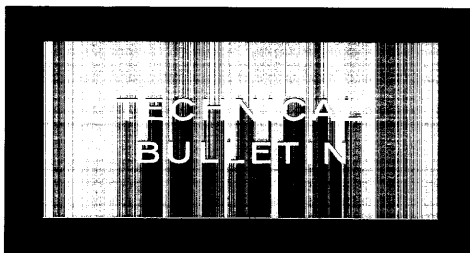


UNIVAC 490 REAL-TIME SYSTEM

# PAPER TAPE SUBSYSTEM



**Reliability**

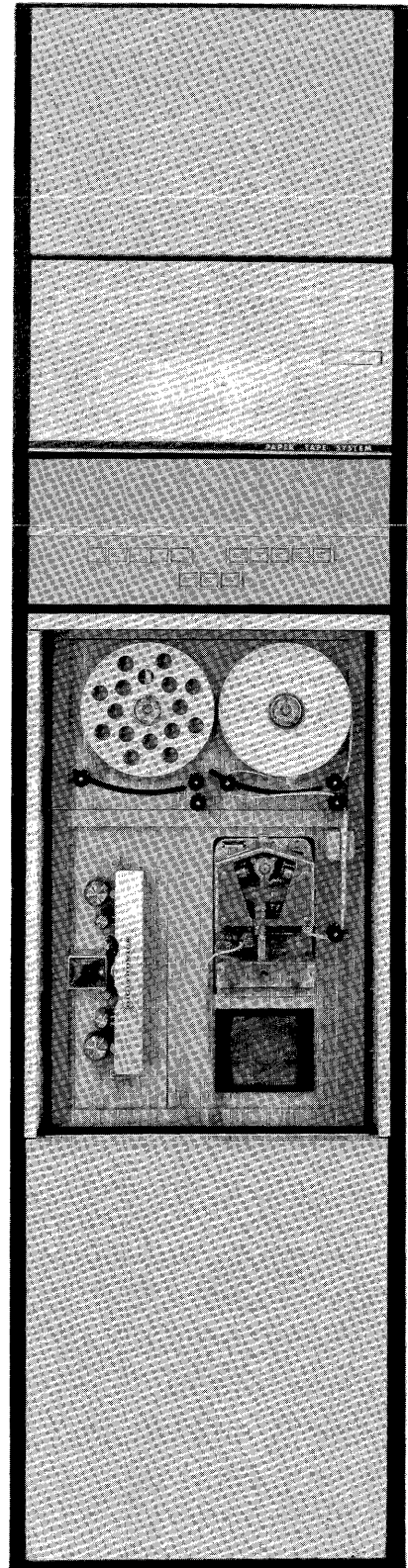
**Flexibility**

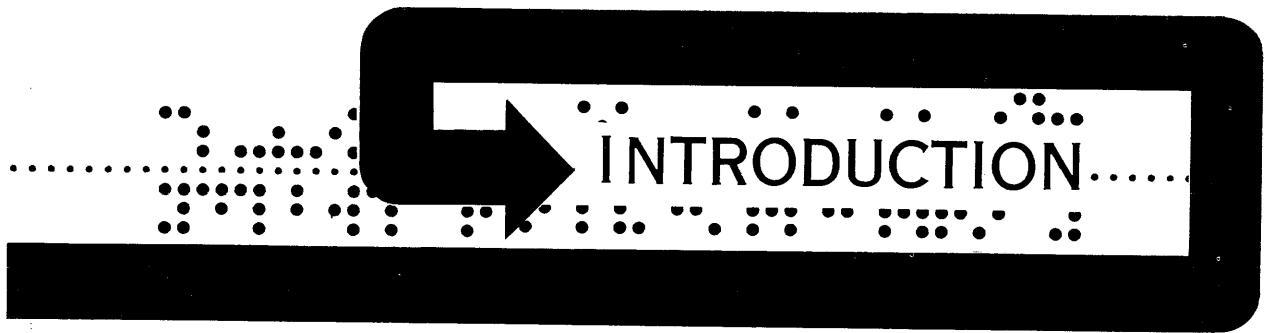
**Economy**

**Compact Configuration**

**Direct Computer Access**

**Permanent or Temporary  
Data Storage**





The Paper Tape Subsystem is a proven, reliable, economical data input and output unit for the UNIVAC<sup>®</sup>490 Real-Time System. This subsystem is an excellent answer for those wishing flexibility, ease of handling and an option for permanent or temporary storage.

Data may be read into the computer at speeds of 400 characters per second and may be read out via the High Speed Punch at a maximum rate of 110 characters per second. The paper tape, used for subsystem input and output, is easily prepared: Data may be punched into the tape by a keyboard-punch unit.

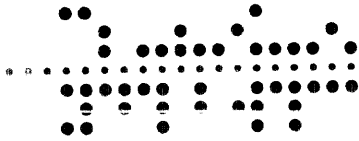
Thus the Paper Tape Subsystem provides a valuable service for programmers, since preparatory routines may be readied in advance on off-line equipment and may then be checked out in the computer by means of the subsystem. Since tape correction is relatively inexpensive the subsystem adds economy to the user's needs.

