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IBM 2671 Paper Tape Reader

This reference publication describes the operation of the IBM 2671 Paper Tape Reader and the IBM 2822 Paper Tape Reader Control Unit when used as input to the IBM System/360 Models 30, 40, and 50. The System/360 channel commands necessary to control the operation of the IBM 2671 are fully described.

Console controls, tape specifications, tape splicing procedures, tape loading procedures, and special features available for the IBM 2671 are also described.

Titles and abstracts of associated publications are listed in the IBM *System/360 Bibliography*, Form A22-6822.



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Figure 1. IBM 2671 Paper Tape Reader and IBM 2822 Control Unit

With the rapid growth in centralized data processing and in data communication equipment, more and more data is being channeled from remote points to a centralized data processing system. The ideal medium for recording this information when it arrives at the central location is punched tape.

The IBM 2671 Paper Tape Reader (Figure 1) provides direct input to the IBM System/360. It operates under program control, like other System/360 I/O components, in applications employing data communications, source recording, scientific data processing, and data acquisition. For a more complete understanding of the material presented in this manual, the reader should be familiar with the SRL publication *IBM System/360 Principles of Operation*, Form A22-6821.

Like other components of the System/360, the IBM 2671 electronic portion is the result of microminiaturization of components and circuits through solid logic technology. All of this means greater reliability, higher speed, lower cost, and more compactness.

Operating Features

The IBM 2671 Paper Tape Reader, combined with the IBM 2822 Paper Tape Reader Control Unit (see Figure 1), can be attached to Models 30 through 50 of the IBM System/360.

The system program instructs the 2671 and 2822 to read tape and translate the characters, if necessary, from paper tape code to an appropriate code by means of a programmed table look-up as soon as either an EOR (End of Record) character or an end-of-tape is detected by the Tape Reader, or the number of characters specified by the computer program has been transmitted. The IBM 2671 Paper Tape Reader photoelectrically reads 5-, 6-, 7-, or 8-track punched chad tape strips at the rate of up to 1,000 characters per second. With optional spooling facilities, reels and rolls are read at a minimum of 500 CPS (after 4 characters of acceleration approximately 8 milliseconds). The information punched in the tape is sent, character by character, to IBM System/360 core storage for further processing.

The 2671 reads strips of punched tape 9 inches to 20 feet long including a 6 inch leader and a 3-inch trailer. A center-roll feeding mechanism, reel-feeding mechanism, and take-up mechanism are provided as special features.

Tape Codes

The IBM 2671 Paper Tape Reader can read punched tape in any one of three sizes:

1 inch	8-track
$\frac{7}{8}$ inch	7- or 6-track
$\frac{1}{16}$ inch	5-track

However, the distance between the feed holes and the lower side of the tape must be constant. Three parallel tracks are always located within this distance.

The characters are represented by one or several punches in a vertical column in accordance with the codes used. Many different codes are presently in use. For many of these codes, accuracy of reading is determined by making a parity check on each character punched in the tape.

The IBM 2671 Paper Tape Reader has been developed to provide a flexible medium between the various tape codes and the processing unit of the IBM System/360 through a Multiplex Channel (usual connection) or a Selector Channel.

Any tape code can be read by the 2671 since translation of the code is accomplished by a programmed table-look-up operation in the System/360. However, if the tape is punched in System/360 code, no translation is necessary.

Control Unit

The IBM 2822 Paper Tape Reader Control Unit, located below the paper tape reader mechanism (see Figure 1), provides the logical and buffering capabilities necessary to operate the paper tape reader. In order for the IBM System/360 to control a wide variety of input/output devices, all control units are designed to respond to a standard set of signals from the system channel that the I/O device is connected to. This control-unit-to-channel connection is called the I/O interface. It enables the System/360 to handle all I/O operations (including the paper tape reader) with only four instructions.

The IBM 2822 Paper Tape Reader Control Unit is composed of two main sections: the I/O interface and an adapter. The adapter is connected between the paper tape reader mechanism and the interface. The adapter is composed of three main parts:

- An any-bit circuit (used to detect the characters punched in the tape)
- A data buffer (8 positions)
- A data register (8 positions).

Reading Mechanism

The reading mechanism consists of the paper tape transport (friction drive and friction brake) and a photoelectric station (Figure 2). The friction brake consists of two braking surfaces under the control of an electromagnet. When the electromagnet becomes energized, the two braking surfaces are released, pinching the tape between them to stop the forward motion of the tape. The positive action of the two braking surfaces enables the tape to be stopped on one character regardless of the speed of the tape. The friction drive consists of a drive roller (continuously running) and an idler roller under the control of an electromagnet. When the electromagnet becomes en-

energized, the two rollers are released pinching the tape between them to impart forward motion to the tape. The friction drive and friction brake are operated in conjunction with an any-bit detection every time a stop condition occurs. The photoelectric station consists of a light projection system, a lens, and eight photocells. The photocells operate when exposed to the light (from the light projection system) passing through holes in the tape. The tape opacity and homogeneity must be sufficient to enable the photocell to register the contrast between the hole and the surrounding tape.

A microswitch, located to the right of the eight photocells, detects an end-of-tape condition and stops the reader.

Two retractable guides, located at the sensing station, allow the tape to be manually set in place. These guides can be set in three different positions depending upon the width of the tape being used (5-, 6- and 7-, or 8-track).

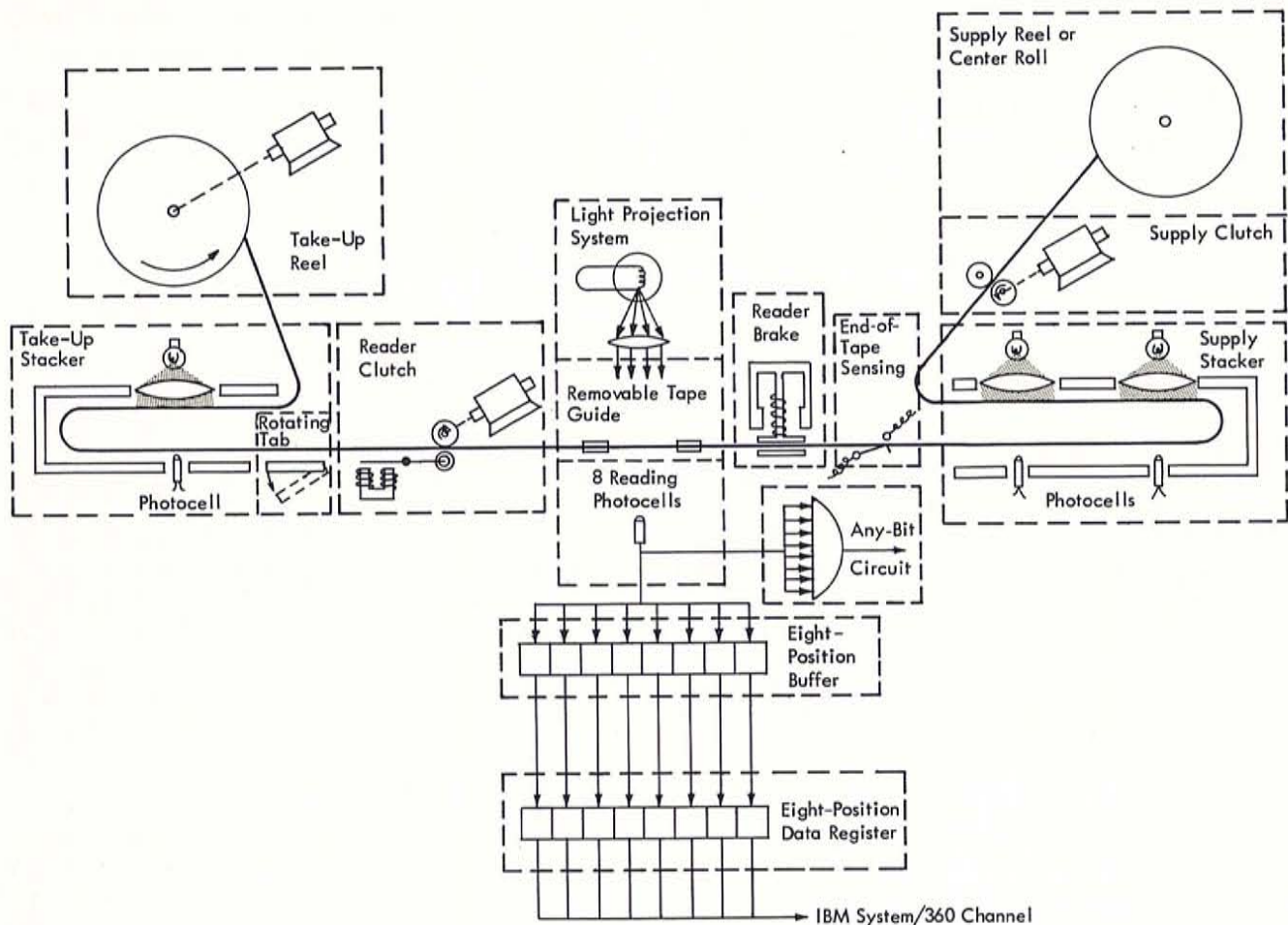


Figure 2. Schematic Drawing of Paper Tape Reader

Operating Switches, Keys, and Indicator Lights

CPU Switch

Emergency Power Off

Operating the System/360 Emergency Power-Off switch removes both ac and dc power from the paper tape reader and the paper tape reader control unit. The Emergency Power Off switch can be reset only by an IBM Customer Engineer.

Console Switches

EOR (End of Record, Tracks 1 through 8)

These eight switches are used when the stored program specifies that an EOR (End of Record) character punched in the tape will stop the paper tape reader. When the reader is programmed to operate in this manner these eight two-position switches allow manual definition of the EOR code. The on or off position of each switch corresponds to a punch or no punch in the correspondingly numbered tape track.

Upon sensing an EOR character, as defined by the setting of the switches, the paper tape reader stops but does not send the EOR character to the System/360.

Delete

To delete an error in the tape, holes are punched in every track of the column where the error has been made. This special character is called a *Delete* character. When the Delete switch is on and a sufficient number of adjacent punches (including track 1) are detected, the character is automatically suppressed in the reader. The channel command word character count remains unaltered and the tape reading process continues. A character is considered a Delete character when punches appear in the tracks of the tape according to the following rules:

$\frac{1}{16}$ inch tape	tracks 1 to 5
$\frac{7}{8}$ inch tape	tracks 1 to 7
1 inch tape	tracks 1 to 8

Delete characters are not checked for parity by the paper tape reader.

If an unusual code is used to designate a Delete character, or if no Delete code exists, the switch must be set to the off position.

Track Suppress

This switch, when on, prevents the eighth track from being read. Data is not transmitted to the CPU and is not considered in parity checking.

By suppressing the eighth track it is possible to read the shifted BCD code while still maintaining odd parity checking.

Parity

The setting of this 3-position switch permits a choice of parity checking. When set to *NONE*, no parity checking takes place. When set to *EVEN*, even-parity checking circuitry is active for all tracks of the tape being used. When set to *ODD*, odd-parity checking circuitry is active for all tracks of the tape being used. Regardless of the setting of the switch, all tracks are transmitted to the CPU (Central Processing Unit). When the width of the tape is such that a track does not exist, a zero-bit is transmitted for that track position.

