISERVO IIIC TAPE THREADING AND MARKING



UNISERVO IIIC TAPE THREADING AND MARKING

APPENDIX C. UNISERVO IIIC INSTRUCTION REPERTOIRE

CODE*		NAME	DESCRIPTION
0200	1200	WRITE BINARY HIGH DENSITY	Write one block at 556 CPI with odd lateral parity, then stop.
0300	1300	WRITE BINARY LOW DENSITY	Write one block at 200 CPI with odd lateral parity, then stop.
0220 0221	1220 1221	WRITE BINARY-CODED DECIMAL HIGH DENSITY	Write one block at 556 CPI with even lateral parity, then stop.
0320 0321	1320 1321	WRITE BINARY-CODED DECIMAL LOW DENSITY	Write one block at 200 CPI with even lateral parity, then stop.
0240	1240	WRITE MULTIBLOCK BINARY HIGH DENSITY	Write one block at 556 CPI with odd lateral parity; stop only if no new *Write* function and data for the same unit are available.
0340	1340	WRITE MULTIBLOCK BINARY LOW DENSITY	Write one block at 200 CPI with odd lateral parity; stop only if no new *Write* function and data for the same unit are available.
0260 0261	1260 1261	WRITE MULTIBLOCK BINARY-CODED DECIMAL HIGH DENSITY	Write one block at 556 CPI with even lateral parity; stop only if no new *Write* function and data for the same unit are available.
0360 0361	1360 1361	WRITE MULTIBLOCK BINARY-CODED DECIMAL LOW DENSITY	Write one block at 200 CPI with even lateral parity; stop only if no new *Write* function and data for the same unit are available.
0230	1230	WRITE END OF FILE HIGH DENSITY	Write one special block consisting of Tape Mark frame (0001111) and its longitudinal parity check frame at spacing of 556 CPI, then stop.
0330	1330	WRITE END OF FILE LOW DENSITY	Write one special block consisting of Tape Mark frame (0001111) and its longitudinal parity check frame at spacing of 200 CPI, then stop.
4200	5200	READ BINARY HIGH DENSITY	Read forward one block at 556 CPI, then stop, checking for odd lateral parity.
4300	5300	READ BINARY LOW DENSITY	Read forward one block at 200 CPI, then stop, checking for odd lateral parity.
4220 4221	5220 5221	READ BINARY-CODED DECIMAL HIGH DENSITY	Read forward one block at 556 CPI, then stop, checking for even lateral parity.
4320 4321	5320 5321	READ BINARY-CODED DECIMAL LOW DENSITY	Read forward one block at 200 CPI, then stop, checking for even lateral parity.
4600	5600	SEARCH BINARY HIGH DENSITY	Read (forward) the first word of all blocks to end of file at 556 CPI, checking for odd lateral parity; compare each first word with Identifier Word; when identical comparison achieved, read the number of words specified by the instruction or the rest of the block, whichever is less.

* 1st column, without interrupt; 2nd column, with interrupt

CODE*		NAME	DESCRIPTION
4700	5700	SEARCH BINARY LOW DENSITY	Read (forward) the first word of all blocks to end of file at 200 CPI, checking for odd lateral parity; compare each first word with Identifier Word; when identical comparison achieved, read the number of words specified by the instruction or the rest of the block, whichever is less.
4620 4621	5620 5621	SEARCH BINARY-CODED DECIMAL HIGH DENSITY	Read (forward) the first word of all blocks to end of file at 556 CPI, checking for even lateral parity; compare each first word with Identifier Word; when identical comparison achieved, read the number of words specified by the instruction or the rest of the block, whichever is less.
4720 4721	5720 5721	SEARCH BINARY-CODED DECIMAL LOW DENSITY	Read (forward) the first word of all blocks to end of file at 200 CPI, checking for even lateral parity; compare each first word with Identifier Word; when identical comparison achieved, read the number of words specified by the instruction or the rest of the block, whichever is less.
2010	3010	REWIND	Rewind the specified UNISERVO unit to the load point.
2110	3110	REWIND WITH INTERLOCK	Rewind the specified UNISERVO unit to the unload position with interlock condition.
4000	5000	BOOTSTRAP	Rewind the UNISERVO unit specified for bootstrap#; read one block at 556 CPI, then stop, checking for odd lateral parity.
2030	3030	BACKSPACE BLOCK	Move tape backward until one of these conditions is encountered, then stop; Load Point, Tape Mark (end of file mark), Between block spacing.
2130	3130	BACKSPACE FILE	Move tape backward until one of these conditions is encountered, then stop; Load Point, Data block of four or fewer frames.
0030	1030	SKIP WHILE ERASING	Move tape forward approximately 4 inches while erasing, writing all "0's", and checking for complete erasure.
2300	3300	TERMINATE	Terminate the present function at the end of the next block and stop.

