# UNIVAC® 1107

## TECHNICAL BULLETIN

# UNIVAC 1107

## UNISERVO IIA

### Magnetic Tape Subsystem

January, 1962

# CONTENTS

# 1. INTRODUCTION

The Magnetic Tape Subsystem is a large capacity, input-output and data storage system designed for use with the UNIVAC 1107 Thin-Film Memory Computer.

Up to 12 UNISERVO* IIA tape units can be connected to a single input-output channel through one tape control cabinet. Each tape unit is capable of performing four basic functions: recording (writing) data on tape; reading data recorded on tape; searching and reading; and rewinding of tape.

At any one instant, the subsystem allows a reading or recording operation to be performed by only one of its units. Any number of tape units, however, may rewind tapes at the same time.

Various checking features provide and maintain accuracy of information as it is read from or recorded on tape. Operator's control panels advise the operator of conditions existing within a Magnetic Tape Subsystem at any given moment. Since the tape unit can process either metallic or plastic base tape, a switch on the front panel of each UNISERVO unit permits the interchanging of metallic or MYLAR** tape.

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* Trademark of the Sperry Rand Corporation.

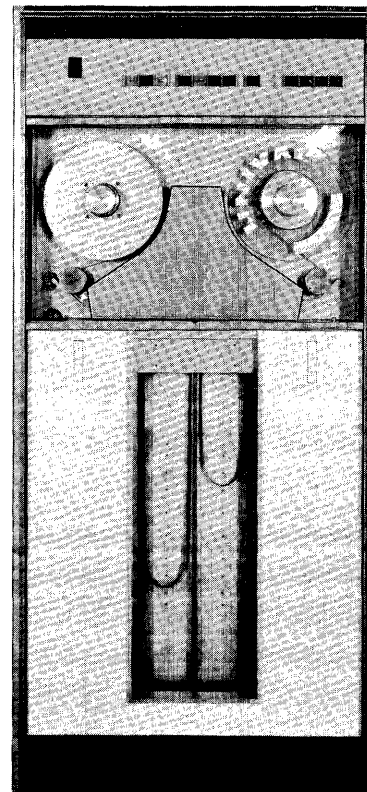**MYLAR is a registered trademark of the E.I. duPont de Nemours & Co., Inc.

Figure 1-1.  UNISERVO IIA Magnetic Tape Unit

# 2. FUNCTIONAL DESCRIPTION

## TAPE HANDLING

One side of the tape, which may have either a plastic or metallic base, is coated with a special magnetic-oxide coating. Data characters are recorded on the oxide coating as unique combinations of magnetic spots. As shown in Figure 2–1, the reel of tape to be processed is mounted on the removable supply reel. An unremovable take-up reel is used to take up the tape as it is processed.

The tape is threaded through guide rollers which form a path for the tape between the supply reel and take-up reel. A pre-threaded leader, extending the full length of the tape path through the rollers (approximately 21 feet), is permanently affixed to the take-up reel. At the conclusion of each operation, when the supply reel is removed, this leader is maintained at the supply reel side of the unit. The leading edge of any newly mounted supply reel can then be attached to the leader,

thereby eliminating the job of threading the tape through the rollers. This leader feature permits supply reels to be changed in about 30 seconds.

The read-write head performs the actual reading and recording of data on the tape. The erase head is used only during a write operation when it becomes necessary to clear the tape of any old information before new data is recorded.

The two vacuum columns are used to maintain the tape slack necessary for rapid starting and stopping of the reels. When the tape loop in the left column is shortened, more tape is fed from the supply reel, and when the tape loop in the right vacuum column becomes too long, the take-up reel pulls up the slack.

In order to remove a tape which has been processed, the tape must first be rewound to the supply reel.

UNISERVO IIA

STATUS INDICATOR LIGHTS

DOOR INTERLOCK SWITCH

TAPE REEL RELEASE

SUPPLY REEL

TAKE-UP REEL

CENTER DRIVE SHAFT
(FORWARD)

READ-WRITE HEAD

END OF TAPE (METAL)

END OF TAPE (BACKWARD)

METAL-PLASTIC SWITCH

MANUAL RUN SWITCH

TAPE WIPER ASSEMBLY

BAD SPOT PHOTOCELLS

END OF TAPE (PLASTIC)