Console Keys

Power On

If Remote-Local switch located on CE panel is set to *LOCAL*, pressing this key supplies ac and dc power to the reader. When Remote-Local switch is set to *REMOTE*, the Power On key is nonfunctioning and power is supplied under control of the System/360.

Power Off

If Remote-Local switch is set to *LOCAL*, pressing this key removes ac and dc power from the reader. When Remote-Local switch is set to *REMOTE*, the Power Off key is nonfunctioning and power is removed under control of the System/360.

Start

Providing all other Ready conditions are satisfied, pressing the Start key puts the tape reader in a Ready condition, turns on the Ready light and signals the System/360 that a paper tape read operation can be initiated.

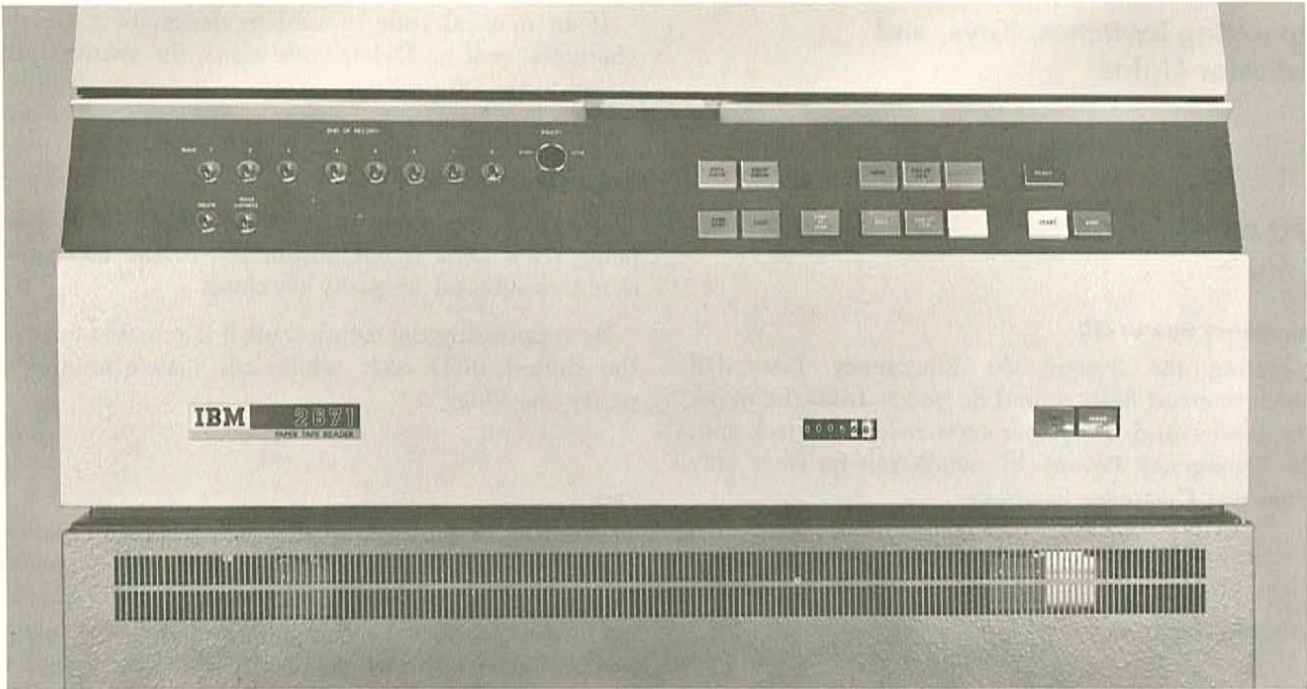


Figure 3. IBM 2671 Paper Tape Reader Console

Stop

When in an NPRO operation, pressing this key stops the tape immediately and turns the NPRO light off.

When in a Ready condition, but out of a read operation, pressing this key turns the Ready light off immediately.

When in a read operation, the Ready light turns off only after the read operation is completed, regardless of the status of the tape reader at the completion of the read operation (see *Paper Tape Reader – Stop Conditions* section of this publication, except *Channel Contention*).

End of File

When several rolls or strips of tape belonging to the same file have to be read, the End-of-File key must be

kept in the off position until the last roll or strip of tape is inserted in the reader. At this time the key is pressed (EOF light turns on); and when the end of the tape is sensed at the reading station, a signal is sent to the System/360 indicating that the last tape of the file has been read.

NPRO (Non Process Run Out)

This key, when operated, starts the tape in motion without processing it if the following conditions are satisfied:

- Power-on
- Ready light off (if on, press stop key)
- Tape properly loaded (load light off).

The tape continues to move forward until the stop key or load key is operated or the end-of-tape is detected. This key is used to rewind a roll of tape after it has been processed, provided that the roll of tape was previously moved from the take-up mechanism to the supply mechanism (reel feeding).

Step by Step

Each time this key is pressed, the tape advances one character position provided the following conditions are satisfied:

- Power is on
- Ready light is off (if on, press Stop key)
- Tape properly loaded (Load light off).

This key is used primarily to position the first character of a predetermined record under the reading station.

Console Indicator Lights

Power On

This light, when on, indicates that ac and dc power are supplied to the paper tape reader either under the System/360 control if Local-Remote Switch is in Remote position or under Power-On and Power-Off keys control if Local-Remote Switch is in Local position.

Ready

The Ready light, when on, indicates that the paper tape reader is either reading tape or waiting for instructions from the System/360. The light turns on when the following conditions are satisfied:

- Power is on
- Tape is properly loaded
- Overstep light is off
- Start key is pressed.

The light turns off when one of the following conditions occurs:

- The operator has pressed the Stop key and the read operation has been completed.
- The operator has removed the tape guides by pressing the load key.
- No tape is under the reading station and the EOF light is off.

- An overstep has occurred on tape stop. Upon receiving a stop signal from the control unit, the tape normally stops on one character. If such were not the case, data would be lost. Such situations may occur on a tape stop that is due either to an end-of-read operation or to channel contention when a read operation is in process (see *Theory of Operation*).

EOF (End of File)

This light, when on, indicates that the EOF key has been pressed. The light turns off when the System/360 is informed that the last tape of the file has been read (Unit Exception status byte), or when the Stop key is operated.

Equipment Check

This light, when on, indicates that a time-out condition has occurred. Each time a character is read, a time interval is initiated. If the following character punched in the tape is not read before the fixed time limit is reached (approximately 1 second), a time-out condition occurs and the Equipment Check light turns on, the tape reader stops, and the Ready light remains on. Any of the following conditions can cause a time-out condition:

- A length of tape containing no punching
- An unusual tape creeping condition
- Failure of the photocell reading system
- Failure of the tape drive motor
- Tape jamming in the optional take-up stacker.

The Equipment Check light is turned off when a new read operation is initiated.

Data Check

This light, when on, indicates that a parity error has been detected. The erroneous character is transmitted to the System/360, the tape reader stops and the Ready light remains on.

NPRO (Non Process Run Out)

This light, when on, indicates that the NPRO key has been pressed. The light turns off when the Stop or Load key is pressed or an end-of-tape is detected.

Overstep

This light, when on, indicates that a character has been lost on a tape stop. This condition causes the

Ready light to turn off. The load key is used to turn off the Overstep light.

Load

This light, when on, indicates that the tape guides (located on the paper tape reader) are not in position (Load key pressed).

Mechanical Switches

Load Switch

This switch is set ON when the right-hand top key (named Load key) is pressed. The tape guides are removed for tape loading.

This switch is set OFF when the left-hand top key is pressed. The tape guides are in position for tape reading. When on, this switch:

- Resets the eight positions of the buffer
- Clears the data register
- Stops the tape immediately when it is running (NPRO light or Ready light are reset)
- Resets the Overstep light.

Supply Switch

This switch is set ON when the supply clutch lever is perpendicular to the supply stacker. This switch is set

OFF when the supply clutch lever is in line with the supply stacker.

When on, this switch allows the supply drive mechanism to feed the tape from the roll under the control of the right photocell. When off, this switch prevents the supply drive mechanism from running (Strip feeding mode).

Take-up Switch

This switch is set ON when the rotating tab is in line with the take-up stacker. It is set OFF when the rotating tab is pressed against the take-up stacker guide.

When on, this switch allows the take-up reel to wind the tape under the control of the photocell. When off, it prevents the take-up reel from running and allows direct output of strips at the front of the take-up stacker.

Tape-Width Selector

The three positions of this selector correspond to the three positions of the tape width lever, which can adjust the tape guides to the three different widths of tape to be read.

The setting of this selector is internally detected to control the transfer of data to the buffer, as follows:

<i>Tape Width Lever Setting</i>	<i>Tape Width</i>	<i>Transferred Tracks</i>
8	1 inch	1 to 8
7	$\frac{7}{8}$ inch	1 to 7
5	$1\frac{1}{16}$ inch	1 to 5

Theory of Operation

When the System/360 requests a paper-tape-read operation the tape character directly under the read station is read and placed in an eight-bit-position buffer (see Figure 2). The data in the buffer is transferred to an eight-bit-position data register and the buffer is cleared. The tape is advanced and the next character is entered in the buffer. At this time the data register is checked to determine if the last character stored had been accepted by the System/360. If so, the data register would be clear and ready to accept the next character stored in the buffer.

However, if the previous character had not been accepted by the System/360 it would still be stored in the data register and the next character setting in the buffer could not be transferred. When this condition exists, the tape reader is signaled to stop, thus preventing the loss of a character because the buffer is already full.

Paper Tape Reader Stop Conditions

Channel Contention

A character can remain stored in the data register at least .8 milliseconds before a tape stop occurs that is

caused by a System/360 channel contention. In this case, the tape reader stops to avoid losing a character and restarts when the System/360 channel is available for the tape reader. The speed of the tape reader (1000 characters per second) can be maintained only if the System/360 channel is available to handle the characters at this rate of speed. The maximum speed is reached only after about four characters are read and the second character is read eight milliseconds after the start of the paper tape read operation.

EOR (End-of-Record) Detection

When the tape reader is stopped after detecting an EOR character in tape, the second character of the next record is located at the reading station, the first character is stored in the buffer and the EOR character is registered in the data register (Figure 4). Because the EOR character is not transferred to the system, the data register is cleared when a new read operation is initiated.

