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# Component Description: IBM 2780 Data Transmission Terminal

This Component Description manual describes the principles of operation of the IBM 2780 Data Transmission Terminal. The data-link control characters, code structures, timeouts, and throughput rates associated with the Binary Synchronous method of transmission are described.

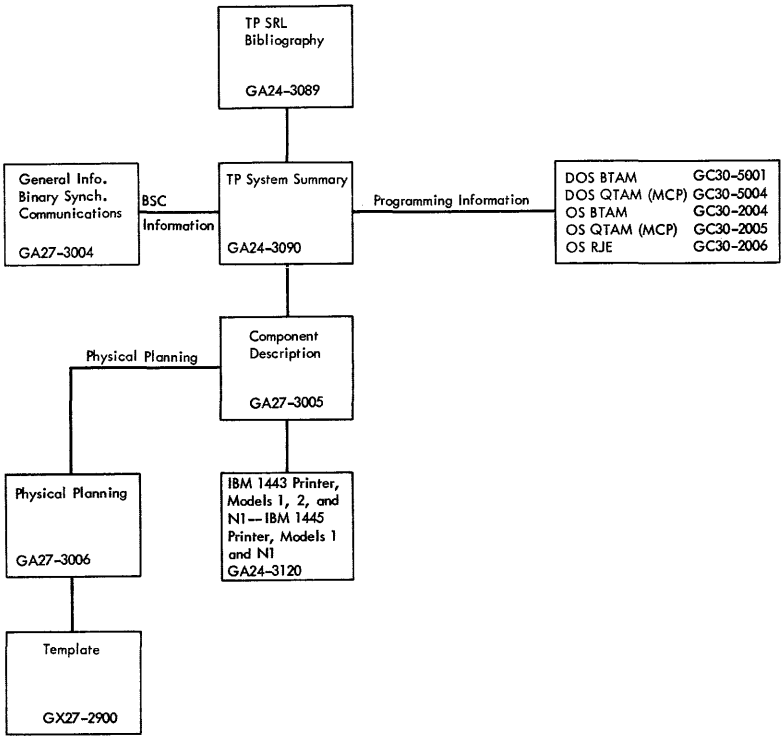
The communications facilities, data sets, and special features available for this teleprocessing terminal are also discussed. For an introduction to the Binary Synchronous method of transmission, refer to the manual, General Information--Binary Synchronous Communications, GA27-3004.

Additional information on the Binary Synchronous method of transmission when using an IBM 2701 or IBM 2703 can be found in the following publications:

- IBM 2701 Data Adapter Unit--Component Description, GA22-6864
- IBM 2703 Transmission Control--Component Description, GA27-2703

**2780 SRL Publications Availability Guide**

Use this guide to determine what available publications will best fulfill your individual requirements.




Fourth Edition (August 1971)

This is a major revision of, and obsoletes, GA27-3005-2 and Technical Newsletters N27-3039, GN27-3045, and GN27-3057. Significant modifications include a change to the machine throughput formula, the addition of information on punching and inserting the carriage tape, and an updating of the programming considerations for various error responses. A more detailed summary of the significant modifications may be found in the "Summary of Amendments" following the tables of contents and illustrations. These and other changes to the text and small changes to the illustrations are indicated by a vertical line to the left of the change.

Changes are periodically made to the information herein; before using this publication in connection with the operation of IBM systems or equipment, refer to the latest SRL Newsletter for the editions that are applicable and current.

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This manual has been prepared by the IBM Systems Development Division, Publications Center, Department E01, P.O. Box 12275, Research Triangle Park, North Carolina 27709. A form for reader's comments is provided at the back of this publication. If the form has been removed, comments may be sent to the above address.

# PREFACE

The purpose of this manual is to inform the reader of the functional and operating characteristics of the IBM 2780 Data Transmission Terminal. This manual was written for the system analyst who requires machine throughput knowledge; for the programmer who needs information on line responses, line-buffer capacity, and the number of records allowed per data block; and for the operator who needs to know the operating, error-recovery, and functional characteristics of the IBM 2780 Data Transmission Terminal.

The manual also contains information on timeout controls, operating characteristics of special features, information on code structures, and an explanation of data-link-control characters.

For a more in-depth understanding of the data-link and end-to-end control characters used by the 2780, the reader should be familiar with the principles involved in the Binary Synchronous method of communication. Manuals providing this BSC (Binary Synchronous Communication) information and other information related to the IBM 2780 are indicated in the Publications Availability Guide.

CONTENTS

## ILLUSTRATIONS

## SUMMARY OF AMENDMENTS FOR GA27-3005-3

### Correction to Machine Throughput Formula

A variable factor has been added to the throughput formula to allow the user to accurately calculate his throughput.

### Card Punching

A statement has been added clarifing what happens if a record contains more than 80 characters with a machine equipped with either Six-Bit Transcode or EBCDIC.

### Printing

A statement has been added to clarifing how many positions a print record can contain and the error condition that will arise if this limitation is exceeded.

### Tape-Controlled Carriage

Information on how to change line spacing from six to eight lines per inch, and how to punch or insert the carriage tape.

### Typebar Removal

A caution notice had been added to ensure that the typebar is not damaged during removal.

### Data-Link Control Characters

Statements have been added or revised to better explain the SYN, STX, RVI, NAK, and WACK control characters, and to explain how an erroneous EOT in text is handled.

### Operator Controls

Minor changes have been made to the Machine Reset key and the Start key.

### Indicators

The explanation of Line Light, Record Light, and Audible Alarm has been rewritten.

### Auto Answer

Information has been added to explain further aspects of the 20-second timeout sequence.

### Operating Procedures

The "Receive Operation" section has been rewritten for easier understanding. New information on operating with a 2780 Model 2 has been added to make the user aware of an operational idiosyncrasy.

### Error-Recovery Procedures

Information has been added to clarify the section on "Suggested Programming Considerations for the Various Error Responses when Operating with a CPU."

## INTRODUCTION

The IBM 2780 Data Transmission Terminal (Figure 1) enables large volumes of card data to be transmitted at line speed with punched or printed output. The IBM 2780 uses the binary synchronous communications (BSC) procedures over leased, privately owned, or switched networks--in EBCDIC, Six-Bit Transcode, or USASCII. The 2780 can communicate directly (point-to-point) through appropriate interface with another IBM 2780, an IBM System/360 Model 20 through 195*, an IBM System/370 Model 135 through 195, an IBM 1130, an IBM 1800, an IBM System/3, or an IBM 2770. (Figure 2 shows an example of point-to-point operation.) Also, the 2780 may be a station on the same multipoint line facility with other BSC-equipped IBM devices (2770, 1130, 1800, 2715, System/3, and System/360 Model 20). A System/360 Model 22 through 195* or a System/370 Model 135 through 195 acts as the control station for a multipoint network. (Figure 3 shows an example of multipoint operation.) The intermix capability of the IBM 2780 and other BSC-equipped IBM terminals and processor terminals is described in the SRL publication, General Information--Binary Synchronous Communications, GA27-3004.

### 2780 Models

The IBM 2780 is available in four models, permitting a variety of system configurations. The four models are:

- Model 1--Card read and print
- Model 2--Card read, card punch, and print
- Model 3--Print only (used as a receive terminal only)
- Model 4--Card read and card punch

### Functional Units of the 2780

The IBM 2780 Data Transmission Terminal consists of:

- A printer similar to the IBM 1443 Printer;
- A card read/punch similar to the IBM 1442 Card Read/Punch;
- A line buffer that stores data received (or data to be transmitted) over a communications line;
- An I/O buffer that provides for the intermediate storage of data between the I/O device and the line buffer;
- A Binary Synchronous Adapter, which controls the flow of data over the communications line and maintains synchronization between the transmitting and receiving terminals;
- Card read/punch and printer operator panels;
- Control circuitry to control the various functions and units of the terminal.

*System/360 Model 20 through 195 or 22 through 195, as used in this manual, excludes Model 44 and also Model 67 except in Model 65 mode.

### Terminology

The following terminology is used throughout the remainder of the manual:

- Record. The data in a single card or a single line of print.
- Block. A group of one or more records that are transmitted as a unit (block) and cause a line turnaround to verify the accuracy of the transmission.
- Message. A group of one or more blocks that represent an entity of data.

NOTE: Refer to Glossary.

### Communications Facilities

The communications facilities used by the IBM 2780 must have appropriate modulation/demodulation capability. The communications facilities can be either leased common-carrier private lines (channels), common-carrier switched telephone networks, or equivalent privately-owned facilities. When transmission speed is a primary consideration on private-line facilities, it may be advantageous to use a four-wire (duplex) private line because it can reduce significantly the time required to reverse the direction of transmission for control purposes. Although use of a four-wire (duplex) communications line can minimize turnaround delay, the IBM 2780 cannot receive and transmit data simultaneously. It is capable of half-duplex data transmission only. (Whether or not duplex charges apply depends on the local common carrier.) Transmission speed--1200, 2000, 2400 or 4800 bps (bits per second)--depends on the type of communications facilities used, and must be specified when the IBM 2780 is ordered.

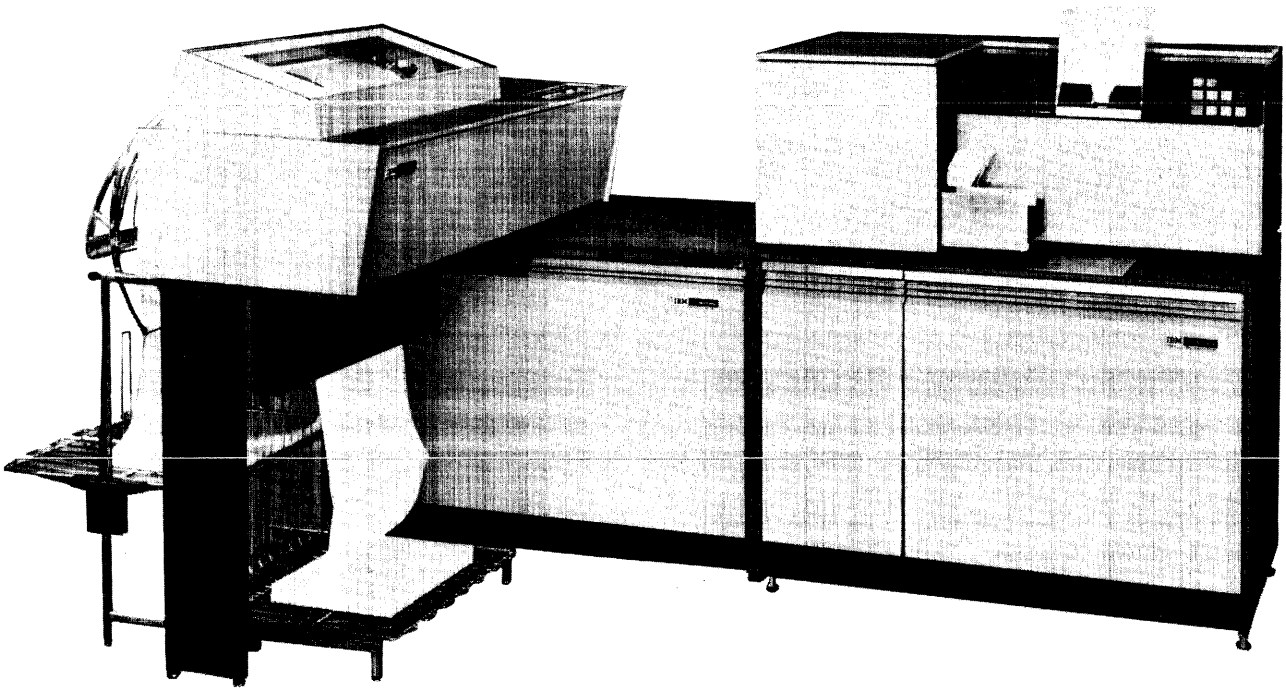


Figure 1. IBM 2780 Data Transmission Terminal

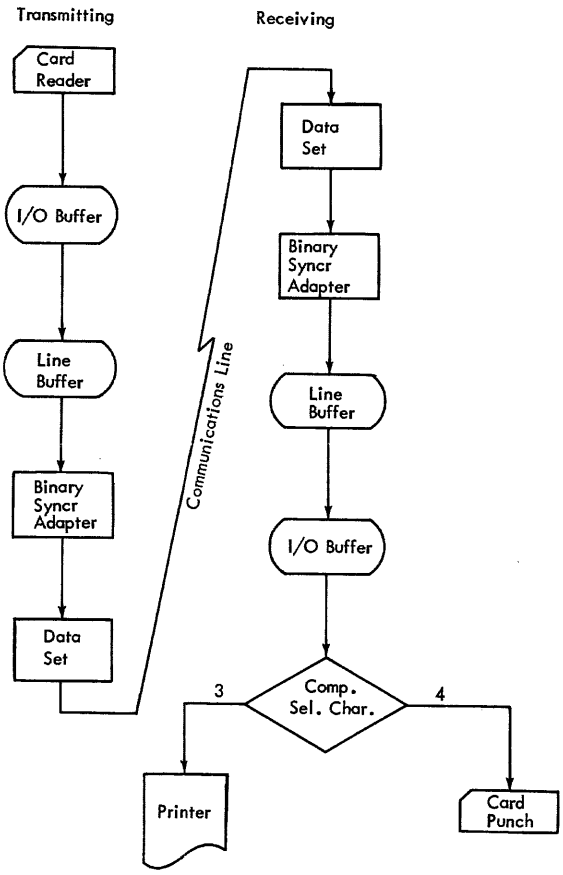



Figure 2. Data Flow, Terminal-to-Terminal Operation

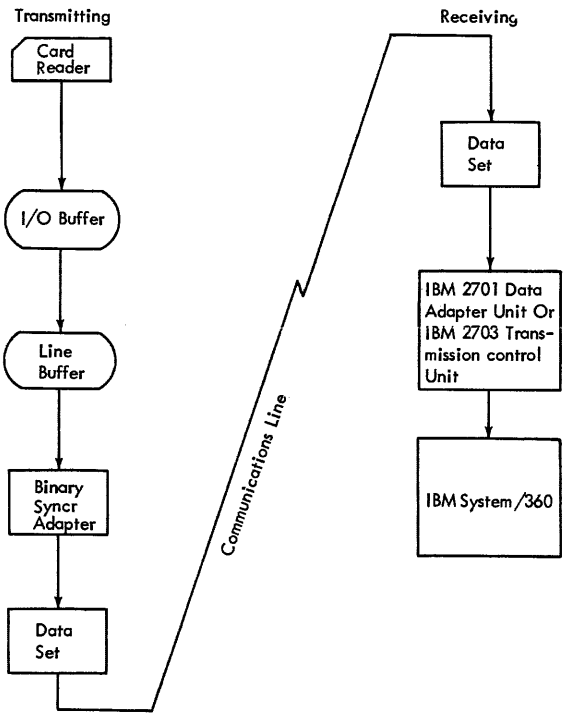



Figure 3. Data Flow, Terminal-to-Computer Operation

The IBM 2780 connects to communications channels via a data set or modem (modulator/demodulator) that may be provided by IBM (if available), by the customer, or by a common carrier. The data set must provide an interface to the 2780 that meets the requirements specified by EIA (Electronic Industries Association) RS-232-C for a type D synchronous interface. When non-IBM data sets (modems) are to be used, an IBM representative should be consulted for additional interface information.

The type of data set, and whether the 2780 is to be used on duplex or half-duplex communications facilities, must be specified when the IBM 2780 is ordered.

## Code Structures

The IBM 2780 Data Transmission Terminal can operate with any one of three code structures. The choice will depend on the application. However, for system compatibility, the same code must be chosen for all terminals on a particular communications line. The three available codes are: Six-Bit Transcode (Six-Bit Transmission Code); EBCDIC (Extended Binary-Coded-Decimal Interchange Code); and USASCII (United States of America Standard Code for Information Interchange). A composite chart of the three codes, including card codes, is shown in the Appendix to this manual (see Figure 27). Not all the data-link control or end-to-end control characters available within each of the three code sets are used by the IBM 2780.

NOTE: The IBM 2780 uses the same data-link and end-to-end control characters in all three codes. The data-link control characters used are: SYN, ENQ, STX, US, ETB, ETX, DLE, NAK, SOH, and EOT. The end-to-end control characters used are: ESC, BEL, HT, and EM. (See "Data-Link and End-to-End Control Characters" section in this manual.)

The 64-character Six-Bit Transcode (Figure 4) provides 47 printable graphics (see "Character Sets"), space, 10 data-link control characters, and 6 end-to-end control characters. (The SUB and DEL end-to-end control characters are not used by the 2780). The data-link and end-to-end control characters cannot be used as data characters. The data is transmitted over the communications line low-order first (543210).

NOTE: A 2780 Terminal using the Six-Bit Transcode cannot operate at 4800 bps with an IBM 2703 Transmission Control Unit.

The eight-bit EBCDIC code (Figure 5) provides 256 different characters. These 256 characters comprise the internal code structure of the IBM System/360, and the transmission of System/360 decks is possible when this code is used. The data-link and end-to-end control characters cannot be used as data characters unless the EBCDIC Transparency special feature is installed (see "Special Features" section of this manual). Up to 62 graphics can be printed (see "Character Sets"). Data is transmitted low-order first (76543210) onto the line. When EBCDIC is used , the EOB character performs the data-link control function of ETB. The PRE character performs the end-to-end control function of ESC (see "Data-Link and End-to-End Control Characters" section of this manual).

The USASCII code (Figure 6) consists of seven data bits plus a check bit, which by its presence or absence provides each character with odd parity. Sixty-three graphics can be printed with this code (see "Character Sets"). The data-link and end-to-end control characters cannot be used as data characters. The order of bits over the transmission line is low-order to high-order--that is, 1, 2, 3, 4, 5, 6, 7, and check bit.

NOTE: A 2780 terminal cannot transmit or receive USASCII in transparent mode. A 2780 using USASCII cannot communicate with an IBM 2701 Data Adapter Unit's Synchronous Data Adapter Type II (SDA-II) or with an IBM 2703 Transmission Control's terminal control (TC) if: (1) the SDA-II is wired with the Transparency feature, or with the Dual Code feature with USASCII transparency; or (2) the TC is wired with the Transparency feature. (If the 2701 had another SDA-II not so wired, or if the 2703 had another TC not so wired, then the 2780 could communicate with it.)