Data output, via paper tape, may be transferred to magnetic tape or punch cards for permanent storage. The paper tape may also be edited with scissors and data read back into the computer in bits, words or blocks.

One of the chief advantages of the Paper Tape Subsystem is that it incorporates economical and proven components: The Modified Bidirectional Digitronics\* B3500 Reader and the Teletype\* BRPE 11 High Speed Punch have a long history of reliability.

The Reader and the Punch, with their associated hardware, are physically housed in a single cabinet. The complete Paper Tape Subsystem is connected to one of the UNIVAC 490 Input/Output channels and only one subsystem may be used on any one channel.

\* Trademarks, Digitronics Corp.; Teletype Corp.



## GENERAL DESCRIPTION

The subsystem communicates directly with the computer, operating on an eight-bit character. The lower order bits, 0 thru 7, are used for data transmission. Bits 0 thru 7 and bit 8 are also used for subsystem control. The remainder of the computer word, bits 09 thru 29, is not used.

The Tape Subsystem receives its operating commands on the same lines which are used for data transmission. When accompanied by an External Function Signal, bits 0 thru 8 become control signals, or Function Words. When this happens the bits are gated into the control logic where the Paper Tape Subsystem is conditioned to perform its operation.

Consisting of a Photoelectric Reader. A High-Speed Punch and associated control and power circuitry, the subsystem may handle 5, 6, 7, or 8 channel (level) tapes. The tapes may be 11/16 inch, 7/8 inch or one inch wide. The subsystem is installed in a standard peripheral cabinet which is eight feet high, two and one-half feet wide, 10.5 inches deep and weighs 475 pounds.

**READER** The function of the Reader (Modified Bidirectional Digitronics B3500) is to photoelectrically sense holes which have been punched into the paper tape and transmit data to the computer, via the subsystem's input control circuitry.

The sequence of events for Reader operation is:

- The computer commands the subsystem to transmit data from the paper tape;
- The Reader senses data and transmits it on the Computer Input Channel;
- The Input Data Request signal is sent to the computer, indicating data has been put on the subsystem's Computer Input Channel;
- The Computer accepts the data;
- The Computer sends an Input Acknowledge signal to the Reader Control and disables the Input Data Request;

- The Reader advances to the next frame of data on the paper tape and the cycle begins again.

**PUNCH** The function of the Punch (Modified Teletype Paper Tape Punch BRPE-11) is to accept data from the UNIVAC 490 Computer and punch the data into paper tape. The sequence of events for punch operation is:

- The UNIVAC 490 Computer commands the Paper Tape Subsystem to accept information to be recorded on paper tape. A Computer Output Channel transfers these commands to the Paper Tape Subsystem which conditions the Punch for operation;
- The Punch Control Circuitry generates an Output Data Request signal;
- The Computer puts the data on the Output Data Lines and generates an Output Data Acknowledge which disables the Output Data Request and gates the data into the Punch Register;
- The Punch takes the data from the Punch Register and punches the character into the paper tape;
- The Punch advances the tape to the next frame as the next character is provided.

**CONTROL** There are four major control functions performed by the Paper Tape Subsystem's input and output control circuitry. They are Reader Control, Punch Control, Punch Compare and Error Control.