Character Count Equals Zero

When the tape reader is stopped by the System/360 (character-count equals zero), the third character of the next record is located at the reading station, the second character is stored in the buffer and the first

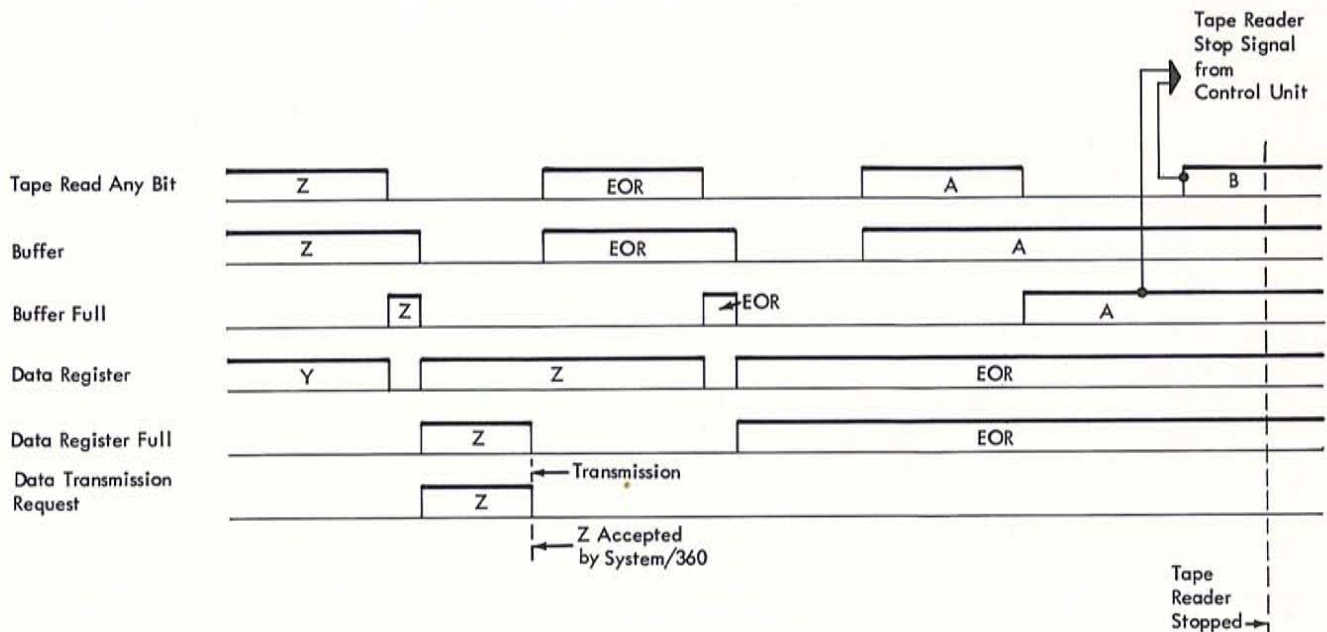


Figure 4. Tape Reader Stop (End-of-Record)

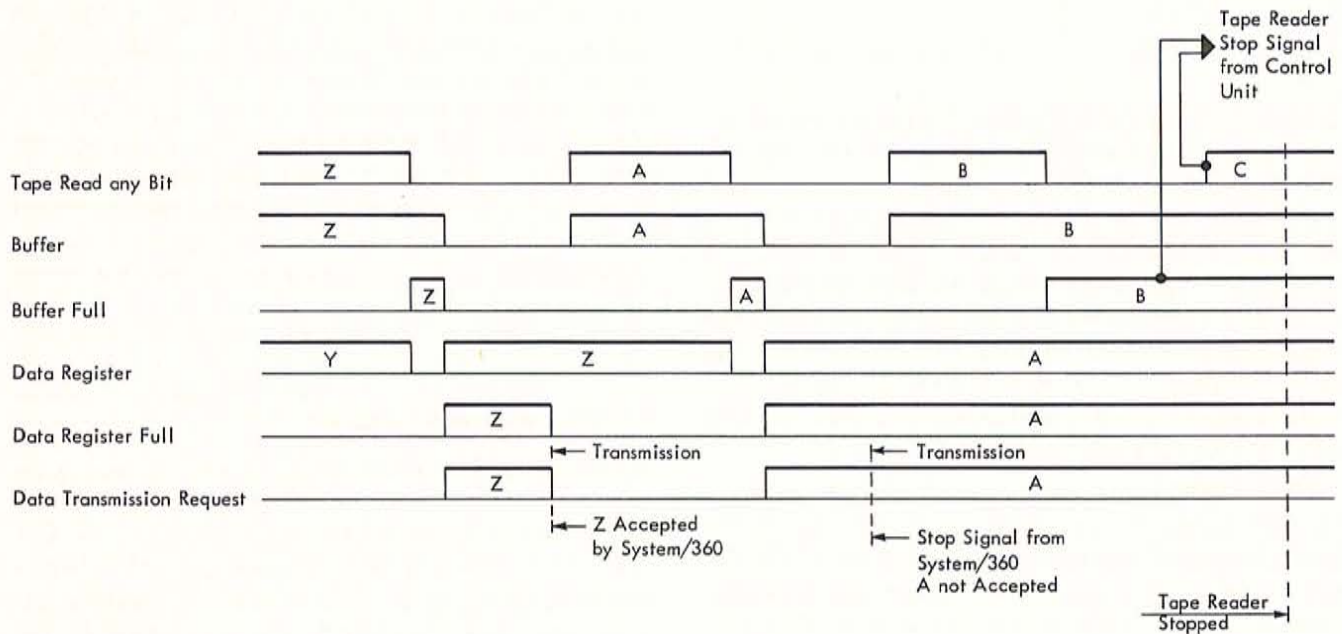


Figure 5. Tape Reader Stop (Character Count Equals Zero)

character is set up in the data register (Figure 5). Therefore, the first character of the next record is ready to be transferred when a new read operation is initiated by the System/360.

Data Check Condition

When the tape reader is stopped after detecting a data check condition, the second character following the incorrect character in the tape is located at the reading station, the first character is stored in the buffer and the incorrect character remains in the data register after being transferred to the system (Figure 6).

There are three different ways to restart the reading operation after a data check condition:

1. The CPU can decide not to consider the incorrect character as wrong and send another read command. No operator intervention is necessary.
2. When the data check light remains on the operator can press the stop and start key successively without disturbing the tape. The CPU is thus warned that a reading operation can be initiated. In this case the incorrect character is considered as wrong but is not read again.
3. When the data check light remains on, the operator can press the load key and backspace the tape two character positions. After pressing the start key a read operation is initiated by the CPU and the character is read again.

Interface

The IBM 2671 Paper Tape Reader is connected to the System/360 I/O Multiplex or Selector Channel through the IBM 2822 Paper Tape Reader Control Unit. The control-unit-to-channel connection is called the I/O interface. The interface consists of a set of wires over which the data and control signals are sent. Following is a summary of the lines in the interface:

Buses (18 Lines)

Bus Out (9)	Channel → I/O Unit(s)
Bus In (9)	Channel ← I/O Unit(s)

Tags (6 Lines)

Address Out	Channel → I/O Unit(s)
Command Out	Channel → I/O Unit(s)
Service Out	Channel → I/O Unit(s)
Address In	Channel ← I/O Unit(s)
Status In	Channel ← I/O Unit(s)
Service In	Channel ← I/O Unit(s)

Selection Controls (7 Lines)

Select Out	Channel → I/O Unit(s)
Select In	Channel ← I/O Unit(s)
Hold Out	Channel → I/O Unit(s)
Request In	Channel ← I/O Unit(s)
Operational Out	Channel → I/O Unit(s)
Operational In	Channel ← I/O Unit(s)
Suppress Out	Channel → I/O Unit(s)

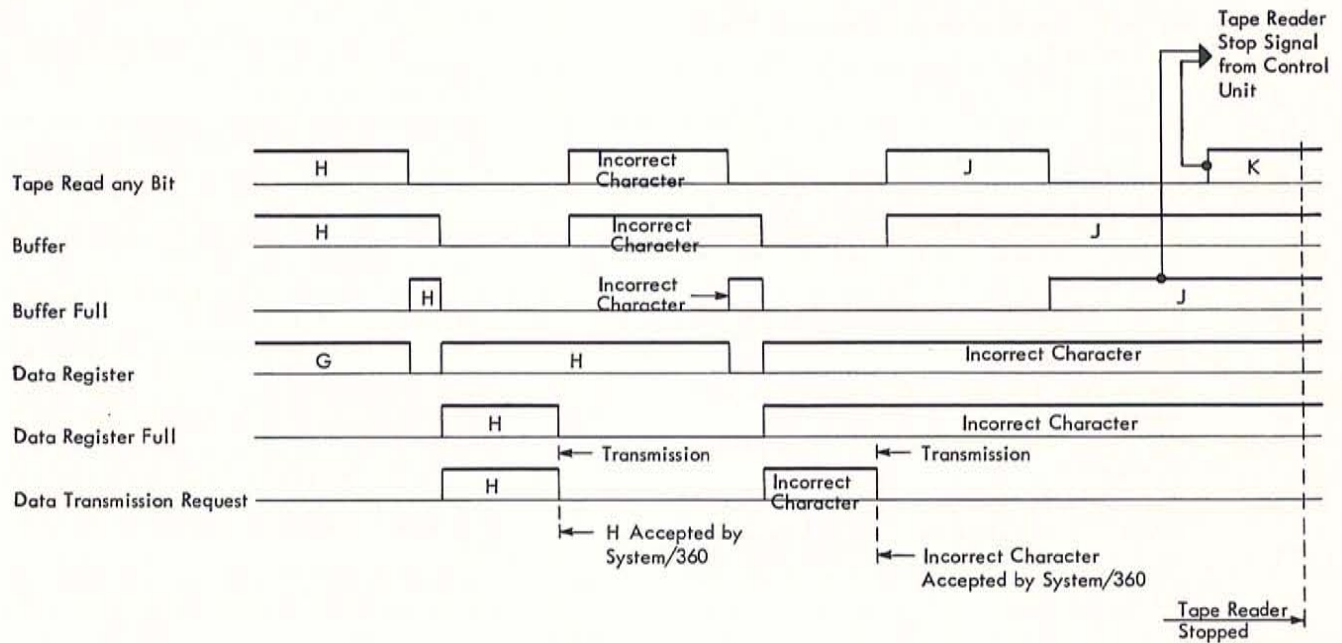


Figure 6. Tape Reader Stop (Data Check)

Metering Controls (3 Lines)

Metering Out	Channel → I/O Unit(s)
Metering In	Channel ← I/O Unit(s)
Clock Out	Channel → I/O Unit(s)

The select-out is bypassed when the power-on/off switch on the paper tape reader is turned off. When the switch is turned on, the electronic circuitry of the paper tape reader is reset and the select-out bypass is released.

When full-speed operation is in effect (1000 cps + 25% variation), the request-in line is activated by the tape reader every .8 milliseconds. In order to have the paper tape reader operate continuously, a data byte must be accepted by the channel within .8 milliseconds after the request-in line is activated.

Addressing

The IBM 2671 Paper Tape Reader is addressed by sending eight bits of address plus a parity bit over the 9 bus-out lines. The tape reader is equipped with an address card which can be adjusted to agree with the address set up by the program. This card can be adjusted only by an IBM Customer Engineer. Any one of 256 bit combinations is valid as an address for the paper tape reader.