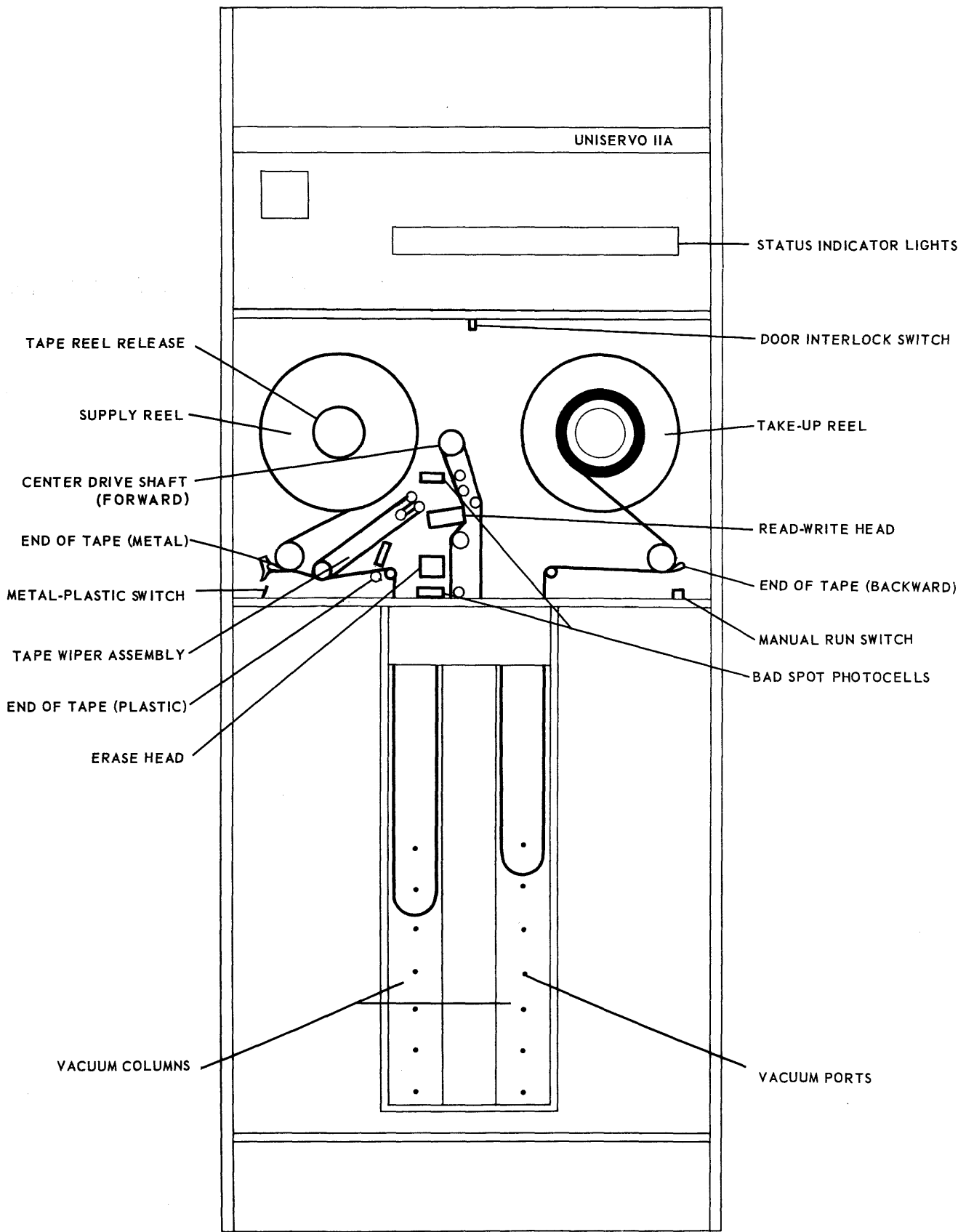ERASE HEAD

VACUUM COLUMNS

VACUUM PORTS

Figure 2-1. Schematic — UNISERVO IIA Magnetic Tape Unit

## TAPE FORMAT

Each character recorded on tape is composed of six data bits, one parity bit, and one sprocket bit. Since the sprocked bit is used merely for timing purposes during the reading of tape, further reference to this bit is omitted. The bit arrangement of characters recorded on tape is shown in Figure 2-2. Data is recorded on tape in units of 36-bit UNIVAC 1107 Computer words. Each word is recorded in groups of six 6-bit characters. Words are written on the tape in groups called blocks. Since a variable block length format is used in recording, a block may contain any number of words.
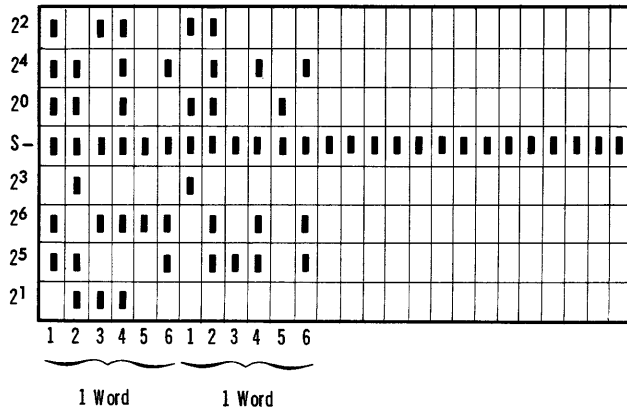


*Figure 2-2. UNIVAC 1107 Tape Bit Configuration*

Characters may be recorded at a density of either 125 or 250 characters per inch while the tape moves at a speed of 100 inches per second. The space between data blocks recorded on tape is 1.05 inches; this constitutes an interblock time of 10.5 milliseconds. The leader is 20 feet and 10 inches in length; it takes the moving tape 2,500 milliseconds to travel this distance. The end of file is detected by the absence of data for 3.5 inches, or 35 milliseconds. Starting and stopping of the tape requires 5 milliseconds.

The UNISERVO IIA magnetic tape unit can read information recorded on the tape at densities of 125 or 250 characters per inch. The unit is also capable of reading information recorded at a density of 50 characters per inch, the recording density of the UNITYPER* Keyboard to Magnetic Tape Unit.

*Trademark of the Sperry Rand Corporation.*

## ERROR DETECTION

The following error checking procedures are incorporated into the UNISERVO tape-handling unit to provide complete accuracy in the recording and reading of tape information:

### Bad Spot Detection

When bad spots on the tape are encountered, the bad spot areas are indicated by marking the tape: bad spots on metallic tape are marked by punching holes in the bad area, and bad spots on plastic tape are marked by scraping the tape (removing some oxide coating) in the bad area.

Photocell circuits in the UNISERVO unit constantly monitor the tape for bad spot indications. When a bad spot is detected by the photocells, circuitry causes the read or write function to be interrupted for the duration of the spot.

If a bad spot is detected during a write function, part of the data word is written before the bad spot area and the other part is written after the bad spot area; three data characters are written before the bad spot and three after it.