*1st column without interrupt; 2nd column with interrupt.

#UNISERVO unit need not be specified in Function Word: designation of unit for *Bootstrap* function is made by dial setting on control cabinet.

APPENDIX D. BASIC PROGRAMMING EXAMPLES

Operation of a UNISERVO IIIC Magnetic Tape Subsystem is controlled by programmed instructions from the Computer. These instructions direct a specific UNISERVO unit on a specified channel to perform a specific function. This appendix contains three basic programming examples to show how this may be accomplished by a Computer program.

WRITE

Writing on tape requires three Instruction Words, two Access-Control Words and one Function Word. In this example, 500_8 words are written in binary-coded-decimal at high density on logical unit 0 on channel 1 with interrupt:

COMPUTER PROGRAM					
ADDRESS	**INSTRUCTION WORD** f j a b h i u 6 4 4 4 1 1 16 bits bits bits bits bit bit bits	**ADDRESS**	**ACCESS-CONTROL WORD** G W V 2 16 18 bits bits bits	**ADDRESS**	**FUNCTION WORD** Func. Code 6 bits; Not Used 6 bits; Func. Code 3 bits; Not Used 9 bits; UNISERVO SELECT 12 bits
1200	75 10 01 00 0 0 001400 f and j: Initiate Function Mode a: channel 1 b, h, and i: not used u: address of Access-Control Word (initiates function mode on channel 1)	1400	6 00001 001401 G: Inhibit increment/decrement of V W: specifies number of words to be transferred. V: address of Function Word (one function word at address 001401)	1401	12 00 2 000 0001 Func. Code: specifies function to be performed. Select: specifies UNISERVO unit to perform function. (See NOTE 1). (write one block of high density BCD data on tape at logical unit 0 with interrupt)
1201	75 12 01 00 0 0 001201 f and j: Function Mode Jump a: channel 1 b, h, and i: not used u: address of this instruction (repeats this instruction until Function Mode is established then takes next instruction 1202)				NOTE 1 Logical unit designation of UNISERVO unit is translated by plugboard/patchcord connections in Tape Adapter Cabinet. Function Word designates logical unit by position of master bit in rightmost octal digits, rather than numeric translation; Octal: 0 0 0 1 Binary: 0 000 000 000 001 Logical Unit: 11 10 9 8 7 6 5 4 3 2 1 0
1202	75 04 01 00 0 0 001402 f and j: Initiate Output Mode a: channel 1 b, h, and i: not used u: address of Access-Control Word (initiates output mode on channel 1)	1402	0 00500 001500 G: increment V W: number of words to be transferred V: address of first word to be transferred. (initiates transfer of 500_8 words beginning at address 1500)		

READ

Reading from tape requires two Instruction Words, two Access-Control Words and one Function Word. The sequence is similar in many respects to that of writing, but the order is reversed; the function is established *after* the memory storage location is determined. In this example, 400_8 high-density binary words are read from tape on logical unit 1 on channel 2, with interrupt:

COMPUTER PROGRAM										
ADDRESS	INSTRUCTION WORD f j a b h i u	ADDRESS	ACCESS-CONTROL WORD G W V	ADDRESS	FUNCTION WORD FUNC. CODE	NOT USED	FUNC. CODE	NOT USED	UNISERVO SELECT
2100	75 00 02 00 0 0 002331 f and j: Initiate Input Mode a: channel 2 b, h, and i: not used u: address of Access-Control Word (initiates input mode on channel 2)	2331	0 00400 002360 G: increment V for each word W: number of words to be read. V: storage address for first word read. (400_8 words to be stored, beginning at address 2360 with incrementation for each word)							
2101	75 10 02 00 0 0 002332 f and j: Initiates Function Mode a: channel 2 b, h, and i: not used u: address of Access-Control Word (initiate function mode on channel 2)	2332	6 00001 002333 G: inhibit increment/decrement of V W: number of words to be transferred V: address of Function Word (transfer Function Word at address 2333)	2333	52	00	0	000	0002	FUNC. CODE: specific function to be performed. SELECT: specifies UNISERVO unit to perform function. (read 400_8 binary high density words from tape on logical unit 1)