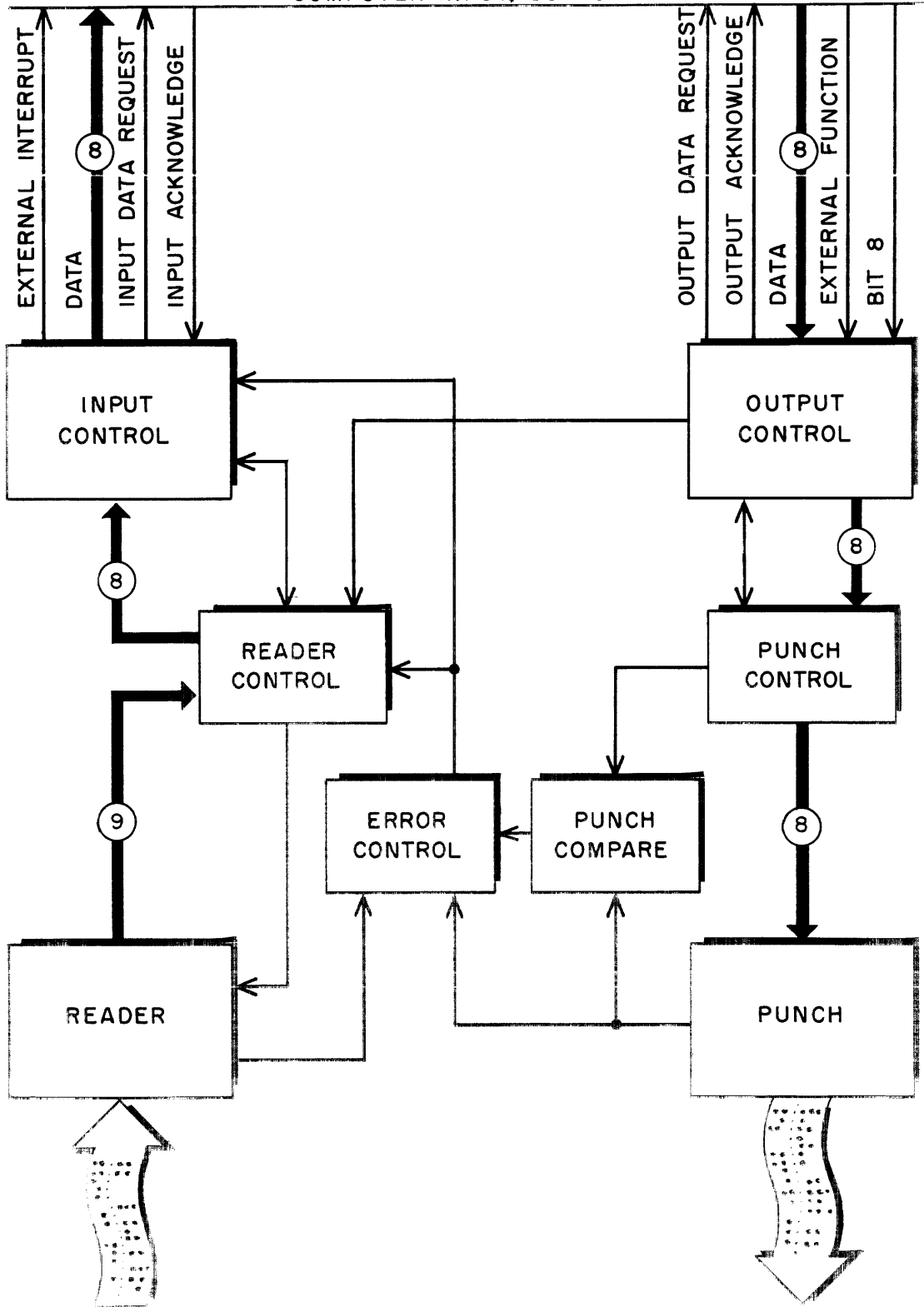
The Reader Control circuits interpret computer functions for controlling the Reader operation. The Reader Control also accepts the information read by the Reader and transfers it to the computer input channel via the computer input control.

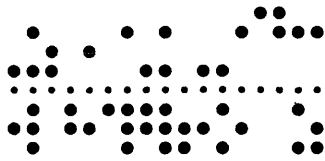
The Punch Control Circuits interpret computer functions for controlling the punch operation. The Punch Control also has a Punch Register which stores the information, data or command, forwarded by the computer. The Punch Control, upon receiving the proper commands, gates the information from the Punch Register to the Punch where the specific character is punched into the tape.

Punch Compare circuits provide a means of comparing the computer output information stored in the Punch Register with the character which has been punched into the paper tape. The Compare circuits notify the error control circuits in case of a Punch Error.

Error control circuits detect a Punch Compare Fault or Tape Motion Fault and also notify the computer when either the Punch or the Reader is out of tape. The Error Control stops the normal operation of the Paper Tape Subsystem in case of fault. Detection of a fault also generates an appropriate signal to the subsystem's Maintenance and Operator's Panels.

COMPUTER INPUT, OUTPUT





## FUNCTIONAL DESCRIPTION



The prime advantage of the 490 Real Time System's Paper Tape Subsystem is the economy of operation and the reliability of the High-Speed Punch and the Bidirectional Reader. Combined with the subsystem's control circuitry these two components supply a versatile and compact computer input and output device.

The Paper Tape Subsystem receives its operating commands directly from the computer. These commands enter the subsystem through computer-oriented circuitry. Thus, the Output Control Circuitry is connected with the computer's output circuitry and controls the Punch. The subsystem's Input Control Circuitry is connected with the computer's input circuitry and controls the Reader operation.

**DATA/FUNCTION WORD TRANSMISSION** There are eight data lines entering and leaving the Paper Tape Subsystem. There are seven more lines which are used for control purposes. The Paper Tape Unit operates entirely under the control of the computer, sending data only at the request of the computer and receiving data for transferral to tape only when commanded to do so by the computer.

Control (Function) lines carry the commands which enable the subsystem's circuitry to interpret computer instructions, transfer data characters from the Paper Tape Reader to the computer and transfer data from the computer to the High Speed Punch. In addition, the control lines carry command signals which notify the computer of errors.

**CONTROL LINES** The Input Acknowledge signal indicates to the subsystem's Reader Control that the computer has sampled data on the lines or has received a function code and is ready for further transmission.

The Output Acknowledge signal indicates to the Punch Control that the Computer has put information on the output channel data lines.

The External Interrupt, combined with a "1" in the  $2^0$  bit position, notifies the computer of a Punch Compare Error (output from the Punch to paper tape is not identical to data forwarded from the computer): The External Interrupt, combined with a "1" in the  $2^1$  bit position signifies a tape fault (Reader-Out-Of-Tape, Punch-Out-Of-Tape or Tape Motion).

The External Function signal differentiates a Function Word transmission from a data transmission. (Bits 0-8 of the computer output channel are used for Function Word transmission and bits 0-7 are used for data transmission). The subsystem receives its direction from the computer by a Function Word transmission. To differentiate a Function Word transmission from a data transmission the External Function signal is sent to the control circuitry along with one of the nine function bits.