## CARD READ/PUNCH

The card read/punch unit of the 2780 Data Transmission Terminal (see Figure 1) provides the terminal with card input and card output capabilities. The same device is used for the 2780 Models 1, 2, and 4, except that Model 1 has no punching capabilities. The card read/punch unit can read up to 400 cpm (cards per minute), and punch up to 355 cpm. However, the actual throughput speed of the card read/

| CHAR. | CARD CODE | 6-BIT TRANSCODE | | | | | | | HEX |
|---|---|---|---|---|---|---|---|---|---|
| SOH | 12-9-1 | | | | | | | P | 00 |
| A | 12-1 | | | | | | 5 | | 01 |
| B | 12-2 | | | | | 4 | | | 02 |
| C | 12-3 | | | | | 4 | 5 | P | 03 |
| D | 12-4 | | | | 3 | | | | 04 |
| E | 12-5 | | | | 3 | | 5 | P | 05 |
| F | 12-6 | | | | 3 | 4 | | P | 06 |
| G | 12-7 | | | | 3 | 4 | 5 | | 07 |
| H | 12-8 | | | 2 | | | | | 08 |
| I | 12-9 | | | 2 | | | 5 | P | 09 |
| STX | 12-9-2 | | | 2 | | 4 | | P | 0A |
| · | 12-8-3 | | | 2 | | 4 | 5 | | 0B |
| ¤ | 12-8-4 | | | 2 | 3 | | | P | 0C |
| BEL | 0-9-8-7 | | | 2 | 3 | | 5 | | 0D |
| Sub | 9-8-7 | | | 2 | 3 | 4 | | | 0E |
| ETB | 0-9-6 | | | 2 | 3 | 4 | 5 | P | 0F |
| & | 12 | | 1 | | | | | | 10 |
| J | 11-1 | | 1 | | | | 5 | P | 11 |
| K | 11-2 | | 1 | | | 4 | | P | 12 |
| L | 11-3 | | 1 | | | 4 | 5 | | 13 |
| M | 11-4 | | 1 | | 3 | | | P | 14 |
| N | 11-5 | | 1 | | 3 | | 5 | | 15 |
| O | 11-6 | | 1 | | 3 | 4 | | | 16 |
| P | 11-7 | | 1 | | 3 | 4 | 5 | P | 17 |
| Q | 11-8 | | 1 | 2 | | | | P | 18 |
| R | 11-9 | | 1 | 2 | | | 5 | | 19 |
| Space | No Punching | | 1 | 2 | | 4 | | | 1A |
| $ | 11-8-3 | | 1 | 2 | | 4 | 5 | P | 1B |
| * | 11-8-4 | | 1 | 2 | 3 | | | | 1C |
| US | 11-9-8-7 | | 1 | 2 | 3 | | 5 | P | 1D |
| EOT | 9-7 | | 1 | 2 | 3 | 4 | | P | 1E |
| DLE | 12-11-9-8-1 | | 1 | 2 | 3 | 4 | 5 | | 1F |
| - | 11 | 0 | | | | | | | 20 |
| / | 0-1 | 0 | | | | | 5 | P | 21 |
| S | 0-2 | 0 | | | | 4 | | P | 22 |
| T | 0-3 | 0 | | | | 4 | 5 | | 23 |
| U | 0-4 | 0 | | | 3 | | | P | 24 |
| V | 0-5 | 0 | | | 3 | | 5 | | 25 |
| W | 0-6 | 0 | | | 3 | 4 | | | 26 |
| X | 0-7 | 0 | | | 3 | 4 | 5 | P | 27 |
| Y | 0-8 | 0 | | 2 | | | | P | 28 |
| Z | 0-9 | 0 | | 2 | | | 5 | | 29 |
| ESC | 0-9-7 | 0 | | 2 | | 4 | | | 2A |
| , | 0-8-3 | 0 | | 2 | | 4 | 5 | P | 2B |
| % | 0-8-4 | 0 | | 2 | 3 | | | | 2C |
| ENQ | 0-9-8-5 | 0 | | 2 | 3 | | 5 | P | 2D |
| ETX | 12-9-3 | 0 | | 2 | 3 | 4 | | P | 2E |
| HT | 12-9-5 | 0 | | 2 | 3 | 4 | 5 | | 2F |
| 0 | 0 | 0 | 1 | | | | | P | 30 |
| 1 | 1 | 0 | 1 | | | | 5 | | 31 |
| 2 | 2 | 0 | 1 | | | 4 | | | 32 |
| 3 | 3 | 0 | 1 | | | 4 | 5 | P | 33 |
| 4 | 4 | 0 | 1 | | 3 | | | | 34 |
| 5 | 5 | 0 | 1 | | 3 | | 5 | P | 35 |
| 6 | 6 | 0 | 1 | | 3 | 4 | | P | 36 |
| 7 | 7 | 0 | 1 | | 3 | 4 | 5 | | 37 |
| 8 | 8 | 0 | 1 | 2 | | | | | 38 |
| 9 | 9 | 0 | 1 | 2 | | | 5 | P | 39 |
| SYN | 9-2 | 0 | 1 | 2 | | 4 | | P | 3A |
| # | 8-3 | 0 | 1 | 2 | | 4 | 5 | | 3B |
| @ | 8-4 | 0 | 1 | 2 | 3 | | | P | 3C |
| NAK | 9-8-5 | 0 | 1 | 2 | 3 | | 5 | | 3D |
| EM | 11-9-8-1 | 0 | 1 | 2 | 3 | 4 | | | 3E |
| DEL | 12-9-7 | 0 | 1 | 2 | 3 | 4 | 5 | P | 3F |

Figure 4. Six-Bit Transcode Character Assignment. Also see Composite Code Charts in Appendix.

punch depends on the number of card columns that are read or punched, the type of code used (Six-Bit Transcode, EBCDIC, or USASCII), and the type of communications facilities used. (Figure 7 shows the formula for calculating the terminal throughput rate in cards per minute or lines per minute. Figures 8, 9, 10, and 11 show the approximate card read/punch throughput rates for both dial and leased lines by code.)

The card read/punch has a hopper with a capacity of about 1200 cards, a card path with read and punch stations, and a single radial stacker with a capacity of 1300 cards. The stacker can be emptied without stopping the unit. Cards feed parallel from the hopper into the card path, move serially through the read and punch stations to a cornering station, and pass parallel into the stacker transport (Figure 12). Since cards move serially through the read and punch stations, simultaneous reading and punching operations are not feasible.

A card is read by sensing a light through the punched hole in the card. Light from beneath the card is directed to all digit positions of the card columns as each column registers above the light source. Any hole punched in the column allows light to pass through and activate a photo transistor. The photo transistor(s) then activate the translation circuitry. Checking circuitry tests the photo transistors twice for each card column and compares the two readings. If the readings are not alike, an error is indicated.

A card to be punched moves through the read station and stops with column one registered at the punch station. A geneva (intermittent) drive mechanism moves the card forward, column by column, after each column is punched. A signal generated by each active punch magnet for the column being punched (punch echo check) is compared with the data to be punched, and an error is indicated when a non-compare condition exists.

## Basic Operation--Card Read/Punch

Card read/punch operation is started by first selecting the appropriate Mode switch setting. Cards are then loaded into the hopper and the start key is pressed until the Ready light turns on. If the proper interlocks

| CHAR. | CARD CODE | EBCDIC CODE | | | | | | | HEX |
|---|---|---|---|---|---|---|---|---|---|
| NUL | 12-0-1-8-9 | | | | | | | | 00 |
| SOH | 12-1-9 | | | | | | | 7 | 01 |
| STX | 12-2-9 | | | | | | 6 | | 02 |
| ETX | 12-3-9 | | | | | | 6 | 7 | 03 |
| PF | 12-4-9 | | | | | 5 | | | 04 |
| HT | 12-5-9 | | | | | 5 | | 7 | 05 |
| LC | 12-6-9 | | | | | 5 | 6 | | 06 |
| DEL | 12-7-9 | | | | | 5 | 6 | 7 | 07 |
| | 12-8-9 | | | | 4 | | | | 08 |
| | 12-1-8-9 | | | | 4 | | | 7 | 09 |
| SMM | 12-2-8-9 | | | | 4 | | 6 | | 0A |
| VT | 12-3-8-9 | | | | 4 | | 6 | 7 | 0B |
| FF | 12-4-8-9 | | | | 4 | 5 | | | 0C |
| CR | 12-5-8-9 | | | | 4 | 5 | | 7 | 0D |
| SO | 12-6-8-9 | | | | 4 | 5 | 6 | | 0E |
| SI | 12-7-8-9 | | | | 4 | 5 | 6 | 7 | 0F |
| DLE | 12-11-1-8-9 | | 3 | | | | | | 10 |
| DC1 | 11-1-9 | | 3 | | | | | 7 | 11 |
| DC2 | 11-2-9 | | 3 | | | | 6 | | 12 |
| DC3(TM) | 11-3-9 | | 3 | | | | 6 | 7 | 13 |
| RES | 11-4-9 | | 3 | | | 5 | | | 14 |
| NL | 11-5-9 | | 3 | | | 5 | | 7 | 15 |
| BS | 11-6-9 | | 3 | | | 5 | 6 | | 16 |
| IL | 11-7-9 | | 3 | | | 5 | 6 | 7 | 17 |
| CAN | 11-8-9 | | 3 | 4 | | | | | 18 |
| EM | 11-1-8-9 | | 3 | 4 | | | | 7 | 19 |
| CC | 11-2-8-9 | | 3 | 4 | | | 6 | | 1A |
| | 11-3-8-9 | | 3 | 4 | | | 6 | 7 | 1B |
| IFS | 11-4-8-9 | | 3 | 4 | 5 | | | | 1C |
| IGS | 11-5-8-9 | | 3 | 4 | 5 | | | 7 | 1D |
| IRS | 11-6-8-9 | | 3 | 4 | 5 | 6 | | | 1E |
| IUS | 11-7-8-9 | | 3 | 4 | 5 | 6 | | 7 | 1F |
| DS | 11-0-1-8-9 | 2 | | | | | | | 20 |
| SOS | 0-1-9 | 2 | | | | | | 7 | 21 |
| FS | 0-2-9 | 2 | | | | | 6 | | 22 |
| | 0-3-9 | 2 | | | | | 6 | 7 | 23 |
| BYP | 0-4-9 | 2 | | | | 5 | | | 24 |
| LF | 0-5-9 | 2 | | | | 5 | | 7 | 25 |
| ETB(EOB) | 0-6-9 | 2 | | | | 5 | 6 | | 26 |
| ESC(PRE) | 0-7-9 | 2 | | | | 5 | 6 | 7 | 27 |
| | 0-8-9 | 2 | | 4 | | | | | 28 |
| | 0-1-8-9 | 2 | | 4 | | | | 7 | 29 |
| SM | 0-2-8-9 | 2 | | 4 | | | 6 | | 2A |
| | 0-3-8-9 | 2 | | 4 | | | 6 | 7 | 2B |
| | 0-4-8-9 | 2 | | 4 | 5 | | | | 2C |
| ENQ | 0-5-8-9 | 2 | | 4 | 5 | | | 7 | 2D |
| ACK | 0-6-8-9 | 2 | | 4 | 5 | 6 | | | 2E |
| BEL | 0-7-8-9 | 2 | | 4 | 5 | 6 | | 7 | 2F |
| | 12-11-0-1-8-9 | 2 | 3 | | | | | | 30 |
| | 1-9 | 2 | 3 | | | | | 7 | 31 |
| SYN | 2-9 | 2 | 3 | | | | 6 | | 32 |
| | 3-9 | 2 | 3 | | | | 6 | 7 | 33 |
| PN | 4-9 | 2 | 3 | | 5 | | | | 34 |
| RS | 5-9 | 2 | 3 | | 5 | | | 7 | 35 |
| UC | 6-9 | 2 | 3 | | | 5 | 6 | | 36 |
| EOT | 7-9 | 2 | 3 | | | 5 | 6 | 7 | 37 |
| | 8-9 | 2 | 3 | 4 | | | | | 38 |
| | 1-8-9 | 2 | 3 | 4 | | | | 7 | 39 |
| | 2-8-9 | 2 | 3 | 4 | | | 6 | | 3A |
| | 3-8-9 | 2 | 3 | 4 | | | 6 | 7 | 3B |
| DC4 | 4-8-9 | 2 | 3 | 4 | 5 | | | | 3C |
| NAK | 5-8-9 | 2 | 3 | 4 | 5 | | | 7 | 3D |
| | 6-8-9 | 2 | 3 | 4 | 5 | 6 | | | 3E |
| SUB | 7-8-9 | 2 | 3 | 4 | 5 | 6 | | 7 | 3F |

| CHAR. | CARD CODE | EBCDIC CODE | | | | | | | HEX |
|---|---|---|---|---|---|---|---|---|---|
| SPACE | NO PUNCHING | 1 | | | | | | | 40 |
| | 12-0-1-9 | 1 | | | | | | 7 | 41 |
| | 12-0-2-9 | 1 | | | | | 6 | | 42 |
| | 12-0-3-9 | 1 | | | | | 6 | 7 | 43 |
| | 12-0-4-9 | 1 | | | | 5 | | | 44 |
| | 12-0-5-9 | 1 | | | | 5 | | 7 | 45 |
| | 12-0-6-9 | 1 | | | | 5 | 6 | | 46 |
| | 12-0-7-9 | 1 | | | | 5 | 6 | 7 | 47 |
| | 12-0-8-9 | 1 | | | 4 | | | | 48 |
| | 12-1-8 | 1 | | | 4 | | | 7 | 49 |
| ¢ | 12-2-8 | 1 | | | 4 | | 6 | | 4A |
| . | 12-3-8 | 1 | | | 4 | | 6 | 7 | 4B |
| < | 12-4-8 | 1 | | | 4 | 5 | | | 4C |
| ( | 12-5-8 | 1 | | | 4 | 5 | | 7 | 4D |
| + | 12-6-8 | 1 | | | 4 | 5 | 6 | | 4E |
| ! | 12-7-8 | 1 | | | 4 | 5 | 6 | 7 | 4F |
| & | 12 | 1 | | 3 | | | | | 50 |
| | 12-11-1-9 | 1 | | 3 | | | | 7 | 51 |
| | 12-11-2-9 | 1 | | 3 | | | 6 | | 52 |
| | 12-11-3-9 | 1 | | 3 | | | 6 | 7 | 53 |
| | 12-11-4-9 | 1 | | 3 | | 5 | | | 54 |
| | 12-11-5-9 | 1 | | 3 | | 5 | | 7 | 55 |
| | 12-11-6-9 | 1 | | 3 | | 5 | 6 | | 56 |
| | 12-11-7-9 | 1 | | 3 | | 5 | 6 | 7 | 57 |
| | 12-11-8-9 | 1 | | 3 | 4 | | | | 58 |
| | 11-1-8 | 1 | | 3 | 4 | | | 7 | 59 |
| ! | 11-2-8 | 1 | | 3 | 4 | | 6 | | 5A |
| $ | 11-3-8 | 1 | | 3 | 4 | | 6 | 7 | 5B |
| * | 11-4-8 | 1 | | 3 | 4 | 5 | | | 5C |
| ) | 11-5-8 | 1 | | 3 | 4 | 5 | | 7 | 5D |
| ; | 11-6-8 | 1 | | 3 | 4 | 5 | 6 | | 5E |
| ¬ | 11-7-8 | 1 | | 3 | 4 | 5 | 6 | 7 | 5F |
| - | 11 | 1 | 2 | | | | | | 60 |
| / | 0-1 | 1 | 2 | | | | | 7 | 61 |
| | 11-0-2-9 | 1 | 2 | | | | 6 | | 62 |
| | 11-0-3-9 | 1 | 2 | | | | 6 | 7 | 63 |
| | 11-0-4-9 | 1 | 2 | | | 5 | | | 64 |
| | 11-0-5-9 | 1 | 2 | | | 5 | | 7 | 65 |
| | 11-0-6-9 | 1 | 2 | | | 5 | 6 | | 66 |
| | 11-0-7-9 | 1 | 2 | | | 5 | 6 | 7 | 67 |
| | 11-0-8-9 | 1 | 2 | | 4 | | | | 68 |
| | 0-1-8 | 1 | 2 | | 4 | | | 7 | 69 |
| | 12-11 | 1 | 2 | | 4 | | 6 | | 6A |
| , | 0-3-8 | 1 | 2 | | 4 | | 6 | 7 | 6B |
| % | 0-4-8 | 1 | 2 | | 4 | 5 | | | 6C |
| — | 0-5-8 | 1 | 2 | | 4 | 5 | | 7 | 6D |
| > | 0-6-8 | 1 | 2 | | 4 | 5 | 6 | | 6E |
| ? | 0-7-8 | 1 | 2 | | 4 | 5 | 6 | 7 | 6F |
| | 12-11-0 | 1 | 2 | 3 | | | | | 70 |
| | 12-11-0-1-9 | 1 | 2 | 3 | | | | 7 | 71 |
| | 12-11-0-2-9 | 1 | 2 | 3 | | | 6 | | 72 |
| | 12-11-0-3-9 | 1 | 2 | 3 | | | 6 | 7 | 73 |
| | 12-11-0-4-9 | 1 | 2 | 3 | | 5 | | | 74 |
| | 12-11-0-5-9 | 1 | 2 | 3 | | 5 | | 7 | 75 |
| | 12-11-0-6-9 | 1 | 2 | 3 | | 5 | 6 | | 76 |
| | 12-11-0-7-9 | 1 | 2 | 3 | | 5 | 6 | 7 | 77 |
| | 12-11-0-8-9 | 1 | 2 | 3 | 4 | | | | 78 |
| | 1-8 | 1 | 2 | 3 | 4 | | | 7 | 79 |
| : | 2-8 | 1 | 2 | 3 | 4 | | 6 | | 7A |
| # | 3-8 | 1 | 2 | 3 | 4 | | 6 | 7 | 7B |
| @ | 4-8 | 1 | 2 | 3 | 4 | 5 | | | 7C |
| ' | 5-8 | 1 | 2 | 3 | 4 | 5 | | 7 | 7D |
| = | 6-8 | 1 | 2 | 3 | 4 | 5 | 6 | | 7E |
| " | 7-8 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 7F |