SEARCH

Searching for a specific block of data (and the subsequent automatic reading) requires two Instruction Words, two Access-Control Words, one Function Word, and one Identifier Word. *Search* is similar to the *read* function, but in addition an Identifier Word must be supplied to which the first word of each block is compared. In this example, the tape on logical unit 2 of channel 3 is searched until a "find" occurs. Then, 600_8 words are read in binary at low density; with interrupt:

COMPUTER WORD													
ADDRESS	INSTRUCTION WORD f j a b h i u							ADDRESS	ACCESS-CONTROL WORD G W V			ADDRESS	FUNCTION AND IDENTIFIER WORD
3301	75	00	03	00	0	0	003227	3227	0	00600	003410		
	f and j: Initiate Input Mode a: channel 3 b, h and i: not used u: address of Access-Control Word (initiates input mode on channel 3)								G: increment V for each word W: number of words to be read. V: storage address for first word read. (600_8 words to be stored, beginning at address 3410 with incrementation for each word)				
3302	75	10	03	00	0	0	003230	3230	0	00002	003231	3231	57 00 0 000 0004
	f and j: Initiate Function Mode a: channel 3 b, h and i: not used u: address of Access-Control Word (initiates function mode on channel 3)								G: increment V for each word W: number of words to be transferred V: address of first word to be transferred (transfer a Function Word from address 3231 and an Identifier Word from 3232)				(search on logical unit 2, when "find" is made read binary words at low density and interrupt when function is completed) 3232 222200000000 (search for this word) NOTE: Identifier Word may be any configuration of 36 binary digits.

APPENDIX E. FUNCTION CODES WITH STATUS CODE RESPONSE

An "X" indicates the possible status code response to each function. Unless indicated in the table, the responses remain the same when the function code is requested with interrupt.

FUNCTION CODES	STATUS CODES											
	20 Channel Synchronizer Sequence Error	24 UNISERVO Unit is rewinding	30 Channel Synchronizer Character Count Error	34 Function Word Error	40 Normal Completion	44 Repeat Operation	50 Control Unit Sequence Error	54 End of File	60 Tape Limit Reached	70 Abnormal Frame Count*	74 Interlock Fault
020 Write Binary High Density	X	X	X	Occurs when a Function Code is received that is NOT listed or when a UNISERVO select error occurs.	Possible response to all codes when interrupt is requested, except for Backspace File.	X	X		X	X	X
030 Write Binary Low Density	X	X	X			X	X		X	X	X
022 Write BCD High Density	X	X	X			X	X		X	X	X
032 Write BCD Low Density	X	X	X			X	X		X	X	X
024 Write Multiblock Binary High Density	X	X	X			X	X		X	X	X
034 Write Multiblock Binary Low Density	X	X	X			X	X		X	X	X
026 Write Multiblock BCD High Density	X	X	X			X	X		X	X	X
036 Write Multiblock BCD Low Density	X	X	X			X	X		X	X	X
023 Write EOF High Density	X	X	X			X	X		X	X	X
033 Write EOF Low Density	X	X	X			X	X		X	X	X
420 Read Binary High Density	X	X	X			X	X	X		X	X
430 Read Binary Low Density	X	X	X			X	X	X		X	X
422 Read BCD High Density	X	X	X			X	X	X		X	X
432 Read BCD Low Density	X	X	X			X	X	X		X	X
460 Search Binary High Density	X	X	X			X	X	X		X	X
470 Search Binary Low Density	X	X	X			X	X	X		X	X
462 Search BCD High Density	X	X	X			X	X	X		X	X
472 Search BCD Low Density	X	X	X			X	X	X		X	X
201 Rewind		X	X								X
211 Rewind with Interlock		X	X								X
400 Bootstrap	X	X	X			X	X			X	X
203 Backspace Block		X	X						X		X
213 Backspace File		X	X						X		X
003 Skip While Erasing		X	X			X			X		X
230 Terminate			X								X

* 70 code during any *Write* operation indicates an Echo-Check error.

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