### Parity Error

Parity error indications are generated by the subsystem Control Unit if a parity error is detected during the read and read-search operations. Although parity is checked upon the reading of each character, an entire block of data is read through. If any character within the block did not have an odd number of bits, the parity error interrupt is generated after the entire block is read.

During a search-read operation, a parity error may occur in either the search or read portion of the operation. If only one word was read into the Channel Synchronizer the parity error occurred in the search identifier word. If more than one word was read, the error occurred in the "find block".

### Character Count Error

The character count error occurs when a multiple of six characters is not available to read or write. On a read or search-read operation, if a character count error is detected, it is indicated after the complete block has been read. If an attempt is

made to read fewer than six characters per word, the characters will be read into the Computer and the block will be terminated.

## Inhibit Write Ring

A metal ring may be inserted on the inside diameter of the supply reel. This ring will prevent the UNISERVO Unit from executing a write instruction. It will not, however, prevent the execution of a read or rewind instruction. This ring thereby eliminates the possibility of inadvertently writing on a master tape.

## Specifications

The major data handling capacities and physical specifications of the UNISERVO IIA Magnetic Tape Unit are presented in Table 1.

| Word Length | 36 bits | | |
|---|---|---|---|
| Tape Length:<br>    Plastic<br>    Metallic | <br>2,400 feet<br>1,500 feet | Tape Speed | 100 inches per second |
| | | Storage Capacity<br>(per 100 feet at<br>   12.5 KC) | 960 one-word blocks or 6.1<br>blocks of 4096 words |
| Block Length | Variable | | |
| Interblock Spacing | 1.05 inches | | |
| Number of Channels<br>on Tape | 8 | Storage Capacity<br>(per 100 feet at<br>   25 KC) | 980 one-word blocks or 12.1<br>blocks of 4096 words |
| UNIVAC Computer<br>Standard Tape Format:<br>    Data<br>    Parity<br>    Sprocket | <br><br>6 bits<br>1 bit<br>1 bit | | |
| | | Word Transfer Rate | 240 us at 25 KC<br>480 us at 12.5 KC<br>1,200 us at 5 KC |
| Recording Density | 125 or 250 characters per inch | Transfer Mode | 6-bit parallel |
| Character Frequency | 5 (read only), 12.5 and 25 KC | Start and Stop Time | 5 ms |
| Recording Method | Return to Bias | Stop-Reverse Time | 600 ms |