Figure 5. EBCDIC Character Assignment (Part 1 of 2). Also see Composite Code Charts in Appendix.

| CHAR. | CARD CODE | EBCDIC CODE | | | | | | | | HEX |
|---|---|---|---|---|---|---|---|---|---|---|
| | 12-0-1-8 | 0 | | | | | | | | 80 |
| a | 12-0-1 | 0 | | | | | | | 7 | 81 |
| b | 12-0-2 | 0 | | | | | | 6 | | 82 |
| c | 12-0-3 | 0 | | | | | | 6 | 7 | 83 |
| d | 12-0-4 | 0 | | | | | 5 | | | 84 |
| e | 12-0-5 | 0 | | | | | 5 | | 7 | 85 |
| f | 12-0-6 | 0 | | | | | 5 | 6 | | 86 |
| g | 12-0-7 | 0 | | | | | 5 | 6 | 7 | 87 |
| h | 12-0-8 | 0 | | | | 4 | | | | 88 |
| i | 12-0-9 | 0 | | | | 4 | | | 7 | 89 |
| | 12-0-2-8 | 0 | | | | 4 | | 6 | | 8A |
| | 12-0-3-8 | 0 | | | | 4 | | 6 | 7 | 8B |
| | 12-0-4-8 | 0 | | | | 4 | 5 | | | 8C |
| | 12-0-5-8 | 0 | | | | 4 | 5 | | 7 | 8D |
| | 12-0-6-8 | 0 | | | | 4 | 5 | 6 | | 8E |
| | 12-0-7-8 | 0 | | | | 4 | 5 | 6 | 7 | 8F |
| | 12-11-1-8 | 0 | | 3 | | | | | | 90 |
| j | 12-11-1 | 0 | | 3 | | | | | 7 | 91 |
| k | 12-11-2 | 0 | | 3 | | | | 6 | | 92 |
| l | 12-11-3 | 0 | | 3 | | | | 6 | 7 | 93 |
| m | 12-11-4 | 0 | | 3 | | 5 | | | | 94 |
| n | 12-11-5 | 0 | | 3 | | 5 | | | 7 | 95 |
| o | 12-11-6 | 0 | | 3 | | 5 | 6 | | | 96 |
| p | 12-11-7 | 0 | | 3 | | 5 | 6 | 7 | | 97 |
| q | 12-11-8 | 0 | | 3 | 4 | | | | | 98 |
| r | 12-11-9 | 0 | | 3 | 4 | | | | 7 | 99 |
| | 12-11-2-8 | 0 | | 3 | 4 | | | 6 | | 9A |
| | 12-11-3-8 | 0 | | 3 | 4 | | | 6 | 7 | 9B |
| | 12-11-4-8 | 0 | | 3 | 4 | 5 | | | | 9C |
| | 12-11-5-8 | 0 | | 3 | 4 | 5 | | | 7 | 9D |
| | 12-11-6-8 | 0 | | 3 | 4 | 5 | 6 | | | 9E |
| | 12-11-7-8 | 0 | | 3 | 4 | 5 | 6 | 7 | | 9F |
| | 11-0-1-8 | 0 | 2 | | | | | | | A0 |
| | 11-0-1 | 0 | 2 | | | | | | 7 | A1 |
| s | 11-0-2 | 0 | 2 | | | | | 6 | | A2 |
| t | 11-0-3 | 0 | 2 | | | | | 6 | 7 | A3 |
| u | 11-0-4 | 0 | 2 | | | | 5 | | | A4 |
| v | 11-0-5 | 0 | 2 | | | | 5 | | 7 | A5 |
| w | 11-0-6 | 0 | 2 | | | | 5 | 6 | | A6 |
| x | 11-0-7 | 0 | 2 | | | | 5 | 6 | 7 | A7 |
| y | 11-0-8 | 0 | 2 | | | 4 | | | | A8 |
| z | 11-0-9 | 0 | 2 | | | 4 | | | 7 | A9 |
| | 11-0-2-8 | 0 | 2 | | | 4 | | 6 | | AA |
| | 11-0-3-8 | 0 | 2 | | | 4 | | 6 | 7 | AB |
| | 11-0-4-8 | 0 | 2 | | | 4 | 5 | | | AC |
| | 11-0-5-8 | 0 | 2 | | | 4 | 5 | | 7 | AD |
| | 11-0-6-8 | 0 | 2 | | | 4 | 5 | 6 | | AE |
| | 11-0-7-8 | 0 | 2 | | | 4 | 5 | 6 | 7 | AF |
| | 12-11-0-1-8 | 0 | 2 | 3 | | | | | | B0 |
| | 12-11-0-1 | 0 | 2 | 3 | | | | | 7 | B1 |
| | 12-11-0-2 | 0 | 2 | 3 | | | | 6 | | B2 |
| | 12-11-0-3 | 0 | 2 | 3 | | | | 6 | 7 | B3 |
| | 12-11-0-4 | 0 | 2 | 3 | | 5 | | | | B4 |
| | 12-11-0-5 | 0 | 2 | 3 | | 5 | | | 7 | B5 |
| | 12-11-0-6 | 0 | 2 | 3 | | 5 | 6 | | | B6 |
| | 12-11-0-7 | 0 | 2 | 3 | | 5 | 6 | 7 | | B7 |
| | 12-11-0-8 | 0 | 2 | 3 | 4 | | | | | B8 |
| | 12-11-0-9 | 0 | 2 | 3 | 4 | | | | 7 | B9 |
| | 12-11-0-2-8 | 0 | 2 | 3 | 4 | | | 6 | | BA |
| | 12-11-0-3-8 | 0 | 2 | 3 | 4 | | | 6 | 7 | BB |
| | 12-11-0-4-8 | 0 | 2 | 3 | 4 | 5 | | | | BC |
| | 12-11-0-5-8 | 0 | 2 | 3 | 4 | 5 | | | 7 | BD |
| | 12-11-0-6-8 | 0 | 2 | 3 | 4 | 5 | 6 | | | BE |
| | 12-11-0-7-8 | 0 | 2 | 3 | 4 | 5 | 6 | 7 | | BF |

| CHAR. | CARD CODE | EBCDIC CODE | | | | | | | | HEX |
|---|---|---|---|---|---|---|---|---|---|---|
| | 12-0 | 0 | 1 | | | | | | | C0 |
| A | 12-1 | 0 | 1 | | | | | | 7 | C1 |
| B | 12-2 | 0 | 1 | | | | | 6 | | C2 |
| C | 12-3 | 0 | 1 | | | | | 6 | 7 | C3 |
| D | 12-4 | 0 | 1 | | | | 5 | | | C4 |
| E | 12-5 | 0 | 1 | | | | 5 | | 7 | C5 |
| F | 12-6 | 0 | 1 | | | | 5 | 6 | | C6 |
| G | 12-7 | 0 | 1 | | | | 5 | 6 | 7 | C7 |
| H | 12-8 | 0 | 1 | | | 4 | | | | C8 |
| I | 12-9 | 0 | 1 | | | 4 | | | 7 | C9 |
| | 12-0-2-8-9 | 0 | 1 | | | 4 | | 6 | | CA |
| | 12-0-3-8-9 | 0 | 1 | | | 4 | | 6 | 7 | CB |
| | 12-0-4-8-9 | 0 | 1 | | | 4 | 5 | | | CC |
| | 12-0-5-8-9 | 0 | 1 | | | 4 | 5 | | 7 | CD |
| | 12-0-6-8-9 | 0 | 1 | | | 4 | 5 | 6 | | CE |
| | 12-0-7-8-9 | 0 | 1 | | | 4 | 5 | 6 | 7 | CF |
| | 11-0 | 0 | 1 | 3 | | | | | | D0 |
| J | 11-1 | 0 | 1 | 3 | | | | | 7 | D1 |
| K | 11-2 | 0 | 1 | 3 | | | | 6 | | D2 |
| L | 11-3 | 0 | 1 | 3 | | | | 6 | 7 | D3 |
| M | 11-4 | 0 | 1 | 3 | | 5 | | | | D4 |
| N | 11-5 | 0 | 1 | 3 | | 5 | | | 7 | D5 |
| O | 11-6 | 0 | 1 | 3 | | 5 | 6 | | | D6 |
| P | 11-7 | 0 | 1 | 3 | | 5 | 6 | 7 | | D7 |
| Q | 11-8 | 0 | 1 | 3 | 4 | | | | | D8 |
| R | 11-9 | 0 | 1 | 3 | 4 | | | | 7 | D9 |
| | 12-11-2-8-9 | 0 | 1 | 3 | 4 | | | 6 | | DA |
| | 12-11-3-8-9 | 0 | 1 | 3 | 4 | | | 6 | 7 | DB |
| | 12-11-4-8-9 | 0 | 1 | 3 | 4 | 5 | | | | DC |
| | 12-11-5-8-9 | 0 | 1 | 3 | 4 | 5 | | | 7 | DD |
| | 12-11-6-8-9 | 0 | 1 | 3 | 4 | 5 | 6 | | | DE |
| | 12-11-7-8-9 | 0 | 1 | 3 | 4 | 5 | 6 | 7 | | DF |
| | 0-2-8 | 0 | 1 | 2 | | | | | | E0 |
| | 11-0-1-9 | 0 | 1 | 2 | | | | | 7 | E1 |
| S | 0-2 | 0 | 1 | 2 | | | | 6 | | E2 |
| T | 0-3 | 0 | 1 | 2 | | | | 6 | 7 | E3 |
| U | 0-4 | 0 | 1 | 2 | | | 5 | | | E4 |
| V | 0-5 | 0 | 1 | 2 | | | 5 | | 7 | E5 |
| W | 0-6 | 0 | 1 | 2 | | | 5 | 6 | | E6 |
| X | 0-7 | 0 | 1 | 2 | | | 5 | 6 | 7 | E7 |
| Y | 0-8 | 0 | 1 | 2 | | 4 | | | | E8 |
| Z | 0-9 | 0 | 1 | 2 | | 4 | | | 7 | E9 |
| | 11-0-2-8-9 | 0 | 1 | 2 | | 4 | | 6 | | EA |
| | 11-0-3-8-9 | 0 | 1 | 2 | | 4 | | 6 | 7 | EB |
| | 11-0-4-8-9 | 0 | 1 | 2 | | 4 | 5 | | | EC |
| | 11-0-5-8-9 | 0 | 1 | 2 | | 4 | 5 | | 7 | ED |
| | 11-0-6-8-9 | 0 | 1 | 2 | | 4 | 5 | 6 | | EE |
| | 11-0-7-8-9 | 0 | 1 | 2 | | 4 | 5 | 6 | 7 | EF |
| 0 | 0 | 0 | 1 | 2 | 3 | | | | | F0 |
| 1 | 1 | 0 | 1 | 2 | 3 | | | | 7 | F1 |
| 2 | 2 | 0 | 1 | 2 | 3 | | | 6 | | F2 |
| 3 | 3 | 0 | 1 | 2 | 3 | | | 6 | 7 | F3 |
| 4 | 4 | 0 | 1 | 2 | 3 | | 5 | | | F4 |
| 5 | 5 | 0 | 1 | 2 | 3 | | 5 | | 7 | F5 |
| 6 | 6 | 0 | 1 | 2 | 3 | | 5 | 6 | | F6 |
| 7 | 7 | 0 | 1 | 2 | 3 | | 5 | 6 | 7 | F7 |
| 8 | 8 | 0 | 1 | 2 | 3 | 4 | | | | F8 |
| 9 | 9 | 0 | 1 | 2 | 3 | 4 | | | 7 | F9 |
| | 12-11-0-2-8-9 | 0 | 1 | 2 | 3 | 4 | | 6 | | FA |
| | 12-11-0-3-8-9 | 0 | 1 | 2 | 3 | 4 | | 6 | 7 | FB |
| | 12-11-0-4-8-9 | 0 | 1 | 2 | 3 | 4 | 5 | | | FC |
| | 12-11-0-5-8-9 | 0 | 1 | 2 | 3 | 4 | 5 | | 7 | FD |
| | 12-11-0-6-8-9 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | | FE |
| | 12-11-0-7-8-9 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | FF |

Figure 5. EBCDIC Character Assignment (Part 2 of 2). Also see Composite Code Charts in Appendix.

| CHAR. | CARD CODE | USASCII CODE | | | | | | | HEX |
|---|---|---|---|---|---|---|---|---|---|
| NUL | 12-0-9-8-1 | | | | | | | | 00 |
| SOH | 12-9-1 | 1 | | | | | | | 01 |
| STX | 12-9-2 | | 2 | | | | | | 02 |
| ETX | 12-9-3 | 1 | 2 | | | | | P | 03 |
| EOT | 9-7 | | | 3 | | | | | 04 |
| ENQ | 0-9-8-5 | 1 | | 3 | | | | P | 05 |
| ACK | 0-9-8-6 | | 2 | 3 | | | | P | 06 |
| BEL | 0-9-8-7 | 1 | 2 | 3 | | | | | 07 |
| BS | 11-9-6 | | | | 4 | | | | 08 |
| HT | 12-9-5 | 1 | | | 4 | | | P | 09 |
| LF | 0-9-5 | | 2 | | 4 | | | P | 0A |
| VT | 12-9-8-3 | 1 | 2 | | 4 | | | | 0B |
| FF | 12-9-8-4 | | | 3 | 4 | | | P | 0C |
| CR | 12-9-8-5 | 1 | | 3 | 4 | | | | 0D |
| SO | 12-9-8-6 | | 2 | 3 | 4 | | | | 0E |
| SI | 12-9-8-7 | 1 | 2 | 3 | 4 | | | P | 0F |
| DLE | 12-11-9-8-1 | | | | | 5 | | | 10 |
| DC1 | 11-9-1 | 1 | | | | 5 | | P | 11 |
| DC2 | 11-9-2 | | 2 | | | 5 | | P | 12 |
| DC3 | 11-9-3 | 1 | 2 | | | 5 | | | 13 |
| DC4 | 4-8-9 | | | 3 | | 5 | | P | 14 |
| NAK | 9-8-5 | 1 | | 3 | | 5 | | | 15 |
| SYN | 9-2 | | 2 | 3 | | 5 | | | 16 |
| ETB | 0-9-6 | 1 | 2 | 3 | | 5 | | P | 17 |
| CAN | 11-9-8 | | | | 4 | 5 | | P | 18 |
| EM | 11-9-8-1 | 1 | | | 4 | 5 | | | 19 |
| SUB | 9-8-7 | | 2 | | 4 | 5 | | | 1A |
| ESC | 0-9-7 | 1 | 2 | | 4 | 5 | | P | 1B |
| FS | 11-9-8-4 | | | 3 | 4 | 5 | | | 1C |
| GS | 11-9-8-5 | 1 | | 3 | 4 | 5 | | P | 1D |
| RS | 11-9-8-6 | | 2 | 3 | 4 | 5 | | P | 1E |
| US | 11-9-8-7 | 1 | 2 | 3 | 4 | 5 | | | 1F |
| SPACE | NO PUNCHES | | | | | | 6 | | 20 |
| ! | 12-8-7 | 1 | | | | | 6 | P | 21 |
| " | 8-7 | | 2 | | | | 6 | P | 22 |
| # | 8-3 | 1 | 2 | | | | 6 | | 23 |
| $ | 11-8-3 | | | 3 | | | 6 | P | 24 |
| % | 0-8-4 | 1 | | 3 | | | 6 | | 25 |
| & | 12 | | 2 | 3 | | | 6 | | 26 |
| ' | 8-5 | 1 | 2 | 3 | | | 6 | P | 27 |
| ( | 12-8-5 | | | | 4 | | 6 | P | 28 |
| ) | 11-8-5 | 1 | | | 4 | | 6 | | 29 |
| * | 11-8-4 | | 2 | | 4 | | 6 | | 2A |
| + | 12-8-6 | 1 | 2 | | 4 | | 6 | P | 2B |
| , | 0-8-3 | | | 3 | 4 | | 6 | | 2C |
| - | 11 | 1 | | 3 | 4 | | 6 | P | 2D |
| . | 12-8-3 | | 2 | 3 | 4 | | 6 | P | 2E |
| / | 0-1 | 1 | 2 | 3 | 4 | | 6 | | 2F |
| 0 | 0 | | | | | 5 | 6 | P | 30 |
| 1 | 1 | 1 | | | | 5 | 6 | | 31 |
| 2 | 2 | | 2 | | | 5 | 6 | | 32 |
| 3 | 3 | 1 | 2 | | | 5 | 6 | P | 33 |
| 4 | 4 | | | 3 | | 5 | 6 | | 34 |
| 5 | 5 | 1 | | 3 | | 5 | 6 | P | 35 |
| 6 | 6 | | 2 | 3 | | 5 | 6 | P | 36 |
| 7 | 7 | 1 | 2 | 3 | | 5 | 6 | | 37 |
| 8 | 8 | | | | 4 | 5 | 6 | | 38 |
| 9 | 9 | 1 | | | 4 | 5 | 6 | P | 39 |
| : | 8-2 | | 2 | | 4 | 5 | 6 | P | 3A |
| ; | 11-8-6 | 1 | 2 | | 4 | 5 | 6 | | 3B |
| < | 12-8-4 | | | 3 | 4 | 5 | 6 | P | 3C |
| = | 8-6 | 1 | | 3 | 4 | 5 | 6 | | 3D |
| > | 0-8-6 | | 2 | 3 | 4 | 5 | 6 | | 3E |
| ? | 0-8-7 | 1 | 2 | 3 | 4 | 5 | 6 | P | 3F |