These bits are gated into the control logic of the Paper Tape Subsystem which is conditioned to perform the command function. A "1" in any of the bit positions in the following table will enable the appropriate command.

**TABLE OF FUNCTIONS**

BIT POSITION	COMMAND
Bit 0	Read Forward
Bit 1	Read Reverse
Bit 2	Fault
Bit 3	Master Clear
Bit 4	Punch On
Bit 5	Reader On
Bit 6	Compare Error Clear
Bit 7	Punch Off
Bit 8	Reader Off

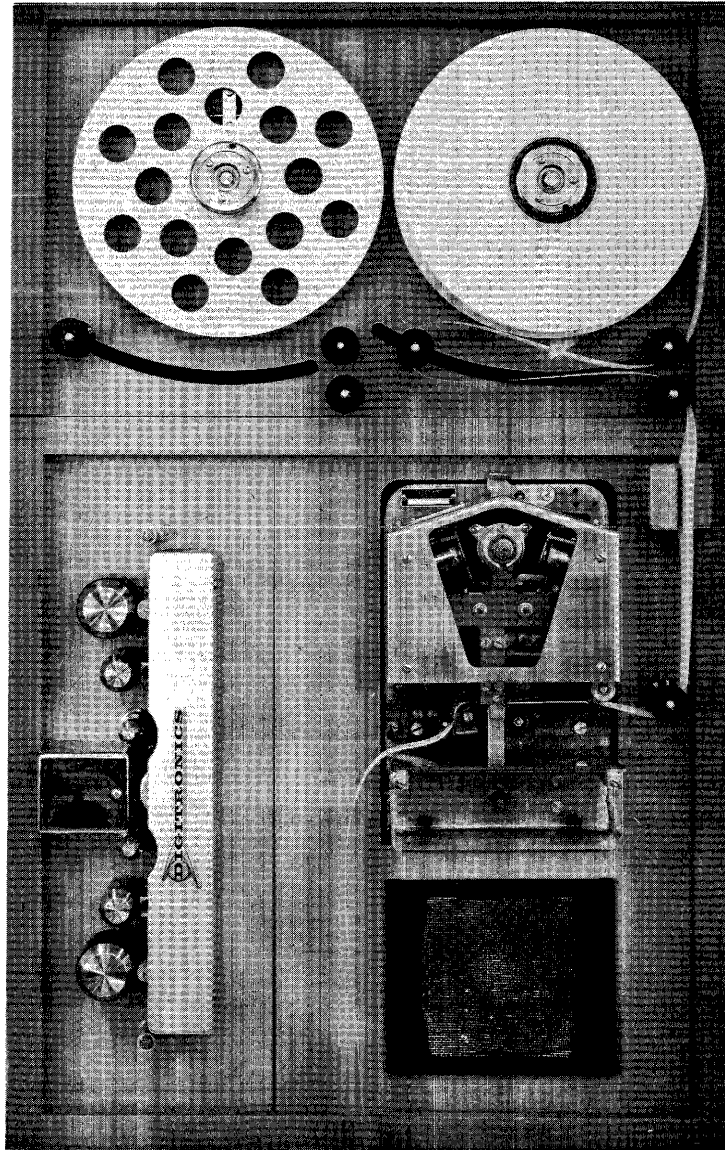
*(last 8 bits forward)*

Bits 0 through 7 are used interchangeably, depending on the presence of the External Function Command signal, as function bits or as data levels.

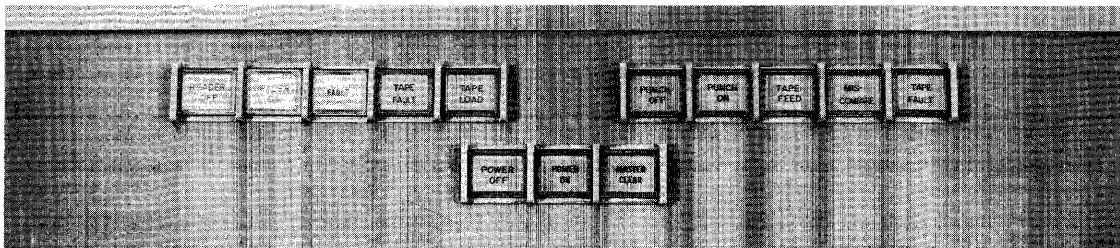
Bit 8 is never used as a data level, but is only used to turn the Reader off. Bits 2 through 7 data lines going to the Reader have gates which are disabled via control circuitry in case of a Reader Error. In addition, bit 0 indicates a compare error and bit 1 indicates a tape fault when accompanied by an External Interrupt signal.



## Punch and Reader Panel



## Paper Tape Operator's Control Panel





The Perforated-Tape Reader is the input device used in the Paper Tape Subsystem. Data is entered into the Reader via opaque paper tape previously prepared by punching. Depending on tape level, data is transferred to the subsystem's Reader Control Circuitry in five, six, seven or eight-bit characters. A manual selector switch on the Reader controls two internal switches and adapts the Reader to the proper tape width and data level. One internal switch enables and disables bits 5 and 6. The other internal switch enables and disables bit 7. When an 8-level (channel) tape is used, both switches remain open.