## TABLE 1. UNISERVO IIA MAGNETIC TAPE UNIT SPECIFICATIONS

# 3. MAGNETIC TAPE SUBSYSTEM

A Magnetic Tape Subsystem consists of from two to twelve UNISERVO IIA Magnetic Tape Units, a Magnetic Tape Control Unit, and a Channel Synchronizer. The Channel Synchronizer and Control Unit are housed in a single cabinet. Data transfers between the tape units and the Computer are routed through the Control Unit and the Synchronizer.

As shown in Figure 3–1, the Magnetic Tape Subsystem is connected to the Computer through an input-output channel. Up to 15 input-output channels may be alloted for tape subsystems. (One input-output channel is normally reserved for the UNIVAC 1107 Computer Control Console.)

If each of the 15 magnetic tape subsystems contained a full complement of 12 tape units, the entire configuration would represent 180 magnetic tape units. Such a configuration would easily satisfy even the most demanding of tape input-output applications. In addition, it also illustrates the great capacity and versatility inherent in the input-output section of the UNIVAC 1107 Computer System.

## MAGNETIC TAPE CONTROL UNIT

The magnetic tape Control Unit controls the operation of the tape handlers during the recording and reproduction of data on the tape. This operation is performed in accordance with Function Words received from the Computer via the Channel Synchronizer. The Control Unit interprets these Function Words. In addition, it checks for various errors that may occur. The Control Unit accepts 6–bit output data characters from the Channel Synchronizer and distributes them to the tape
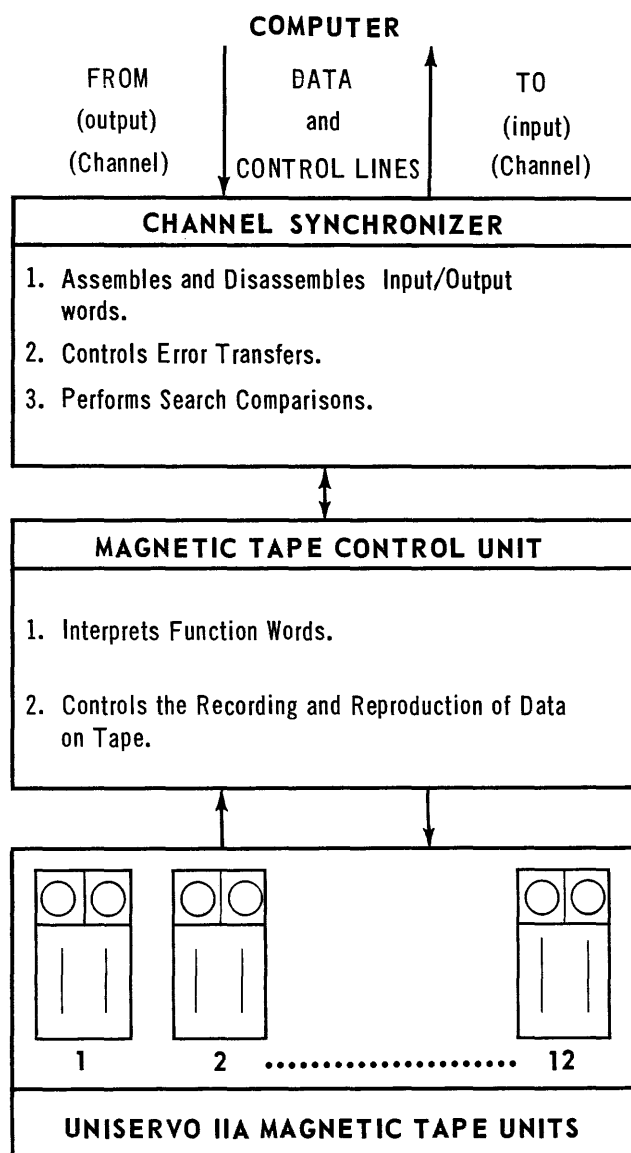


Figure 3–1. Magnetic Tape Subsystem

units, as specified by the computer program. The Magnetic Tape Control Unit also transmits the 6–bit input data characters (received from the tape units) to the Channel Synchronizer.