| CHAR. | CARD CODE | USASCII CODE | | | | | | | HEX |
|---|---|---|---|---|---|---|---|---|---|
| @ | 8-4 | | | | | | 7 | | 40 |
| A | 12-1 | 1 | | | | | 7 | P | 41 |
| B | 12-2 | | 2 | | | | 7 | P | 42 |
| C | 12-3 | 1 | 2 | | | | 7 | | 43 |
| D | 12-4 | | | 3 | | | 7 | P | 44 |
| E | 12-5 | 1 | | 3 | | | 7 | | 45 |
| F | 12-6 | | 2 | 3 | | | 7 | | 46 |
| G | 12-7 | 1 | 2 | 3 | | | 7 | P | 47 |
| H | 12-8 | | | | 4 | | 7 | P | 48 |
| I | 12-9 | 1 | | | 4 | | 7 | | 49 |
| J | 11-1 | | 2 | | 4 | | 7 | | 4A |
| K | 11-2 | 1 | 2 | | 4 | | 7 | P | 4B |
| L | 11-3 | | | 3 | 4 | | 7 | | 4C |
| M | 11-4 | 1 | | 3 | 4 | | 7 | P | 4D |
| N | 11-5 | | 2 | 3 | 4 | | 7 | P | 4E |
| O | 11-6 | 1 | 2 | 3 | 4 | | 7 | | 4F |
| P | 11-7 | | | | | 5 | 7 | P | 50 |
| Q | 11-8 | 1 | | | | 5 | 7 | | 51 |
| R | 11-9 | | 2 | | | 5 | 7 | | 52 |
| S | 0-2 | 1 | 2 | | | 5 | 7 | P | 53 |
| T | 0-3 | | | 3 | | 5 | 7 | | 54 |
| U | 0-4 | 1 | | 3 | | 5 | 7 | P | 55 |
| V | 0-5 | | 2 | 3 | | 5 | 7 | P | 56 |
| W | 0-6 | 1 | 2 | 3 | | 5 | 7 | | 57 |
| X | 0-7 | | | | 4 | 5 | 7 | | 58 |
| Y | 0-8 | 1 | | | 4 | 5 | 7 | P | 59 |
| Z | 0-9 | | 2 | | 4 | 5 | 7 | P | 5A |
| [ | 12-8-2 | 1 | 2 | | 4 | 5 | 7 | | 5B |
| \ | 0-8-2 | | | 3 | 4 | 5 | 7 | P | 5C |
| ] | 11-8-2 | 1 | | 3 | 4 | 5 | 7 | | 5D |
| ¬ | 11-8-7 | | 2 | 3 | 4 | 5 | 7 | | 5E |
| ← | 0-8-5 | 1 | 2 | 3 | 4 | 5 | 7 | P | 5F |
| ` | 8-1 | | | | | 6 | 7 | P | 60 |
| a | 12-0-1 | 1 | | | | 6 | 7 | | 61 |
| b | 12-0-2 | | 2 | | | 6 | 7 | | 62 |
| c | 12-0-3 | 1 | 2 | | | 6 | 7 | P | 63 |
| d | 12-0-4 | | | 3 | | 6 | 7 | | 64 |
| e | 12-0-5 | 1 | | 3 | | 6 | 7 | P | 65 |
| f | 12-0-6 | | 2 | 3 | | 6 | 7 | P | 66 |
| g | 12-0-7 | 1 | 2 | 3 | | 6 | 7 | | 67 |
| h | 12-0-8 | | | | 4 | 6 | 7 | | 68 |
| i | 12-0-9 | 1 | | | 4 | 6 | 7 | P | 69 |
| j | 12-11-1 | | 2 | | 4 | 6 | 7 | P | 6A |
| k | 12-11-2 | 1 | 2 | | 4 | 6 | 7 | | 6B |
| l | 12-11-3 | | | 3 | 4 | 6 | 7 | P | 6C |
| m | 12-11-4 | 1 | | 3 | 4 | 6 | 7 | | 6D |
| n | 12-11-5 | | 2 | 3 | 4 | 6 | 7 | | 6E |
| o | 12-11-6 | 1 | 2 | 3 | 4 | 6 | 7 | P | 6F |
| p | 12-11-7 | | | | 5 | 6 | 7 | | 70 |
| q | 12-11-8 | 1 | | | 5 | 6 | 7 | P | 71 |
| r | 12-11-9 | | 2 | | 5 | 6 | 7 | P | 72 |
| s | 11-0-2 | 1 | 2 | | 5 | 6 | 7 | | 73 |
| t | 11-0-3 | | | 3 | 5 | 6 | 7 | P | 74 |
| u | 11-0-4 | 1 | | 3 | 5 | 6 | 7 | | 75 |
| v | 11-0-5 | | 2 | 3 | 5 | 6 | 7 | | 76 |
| w | 11-0-6 | 1 | 2 | 3 | 5 | 6 | 7 | P | 77 |
| x | 11-0-7 | | | 4 | 5 | 6 | 7 | P | 78 |
| y | 11-0-8 | 1 | | 4 | 5 | 6 | 7 | | 79 |
| z | 11-0-9 | | 2 | 4 | 5 | 6 | 7 | | 7A |
| { | 12-0 | 1 | 2 | 4 | 5 | 6 | 7 | P | 7B |
| \| | 12-11 | | | 3 | 4 | 5 | 6 | 7 | 7C |
| } | 11-0 | 1 | | 3 | 4 | 5 | 6 | 7 | P | 7D |
| ~ | 11-0-1 | | 2 | 3 | 4 | 5 | 6 | 7 | P | 7E |
| DEL | 12-9-7 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | | 7F |

Figure 6. USASCII Character Assignment. Also see Composite Code Charts in Appendix.

Throughput Rate (Cards or lines per minute) $= \frac{60{,}000 \times N}{\text{Greater of } X' \text{ or } X'' \text{ or } X'''}$

Test for X', X", or X"'

A. $[N (C + 3) + 5] R + F + K + 6R = X'$

B. $N (Y) = X''$

C. Punch or Printer: $(C + 8) R + Y (N - 1) + F + K + 6R = X'''$

Reader: $(C + 4) R + Y (N - 1) + F + K + 6R = X'''$

Where: N = Number of records per block

C = Data characters per record including HT and escape sequences

R = Transmission rate

2000 BPS . . . 6 Bit - 3.0 MS/Char
8 Bit - 4.0 MS/Char

2400 BPS . . . 6 Bit - 2.5 MS/Char
8 Bit - 3.33 MS/Char

4800 BPS . . . 6 Bit - 1.25 MS/Char
8 Bit - 1.67 MS/Char

K = Line turnaround = 300 MS @ 2000 bps (2 Wire)
58 MS @ 2400 bps (4 Wire)
0 MS @ 4800 bps*(4 Wire) (See Note)

Y = Cycle Time for I/O component

Printer: 39 Char. Set = 200 ms
47/52 Char. Set = 250 ms
63 Char. Set = 300 ms

Punch: 6.25 ms X P + 160 ms = Cycle Time
P = Number of characters punched

Reader: 150 ms

F = CPU process time

Note: The line turnaround times shown are approximate and are intended to be used as a guide only. The actual time will vary with the transmission facilities used (communication line, data set, line length, etc.). This formula does not apply when the EBCDIC Transparency or Synchronous Clock special feature is used.

* Should be verified by modem supplier.

Figure 7. Throughput Formula

are satisfied, cards will be fed until a card is registered at the read or punch station.

Card Reading

A card read/punch ready condition, a result of operation of the start key in transmit mode, causes the Binary Synchronous Adapter to bid for the line. Once the line is secured, I/O buffer controls card reading. Variable-Record Reading (a standard feature of the 2780) increases the throughput rate by allowing the transmission of short card records. When an EM (End-of-Media) character is read from a card, it prevents further reading of that card. This eliminates the transmission of space characters representing the remaining blank columns of the card. The EM character is transmitted and punched, but not printed, at the receiving terminal.

The receipt of a short card record causes the receiving punch to feed another card immediately, which results in increased punch throughput. Therefore, using the EM (end-to-end) control character to indicate the end of a short card record results in both increased transmission efficiency and increased card punch throughput (see discussion of EM in the "Data-Link and End-to-End Control Characters" section of this manual).

An ETX character in a card record provides the same function as EM; however, the ETX results in ending the transmission and deselection of the card read/punch. If neither an EM nor ETX character is part of the card record, 80 columns will be read. Card reading continues until all cards in the transport have been read, or until an ETX is read from a card. The last card will be moved automatically to the stacker and the card read/punch will become not-ready.

The following checks are made during a card read operation:

- All characters transferred to buffers are checked for odd parity. Even parity turns Parity Check indicator light on.
- Each column of the card is checked for multiple punches in punching positions 1 through 7. Data Check and Equipment Check indicator lights turn on if multiple punches are detected.
- The US, ETB, NAK, ENQ, AND EOT data-link control characters should not be punched in the card. If the US or ETB character is detected, the Data Check indicator lights turn on. If the NAK, ENQ, or EOT character is detected, the Data Check and Equipment Check indicator lights turn on.

Card Punching

A card read/punch ready condition, a result of operation of the start key in receive or punch mode, allows the Binary Synchronous Adapter to respond positively to a line bid by a remote terminal.

The Binary Synchronous Adapter and I/O buffer control punching. A card record is punched, character by character, until a US, ETB, or ETX character is read from the I/O buffer or until the 80th character has been punched. The US, ETB, or ETX character is not punched. If the record contains more than 80 but less than 170 characters and the 2780 terminal is equipped with Six-Bit Transcode or USASCII, the first 80 characters will be punched and the remainder of the record is lost with no error indication. A record containing 170 characters or more will give an overrun error indication. If the 2780 terminal is equipped with EBCDIC and the record contains more than 80 characters, the

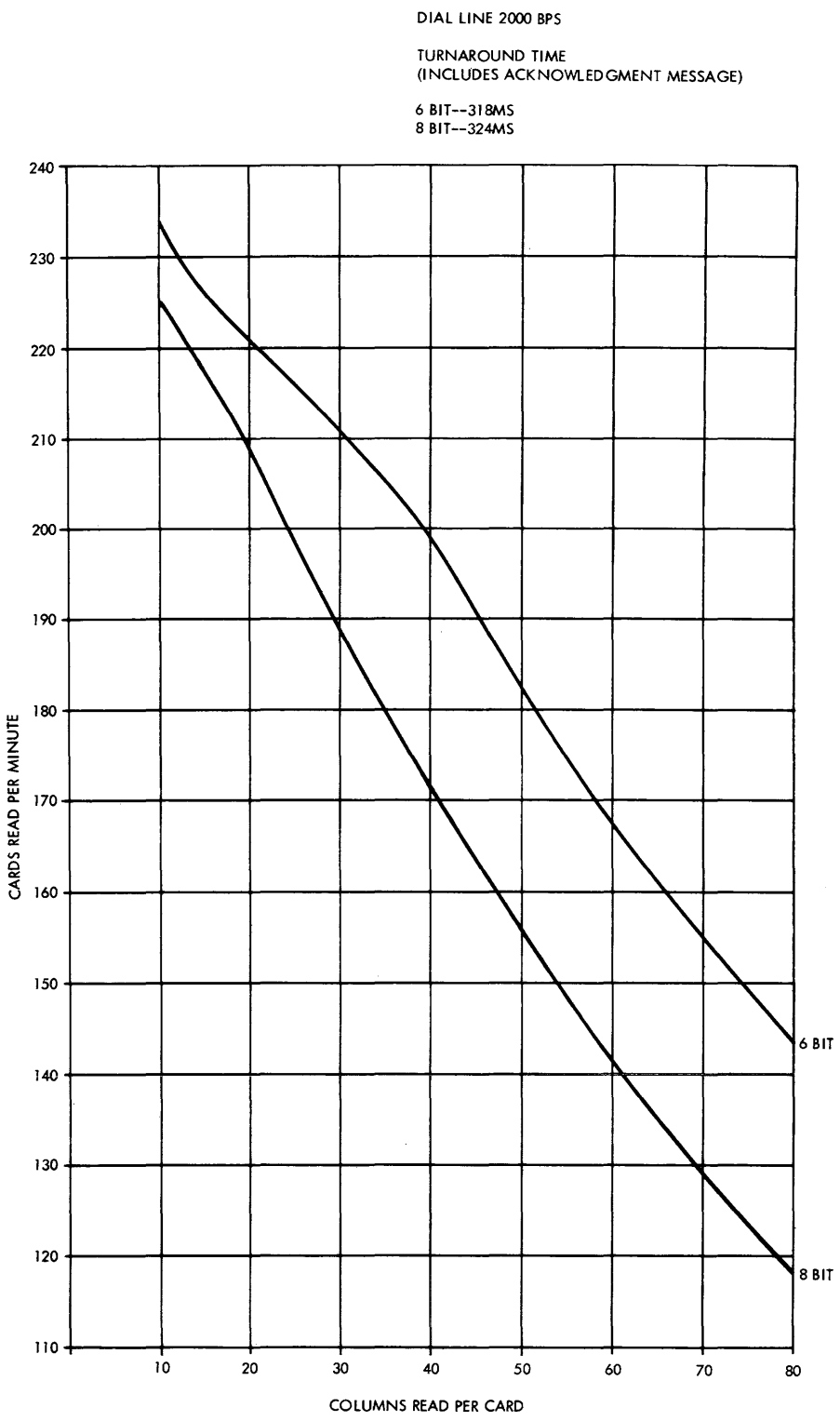



Figure 8. IBM 2780 Card Reader Approximate Throughput Rate--Dial Line (See NOTE in Figure 7)

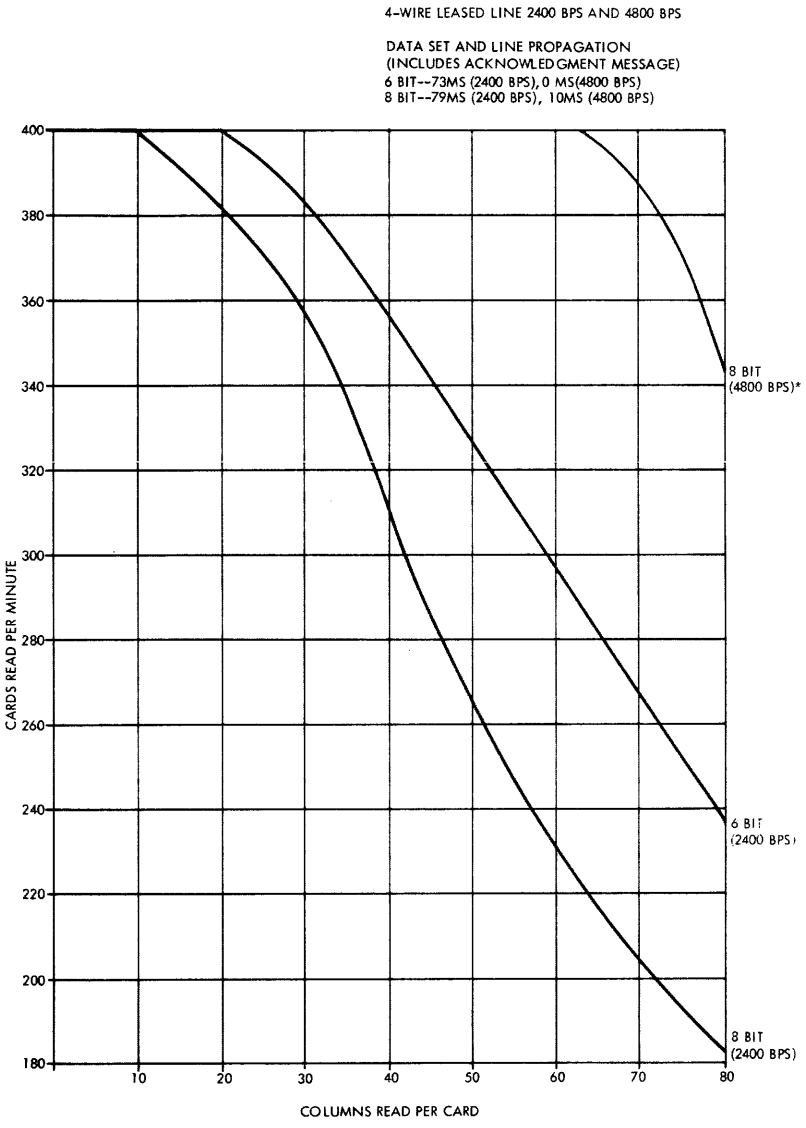



Figure 9. IBM 2780 Card Reader Approximate Throughput Rate--Four-Wire Leased Line (See NOTE in Figure 7)

2780 terminal will attempt to punch the record but will generate parity checks, send an EOT response to the last block checking character, and sound the audible alarm. Punching will be suspended for the remainder of the card (short card record) when the EM (End-of-Media) control character is received. The EM character is punched, the card is released immediately from the punch station, and another card is fed (see discussion on card reading and EM under End-to-End Control Characters in the "Data-Link and End-to-End Control Characters" section of this manual).