Commands

The tape reader can accept all the System/360 I/O commands except Read Backward and Write, which are treated as invalid commands. The valid commands for the tape reader are:

Bit Positions	P	0	1	2	3	4	5	6	7
Read	{ 0	0	0	0	0	0	0	1	0
	{ 1	0	0	0	0	0	1	1	0
Sense	0	0	0	0	0	0	1	0	0
Test I/O	1	0	0	0	0	0	0	0	0
Control	1	0	0	0	0	0	0	1	1

Interface Bit-5 is a bit modifier for the Read command. The absence of this bit indicates that the read operation will stop when a count in the CPU Control Command Word reaches zero (stop signal transmitted from the System/360 to the tape reader).

The presence of a Bit-5 indicates that the read operation will stop as soon as an EOR byte is detected in the paper tape reader or the count in the CPU Control Command Word reaches zero. The programmer, therefore, should exercise caution when establishing the count in the CPU Control Command Word.

Status Byte

The status byte is used for signaling between the tape reader and the system I/O channel. With the excep-

tion of Busy and Unit Check caused by the Ready light being off, the following conditions are reset when accepted by the channel:

- Bit 0 *Not used*
- Bit 1 *Not used*
- Bit 2 *Not used*
- Bit 3 *Busy*. Indicates that a command is being executed or the tape reader is waiting to send an interrupt including Channel End and Device End.
- Bit 4 *Channel End*. Indicates that transmission of bytes over the interface for a given command has been completed.
- Bit 5 *Device End*. The tape reader can accept a new read command.
- Bit 6 *Unit Check*. The 6-bit is sent each time a Sense bit is set on.
- Bit 7 *Unit Exception*. Indicates that the end of the tape has been detected and that the End-of-File key was operated before or during the read operation. The tape which has just been read is the last tape of a file.

Sense Byte

When a sense command is received by the tape reader, one byte of sense information is transmitted to the system I/O channel. The following bit assignment is used in the sense byte:

- Bit 0 Command Reject
- Bit 1 Intervention Required
- Bit 2 Bus Out Check
- Bit 3 Equipment Check
- Bit 4 Data Check
- Bit 5 Not Used
- Bit 6 Not Used
- Bit 7 Not Used

These conditions are reset at the beginning of the next Read Command with the exception of Intervention Required, which is reset by pressing the start key after all requirements for a ready condition are satisfied.

- Bit 0 *Command Reject*. This condition is detected when a Read Backward or a Write command is received at the tape reader, or when valid commands have invalid modifier bits. A parity error on the command prevents this condition from being detected.
- Bit 1 *Intervention Required*. The tape reader is Not Ready. This is best described by stating the conditions for Ready. The tape reader is Ready when:
 - Power is on
 - Tape is properly loaded
 - Overstep light is off
 - Start key is pressed.

The tape reader becomes Not Ready *immediately* when either:

- The stop key is pressed while no read operation is in progress, or
- The load key is pressed.

The tape reader becomes Not Ready *at the completion* of a read operation when:

- There is an Overstep condition (tape did not stop on one character) on a normal or abnormal tape stop (see *Tape Reader Stop Conditions*). The Overstep condition is reset by pressing the Load key.
- The end of tape is detected at the reading station (EOF light being off).
- The Stop key has been operated during the read operation and a normal or abnormal completion has occurred (see *Tape Reader Stop Conditions* except Channel contention).

As soon as the tape reader is restored from any one of the Not-Ready conditions back to a Ready condition, a Device-End interrupt is generated to inform the program of this transition.

- Bit 2 *Bus Out Check*. A parity error has been detected for a command issued by the System/360.
- Bit 3 *Equipment Check*. This sense bit indicates that a time-out has been detected in the tape reader since the last data byte was sensed at the tape read station. This time-out of approximately 1 second can be caused by:
 - A failure of the photocells or the light projection system
 - A tape drive motor failure
 - An unusual tape creeping condition
 - A length of tape without punching
 - Tape jamming in the optional take-up stacker.

Programming Note. It is suggested that the System/360 program be written to include a Read command following an Equipment Check condition, and allow the program to decide that there is a breakdown in the paper tape reader only after three consecutive equipment check conditions have been detected.

- Bit 4 *Data Check*. Parity of the data that is read can be checked if the Parity switch is set to the Odd or Even position. Regardless of the tape code used, the data that is sent to the system is in odd parity which is required by the System/360.

Bits 5, 6, 7 *Not Used*.

Metering

Time is recorded on the usage meter (located on the 2671 Console):

- From the first read command until a run-out condition (end-of-tape) has been detected.
- During a tape rewind operation providing the CE (Customer Engineer) key switch located inside the 2822 Control Unit is turned off.

Operational Characteristics

Tape Reading

When the status of the tape reader changes from Not Ready to Ready, a Device-End status byte is sent to the system to cause an interrupt and alert the main program that a Read operation can be performed by the tape reader. By sending a Read command to the tape reader, the System/360 initiates a Read operation which starts the tape in motion. The read operation is completed as soon as a status byte, including Channel End and Device End generated by the tape reader, is accepted by the System/360.

Channel End, Device End

This status byte is transmitted to the System/360 every time a tape read operation has been properly performed, or a Halt I/O signal has been detected. If a bit modifier is not present in the Read Command byte, the Read operation is completed upon receiving a Stop signal from the system (character count equals zero). If the Read Command byte contains a bit modifier, the Read operation is normally stopped when an EOR byte is detected by the tape reader (the EOR byte is not transmitted to the system). The Channel-End, Device-End status byte can also be generated by an end-of-tape at the read station.

As soon as the Channel-End, Device-End status byte is accepted by the system, the tape reader becomes Not Ready (Sense bit-1, Intervention Required, turns on) if one of the following conditions is satisfied:

- An end-of-tape is detected (EOF key not operated).
- An Overstep occurs on a normal tape stop, except Channel contention.
- The Stop key is operated during the tape read operation.

Channel End, Device End, Unit Check

This status byte, when issued, indicates an unusual condition has occurred in the tape reader which prevents the following data bytes in the tape from being read properly. Operator intervention may be required, depending upon the sense bit that set Unit Check.

By issuing a Sense command, the system-stored program is able to determine the exact condition that

caused the Channel End, Device End, Unit Check status byte to be issued by the tape reader.

- *Sense Bit-1 (Intervention Required)*. Indicates that the tape reader became Not Ready before the normal completion of a read operation (Overstep on a tape stop due to a channel contention, or the Load key pressed).
- *Sense Bit-3 (Equipment Check)*. Indicates that a time-out has occurred (approximately 1 second) since the last data byte was read. A time-out condition is caused by a tape reader (unit) failure or a length of tape without punched holes. The tape reader, however, remains in a Ready status. The System/360 program can either initiate a new Read command or request operator intervention.
- *Sense Bit-4 (Data Check)*. Indicates that incorrect parity has been detected on a data byte at the read station. This data byte, however, was transmitted to the system I/O channel and the tape reader remains in a Ready status. The System/360 program can either initiate a new Read command or request operator intervention.

Device End

This status byte, when issued, indicates the paper tape reader has been restored from any one of the Not Ready conditions back to a Ready condition.

Busy

A Busy status byte is issued by the tape reader when it is still executing a command and another command is received from the system.

Unit Check

This status byte is sent to the system to reject a command. A sense command can be issued by the system to interrogate the tape reader as to why the command was rejected.

- Sense Bit 0 *Command Reject*. Invalid command.
- Sense Bit 1 *Intervention Required*. The tape reader is unable to perform a Read Operation.
- Sense Bit 2 *Bus Out Check*. Incorrect parity of a valid or invalid command.

Unit Exception

This status byte is issued by the tape reader to reject the first read command following the end of the last tape of a file (End-of-File light on). The status of the tape reader becomes Not Ready after issuing this status byte.

Tape Code Translation

The IBM 2671 Paper Tape Reader is capable of reading any tape code that can be punched in 5-, 6-, 7-, or 8-track tape. (Feed holes alone are ignored.) This is possible because the translation of the code punched in the tape is performed by the System/360. The eight tracks of the paper tape reader are connected to the system I/O channel by Bus-In lines in the following manner:

Track Number	8	7	6	5	4	3	2	1	Generated
	↓	↓	↓	↓	↓	↓	↓	↓	Odd Parity
Bus-In line	0	1	2	3	4	5	6	7	P

When the width of the tape is such that a track does not exist, a zero bit is transmitted for that track position.

The eight Bus-In lines connect to the 8 bits of a core-storage byte in the System/360 in the following manner:

Bus-In Lines	0	1	2	3	4	5	6	7
	↓	↓	↓	↓	↓	↓	↓	↓
Core Storage	0	1	2	3	4	5	6	7

A hole punched in a track of paper tape is represented as a 1-bit in its respective position of core storage. A blank in a track of paper tape is represented as a 0-bit in its respective position of core storage.

The Translate instruction in the System/360 may be used to convert the tape code to the desired internal code. The Translate instruction operates by adding the binary value represented by the tape code to the starting address of a table. The sum of these two numbers is the address of a position in the table that contains the desired internal EBCDIC (Extended Binary Coded Decimal Interchange Code) or ASCII (American Standard Code for Information Interchange) code for the character. The internal code is automatically taken from the table and replaces the tape code in the read-in area.

Normal Stop Conditions

After a tape-read operation has been completed, the stop signal comes either from the system (when the character count equals zero), or from the detection of an end-of-record character. The Ready light remains on and no operator intervention is required, except when the Stop key was previously operated. If the Stop key was operated during the read operation, the Ready light turns off and the Start key must be operated to resume the tape read operation.

If a run-out of tape is detected at the tape read station and the EOF light is off, the Ready light turns

off. A new tape must be loaded and the Start key pressed to resume the tape read operation.

When a channel contention exists (character not yet transferred to the system .8 milliseconds after it is available for the channel), the tape reader stops and restarts when the data register becomes free. No character is lost and no operator intervention is required.

Abnormal Stop Conditions

Operator Intervention

Removing the tape guides by pressing the Load key while a read operation is in process induces a Reset condition. The tape reader stops, the Ready light turns off, and the buffer and data register are cleared.

Without Operator Intervention

The paper tape reader stops during a read operation when abnormal conditions occur either in the system or in the tape reader:

In the System

- The tape reader stops when the Emergency Power Off switch (located on the System/360) is operated. All power, both ac and dc, is removed from the tape reader.
- When a Halt I/O is initiated by the System/360, the tape reader stops on the second character following the last one sent to the System/360 (in the same way as for a Channel Contention). The tape reader remains Ready and a Channel-End, Device-End status byte is generated.
- When a selective or general reset is initiated by the System/360 the tape reader stops immediately and resets all the control unit functions including buffer and data register. No status byte is generated and the tape reader remains Ready.

In the Tape Reader

- If the tape reader stops with the Ready and Equipment Check lights on, a time-out has occurred because the last character was transferred to the system.
- If the tape reader stops with the Ready and Data Check lights on, a parity error has occurred.
- Regardless of the other lights, the Overstep light is on and the Ready light is off each time an overstep condition is detected on a normal or abnormal tape reader stop.

Paper Tape Specifications

The IBM 2671 Paper Tape Reader is designed to operate with either IBM 190216 (1 1/16-inch width, 5-track) or IBM 304469 (1-inch width, 8-track) paper tape. Other paper tape of equivalent paper stock may be used.