## CHANNEL SYNCHRONIZER

As shown in Figure 3–1, the Channel Synchronizer provides an interface, common electrical and logical boundary, between the Computer and the Tape Control Unit.

During a write operation (Computer to Tape Control Unit), the Synchronizer stores the 36–bit computer word in its Assembly-Disassembly Register. Then, when the Control Unit is ready to receive the data, the Channel Synchronizer disassembles the 36–bit word into six 6–bit characters for transfer to the Control Unit. During read operations, the Synchronizer assembles the 6–bit characters received from the Tape Control Unit into 36–bit words for transmission to the Computer. In effect, the Channel Synchronizer serves as a medium of storage during the input-output transfers of data between the Computer and the Magnetic Tape Control Unit.

In addition to the assembling and disassembling of words and the comparing of characters during a search, the Channel Syncrhonizer also checks for certain error conditions.

The Channel Synchronizer handles four types of words which are used in connection with the Magnetic Tape Subsystem.

### Data Word

As shown in Figure 3–2, the data word, a 36–bit word, is arranged in six groups of 6–bit characters.

The assembling and disassembling of data words during read and write operations takes place in the Channel Synchronizer.

| | | | | | |
|---|---|---|---|---|---|
| 35 30 | 29 24 | 23 18 | 17 12 | 11 6 | 5 0 |

Figure 3–2. The Data Word

### Function Word

A 36–bit function word contains operating instructions for the subsystem tape units. These instruc-

tions (see Magnetic Tape Subsystem Repertoire, page 3-6) are in the form of a 6–bit function code which is stored in bit positions 30 through 35 of the function word. (See Figure 3–3.)

| FC | NOT USED | | | TAPE UNIT-SELECT | |
|---|---|---|---|---|---|
| 35 30 | 29 24 | 23 18 | 17 12 | 11 6 | 5 0 |

Figure 3–3. The Function Word

Bit positions 0 through 11 of the function word are used to store the tape unit–select bits. These master bits designate which UNISERVO tape handling unit is to be used for the operation specified by the function code.

A particular tape unit is selected by the position of a master bit rather than a binary code (the addressing system of the Magnetic Drum Subsystem utilizes a binary code). For example, a bit in position 11 designates tape unit number 12; a bit in position 10 designates tape unit 11, and so on.

The remaining bit positions of the Function Word are not used.

A Function Word is sent to the Channel Synchronizer before any type of input, output, or special operation is initiated. A Function Word is always accompanied by an external function signal to distinguish it from a data word. Upon receiving a function word, the Synchronizer decodes the function code bits which set the operating mode for the Synchronizer. The Tape Control Unit utilizes the function code to direct the operations of the subsystem tape units.

### Identifier Word

An identifier word is a Computer output word which is transmitted immediately after a function word containing a Search-Read function. As in the case of the Function Word, the identifier word is also accompanied by an external function signal when it is sent from the Computer to the Magnetic Tape Subsystem.

The identifier word can be in any bit configuration (see Figure 3–4). When it is received at the Channel Synchronizer, it is stored in the As-

embly-Disassembly Register and compared character-by-character with the first word of each block of data read from tape until a comparision is found.
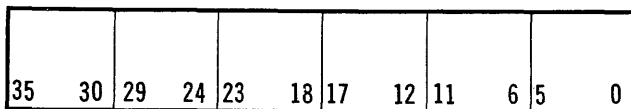
| 35 | 30 | 29 | 24 | 23 | 18 | 17 | 12 | 11 | 6 | 5 | 0 |
|----|----|----|----|----|----|----|----|----|----|----|----|

*Figure 3—4. The Identifier Word*

### Status Word

The status word transmits to the Computer all indications of error information and external interrupts. Error information is stored in the four most significant bit positions of the status word, bit positions 32 through 35. All other bit positions in the status word are not used. (See Figure 3—5.)
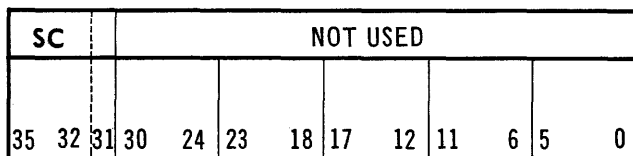
| SC | | NOT USED | | | | | | | | | |
|----|----|----|----|----|----|----|----|----|----|----|----|
| 35 | 32 | 31 | 30 | 24 | 23 | 18 | 17 | 12 | 11 | 6 | 5 | 0 |

*Figure 3—5. The Status Word*

Actual coding of the error information in the status word begins at the Magnetic Tape Control Unit. From there, the status word is sent to the Channel Synchronizer. If the Synchronizer has any error information, it is added to the status word. When the Synchronizer has accumulated all the error information, it sends an External Interrupt to the Computer.