## Reader and Punch Checking

### Reader Checking

When reading cards, the following not-ready conditions and reader checks result in transmitting an STX ENQ sequence:

- Card read/punch not ready
- Operation of the stop key
- Feed clutch--extra feed cycle
- Equipment check
- Data check

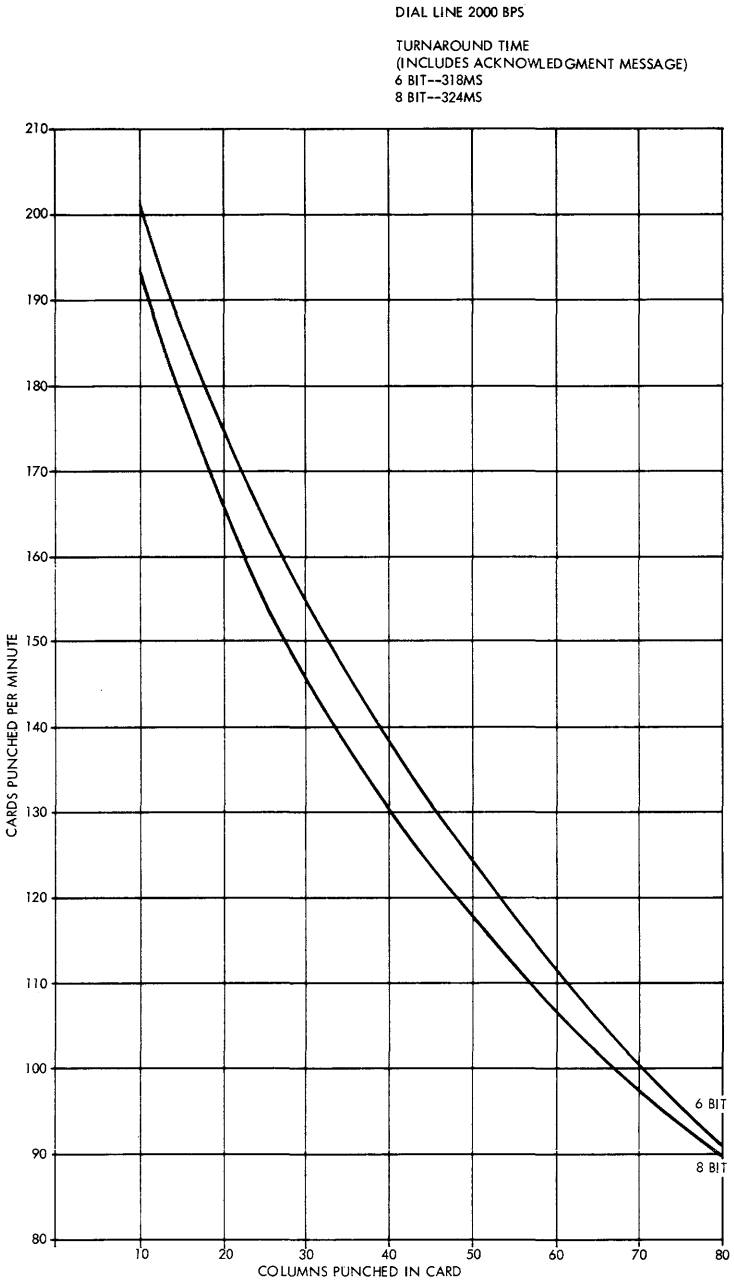


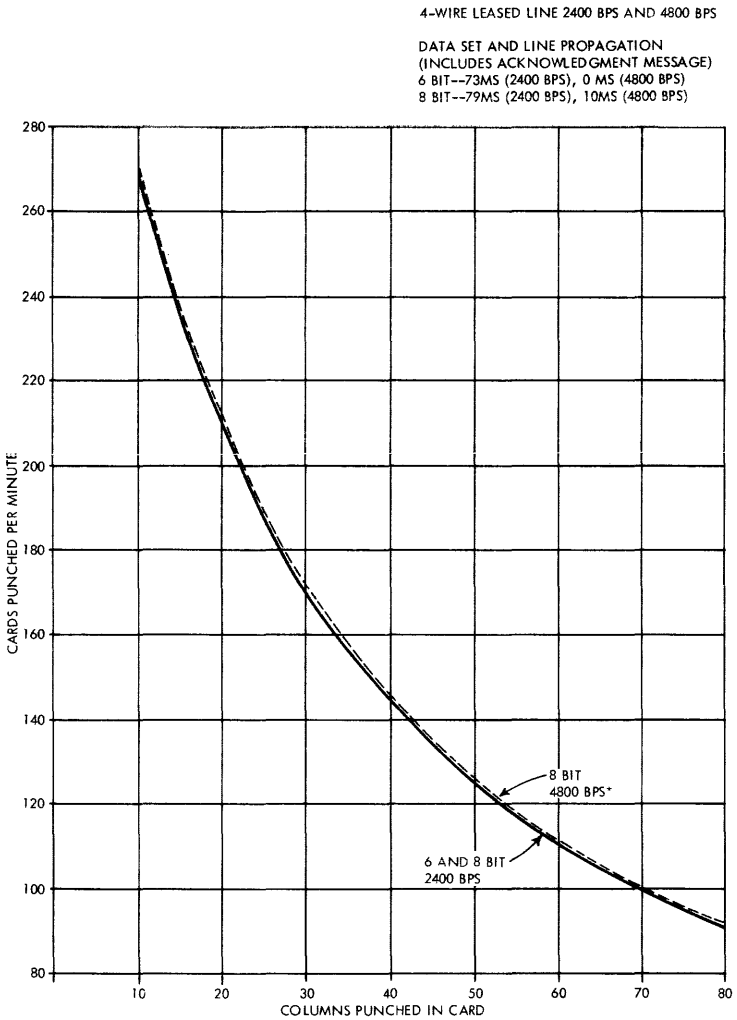

Figure 10. IBM 2780 Card Punch Approximate Throughput Rate--Dial Line (See NOTE in Figure 7)

Hopper feed failure
Read-station jam or defective photo transistor
Stacker full
Chip box full or not in position
Misfeed or jam at the punch station, or a transport jam
Hopper empty after last card is transmitted and End of File key not operated

Punch Checking

When punching, the following not-ready conditions and punch checks are considered as I/O checks and result in an EOT response to a block-check sequence:

Hopper feed failure
Read-station jam
Misfeed or jam at punch station




See NOTE in Figure 7 and NOTE under "Multiple-Record Transmission" in the "Special Features" section of this manual.

Figure 11. IBM 2780 Card Punch Approximate Throughput Rate -- Four-Wire Leased Line

Card jam in the transport
Feed clutch--extra feed cycle
Invalid combination of punches
Punch echo check
Card read/punch not-ready
Operation of the stop key
Hopper empty
Stacker full
Chip box full or not in position

## BUFFERS AND CONTROL CIRCUITRY

The control circuitry of the IBM 2780 Data Transmission Terminal is located in the base of the I/O units (card read/punch and printer). The control circuitry contains the electronic circuitry for encoding (generating) data-link control characters and controlling the terminal operation. The control unit also provides two buffers (line and I/O) for the terminal. Using two buffers enables the read, punch, and print operations to be executed without holding up the communications line.

### Line Buffer

The line buffer is a 400-position, 8-bits-per-position buffer with two address registers. The line buffer will store two maximum-length records, the associated end-of-record character (US, ETB, or ETX), and the component-select or carriage-control sequence.

NOTE: Although the line buffer contains 400 storage positions, not all positions are usable unless the Multiple-Record Transmission special feature is installed (see "Special Features").

### I/O Buffer

The I/O buffer is a 200-position, 8-bits-per-position buffer with one address register. The I/O buffer will

store one maximum-length record (transmit or receive) and the associated end-of-record character (only if the punch is selected).

## Buffer Operation

### Transmit

After the communications path has been established, the first card (record) is read. Reading of the card data continues until an EM, an ETX, or column 80 is loaded into the I/O buffer. The record is then transferred to the line buffer. The data transfer terminates after an EM or ETX character, or after 80 characters. Following an EM character, or column 80, a US character is inserted into the line buffer. Recognition of the US or ETX character will advance the input counter.* Following the US character, the second card is read, data is transferred to the line buffer, and the input counter is advanced to 2. A third card will be read and loaded into the I/O buffer. However, because the input counter is at 2, no transfer will occur. Recognition of an ETX causes reading to be suspended.

Data is loaded into consecutive addresses of the line buffer. When the input counter is advanced following completion of the transfer, data transmission begins. Recognition of a US or ETX character when transmitting causes the output counter to advance. If the counters are equal, transmission is suspended until the second data transfer is complete from the I/O buffer to the line buffer. The first character of the second record is loaded into the address immediately following the last character of the first record.

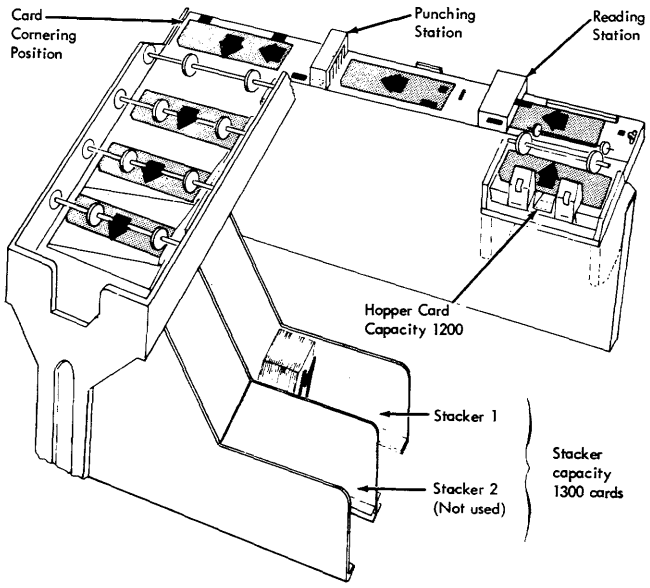



Figure 12. IBM 2780 Card Feed and Punch Schematic

When the input counter is advanced to 2, data transmission is continuous until a US or ETX character is recognized. The recognition of US or ETX causes the output counter to advance to 2. With the input counter and output counter equal (2), the US character will be changed to ETB unless an end-of-file (EOF) condition exists, in which case the US is changed to ETX. A NAK response to the block-check sequence causes the output counter to be reset, and a retransmission to occur. The proper DLE response resets both the input and output counters and card reading continues.

### Receive

As the first record is received at the receiving terminal, the data after the STX character (up to and including the US character) is loaded into the line buffer. If the record is good, the input counter is advanced. The data of the second record is loaded up to and including the ETB or ETX and the input counter advanced if the record is good.

When the input counter is advanced to 1, the record is transferred to the I/O buffer. If the first character is an ESC character, the ESC and the following character are removed from data. Upon recognition of the US character, the transfer is terminated and the output counter advanced. If the punch is selected, the US (or ETB or ETX) control character is loaded into the I/O buffer. If the printer is selected, space characters will automatically be inserted in the remainder of the buffer. When the I/O operation is complete and the counters are unequal, the second record is transferred to the I/O buffer. The recognition of an ETB or ETX causes the transfer to be completed, the output counter to be advanced, and the space characters to be inserted if the printer is selected. With the input and output counters at 2, the terminal responds with a DLE 0 or DLE 1 and resets the counters.

The input counter is not advanced on an error record. Therefore, the record is not transferred to the I/O buffer or outputted to an I/O device. If the first record of a transmission block is in error, the input counter is not advanced, and the following record is ignored. The terminal will respond with NAK. If the first record is received correctly, the input counter is advanced, and the record transferred and outputted. If the second record is in error, the input

* The buffer circuitry includes two line-buffer counters (input and output). The input counter is advanced 1 after each record is transferred from the I/O buffer to the line buffer. The output counter is advanced 1 after the complete record is transmitted from the line buffer. Since two records comprise a block, the counters will never advance beyond 2 (normal operation).

counter is not advanced and the terminal responds with a NAK. The NAK response resets only the input counter. Both records of the retransmission must be received correctly for the second (error record) to be outputted. Receipt of the first record correctly causes the input counter to advance to 1. Since the output counter is also equal to 1, no transfer will occur. With both records received correctly, the input counter will have advanced to 2, a transfer will occur, and normal operation follows.

Buffer Checking

Buffer checking depends on the transmission code:

- With the USASCII code, an odd vertical redundancy check (VRC) is performed on all data entering or leaving the buffers.

- With the Six-Bit Transcode, an odd vertical redundancy check (VRC) bit is generated for each character that enters the line buffer or the I/O buffer. As data is read from the buffers, it is checked for parity.

- When the EBCDIC code is used, a modified longitudinal redundancy check (LRC) is performed. As a record enters a buffer, an odd/even bit count is generated. Following the ETX, ETB, or US character, a character of all 0 (zero) bits is written if the number of bits in the record is even, or a character of all 1 bits if the number of bits in the record is odd. As the record is read from the buffers, the odd/even bit count is generated again and compared with the all-0 or all-1 character. Failure to compare is indicated as a buffer parity check.

In addition to the above checking, the line buffer is checked when transmitting and receiving to determine that the buffer capacity has not been exceeded. Also, a check is made to determine that no more than two records per block are received on a standard machine, or no more than seven records on a machine equipped with the Multiple-Record Transmission special feature. These conditions are indicated as overrun. The I/O buffer is checked to determine that address 170 has not been reached. If address 170 has been used, it is indicated as an overrun condition.

## PRINTER

The 2780 print unit (see Figure 1) provides printed output for the terminal when operating on-line, and enables a card reader-to-printer listing operation to be performed when operating off-line. The print unit is similar in appearance and operation to the IBM 1443 Printer used in data processing system configurations. The maximum rated speed of the printer is 300 lpm (lines per minute). However, the actual speed depends on the communication facilities used and the number of characters in the character set being used:

39-character set--300 lpm
47/52-character set--240 lpm
63-character set--200 lpm

Figure 7 shows the formula for calculating the terminal throughput rate in either lines per minute or cards per minute. Figures 13 and 14 show the approximate printer throughput rate for both dial and leased lines by code.

The basic 2780 terminal has a maximum print speed of 240 lpm and a print cycle of 250 ms. The actual print time required is 198 ms--the remaining 52 ms being used to move the paper forms and restore the print hammers. Skips or line spaces greater than two single spaces take an additional 10 ms per line. Normal forms movement takes place during the last 24 ms of each printing cycle, and two lines can be spaced during this period of time. Each additional line requires another 10 ms. This speed is equivalent to approximately 15 inches per second.

The standard printer can print 80 positions on one line. Both 120 and 144 positions are also available as special features (see "Special Features" section in this publication). All print positions will print all characters of the character set being used. Character density is 10 per inch, thereby providing a printing line of 8, 12, or 14.4 inches.

NOTE: All data to be printed that exceeds the capacity of the printer (80, 120, or 144 print positions) will be lost with no indication unless the record contains more than 170 characters, in which case the terminal will give an overrun error indication. If the Horizontal Format special feature is used, the 80, 120, or 144 print positions include the print positions involved in the tab functions.

All characters of the character set are mounted on a typebar that travels horizontally on the paper. The typebar ensures that each character of the character set successively passes each print position. To print, a magnet releases a spring-loaded hammer at the proper time so that the desired character is pressed against the ribbon and paper. Characters to be printed are checked for parity while in the buffer. A parity-check error at the receiving terminal results in an EOT (end-of-transmission) character being encoded in place of the normal block-checking response. This may result in a partially-printed line depending upon when the error was detected.

Character Sets

The character sets available for the print unit depend on the type of transmission code used with the system.

A 63-character set (plus space) is provided with the USASCII code; however, the Selective Character Set special feature is a prerequisite (see "Special Features"). The standard EBCDIC character set includes 52 printable characters. A 63- or 39-character set is also available as a special feature. The standard Six-Bit Transcode character set includes 47 printable characters. A 39-character set is also available as a special feature (see Figure 15).

All printable character sets for the print unit include the alphabetic characters A through Z and numeric characters 0 through 9.

## TAPE-CONTROLLED CARRIAGE

The IBM 2780's tape-controlled carriage operates similarly to the IBM 1443 Printer tape-controlled carriage. The carriage movement is initiated by a two-character sequence code; however, if no specific spacing instruction is received, the carriage automatically single spaces after printing.

The operator manually sets vertical line spacing for either six or eight lines to the inch. This is accomplished by raising the safety cover and then pushing the tension-lock release lever to the rear (see Figure 20). The belt can now be shifted from one set of pulleys to the other set. The inner pulley set delivers eight lines per inch; the outer set, six lines per inch. After shifting the belt, press down on the tension lever to restore belt tension, and then latch the safety cover.

Individual two-character sequence codes for controlling the spacing and skipping operations of the carriage permit flexibility of form design. Figure 16 gives the two-character sequence code for each operation, by transmission code. The overflow operation from form to form (channel 12 to channel 1) after printing is automatic and requires no instruction code.