Data is transferred from the tape by means of photodiodes enabled by light passing through one or more of the perforations in the tape. Eight photodiodes are used for data transfer; a ninth, the sprocket control bit, is used to activate a series of control signals. The light on the photodiodes enables data lines, which in turn transmit data in the form of electrical pulses through the Reader Control Circuitry to the subsystem's Computer Input Control.

A ninth photodiode activates the sprocket signal. The resulting signal sets up a Timing Probe which samples the other eight photodiodes for the data transfer sequence. The sprocket signal also institutes an Input Data Request to the computer.

The Input Data Request signal, set up by the sprocket photodiode signal, serves to notify the computer there is data available.

**READER CONTROL** The Reader may operate in either the forward or reverse mode (reverse is limited to approximately 12 inches of tape). Four solenoids control tape movement. There is one solenoid for each of the following: Forward Pinch Roller; Forward Brake; Reverse Pinch Roller and Reverse Brake. These solenoids are enabled by commands from either the subsystem's operator panel or from the computer. Originating only at the operator's panel is a Brake Disable Signal which disables all the solenoids so the Reader may be loaded with tape.

The Reader Control is divided into two logical sections. One section accepts commands such as Reader On/Off and Input Data Acknowledge from the computer. The other logical section senses data read from the tape. This second section presents the data to the computer via the subsystem's Computer Input Control Circuitry.

The Input Data Request, generated by the sprocket photodiode, sets up the tape reader control circuitry for transmission of data to the computer. The sprocket photodiode also generates a Timing Probe which gates data into the Reader Control.

The Input Data Request informs the computer that data is being presented. The return of the Input Data Acknowledge signal from the computer activates the Reader Control, saying that the computer has received the data.

To differentiate a data transmission from a Function Word transmission, an External Function signal is sent from the computer to the control logic along with one of the nine Function Word bits (Master Bit Transmission). These bits are gated to either the Reader or to the Punch Control Circuitry. The commands affecting the Reader are Reader Forward (Bit 0), Reader Reverse (Bit 1), Fault (Bit 2), Master Clear (Bit 3), Reader On (Bit 5), and Reader Off (Bit 8--never used for data transfer).

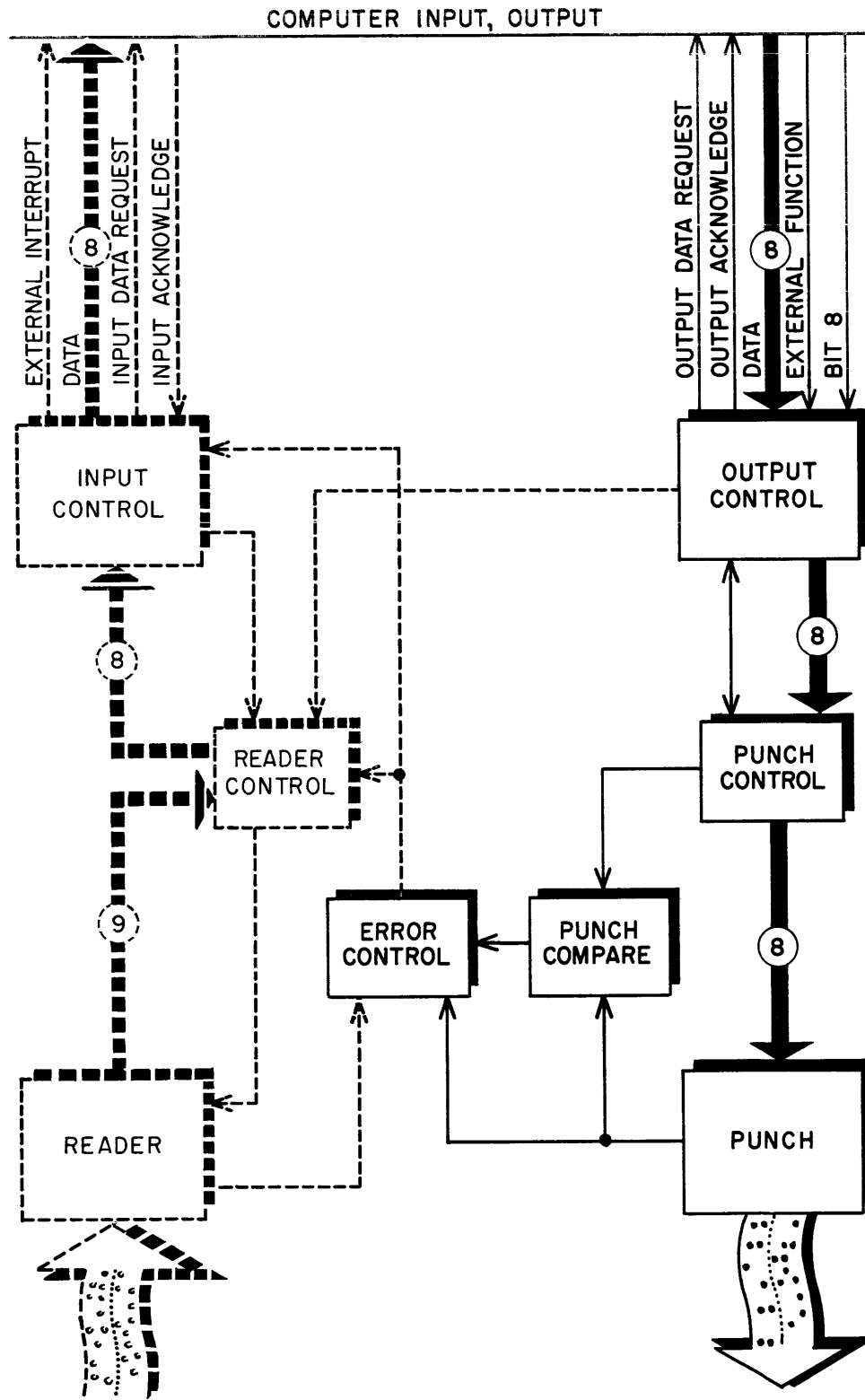
**CONTROL LOGIC** The control logic conditions the Reader to perform five major functions. They are: Fault, Forward-Reverse, Read, Acknowledge and Reader On-Off.