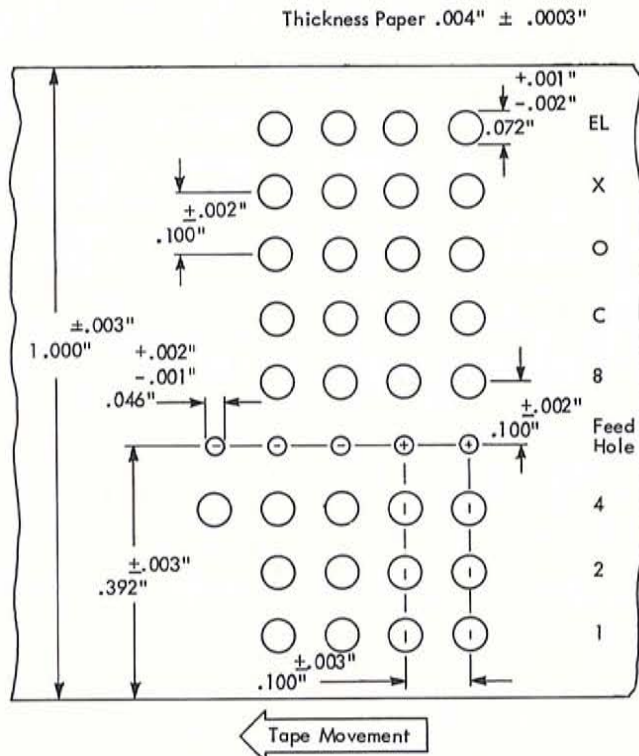
Dimensions

Perforated paper tape with the following dimensions is acceptable as input to the tape reader (Figure 7):

1. Widths of tape

- 1 1/16" ± .003"
- 7/8" ± .003"
- 1" ± .003"

2. Distance from three-hole edge of tape to center line of feed holes:
.392" ± .003"
3. Vertical distance (across width of tape) between centers of holes:
.100" ± .002"
4. Horizontal distance (parallel with edges of tape) between centers of feed and code holes:
.100" ± .003"
with a maximum accumulation of ±.009" within spans of .9" to 6.0" measured at the feed holes.
5. Vertical distances (across width of tape) across holes:
.072" + .001" - .002" for code holes
.046" + .002" - .001" for feed holes
6. Thickness of tape:
Paper .004" ± .0003"



Note: Widths of Tape

- 1 1/16" ± .003"
- 7/8" ± .003"
- 1" ± .003"

Figure 7. Tape Specifications

Feed Holes

The IBM 2671 Paper Tape Reader does not read feed holes. Therefore, the position of the feed holes is of no consequence.

Chad

The tape reader reads only chad tape (holes completely punched).

Paper Tape Handling

The tape reader is capable of reading the same piece of paper tape at least 30 times without significant damage to the tape. The loading time for a strip of tape, by a reasonably skilled operator, is approximately 10 seconds.

Paper Tape Splicing

Occasionally punched paper tape requires splicing. The ability of the IBM 2671 Paper Tape Reader to successfully read spliced tape depends upon the quality of the splice. The quality of the splice depends upon the type of splicing equipment, splicing material, adhesive, and in some cases, the skill of the operator.

Paper tape splices are of two types, overlap splices and butt-joint splices.

Overlap Splice

The overlap splice is made by overlapping matching paper tape ends, by at least one punched tape column, and cementing the ends to hold them in place (Figure 8). Some advantages of using the overlap splice are:

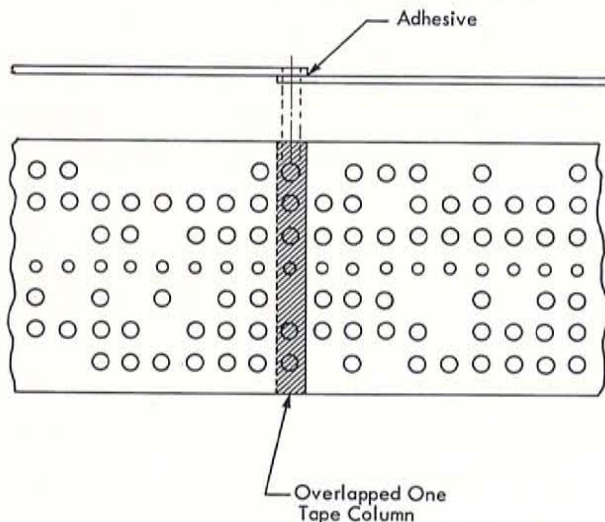


Figure 8. Overlap Splice

1. A large variety of overlap splicing equipment is available.
2. Many splices are available at a reasonable cost.
3. Quality of splice is not usually dependent upon the skill of the operator.

Some disadvantages of using the overlap splice are:

1. Splice cannot be made in data area of the tape without the loss of data, parity conditions, and/or invalid characters.
2. Most adhesives require a relatively long time to dry.
3. Short life of splice.

Butt-Joint Splice

The butt-joint splice (Figure 9) is made by butting two complementary tape ends together and holding them in position by a bonding agent and an overlay material. The overlay material must be sufficiently transparent to allow proper reading of the tape if the splice is in a data portion of the tape.

Some advantages of using the butt-joint splice are:

1. Splice can be made in the data area of the tape without the loss of data.
2. Data portion of the tape can be repaired if torn or damaged.
3. Splice has relatively long life.

Some disadvantages of using butt-joint splice are:

1. There is a limited choice of accurate tape splicing equipment.
2. The quality of the splice is directly dependent upon the skill of the splice equipment operator.
3. If overlays are used on both faces of the tape they must be offset by at least one feed hole.

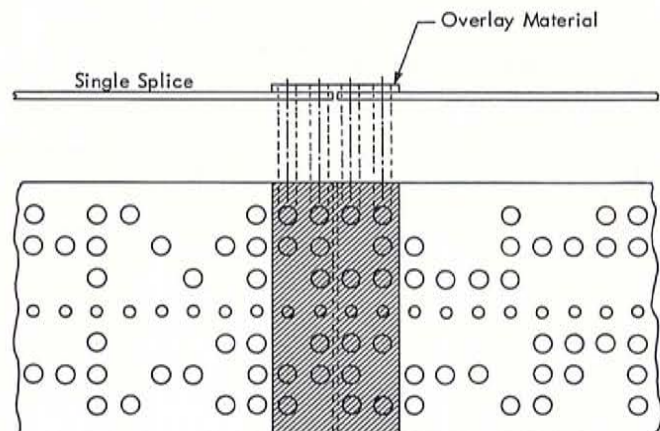


Figure 9. Butt-Joint Splice

Spliced Tape Specifications

The dimensions of spliced tape must conform to the allowable tolerances as stated in *Paper Tape Specifications*. In addition, the spliced tape must conform to the following:

1. The total thickness of the splice must not exceed .010 inch.
2. The width of the splice must match the width of the tape.
3. The splice must be approximately as strong as IBM paper tape.
4. The splice must be flexible.
5. The splice must be clean and free of any substance that could create a hindrance in the tape feed area.

Tape Loading Instructions

Preparing Paper Tape Reader for Strip Feeding

Refer to Figures 10A, 10B and 11 for the procedure.

1. Open top cover of paper tape reader.

2. Set Tape Width Selector to proper tape width ($\frac{1}{16}$ " , $\frac{3}{8}$ " , or 1").
3. Press the right-hand top key (Load key) to disengage the reader tape guide.
4. Check to see that the supply clutch is disengaged (if the supply mechanism special feature is installed).
5. Move the rotating tab of the take-up stacker backwards (if the take-up stacker special feature is installed).
6. Insert the tape vertically above the reader. The three-hole side is introduced first. The tape is located on the right of the machine.
7. Feed the tape through the brake gap, between the two feed rolls, and up to the lower guide.
8. Press the left-hand top key to reset the tape guide.
9. Press Power-On key (if Remote/Local switch is set to LOCAL).
10. Set End-of-Record switches (if necessary).
11. Set Delete switch and Track Suppress switch.
12. Press End-of-File key (if necessary).
13. Set Parity switch.
14. Close Top Cover (if desired).
15. Press Start key.

The tape reader is now in a Ready status.