The paper form is positioned manually, at the beginning of the operation, to receive the first line of print. Thereafter all spacing and skipping is controlled by the two-character spacing and skipping codes received by the terminal. Interlocks prevent printing while the carriage is in motion (skipping within the form and overflowing to the next form); therefore, no characters need be inserted in the

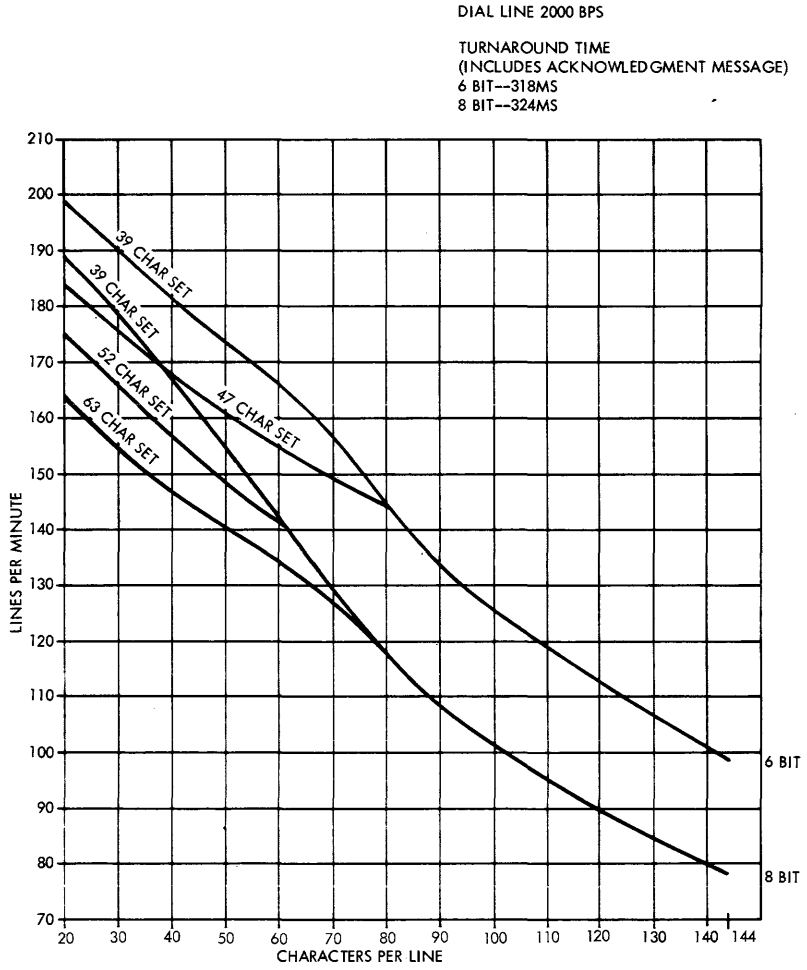



Figure 13. IBM 2780 Printer Approximate Throughput Rate -- Dial Line (See NOTE in Figure 7)

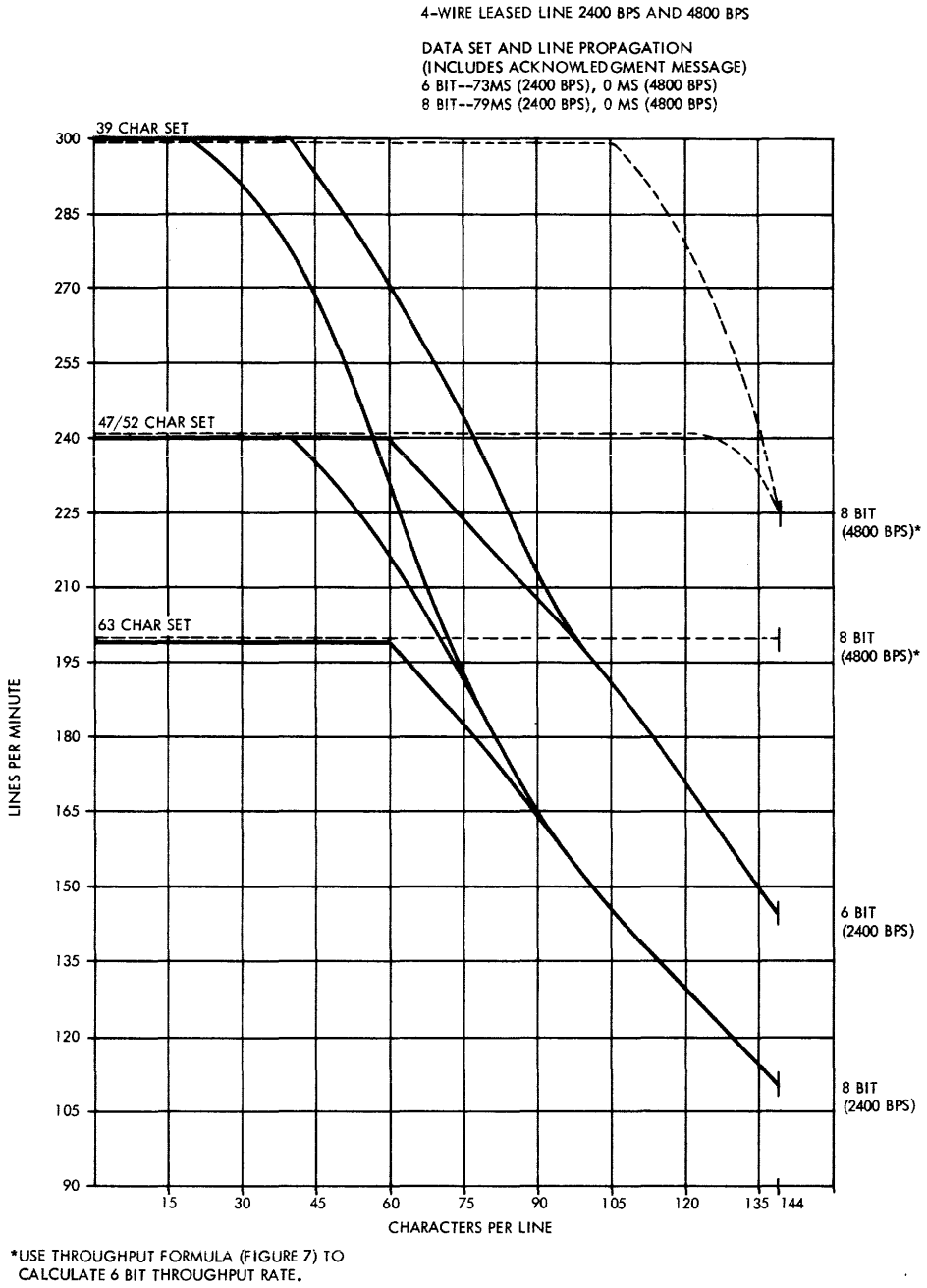



Figure 14. IBM 2780 Printer Approximate Throughput Rate -- Four-Wire Leased Line (See NOTE in Figure 7)

message to compensate for the time involved in the skipping or overflow operation. (See "ESC (Escape)" under "End-To-End Control Characters" in the "Data-Link and End-To-End Control Characters" section of this manual.

## Carriage-Control Tape

The carriage-control tape (see Figure 23) has 12 columnar positions indicated by vertical lines. These positions are called carriage-control channels. Channels 1 through 8 are used when skipping within the form, and channel 12 is used when overflowing from form to form. Channels 9, 10, and 11 are not used.

Holes can be punched in each channel throughout the length of the tape. A maximum of 132 lines can be used to control a form, although for convenience the control tape is slightly longer. Round pre-punched holes in the center of the tape are engaged by the

| USASCII | EBCDIC | | | Six-BIT Transcode | |
|---|---|---|---|---|---|
| 63* | 63 | 52* | 39 | 47* | 39 |
| ¬ | ¬ | | | | |
| " | " | | | | |
| : | : | | | | |
| . | . | . | . | . | . |
| $ | $ | $ | $ | $ | $ |
| ' | ' | ' | ' | ' | ' |
| # | # | # | | # | |
| < | < | ¤ | | ¤ | |
| * | * | * | | * | |
| % | % | % | | % | |
| @ | @ | @ | | @ | |
| ( | ( | ( | | | |
| ) | ) | ) | | | |
| ¬ | ¬ | | | | |
| - | - | - | | | |
| + | + | + | | | |
| ; | ; | | | | |
| ≡ | ≡ | = | | | |
| ⌐ | ¢ | | | | |
| ⌐ | | | | | |
| ? | ? | | | | |
| & | & | & | | & | |
| - | - | - | | - | |
| / | / | / | | / | |
| > | > | | | | |
| \ | \| | | | | |

* Standard Bar

Figure 15. Special Characters Printed in Each Character Set

pin-feed mechanism, which advances the tape synchronously with the movement of the printed form through the carriage. Once one of the two-character sequence codes initiates a carriage-skip operation; for example ESC B (see "End-to-End Control Characters" in the "Data-Link and End-to-End Control Character" section of this manual) sensing a hole punched in tape channel 2 will stop the skip operation.

Punching the Tape

A small compact punch (Figure 17) is provided for punching the tape. The following steps should be used to punch the tape:

1. Lay the tape beside the left edge of the form it is to control with the top line (immediately under the glue portion) even with the top edge of the form.
2. Mark the tape in the first channel on the line that corresponds to the first printing line on the form.
3. Make additional marks in the appropriate channels for each of the other skip stops and for the overflow signal required for the form.
4. Repeat steps 1 thru 3 as many times as the usable length of the tape (22 inches) allows.
5. Mark the line corresponding to the bottom edge of the last form.

| USASCII | EBCDIC and Six-Bit Transcode | Carriage Operation after Printing |
|---|---|---|
| ESC Q | ESC / | Single Space |
| ESC R | ESC S | Double Space |
| ESC S | ESC T | Triple Space |
| ESC A | ESC A | Skip to Channel 1 |
| ESC B | ESC B | Skip to Channel 2 |
| ESC C | ESC C | Skip to Channel 3 |
| ESC D | ESC D | Skip to Channel 4 |
| ESC E | ESC E | Skip to Channel 5 |
| ESC F | ESC F | Skip to Channel 6 |
| ESC G | ESC G | Skip to Channel 7 |
| ESC H | ESC H | Skip to Channel 8 |

Figure 16. Two-Character Sequence Code for Each Operation

6. For each line marked for punching:
   a. Insert the tape in the punch by positioning the line to be punched over the guide line on the base of the punch and placing the center feed holes of the tape over the pins projecting from the base.
   b. Position the indicator or dial to the number of the channel to be punched and press on the top of the punch (towards the back).

NOTE: Never punch the tape more than one channel per line.

After the tape is punched, cut and loop it into a belt. Glue the bottom end to the top section (marked "glue") so that the bottom line coincides with the top line. Before the tape is glued, the glaze on the tape should be removed by an ink eraser to ensure a strong bond between the two tape surfaces. The center feed holes should coincide when the two ends of the tape are glued together.

The last hole punched in the tape should be at least four lines from the cut edge because approximately the last half inch of the tape overlaps the glue section when the two ends are spliced. If it is necessary to punch a hole lower than four lines up from the bottom of the form, the tape should be placed with the top line (immediately under the glue portion) four lines lower than the top edge of the form before marking the channels. To compensate for the loss, the tape should then be cut four lines lower than the bottom of the edge of the form.

Inserting the Tape in the Carriage

The following steps should be used to insert a carriage-control tape:

1. To gain access to the tape-reading mechanism (Figure 19), press up on the cover release latch and raise the counter-balanced cover of the printer.
2. Turn the manual clutch knob to disengage the clutch.
3. Raise the carriage brushes by lifting the latch located on the side of the carriage brush holder.
4. Place one end of the tape loop (held so that the printed captions can be read) over the pin-feed drive wheel so that the pins engage the center drive holes.
5. Place the opposite end of the loop around the adjustable carriage control tape idler.
6. Remove the excess slack from the tape by loosening the locking knob on the idler and moving the idler in its track. Tighten the knob when the desired tension is reached. The tape should be just tight enough so that it gives slightly when the middle portions of the loop are pressed together. If it fits too tightly, damage can occur to the pin-feed holes.
7. Press the brushes into operating position until they latch and close the printer cover when the tape is in position.
8. Press the Carriage Restore key to bring the tape to its home position and turn the manual clutch knob back to the engaged position. The carriage is now ready to operate.

## Paper Forms

The forms used must be designed for use with a tractor feed (Figure 18). Therefore, the forms must be continous with feed holes on both sides. No provision is made for pressure feeding of forms. The maximum form width recommended is 16-3/4 inches and the minimum 4 inches.

## Carriage Controls and Switches

### Clutch Knob

The manual-clutch knob (Figure 18) controls the carriage-tape drive and the form-feeding mechanism. The clutch knob has two settings, OUT and IN. The OUT position disengages the feed clutch so that the form does not move with the carriage drive. The IN position engages the clutch so that the form is moved in synchronization with the carriage tape.

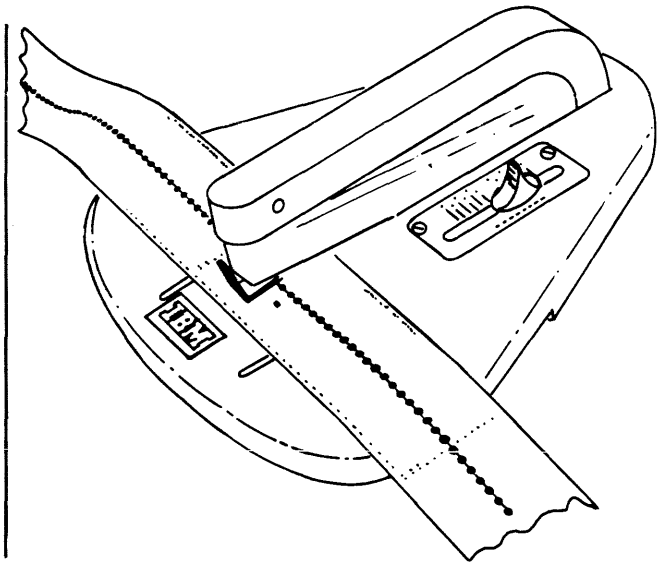


Figure 17. Tape Punch

NOTE: Overprinting will occur if the clutch knob is left in the OUT position.

### Typebar Motor Switch

This switch, mounted under the top cover and near the typebar drive, has three positions: ON, OFF, and TYPEBAR REMOVAL (Figure 19). The OFF position turns off the ribbon and typebar motors and de-energizes the solenoid in the typebar drive unit.

The TYPEBAR REMOVAL position turns off the ribbon and typebar motors but leaves the solenoid energized to permit easy operation of the typebar drive handwheel. Use this position when removing or installing a typebar.

CAUTION
Always remove the typebar before replacing the ribbon. Do not turn this switch to OFF or to TYPEBAR REMOVAL while the typebar is in motion.

### Paper Brake

This control is located on the left side of the lower forms guide (Figure 20). It maintains a horizontal print line. It has six positions: 0 through 5. Turn the adjusting control clockwise to increase the amount of drag the brake fingers exert on the form. Excessive pressure results in tearing the forms. Too little pressure can result in a wavy line of printing or in unequal spacing.

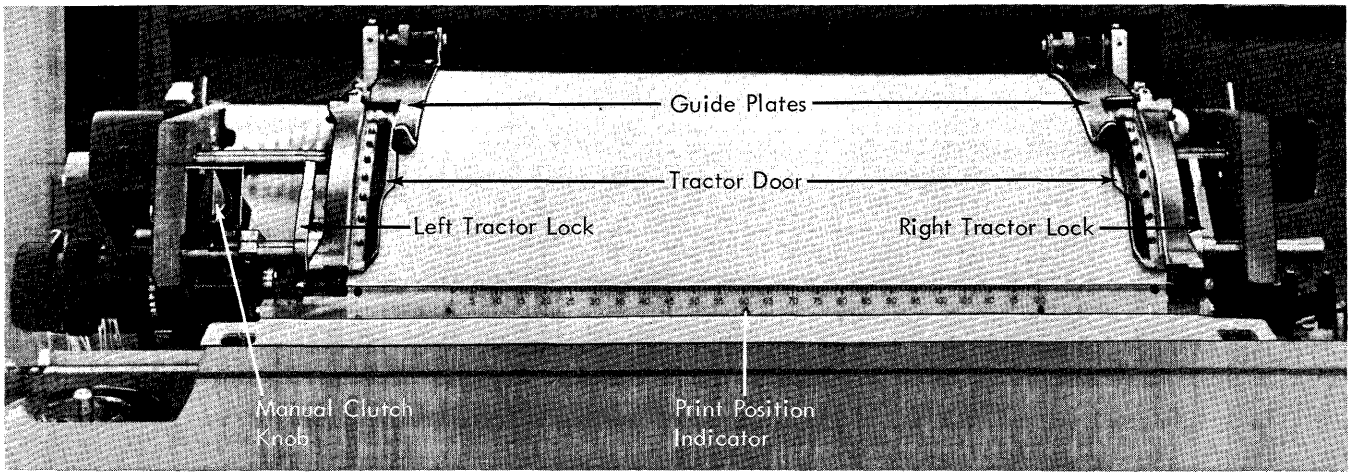



Figure 18. Tractor Feed

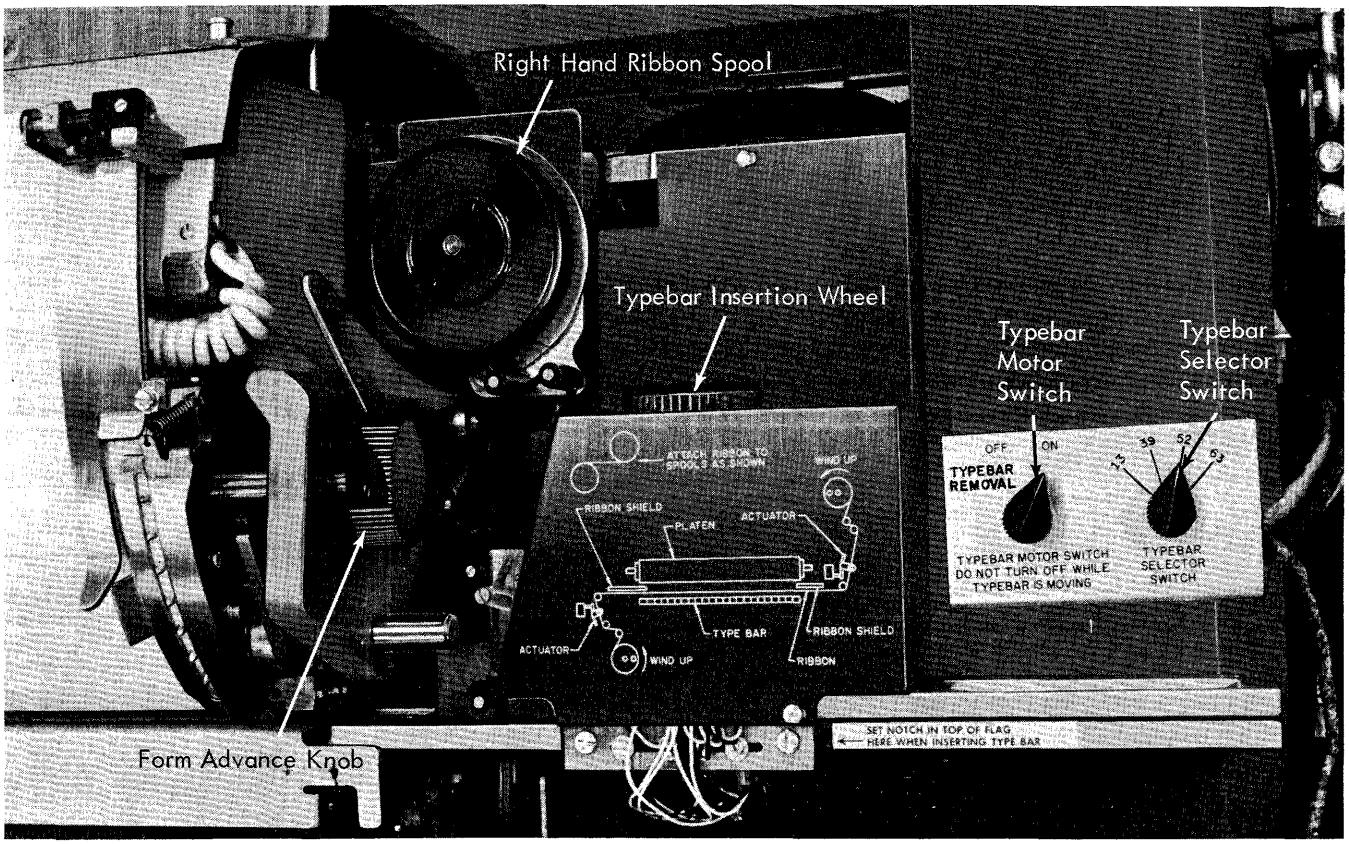



Figure 19. Printer Right-Hand Controls

Suggested paper-brake settings are:

1-part form, 1-1/2 or 2 drag setting;
2-part form, 1-1/2 or 2 drag setting;
4-part form, 2-1/2 or 3 drag setting;
6-part form, 2-1/2 or 3 drag setting.