When a Fault occurs, a light flashes on the Operator's Panel and the Input Data Acknowledge and Input Data Request lines are disabled. The External Interrupt signal notifies the computer when the Fault has occurred.

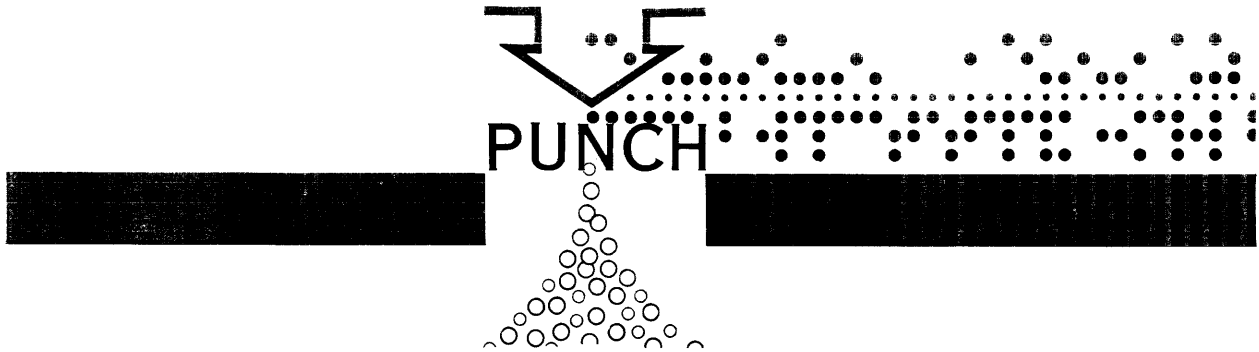
A Fault may be cleared by a switch on the Operator's Panel, by the computer via an External Function Signal which initiates a Master Clear or by a Master Clear from the subsystem's Operator's Panel.

A Read control sequence is generated by the Input Acknowledge signal originating at the computer. The acknowledge signal is activated by the Input Data Acknowledge which originates in response to the Input Data Request. The Acknowledge signal in turn generates the Read Sequence. This sequence governs the Forward or Reverse motions of the Tape and also generates the Reader's Stop signal. The Forward-Reverse command may also be generated by the External Function signal.

The Reader On/Off is controlled by the External Function signal (Master Bit Instruction) and may also be originated at the Operator's Control Panel or at the Maintenance Panel.



READER Logic



Data to be punched on the paper tape is sent directly to the subsystem. This data is gated into the Punch Register located in the subsystem's Computer Output Control Section. The paper tape punch is a modified Teletype BRPE-11 capable of punching 5, 6, 7 or 8 channel tape at a speed of 110 characters per second. The punch is manually adapted for tape widths.

The Punch receives its information via the Punch Register in the 5, 6, 7 or 8-bit parallel mode accompanied by a sprocket pulse which is generated from the computer's Output Data Acknowledge signal. The sprocket pulse punches the sprocket hole which, acting as a leader, moves the tape one frame at a time.

The Punch is a synchronous unit having two electromechanical probing units triggered by magnetic heads. These heads sense the rotational position of the punching mechanism. One head produces a timing pulse which assembles and synchronizes data being held in the Punch Register; this pulse also begins the punching process. A second head produces a timing pulse which is used for error comparison, clearing the Punch Register and initiating an Output Data Request.

The 8-bit Punch Register is the subsystem's storage area which holds characters coming from the computer and forwards them to the Punch. The characters are gated into the Punch Register where they remain until the Punch is conditioned by timing probe to receive the character. When data is punched, the second timing pulse clears the tape feed and initiates a compare probe. If no error is found, the Punch Register is cleared and another character is requested from the computer. Another Output Data Request is then initiated by the subsystem's control logic. If an error is detected, the output operation terminates until the error is cleared by the computer or at the operator's or maintenance panel.

**DATA FLOW** The Punch Register stores the character to be punched and coordinates the operation of the Punch. When the Punch is first turned on, or, when it completes a punching sequence, an Output Data Request is sent to the computer, which in effect says the subsystem is ready to operate, or ready to accept the next character.