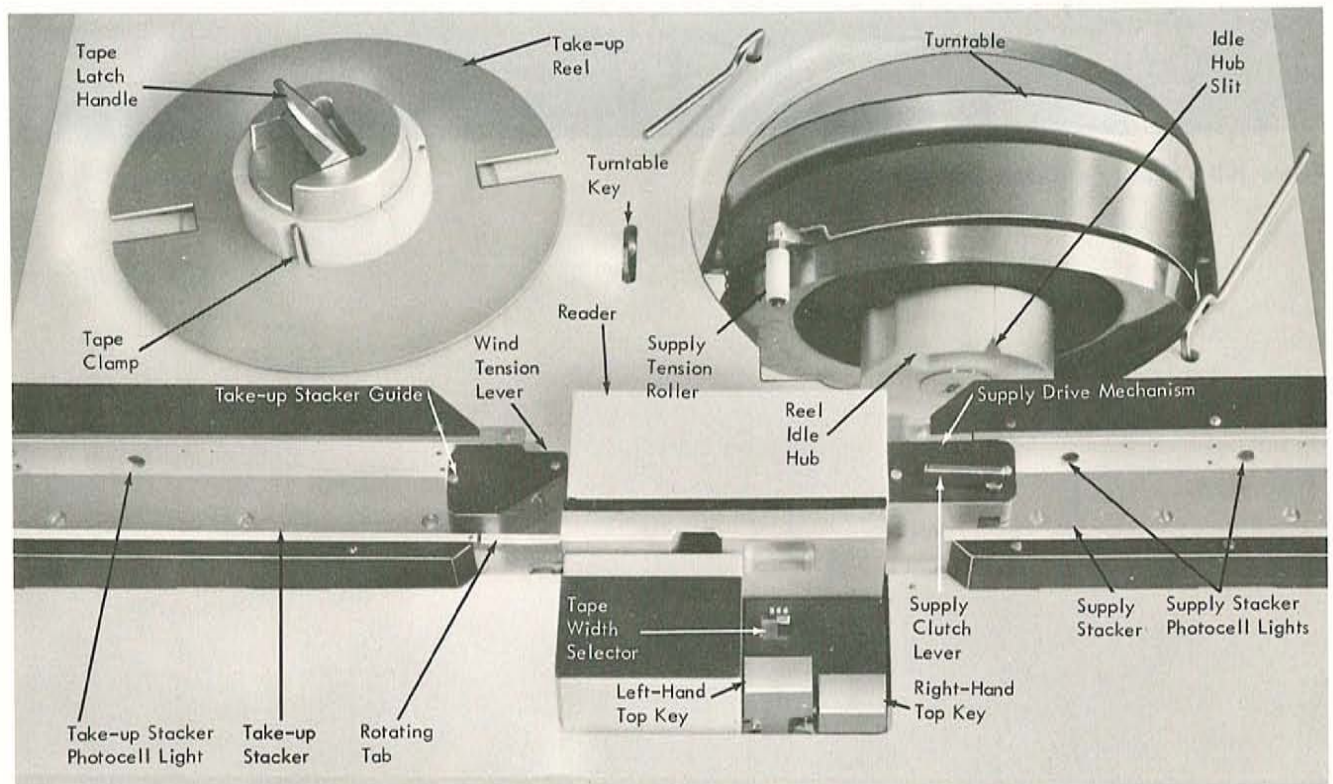


Figure 10A. Paper Tape Reader Before Tape Loading

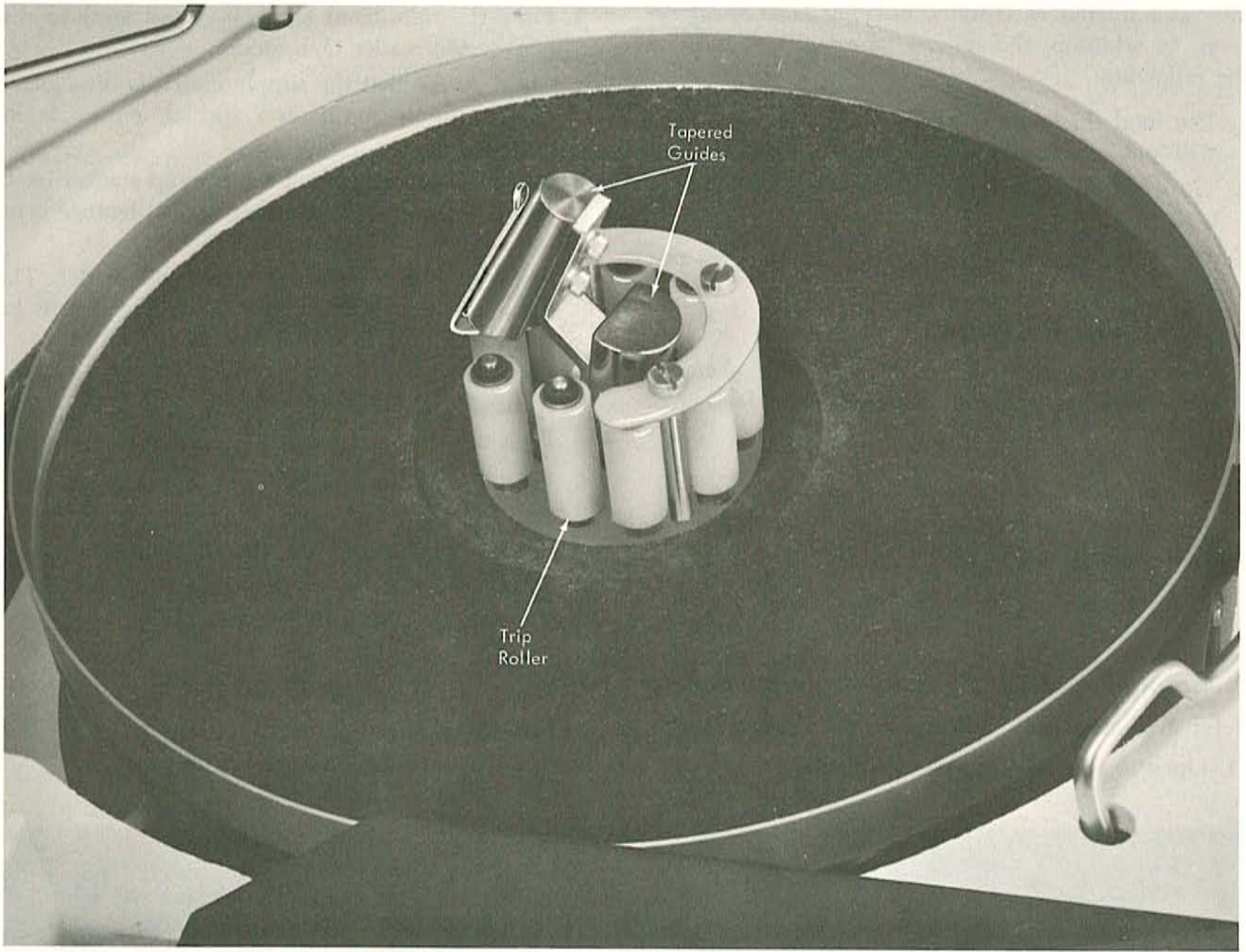


Figure 10B. Center Roll Before Tape Loading

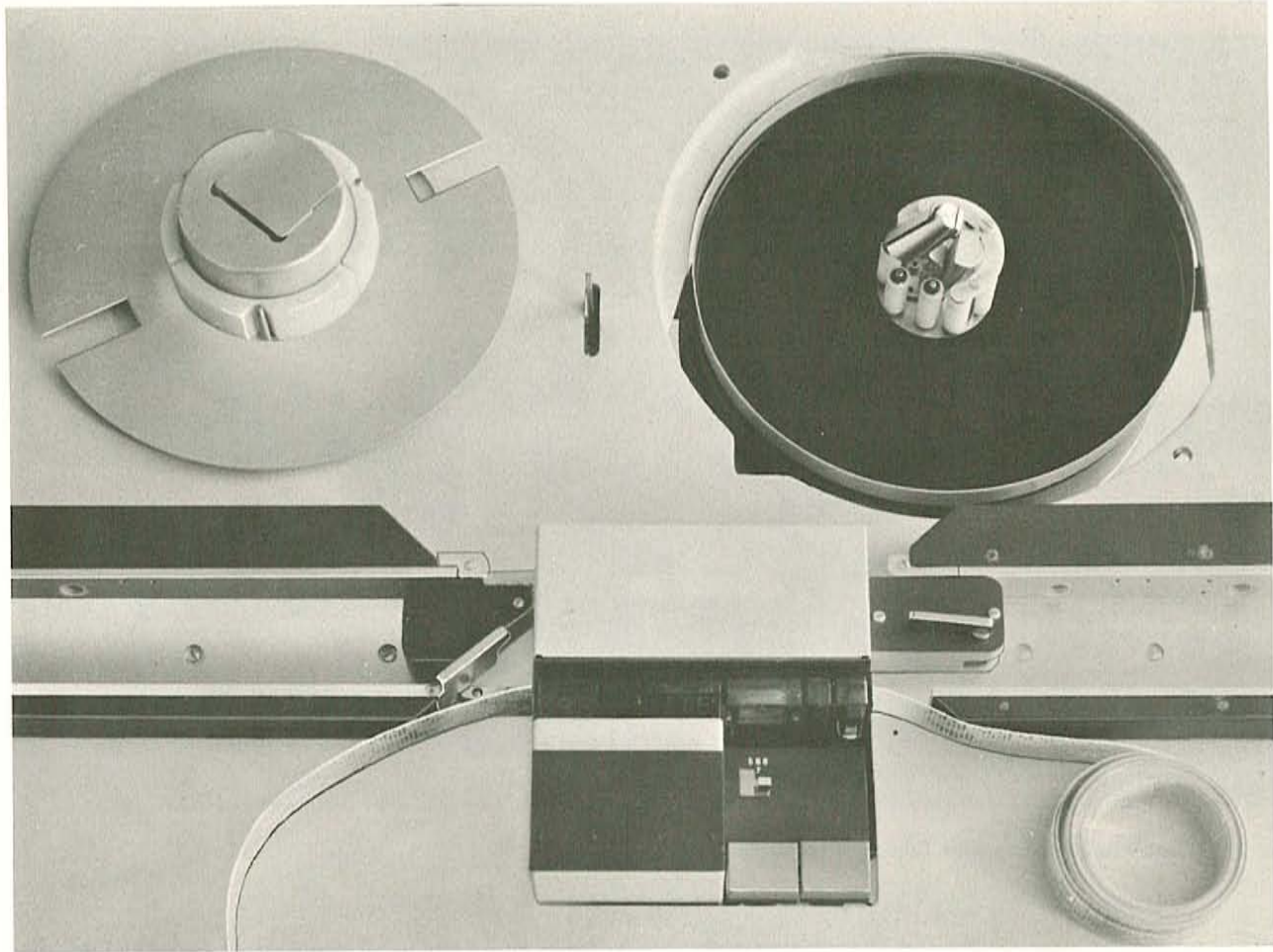


Figure 11. Strip Feeding

Preparing Paper Tape Reader for Center Roll Feeding with Take-up Mechanism Winding

Refer to Figures 10A, 10B and 12 for this procedure.

1. Open top cover of paper tape reader.
2. Set Tape Width Selector to proper tape width, ($1\frac{1}{16}$ "", $\frac{7}{8}$ "", or 1").
3. Press the right-hand top key (Load key) to disengage the reader tape guide.
4. Check to see that the supply clutch is disengaged.
5. Check to see that the rotating tab of the take-up stacker is in line with the stacker and that the tape clamp is released.
6. If the turntable shows the outside reel feeding up, press the turntable key to unlock it and turn it upside down until it latches in its horizontal position.
7. Place the roll of tape on the turntable concentric with the rollers. The roll must be wound clockwise viewed from the top with the three-hole side down.
8. Hold the leading end of tape and draw it inside the ring of fixed rollers by passing it to the right of the trip roller.
9. Pull the tape from the trip roller and draw the end around the two tapered guides.
10. Engage the tape in the supply clutch and feed the tape through the read station.
11. Push the tape wind tension lever and engage the tape around the take-up stacker guide.
12. Secure the leading end of tape to the take-up reel by engaging the tape in a tape clamp and pressing the tape latch handle.
13. Press the left-hand top key to reset the tape guide.
14. Engage the supply clutch.