When forms are inserted into the lower forms guide, fully retract the brake fingers by turning the control as far as possible and locking it.

Typebar Insertion Wheel

This wheel is located on the right side of the carriage and on the upper rear of the typebar drive unit (see Figure 19). Manually rotating the wheel positions the typebar. Use it when inserting or removing a typebar in the printer. With the power on and the typebar motor switch set to the REMOVAL position

to energize the typebar solenoid, the typebar can be removed or replaced. Then turn the typebar insertion wheel until the notch on the typebar flag of the 39-, 47-, 52-, or 63-character typebar is aligned properly to the decal. Be careful to avoid damage to the typebar.

When a typebar has been changed, press the printer reset key before the start key to prevent a Sync-Check indication.

### Forms Thickness Adjustment

The platen-positioning knob (see Figure 20) can adjust the platen toward or away from the typebar to compensate for the number of carbon copies used.

The adjustment is made through a knob and detent combination below the left end of the carriage. Control setting 3 is the standard position for the average one-part form of regular-weight paper. For increasing thickness the knob should be turned counterclockwise.

The control provides sixteen positions. To insert a new form, the control should be turned fully counterclockwise, then readjusted before printing is started.

Suggested platen settings are:

| Form | Setting # |
|---|---|
| 1-part form, 0.002-0.005 inch thick | 3 |
| 2-part form, 0.006-0.012 inch thick | 4 or 5 |
| 4-part form, 0.014-0.026 inch thick | 6, 7, 8, 9, or 10 |
| 6-part form, 0.022-0.030 inch thick | 8, 9, 10, or 11 |
| Regular card stock, 0.007-0.015 thick | 6 |

### Typebar Selector Switch

This rotary switch (see Figure 19) should be set to the position that corresponds with the typebar character set being used. Position 52 is used for both the 47 and 52 character set, and position 13 is not used by the 2780.

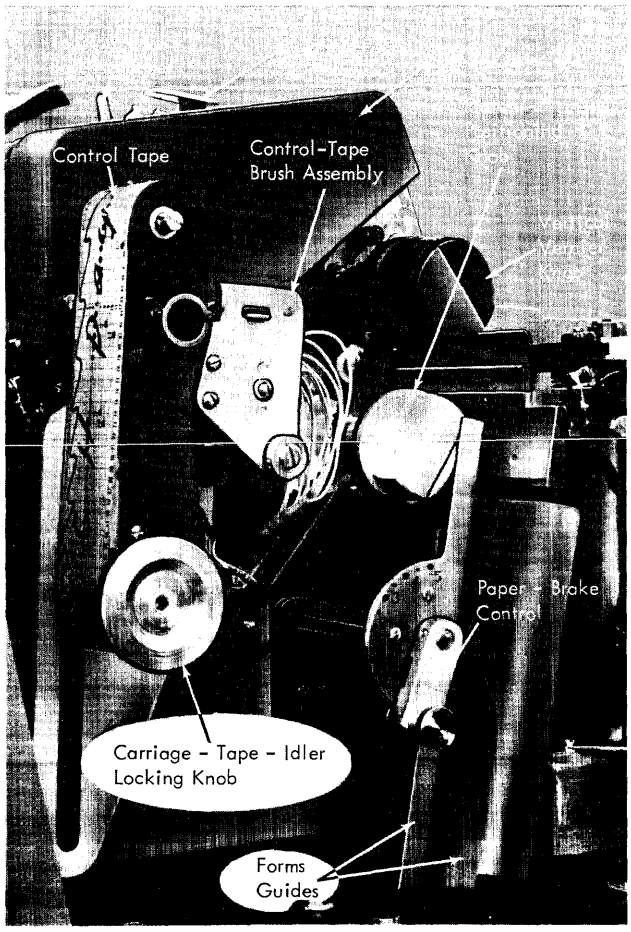



Figure 20. Printer Left-Hand Controls

### COMPONENT SELECTION, BASIC TERMINAL (CONTENTION)

When the mode switch is set to the REC (Receive) position, a two-character sequence, ESC plus a component-selection code controls selection of the output unit (punch or printer). This sequence must be the first two characters following the STX or US character and must appear in the first record of a transmission, as shown in the following example:

| | | | | | | |
|---|---|---|---|---|---|---|
| S S E<br>Y T S<br>N X C | ? | Text | U<br>S | Text | E<br>T<br>B |

The component selection sequence is removed from the message at the receiving terminal and is neither printed nor punched. Component selection sequences removed from the message do not create blank print positions or blank columns in the card. This fact should be considered when designing print forms and cards to be used in the system. No further selection is required throughout the transmission until the selection of another output unit is desired. The following sequences select output units:

| | | |
|---|---|---|
| ESC | 4 | Punch |
| ESC | (Note) | Printer |

If the mode switch is set to the Punch or Print position, no component selection sequence is required. However, if a component selection sequence is received when the mode switch is set to Punch or Print, the selection sequence is removed from the data, the same as when the mode switch is set to Receive.

NOTE: The character following the ESC for printer selection can be any printer control character, such as a / (print and single space), or A (print and skip to 1) (See "Tape-Controlled Carriage" section in this manual). If an invalid two-character sequence is received, it is either ignored or an erroneous output component function control is initiated, depending on the specific character following the ESC character.

When the Multipoint Line Control special feature is used, basic component selection (ESC plus follower code) is inoperative. The address sequence of the feature controls selection of the output unit (see "Multipoint Line Control" in the "Special Features" section of this manual).

If one output device is ready and the other not-ready at the receiving terminal, an EOT is sent as a reply to block checking if the not-ready device is selected. If both devices are ready, but neither one is selected, an EOT is sent as a block-check response.

With the Multipoint Line Control special feature, the Mode switch functions are modified so that they merely define the I/O units that can be operated.

The IBM 2780 Data Transmission Terminal uses the Binary Synchronous method of transmission. This transmission method is a general-purpose data-link (line) control procedure for executing half-duplex, digital, serial, synchronous (by bit and by character) communication between two or more stations on a point-to-point or multipoint communications lines.

## DATA-LINK CONTROL CHARACTERS

Ten basic data-link control characters control the contention for the line, transmission of data, and termination of transmission operations for the system. The same basic data-link control characters are used regardless of the type transmission code that is used (Six-Bit Transcode, EBCDIC, or USASCII).

The ten basic data-link control characters are: SYN, ENQ, STX, US, ETB, ETX, DLE, SOH, NAK, and EOT. Because headings are not used by the IBM 2780, SOH (Start of Heading) character is not used. However, to allow operation on the same line with a terminal using headings, the 2780 accepts an SOH character as an STX (Start of Text) character. All data-link control characters are automatically encoded by the 2780 control unit and are not required in the input media. The data-link control characters are also removed from the transmitted data by the receiving terminal.

### SYN (Synchronous Idle)

The IBM 2780 uses the SYN character to establish character-phase synchronism between the transmitting and receiving terminals. Three SYN characters (or 7 if the Synchronous Clock special feature is installed) will precede any 2780 transmission. A minimum of two SYN characters are required to obtain synchronization when in receive mode. When using Six-Bit Transcode and biding for the line (point-to-point operation), the two SYN characters and the ENQ character must be contiguous.

### ENQ (Enquiry)

The ENQ character is used to request a response, to request terminal status (such as readiness to receive), or to indicate an I/O error when transmitting. The ENQ can also be used to obtain a repeat transmission of a reply in the event one was not received when expected.

### STX (Start of Text)

The STX character precedes a sequence or block of text characters and signals the receiving terminal that the text portion of the message will follow. Leading graphics, received from another binary synchronous device using the Terminal Identification feature and received prior to the receipt or transmission of the first block of text by the 2780, are acceptable to the 2780 (except Six-Bit Transcode), but ignored as data.

### ITB (Intermediate Block Check)

The ITB character (shown in the Six-Bit Transcode and USASCII code charts as US, Unit Separator, and in the EBCDIC code chart as IUS, Information Unit Separator) is automatically encoded by the control unit at the end of each record except the last record in the block of transmitted text. The ITB character allows the first record in the block to be checked at the receiving terminal without causing a line turnaround and an answerback to the transmitting terminal.

### ETB (End of Transmission Block)

The control unit automatically encodes the ETB character at the end of the last record of a block of transmitted text. However, the ETB character is not encoded for the last block of a message.

Each block of data within the message is identified by the STX character at the beginning and the ETB character at the end. However, the last message block is identified by the ending character of ETX. The ETX character signifies the last block of data within the message has been transmitted or received.

The ETB character causes checking with a line turnaround and a response. If retransmission is required, all data framed by the ETB character and the previous STX character, including these two characters, is retransmitted.

NOTE: When the EBCDIC code is used, the data-link control function of ETB is performed by the EOB character.

### ETX (End of Text)

The control unit automatically encodes the ETX character at the end of the last record in a message, provided the end-of-file key was operated. An ETX

can also be punched in the last card of a group of cards to be transmitted. The ETX character causes checking with a line turnaround and a response to take place. If retransmission is required, all the data between the ETX character and the previous STX character, including the STX and ETX characters, is retransmitted. A positive response to an ETX block check causes the transmitting terminal automatically to encode an EOT character, relinquish the communications line, and turn on the audible alarm.

DLE (Data-Link Escape)

The DLE character preceding a character alters the meaning of that character, thus providing additional controls. The DLE control character is not included in the block-check accumulation except under the following conditions:

Normal Mode

- If DLE is in the middle of a record.

Transparent Mode

- If DLE follows a US sequence;
- If DLE follows an SOH character;
- If DLE follows another DLE character.

ACK 0 and ACK 1 (Positive Acknowledgment)

The ACK 1 (odd) and ACK 0 (even) control characters are represented in the 2780 by DLE sequences.

The alternating acknowledgment responses (odd and even) that follow the DLE character are different for each of the three codes that can be used. Figure 21 shows the code representation.

NOTE: Although DLE 0 and DLE 1 are only the USASCII code representation of the ACK 0 and ACK 1 sequences, for ease of reading and illustration they will be used throughout the manual to represent ACK 0 and ACK 1. Also, examples are shown in one-record blocks unless the example requires multiple records for clarity.

The receiving terminal automatically encodes the acknowledgment sequence. This sequence is sent to the transmitting terminal as an affirmative answer to block checking, if the block of data is received correctly. The DLE character is followed by an even or odd code depending on whether the block of data being checked is an odd- or even-numbered block. DLE 1 is transmitted as the affirmative reply for each alternate block in a transmission starting with the first and all successive odd-numbered blocks. DLE 0 is transmitted as the affirmative reply for each alternate block in a transmission starting with the second and all successive even-numbered blocks. The odd/even count maintained by the transmitting station is compared with the digit following the DLE character. The odd/even counts must compare before the block is considered to have been sucessfully transmitted.

The DLE 0 is also used as a response to an initial enquiry (ENQ). Receiving a DLE 0 in response to an initial ENQ character indicates to the transmitting terminal that the terminal selected is ready to receive.

Figure 21 shows the sequences used to represent DLE in the three available transmission codes.

RVI (Reverse Interrupt)

The RVI control sequence is a positive response that is used in place of the DLE 0 or DLE 1 positive acknowledgment. RVI is used when a receiving CPU wishes to terminate the present transmission because of a high-priority message it must transmit. The transmitting 2780 treats the RVI response as a positive acknowledgment and responds by transmitting the remaining record in the I/O buffer followed by the ETX character. Upon receiving a positive acknowledgment to this record, the transmitting 2780 will send the EOT character. At this time the transmitting 2780 printer can be selected to receive and print the priority message.

NOTE: Upon receipt of the RVI response, the transmitting 2780 is expected to terminate the transmission with an EOT immediately or directly after the last record in the I/O buffer is transmitted. The printer must be in a Ready status to receive the incoming message.

Transmission can be reinitiated when operating point-to-point by the receipt of an EOT character, or by pressing the start key; or if in a multipoint environment, by receipt of a polling sequence.

The user may specify an option called Operator Intervention Required to be used with the RVI control sequence. This option prevents the transmission from being automatically reinitiated when a polling sequence or an EOT character has been received following a processor interrupt (RVI control sequence). The transmission can be restarted only by the 2780 terminal operator pressing the Start key. This allows the 2780 terminal operator time to examine a message which may have been sent to the terminal via the application program, and to take appropriate action before restarting the transmission.

Figure 22 shows the sequences used to represent RVI in the three available transmission codes.

| Code | ACK 1 Odd Representation | ACK 0 Even Representation |
|---|---|---|
| EBCDIC | DLE (Hex 61)01100001 | DLE (Hex 70) 01110000 |
| Six-Bit Transcode | DLE T | DLE - |
| USASCII | DLE 1 | DLE 0 |

Figure 21. Code Representation of DLE Character for Each Code

| Codes | | Representation | |
|---|---|---|---|
| EBCDIC | DLE | (Hex 7C) | 01111100 |
| USASCII | DLE | < | |
| Six-Bit Transcode | DLE | 2 | |

Figure 22. Code Representation of RVI for Each Code

NAK (Negative Acknowledgment)

This character is a reply signal and can be sent only by a terminal that is being selected to receive or is already receiving a transmission. It is a negative reply for the last block of text received in the current transmission, or a not-ready-to-receive signal if selected to receive a transmission. A NAK character is recognized as legitimate (except Six-Bit Transcode) only when the first four bits of the following character are all "1" bits (PAD character).

WACK (Wait Before Transmit-Positive Acknowledgment)

The WACK sequence is used when a receiving CPU program responds to an ETB and block-check-character sequence from a transmitting 2780. The WACK sequence informs the 2780 that the data just received by the CPU is correct, but the CPU is not ready to receive additional data at this time. Recognition of the WACK response by the 2780 causes the Line and Record indicator lights to turn on, and an ENQ response to be automatically generated and transmitted to the CPU.

The CPU program will continue to send the WACK sequence in response to each ENQ from the 2780 until the CPU is ready to continue. At this time, a DLE 0 or 1, RVI, or EOT is sent to the 2780. The proper DLE response causes the line and record indicator lights to turn off and the transmission to continue. An RVI response causes the 2780 to terminate the transmission with an EOT immediately or directly after the last record in the I/O buffer is transmitted. An EOT response after a WACK completes the positive acknowledgment of the previous data, but causes an incomplete condition. (INCP light turns on.)

Each WACK response resets the ENQ counter; therefore, the 2780 does not time-out and send EOT after three ENQ's. The WACK sequences that the 2780 responds to are:

| | |
|---|---|
| EBCDIC Code | DLE, |
| USASCII Code | DLE; |
| Six-Bit Transcode | Not Used |

The 2780 does not transmit the WACK character.

EOT (End of Transmission)

The EOT character terminates the current transmission and returns all terminals in the data-link to control mode. When sent by the transmitting terminal, it indicates that the terminal has nothing more to transmit and is relinquishing the communications line. The receiving terminal can send an EOT character instead of a normal DLE 0, DLE 1, or NAK response. The EOT character in this case is an abort signal that terminates the transmission. When sent in response to a polling operation, the EOT character indicates that the polled terminal has no data to transmit or is unable to continue transmission. An EOT character is recognized (except in Six-Bit Transcode) only when immediately preceded by a SYN pattern (SYN SYN EOT PAD), or when immediately preceded by a DLE and followed by a character of which the first four bits must be all "1" bits (PAD character) DLE EOT PAD.

## END-TO-END CONTROL CHARACTERS

Four end-to-end control characters (ESC, BEL, HT, and EM) can be used by a transmitting terminal (2780 or CPU) to control certain functions at a receiving 2780 terminal. Only one of the four end-to-end control characters (EM) can be used when a 2780 terminal is transmitting to a CPU. The function initiated at the receiving 2780 terminal for each of the four end-to-end control characters is as follows:

ESC (Escape)

The ESC character, and the character following, form a two-character component selection control sequence. ESC 4 selects the punch at the receiving terminal. The printer is selected by using the ESC character followed by one of the characters listed in Table II. This two-character printer control sequence not only selects the printer, but also initiates a carriage spacing or skipping operation. The carriage skipping operation, once initiated, is stopped by sensing a hole in the specified channel of the carriage control tape.

Spacing and skipping operations are performed after all of the data following the ESC sequence is printed. Double space, triple space, or skip operations are not retained beyond one record (that is, the carriage reverts back to normal single spacing). However, printer selection is retained and no further selection is required throughout the transmission until the selection of the punch is desired. (See "Component Selection, Basic Terminal-Contention" in this manual.)

The ESC control character must be the first character in the record when transmitting or receiving. The ESC control character and the character following are removed from the record at the receiving terminal. The third character in the record is then treated as the first data character and is punched in column 1 of the card or printed in print position 1. When an ESC control sequence is transmitted by the 2780, the sequence is always punched in the first two columns of the card being read; therefore the number of data characters in the record is limited to 78.

The format of the two-characters ESC sequence is as follows:

ESC Sequence from Figure 16

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| S | E | | | U | E | | | | E |
| T | S | * | DATA | S | S | * | DATA | | T |
| X | C | | | | C | | | | B |

Figure 23 shows the ESC sequences and the carriage tape punching for a typical invoice application. The ESC sequences are shown vertically to the left of the tape. The parenthetical reference letters A, B, C, and D, shown vertically to the right of the tape, point out how the various tape-track punches are used, as follows:

Reference (A)--Track 1. This punch represents the first print line on the form. On an overflow operation, the printer will stop the form on this line. This line is normally used for identification printing.

Reference (B)--Tracks 3 through 8. Holes in any of these tracks terminate skipping when they are sensed. In the figure, tracks 3 through 6 are used for different types of heading stops.

Reference (C)--Track 2. This represents the first body line of the form.