Data may then be put on the computer output lines and an Output Data Acknowledge signal sent to the Paper Tape Subsystem. When the data enters the subsystem's Computer Output Control it is immediately gated into the Punch Register. The Punch Register stores the information for the Punch and the Compare Register. When the data is punched, an electromechanical compare sequence is established to check data transmitted to the tape with data sent by the computer. If there is no error, another Output Data Request is originated by the subsystem. If there is an error, an External Interrupt Signal is sent with a "1" in the  $2^0$  bit position which notifies the computer of a Compare Error.

An Output Data Request can only be originated when the Punch is on, when there is no Compare Error or Tape Error and after the Punch Register has been cleared.

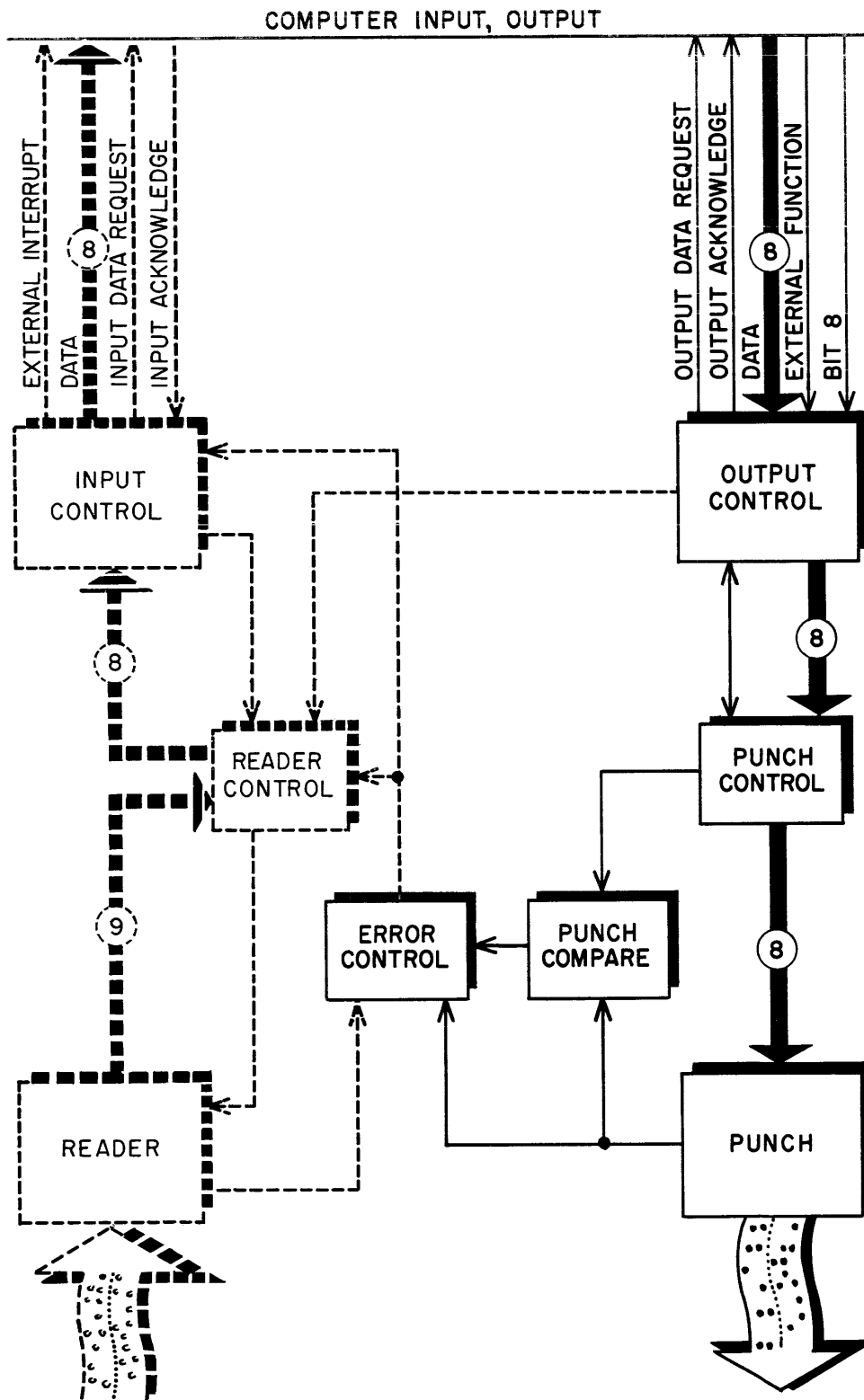
The Punch Enable signal enables data to flow from the Punch Register to the Punch. This signal is generated by the Tape Feed Signal when the Punch Register has been cleared, when there has not been a tape error, and when the proper timing pulse is present.

**PUNCH REGISTER** The Punch Register is made up of eight flip-flops and drivers. This register is cleared after each cycle of operation and when the power is first turned on. When one of the eight flip-flops is set, that level or bit will be punched. The data comes from the Computer Output Control on lines which transmit Bit 0 thru Bit 7.

There is a dual output from the Punch Register. Data flows directly to the Punch and also to the Punch Compare circuitry. The Punch Enable signal gates data to the Punch drivers and also causes the sprocket hole to be punched.