The status (error) codes shown in Table 2 can be generated by the Control Unit and Channel Synchronizer of the Magnetic Tape Subsystem.

### SYNCHRONIZER-CONTROL UNIT COMMUNICATIONS

A block diagram of the major registers and communication lines relating to transfers of control signals and data between the Channel Synchronizer and the Tape Control Unit is shown in Figure 3—6.

The following information pertains to the sequence of events that takes place during communications between the Synchronizer and Control Unit. It is assumed that the Tape Control Unit is in a cleared condition.

| STATUS CODE (octal) | BINARY* | DESCRIPTION |
|---------------------|---------|-------------|
| 60 | 110000 | Parity error , Control Unit |
| 30 | 011000 | Character count error, Channel Synchronizer |
| 70 | 111000 | Character count error, Control Unit |
| 20 | 010000 | Sequence operational error, Channel Synchronizer |
| 50 | 101000 | Illegal function code. Function Word contains code not included in instruction repertoire. No operation is initiated when this type of error occurs. |
| 54 | 101100 | Tape unit-select error. Tape unit-select portion of Function Word contains incorrect tape unit-select bit code Control Unit. |
| 74 | 111100 | Interlock error. Error interrupt occurs when the Computer requests the operation of an interlocked UNISERVO tape handling unit, or when an attempted write operation is made on a master tape protected by an inhibit write ring. |
| 34 | 011100 | End of file. This is not error code but an indication to the Computer that no data has been read from the tape for 35 ms. |
| 44 | 100100 | End of tape interrupt. |

*
* The upper four bits contain the actual code. The low order two bits have no significant meaning to the Computer and can be either 0 or 1.
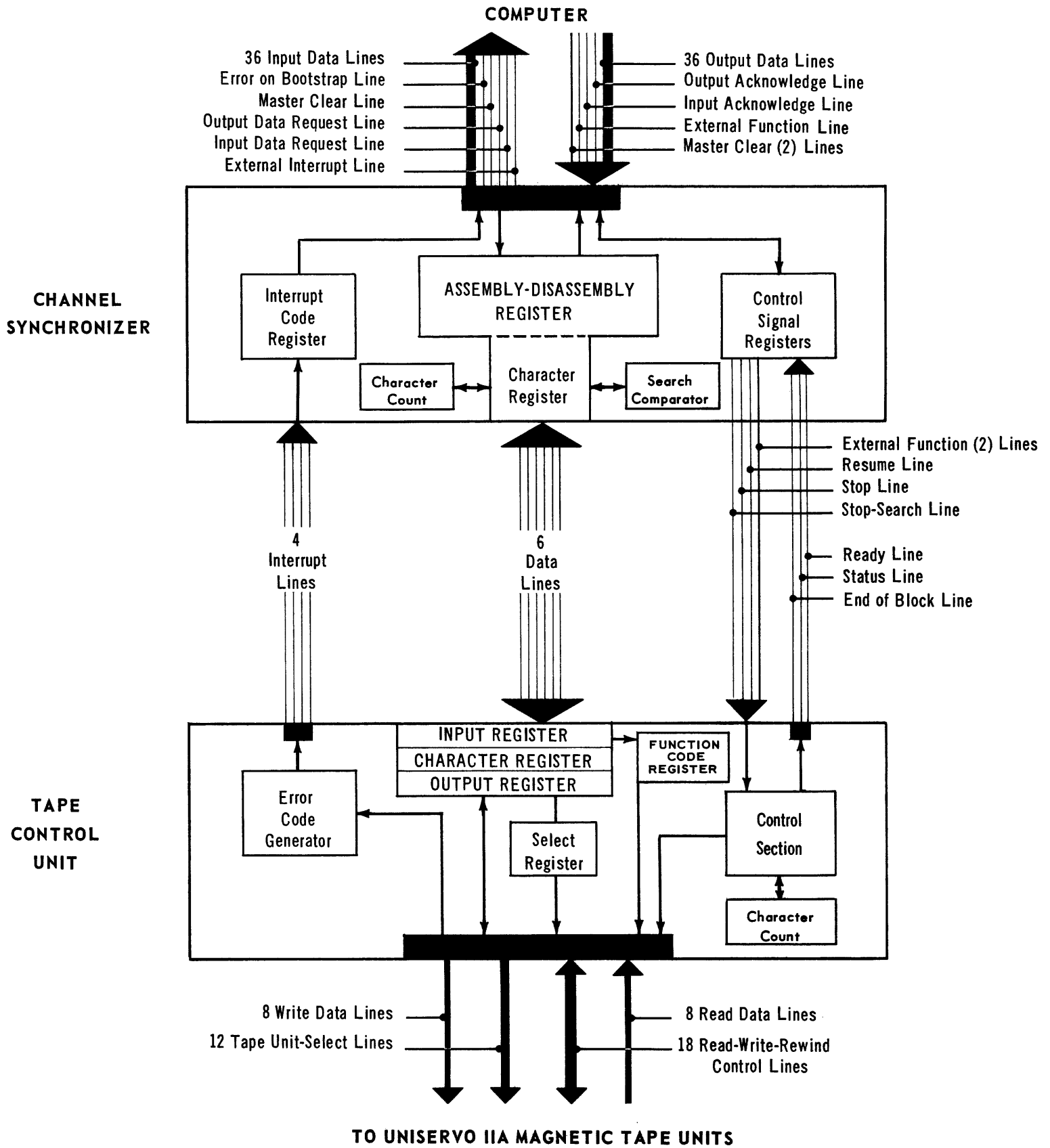
*TABLE 2. STATUS CODES*