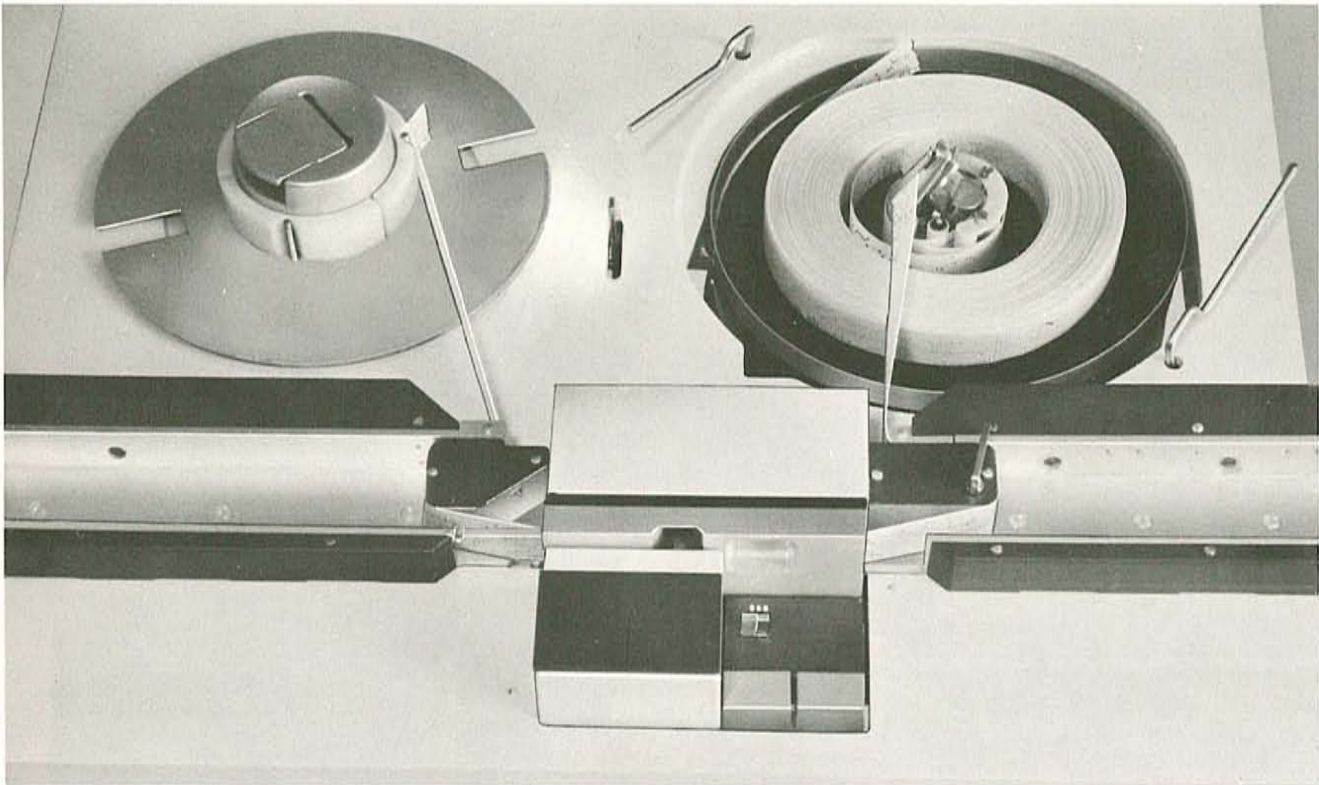


Figure 12. Center-Roll Feeding with Take-up Mechanism

15. Press Power-On key (if Remote/Local switch is set to LOCAL).
16. Set End-of-Record switches (if necessary).
17. Set Delete switch and Track Suppress switch.
18. Press End-of-File key (if necessary).
19. Set Parity switch.
20. Close top cover (if desired).
21. Press Start key.

The tape reader is now in a Ready status.

Preparing Paper Tape Reader for Center-Roll Feeding Only

Refer to Figures 10A, 10B and 13 for this procedure.

1. Open top cover of paper tape reader.
2. Set Tape Width selector to proper tape width ($\frac{11}{16}$ ", $\frac{7}{8}$ ", or 1").

3. Press the right-hand top key (Load key) to disengage the reader tape guide.
4. Check to see that the supply clutch is disengaged.
5. If the turntable shows the outside reel feeding up, press the turntable key to unlock the turntable and turn it upside down until it latches in its horizontal position.
6. Place the roll of tape on the turntable concentric with the rollers. The roll must be wound clockwise viewed from the top with the three-hole side down.
7. Hold the leading end of tape and draw it inside the ring of fixed rollers by passing it to the right of the trip roller.
8. Pull the tape from the trip roller and draw the end around the two tapered guides.
9. Engage the tape in the supply clutch and feed the tape through the read station.
10. Press the left-hand top key to reset the tape guide.
11. Engage the supply clutch.
12. Press Power-On key (if Remote/Local switch is set to LOCAL).

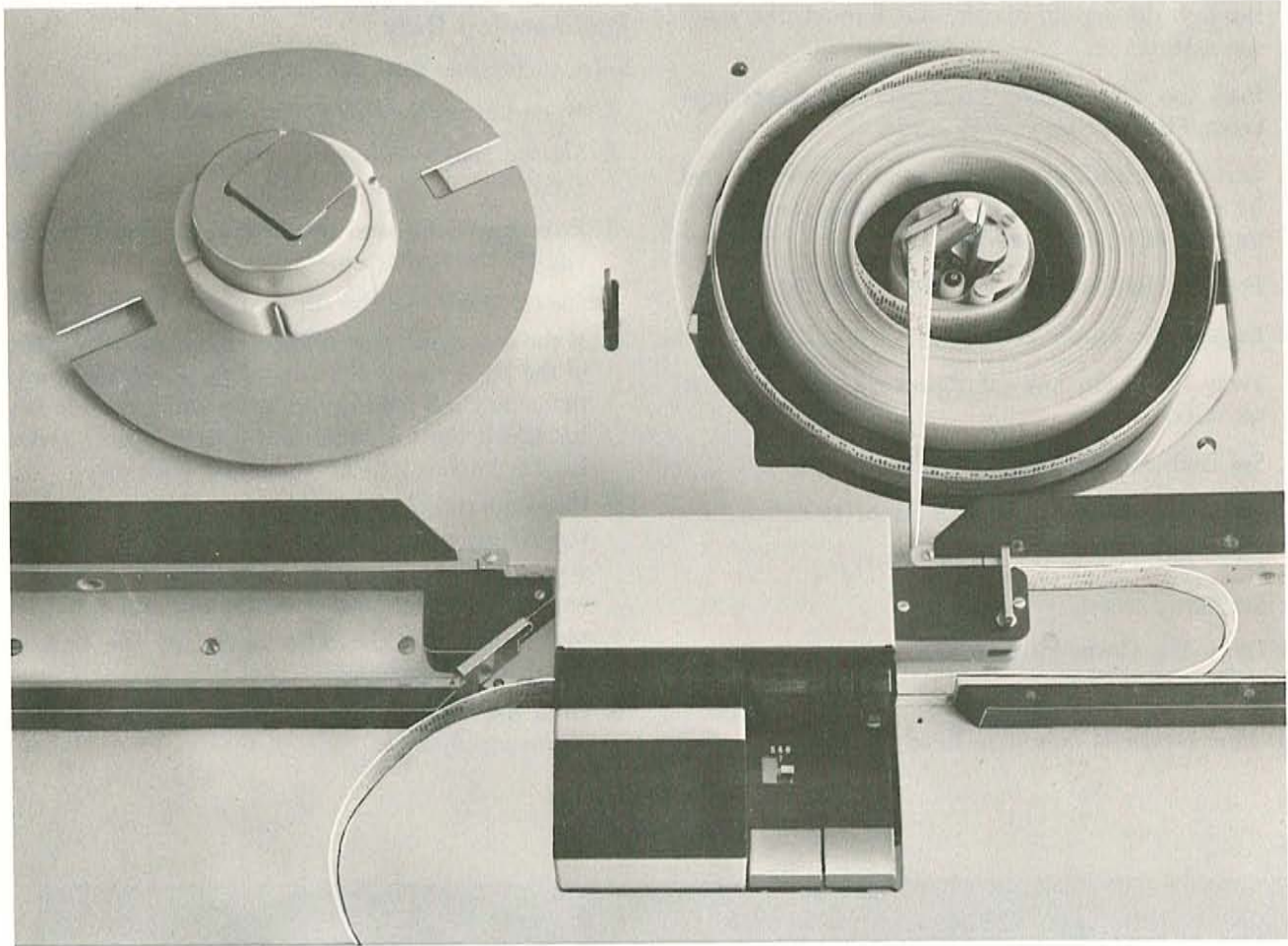


Figure 13. Center-Roll Feeding Without Take-up Mechanism

13. Set the End-of-Record switches (if necessary).
14. Set the Delete switch and Track-Suppress switch.
15. Press End-of-File key (if necessary).
16. Set the Parity switch.
17. Close top cover (if desired).
18. Press Start key.

The tape reader is now in a Ready status.

Preparing Paper Tape Reader for Reel Feeding with Take-up Mechanism Winding

Refer to Figures 10A, 10B and 14.

1. Open top cover of paper tape reader.
2. Set the tape width selector to proper tape width ($\frac{1}{16}$ " , $\frac{7}{8}$ " , or 1").
3. Press the right-hand top key (Load key) to disengage the reader tape guide.

4. Check to see that the supply clutch is disengaged.
5. Check to see that the rotating tab of the take-up stacker is in line with the stacker and that the tape clamp is released.
6. If the center-roll option is installed instead of the basic round plate and if the turntable shows the center roll feeding up, press the turntable key to unlock the turntable. Turn it upside down until it latches in its horizontal position.
7. Place the roll of tape, either on the turntable or on the round plate (depending on whether the center roll special feature is installed or not), concentric with the idle hub while engaging the tape trailer in the hub slit.
8. Make sure that the 3-hole edge of the tape is toward the machine.
9. Hold the leading end of tape at the left side of the supply reel.

10. Feed the tape around the supply tension roller, through the supply clutch, and through the reading station.
11. Push the wind tension lever and engage the tape around the take-up stacker guide.
12. Secure the leading end of tape to the take-up reel by engaging the tape in a tape clamp and pressing the tape latch handle.
13. Press the left-hand top key to reset the tape guide.
14. Engage the supply clutch.
15. Press Power-On key (if Remote/Local switch is set to LOCAL).
16. Set End-of-Record switches (if necessary).
17. Set Delete switch and Track Suppress switch.
18. Press End-of-File key (if necessary).
19. Set Parity switch.
20. Close Top Cover (if desired).
21. Press Start key.

The tape reader is now in a Ready status.

Preparing Paper Tape Reader for Reel Feeding Only

Refer to Figures 10A, 10B and 15.

1. Open top cover of paper tape reader.
2. Set the tape width selector to proper tape width ($\frac{1}{16}$ ", $\frac{7}{8}$ ", or 1").
3. Press the right-hand top key (Load key) to disengage the reader tape guide.
4. Check to see that the supply clutch is disengaged.
5. If the center roll special feature is installed instead of the basic round plate and if the turntable shows the center roll feeding up, press the turntable key to unlock the turntable and turn it upside down until it latches into its horizontal position.
6. Place the roll of tape either on the turntable or on the round plate (center roll special feature installed or not) concentric with the idle hub while engaging the tape trailer in the hub slit.
7. Make sure that the 3-hole edge of the tape is towards the machine.
8. Hold the leading end of the tape at the left side of the supply reel.