The heart of the Punch Compare is two parity check cards. Each has eight data lines with two inputs. As the Punch Register transmits data to the Punch, it also transmits data to the Compare circuitry. This compare action is electromechanical in nature--the solenoids controlling the Punch action close contacts which begin the data compare sequence. As the data is punched in 5, 6, 7 or 8 bits a sensing signal probes the Compare circuitry to match up the punched data with the data forwarded by the computer via the Punch Register.

If there is no error--if the punched data on the paper tape is the same as the output data--the subsystem proceeds. If an error is indicated, the Punch ceases operation until it is cleared by the computer or at the operator's or maintenance panel.



Punch Logic

# APPENDIX A

## PROGRAMMING THE PAPER TAPE SUBSYSTEM

The Paper Tape Subsystem is programmed in a manner similar to other Input/Output operations. The I/O transfer is initiated by the External Function instruction and Initiate Input Buffer Mode/Initiate Output Buffer Mode instruction of the main program, activating the subsystem channel preparatory to data transfer. The paper tape Function Word is decoded in the subsystem's control unit. (The first word sent to the Subsystem must be the Function Word, which is accompanied by an External Function signal). A Channel Synchronizer is not used with the Paper tape subsystem.

The paper tape Function Word is dissimilar to other Function Words; the function is commanded by way of a select bit code using the lowest-order nine bits of the Function Word. The remainder of the word is irrelevant.

The paper tape Data Word uses only the same lowest-order eight bits of the word, ignoring all upper-order bits. The only difference between a Function Word and a Data Word is in the sending of an External Function control signal when a Function Word is being transmitted. The binary information is sent on nine bit-parallel data lines between the computer and the subsystem.

### PAPER TAPE FUNCTION WORD

29	NOT USED	09	08	FUNCTION CODE	00
----	----------	----	----	---------------	----

### PAPER TAPE FUNCTIONS

FUNCTION CODE (octal)	DESCRIPTION
001	READ FORWARD
002	READ BACKWARD
004	FAULT ON READ
010	MASTER CLEAR
020	PUNCH ON
040	READER ON
100	COMPARE ERROR CLEAR
200	PUNCH OFF
400	READER OFF



# APPENDIX B

## EQUIPMENT SPECIFICATIONS AND INSTALLATION REQUIREMENTS

### ELECTRICAL

Power requirements for the Paper Tape Subsystem are listed below:

1. Primary power input is required to be 115 volts ac  $\pm$  10% which is capable of supplying 30 amperes current as follows:

- |                               |            |
|-------------------------------|------------|
| a. Auxiliary Output           | 10 amperes |
| b. Reader AC                  | 2          |
| c. Blower Motor               | 4          |
| d. Punch AC                   | 3          |
| e. -28 Volt Power Supply      | 3          |
| f. $\pm$ 15 Volt Power Supply | 3          |

2. The following secondary power is required to meet the operational requirements of the system. This secondary power is supplied to the system by two power supplies, one for the -28 volt power and one for the remainder of the secondary power:

- |                                |                            |
|--------------------------------|----------------------------|
| a. -28 volts at 5 amperes      | d. -15 volts at 10 amperes |
| b. $\pm$ 15 volts at 3 amperes | e. -25 volts at 5 amperes  |
| c. - 3 volts at 8 amperes      |                            |

(Voltages listed above under b, c, d, and e are supplied by one power supply.)

### PHYSICAL

The Paper Tape Subsystem is contained in a standard peripheral cabinet which consists of an Operator's Control Panel, Maintenance Panel, Paper Tape Reader, Paper Tape Punch, Logic Deck, two power supplies and a blower for cooling the system.

#### Physical Characteristics

Height	96 inches	Depth	34 1/2 inches
Width	24 inches	Weight	475 pounds

#### Loading

pounds per square foot 90

**Clearances (for maintenance)**

Front	60 inches
Rear	72 inches
Sides	None required

**Paper Tape Reader**

Channels	5, 6, 7, or 8
Tape Widths	11/16, 7/8 or 1 inch
Tape Speed	40 inches per second free running (forward or reverse)
Rate	400 characters per second

**Paper Tape Punch**

Channels	5, 6, 7, or 8 plus inline sprocket
Tape Widths	11/16, 7/8 or 1 inch
Characters per inch	10
Tape Speed	11 inches per second
Transfer Rate	110 characters per second

**ENVIRONMENTAL CONDITIONS**

The environment specified for the UNIVAC 490 or 1107 Computer Systems will be sufficient for the Paper Tape Subsystem.

**Specifications**

Ambient Temperature Range	20°C - 27.7°C (68° - 82°F)	BTU Output	5100 BTU/hr
		Cooling Air	400 CFM
Humidity Range	40% - 70% RU		

The air intake is through a grill at the bottom rear of the cabinet. A blower is located in the base of the cabinet to provide air circulation at a rate of 400 cubic feet/minute.

**CABLING REQUIREMENTS**

The Paper Tape Subsystem should not be located more than 300 feet from the central computer. This distance includes total cable length inside the cabinet as well as outside the cabinet, not the physical distance.

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