COMPUTER

36 Input Data Lines
Error on Bootstrap Line
Master Clear Line
Output Data Request Line
Input Data Request Line
External Interrupt Line

36 Output Data Lines
Output Acknowledge Line
Input Acknowledge Line
External Function Line
Master Clear (2) Lines

**CHANNEL SYNCHRONIZER**

Interrupt Code Register

ASSEMBLY-DISASSEMBLY REGISTER

Control Signal Registers

Character Count

Character Register

Search Comparator

External Function (2) Lines
Resume Line
Stop Line
Stop-Search Line

Ready Line
Status Line
End of Block Line

4 Interrupt Lines

6 Data Lines

**TAPE CONTROL UNIT**

Error Code Generator

INPUT REGISTER
CHARACTER REGISTER
OUTPUT REGISTER

FUNCTION CODE REGISTER

Control Section

Select Register

Character Count

8 Write Data Lines
12 Tape Unit-Select Lines

8 Read Data Lines
18 Read-Write-Rewind Control Lines

**TO UNISERVO IIA MAGNETIC TAPE UNITS**

*Figure 3—6. Block Diagram — Synchronizer and Control Unit*

## FUNCTION: *EXTERNAL*

DESCRIPTION: Synchronizer transfers function code character of Function Word to Input Register of Control Unit.

Synchronizer sends External Function signal to Control Unit via External Function Line.

Upon detecting the external function signal, the Tape Control Unit samples the contents of the Input Register and transfers the contents of the Input Register to the Function Code Register.

Control Unit sends Ready signal to Synchronizer via the Ready Line.

The next three characters of the function word are transferred to the Control Unit and discarded. The next two characters received by the Control Unit are transferred to the Select Register for tape unit-select operation. Each character of the Function Word is accompanied by an EF control signal to identify it as a function character.

Tape movement control signals are generated by the function code. These signals set up the designated UNISERVO tape handling unit to perform the specified operation.

If no data transfer is indicated by the function code, the external sequence is ended. If either an input or an output data transfer is indicated by the function code, the sequence of events continues as follows:

## FUNCTION: *INPUT*

DESCRIPTION: If an input data transfer is specified by the function code, the Control Unit sends a Ready signal to the Channel Synchronizer. The Synchronizer answers with a Resume signal when it is ready to receive the first data character.

The first 6—bit character is read by the tape unit and sent to the Input Register. It is then transferred to the Character Register for a parity check. From the Character Register the data character is transferred to the Output Register. The 6—bit character and a Ready signal are then sent to the Channel Synchronizer.

Upon detection of the Ready signal, the Channel Synchronizer: samples its Character Register; and then transfers the contents of its Character Register to the appropriate character position of its Assembly-Disassembly Register.

The Channel Synchronizer then returns a Resume signal to the Magnetic Tape Control Unit, thereby indicating it is ready to receive the next 6—bit character.

*Repeat Above Steps Until End of Input Data*

## FUNCTION: *OUTPUT*

DESCRIPTION: If an output data transfer is specified by the function code, the Synchronizer sends a 6—bit character of output data to the Input Register of the Control Unit and a Resume signal is sent to the Control Section of the Control Unit.