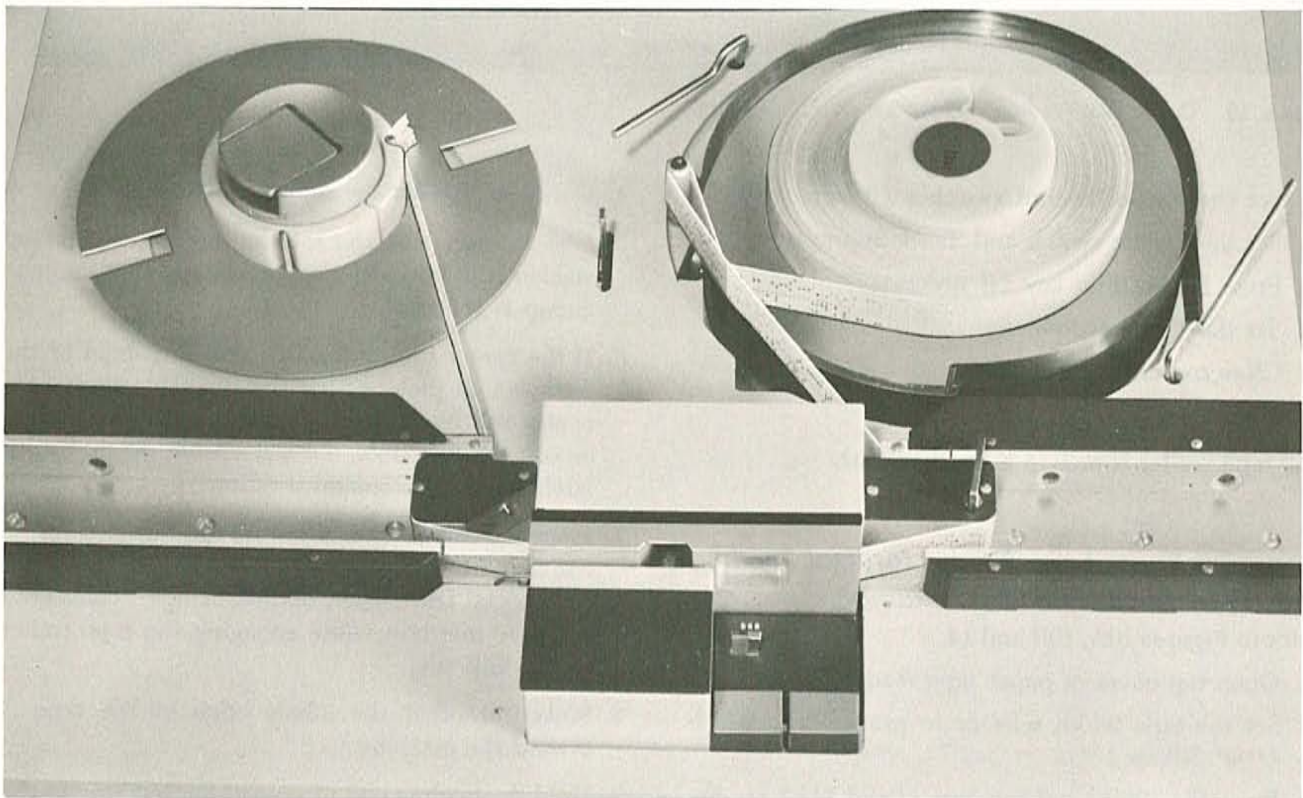


Figure 14. Reel Feeding with Take-up Mechanism

9. Feed the tape around the supply tension roller, through the supply clutch and through the reading station.
10. Press the left-hand top key (Load key) to reset the tape guide.
11. Engage the supply clutch.
12. Press Power-On key (if Remote/Local switch is set to LOCAL).
13. Set End-of-Record switches (if necessary).
14. Set Delete switch and Track Suppress switch.
15. Press End-of-File key (if necessary).
16. Set Parity switch.
17. Close Top Cover (if desired).
18. Press Start key.

The tape reader is now in a Ready status.

Tape Unloading Instructions

Without Take-up Mechanism

1. Pull the tape trailer out of the reader or press the NPRO key.

With Take-up Mechanism

1. Press the NPRO key.
2. Lift the tape latch handle to disengage the tape leader from the tape clamp.
3. Remove the roll of tape from the take-up reel.

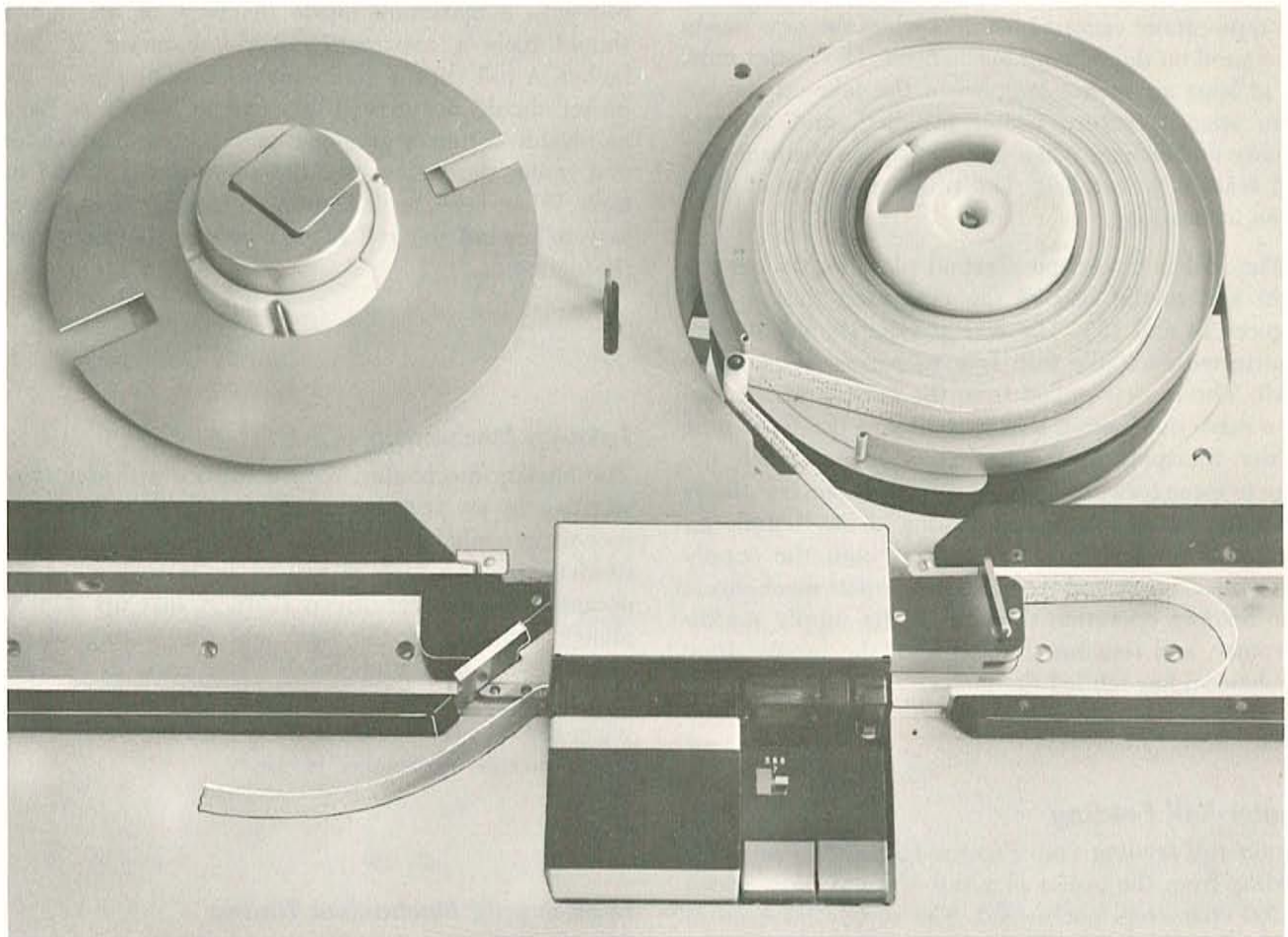


Figure 15. Reel Feeding Without Take-up Mechanism Winding

Special Features

Supply Mechanism

The supply mechanism (see Figures 14 and 15) provides feeding of paper from reels at an average speed of 500 characters per second.

Punched paper tape that is wound clockwise (viewed from top with three-hole side down) around itself, beginning with the leading end, is called a reel. The 2671 can also accommodate punched paper tape reels that are wound counterclockwise (viewed from the top with three-hole side down), beginning with the trailing edge.

When mounted on the paper tape reader, a reel feeds from the leading end on the outside, toward the trailing end on the inside. The inside diameter of the reel must be either 4½ inches or 2 inches (2 different supply idle hubs are available) and the outside diameter cannot be greater than 10½ inches. The length of the tape cannot exceed 1,000 feet when the tape has to be wound on the take-up mechanism. The leader must be at least six inches long when the take-up mechanism special feature is not installed, and at least twenty inches long when the take-up mechanism special feature is installed. The trailer must be at least three inches long.

The reel is placed on a round plate located to the right and to the rear of the tape read station (see Figures 14 and 15). The reel of tape should be concentric with an idle hub free to rotate on its pivot shaft. The tape is pulled from the outside of the reel by a drive mechanism that is similar to the basic tape reader transport mechanism (two rollers pinch the tape to force forward motion). A supply stacker allows buffering of the tape and testing of its length by means of photocells which control both the supply drive mechanism and the reader transport mechanism. The reading operation stops when the supply stacker is empty, and remains stopped until the supply drive mechanism has refilled the buffer.

Center-Roll Feeding

Center-roll feeding (see Figures 12 and 13) provides feeding from the center of a roll at an average speed of 500 characters per second. The supply mechanism (special feature) is a prerequisite for mounting the center roll feeding device. The center roll feeding fea-

ture includes only the turntable on which the rolls of tape are placed. The tape is pulled from the center of the roll by the supply drive mechanism into the stacker of the supply mechanism.

When the center roll feeding feature is installed, the round plate used for reel feeding is removed to mount the turntable. One side of the turntable is used for center roll feeding and the reverse side for reel feeding. A turntable key is used to latch the turntable in a horizontal position. By pressing the turntable key it is possible to unlock the turntable and turn it upside down to change from one feeding mode to the other.

A roll is defined as a section of tape wound so that the information content begins at the center of the roll and proceeds toward the outside. The roll is wound clockwise (viewed from the top with the three-hole side down) beginning with the leading end. A roll with a maximum inside diameter of 4½ inches should have a maximum outside diameter of 10½ inches. A roll with a minimum inside diameter of 2¾ inches should not exceed 300 feet in length or have an outside diameter greater than 6 inches. The leader and trailer dimensions are the same as for a reel of tape. When center-roll feeding is used, it is unnecessary to rewind the roll of tape at the completion of the operation.

Take-up Mechanism

The take-up mechanism special feature provides tape winding at an average speed of 500 characters per second, provided the tape is fed through the supply mechanism. The tape is wound on a reel which is operated by a motor-driven shaft. A take-up stacker allows buffering of the tape and the testing of its length by means of a photocell which controls the reel motor (see Figure 14). Rewinding of the tape starts when the take-up stacker is filled with tape and stops when the take-up stacker is empty.

Tape Supply Mechanism Timing

The speed of the tape transport mechanism at the reading station (after acceleration) is always 1,000 charac-

ters per second. Since the tape supply mechanism operates at only 500 characters per second, the tape reader must stop from time to time to allow buffering of the tape. The portion of the tape which is buffered in the supply stacker contains 100 characters. When a tape Read Command is issued by the system, the tape is read at 1,000 characters per second until the supply of tape in the supply stacker becomes exhausted. At this time the read operation is delayed 200 milliseconds to allow buffering a new portion of tape.

Therefore, when the tape records are 100 characters or less in length, and the elapsed time between read commands is 200 milliseconds or greater, the speed of the tape reader is always 1,000 characters per second. When tape records consist of more than 100 characters, the average speed of the tape reader is at least 500 characters per second (the tape reader is stopped 200 milliseconds every 100 characters to permit refilling of the supply stacker).

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IBM 2671

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A24-3388-0

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