Upon detecting the Resume signal, the Tape Control Unit: identifies the character in its Input Register as part of a data word; and then transmits a Ready signal to the Channel Synchronizer. The Control Unit transfers the 6—bit data character from the Input Register to the Character Register. A parity bit is added in the Character Register of the Control Unit, and the character is transferred to the Output Register. From the Output Register the character is transferred to the selected UNISERVO unit for writing on tape.

Upon detecting the Ready signal, the Channel Synchronizer: sends the next character of output data to the Input Register of the Control Unit; and then sends a Resume signal to the Control Section of the Tape Control Unit.

*Repeat Above Steps Until End of Output Data*

## MAGNETIC TAPE SUBSYSTEM REPERTOIRE

The following operations are performed by the Magnetic Tape Subsystem.

| FUNCTION CODE | DESCRIPTION |
|---|---|
| **WRITE** | |
| 01 | Write one block of data on tape at 12.5 KC in UNIVAC Computer format. |
| 11 | Write one block of data on tape at 12.5 KC in UNIVAC Computer format, and then send an External Interrupt signal to the Computer. |
| 02 | Write one block of data on tape at 25 KC in UNIVAC Computer format. |
| 12 | Write one block of data on tape at 25 KC in UNIVAC Computer format, and then send an External Interrupt signal to the Computer. |
| **REWIND** | |
| 20 | Rewind tape. |
| 21 | Rewind tape and interlock transport mechanism against further functions. |
| 30 | Rewind tape and send External Interrupt signal to Computer. |
| 31 | Rewind tape; interlock transport mechanism against further functions; and send External Interrupt signal to Computer. |
| **TERMINATE** | |
| 23 | Terminate present operation. |
| 33 | Terminate present operation and send External Interrupt to Computer. |
| **AUTOMATIC BOOTSTRAP** | |
| 40 | Terminate any function in progress. Rewind tape and read forward at normal gain from special selected UNISERVO tape handling unit. |
| 50 | Terminate any function in progress. Rewind tape and read forward at normal gain from special selected UNISERVO tape unit. When read function is terminated, send External Interrupt to Computer. |
| **READ** | |
| 41 | Read forward one block of data on tape at low gain. |
| 42 | Read forward one block of data on tape at normal gain. |
| 43 | Read forward one block of data on tape at high gain. |

| FUNCTION CODE | DESCRIPTION |
|---|---|

**READ**
**(cont.)**

| | |
|---|---|
| 51 | Read forward one block of data on tape at low gain and send External Interrupt to Computer. |
| 52 | Read forward one block of data on tape at normal gain and send External Interrupt to Computer. |
| 53 | Read forward one block of data on tape at high gain and send External Interrupt to Computer. |
| 61 | Read tape backward at low gain. |
| 62 | Read tape backward at normal gain. |
| 63 | Read tape backward at high gain. |
| 71 | Read tape backward at low gain and send an External Interrupt signal to the Computer. |
| 72 | Read tape backward at normal gain and send an External Interrupt signal to the Computer. |
| 73 | Read tape backward at high gain and send an External Interrupt signal to the Computer. |

**SEARCH READ**

| | |
|---|---|
| 45 | Search for first word of block on tape; when find is made, read block containing that word at low gain. |
| 46 | Search for first word of block on tape; when find is made, read block containing that word at normal gain. |
| 47 | Search for first word of block on tape; when find is made, read block containing that word at high gain. |
| 55 | Search for first word of block on tape; when find is made, read block containing that word at low gain. When read function is completed, send External Interrupt signal to the Computer. |
| 56 | Search for first word of block on tape; when find is made, read block containing that word at normal gain. When read function is completed, send an External Interrupt signal to the Computer. |
| 57 | Search for first word of block on tape; when find is made, read block containing that word at high gain. When read function is completed, send an External Interrupt signal to the Computer. |
| 65 | Search-read backward on tape at low gain. |
| 66 | Search-read backward on tape at normal gain. |

| FUNCTION CODE | DESCRIPTION |
|---|---|

SEARCH READ
(cont.)

| | |
|---|---|
| 67 | Search-read backward on tape at high gain. |
| 75 | Search-read backward on tape at low gain; when operation is completed, send an External Interrupt signal to the Computer. |
| 76 | Search-read backward on tape at normal gain; when function is completed, send an External Interrupt signal to the Computer. |
| 77 | Search-read backward on tape at high gain; when operation is completed, send an External Interrupt signal to the Computer. |

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