Reference (D)--Track 5. This is one of the normal skip-stop tracks used; in this case it is used to stop the form for printing on a predetermined total-line position. Any one of tracks 3 through 8 could be used for this.

HT (Horizontal Tab)

The HT control character is used with the Printer Horizontal Format Control special feature. This feature is similar to the Tab function on a typewriter. The HT character is used in three ways:

- When the HT character follows the ESC character at the beginning of a record, it signifies that the remainder of the record is a printer horizontal format control record that is to be stored by the receiving 2780 (see discussion on Printer Horizontal Format Control in the "Special Features" section of this manual).

- When an HT character appears within a printer horizontal format control record, it causes an electronic tab stop to be set for the printer. Each HT character within the horizontal format control record sets up a tab stop, thereby establishing the horizontal format control for the printing of subsequent records.

- When the HT character appears within subsequent records, it causes the data following the HT character to be printed, starting at the next tab stop that was set by the preceding horizontal format control record (see discussion on Printer Horizontal Format Control in the "Special Features" section of this manual).

EM (End of Media)

The EM control character is used to indicate the end of a record when transmitting records of variable length. The EM character is punched in the card column following the last column containing data. When the EM character is read from a card it prevents further reading of that card. The transmitting 2780 then generates automatically and transmits an end-of-record (US or IUS in EBCDIC), or end-of-block (ETB) character following the EM character.

If the punch is selected at the receiving terminal, the EM character is punched. If the printer is selected at a receiving terminal equipped with Six Bit Transcode or EBCDIC, the EM character is not

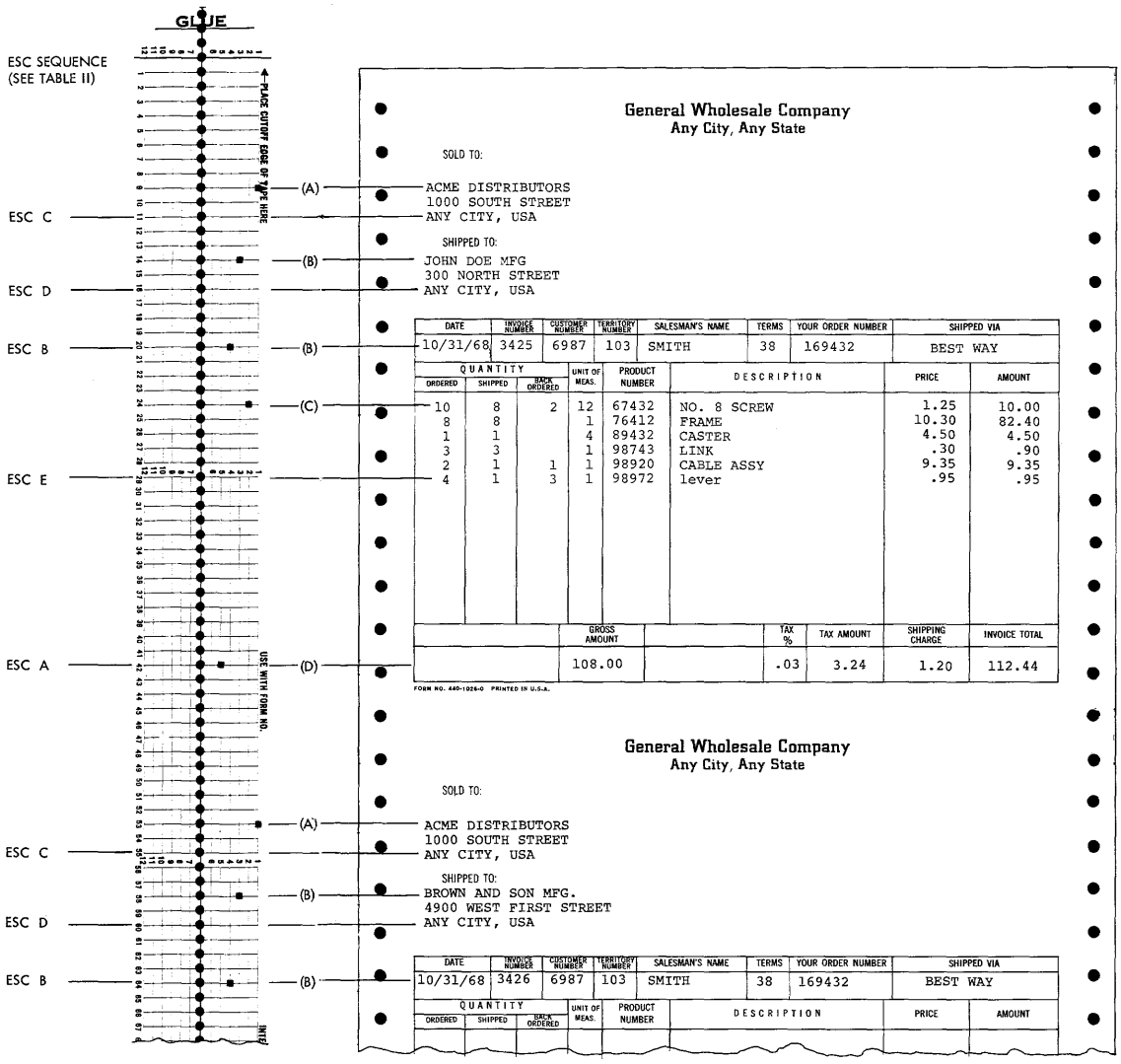



Figure 23. ESC Sequences and Tape Punching for a Typical Application

printed since there is no printable graphic defined for this character. If the printer is selected at a receiving terminal equipped with USASCII, receiving an EM character in text just before a US, ETB, or ETX can cause loss of characters or possibly sync checks.

When the punch is selected at the receiving terminal, the end-of-record or end-of-block character following the EM character causes a feed cycle to occur immediately. This causes the remaining columns of the card (columns following the punched EM characters) to pass through the punch station in one continuous movement rather than the normal column-by-column type of movement.

BEL (Bell)

The Bell key is operated to signal the remote terminal operator that voice communication is desired. Operating the Bell key causes the BEL character to be transmitted to the receiving 2780 terminal. However, the BEL character is not transmitted if the 2780 is in text mode (transmitting or receiving data). The BEL character, when received, causes the Bell indicator light to turn on and the audible alarm to sound at the remote terminal (see Bell Key and Bell Light under "Operator Controls" in this manual).

SUB (Substitute)

The SUB end-to-end control character is not used with the 2780 terminal.

DEL (Delete)

The DEL end-to-end control character is not used with the 2780 terminal.

## TRANSMISSION CHECKING

### Redundancy Check

A redundancy check is performed on all data. A check character is accumulated for each record of data at both the transmitting and receiving terminal. The check-character accumulation is initiated by, but does not include, the STX character. All characters--except SYN--following the STX, to and including the end-of-record character, are part of the accumulation. An STX character following a US sequence is optional. If STX is used following a US check sequence, it is included in the redundancy-check accumulation. The receiving terminal compares the received check character that follows the end-of-record character with the one it has accumulated. If the redundancy accumulations are different, an error has occurred.

The method of accumulating the check character varies depending on the code being used:

EBCDIC--A 16-bit cyclic accumulation using the polynomial $x^{16} + x^{15} + x^2 + 1$. This check character is sent as two eight-bit bytes and is referred to as the CRC (cyclic redundancy check) character.

Six-Bit Transcode--A 12-bit cyclic accumulation using the polynomial $x^{12} + x^{11} + x^3 + x^2 + x + 1$. This check character is sent as two six-bit bytes and is referred to as the CRC character.

USASCII--Odd-parity VRC (vertical redundancy check) on each character, and an eight-bit cyclic accumulation for the record using the polynomial $x^8 + 1$ (LRC). The LRC (longitudinal redundancy check) character is sent as one eight-bit character. A VRC check is performed on the LRC character.

The redundancy-check character is accumulated serially by bit. A pad character is required following the block-check characters to cause insertion of the last byte or character in the redundancy-check register. For correct transmission of a record, the redundancy accumulation must be all zero bits following complete insertion of the block-check characters.

Therefore, the end-of-block-checking sequences are as follows:

| | | |
|---|---|---|
| Six-Bit Transcode or EBCDIC | E C C p<br>T R R a<br>B C C d | E C C p<br>T R R a<br>X C C d |
| USASCII | E L p<br>T R a<br>B C d | E L p<br>T R a<br>X C d |

NOTE: The two checking characters (CRC and LRC) are shown in examples throughout the remainder of the manual as bcc (block-check character). The LRC check character is transmitted as a single block-check character and the CRC check characters are transmitted as two bcc characters. The block-check character is shown in lower case to distinguish it from text and data-link control characters.

A pad character must always be transmitted at the end of any transmission. The pad character transmitted by the 2780 consists of all "1" bits. The first character received by the 2780 after a US sequence will be treated as data unless it is a defined control character.

The end-of-record characters are:

US-Unit Separator: Encoded after a record of text. This character does not cause a line turnaround, but it does cause checking to be performed at the receiver. This character may also be called ITB (Intermediate Block) or IUS (Information Unit Separator).

ETB--End of Transmission Block: Encoded at the end of a block of data. This block of data may include one or more records. This character causes a line turnaround. The receiving terminal performs a check, and indicates to the transmitting terminal whether or not the block of data was received correctly. The block is incorrect if an error occurred in any of the records of the block.

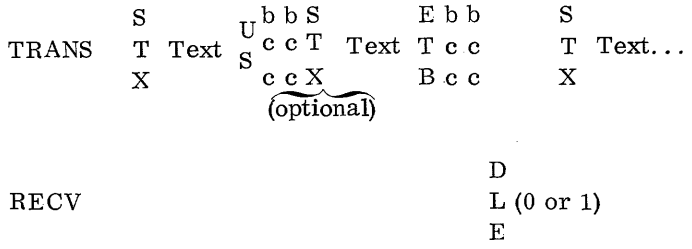
ETX--End of Text Transmission: Encoded at the end of the last block of data in a message. This character causes a line turnaround. If the acknowledgment indicates that the block of data was received correctly, the transmitting terminal ends the transmission by sending an EOT.

A receiving terminal responds to an ETB or an ETX, at the end of each block of text, with a positive or negative reply. The replies are:

DLE 0, DLE 1--These two-character positive responses are used alternately in accordance with the even/odd block count.

NAK--This is a negative acknowledgment. This reply means that a transmission error has occurred in the last block of data.

Example: Normal Operation of Block Checking

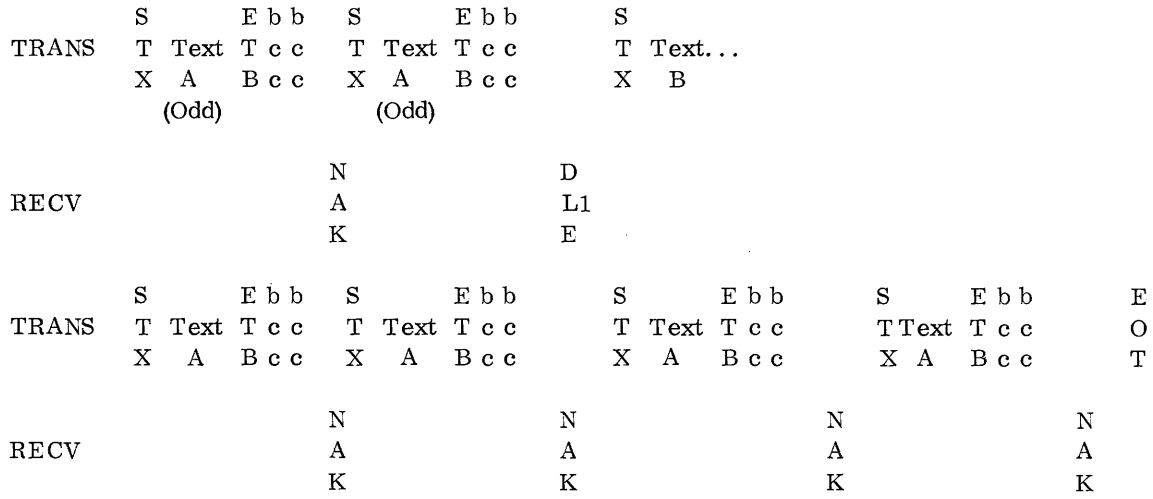



A negative reply to a block-check sequence causes retransmission of the block. The number of retransmissions is determined by the type of system: terminal-to-terminal, or terminal-to-CPU.

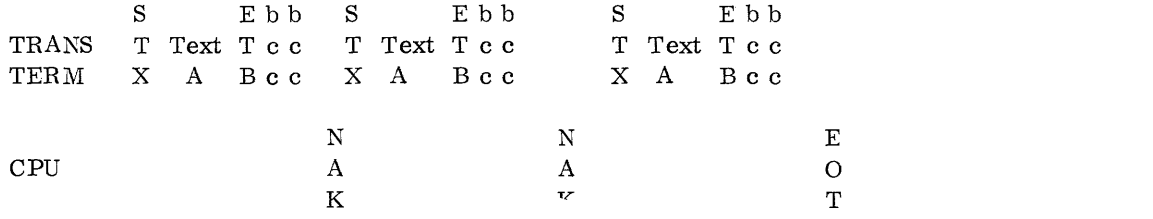
In terminal-to-terminal or terminal-to-CPU operation, the number of retransmissions is limited to three; i.e., the same block of data is transmitted four times. If a positive reply occurs for a retrans-

---

Example: Retransmission, Terminal-to-Terminal




Example: Retransmission, Terminal-to-CPU



mission, the transmitting terminal goes on to the next block of data it has to send. If the third retransmission is still unsuccessful, the transmitter ends transmission by sending an EOT.

In CPU-to-terminal operation, the number of retransmissions is determined by the CPU. The CPU terminates the retransmissions by sending an EOT response instead of a NAK. A positive response will cause the terminal to go on to the next block. No attempt is made to output an error record. A block-checking reply other than the proper DLE response, NAK, or EOT will cause the transmitting terminal to send an ENQ. The ENQ will also be sent if no response is received within three seconds. The ENQ is a request to the receiving terminal to repeat the last block-checking reply. A maximum of three ENQ's will be sent. Failure to receive a usable response after three ENQ's will cause the transmitting terminal to end transmission by sending an EOT.

An EOT character will never be sent in the text portion of a record; however, if a character interpreted erroneously as an EOT is received in text, the receiving terminal responds with a NAK.

The transmitting terminal then retransmits the block of text in which the erroneous EOT character appeared.

Example: Erroneous EOT in text

```
      S        E     Ebb   S        Ebb  S
TRANS T TEXT A O XXX Tcc   T TEXT A Tcc  T TEXT B
      X (ODD) T     Bcc   X (ODD)   Bcc  X (EVEN)

RECV                 N                  D
                     A                  L1
                     K                  E
```

Format Check

The four permissible formats for a block of data follow:

1. S T X Text — US — S T X Text — E T B
   (optional)
2. S T X Text — US — S T X Text — E T X
3. S T X — E T B
4. S T X — E T X

If the required STX is missing, the receiving terminal does not accept the block. The receiving terminal will not reply. The transmitting terminal will wait three seconds for the reply, and, receiving none, will send the ENQ character. The receiving terminal will then reply with a repeat of the response generated by the last block received. The transmitting terminal will then retransmit the block of data:

Example: Format Checking

```
      S       E b b       E b b E S       E b b S
TRANS T Text  T c c Text  T c c N T Text  T c c T...
      X       B c c       B c c Q X       B c c X
       (Odd)        (Even)          (Even)

RECV              D          No D            D
                  L1         Ans. L1         L0
                  E             E            E
```

Odd/Even Block Count

The transmitting and receiving terminals maintain an alternating count of the blocks transmitted and received. The first block of text after a line bid is an odd block; the next block is an even block, and subsequent blocks alternate until an EOT occurs.

The count at the transmitting terminal is changed only after a correct positive reply is received. The count at the receiving terminal is changed just before a positive reply is to be sent to a block-check sequence. The receiving terminal's count will not be changed if the reply is a response to an ENQ.

Example: Odd/Even Block Counting--Normal Operation

```
       S       E b b S       E b b S
TRANS  T Text  T c c T  Text  T c c T  Text...
       X       B c c X       B c c X
        (Odd)          (Even)         (Odd)
                  D              D
RECV              L1             L0
                  E              E
```

If the reply and transmitting terminal's counts do not agree, the transmitting terminal will send an ENQ requesting the receiving terminal to repeat the reply. If the reply and transmitting terminal's counts do not compare after three ENQ's, the transmitting terminal will end the transmission by sending an EOT. When transmitting terminal-to-terminal or terminal-to-CPU, the number of ENQ's sent by the transmitting terminal is limited to three (incorrect odd/even block count received four times).

When a CPU is transmitting to a terminal, the number of ENQ's transmitted by the CPU is under control of the CPU program routine. If the odd/even block count received by the CPU is still incorrect after a predetermined number of ENQ's, the program should branch to an error correction routine.

Example: Failure of Reply and Transmit Counts to Compare

```
       S       E b b    E E E E
TRANS  T Text  T c c    N N N O
       X       B c c    Q Q Q T
        (Odd)
                  D  D  D  D
RECV              L0 L0 L0 L0
                  E  E  E  E
```

I/O and Buffer Check

An I/O or buffer check condition at the transmitting terminal will cause transmission to end. This is accomplished by transmitting an ENQ in text. The receiving terminal responds with a NAK, and after the transmitting terminal receives the NAK, it sends an EOT.

With a line-buffer parity check or line-buffer overflow, the ENQ is transmitted immediately upon detection of the check. With an I/O or I/O buffer check condition, those complete records in the line buffer will be transmitted normally. Following a correct response to the block check, an STX ENQ sequence is sent by the transmitting terminal. This sequence is the same as an ENQ in text and the resultant sequence is identical.

Example: Line-Buffer Parity or Overflow

```
       S       E E
TRANS  T Text  N O
       X       Q T

                N
RECV            A
                K
```

Example: I/O or I/O Buffer Check

```
       S       E b b  S E E
TRANS  T Text  T c c  T N O
       X       B c c  X Q T

                  D    N
RECV              L1   A
                  E    K
```

A line-buffer overflow at a receiving terminal results in a NAK response to a block-checking sequence.

All other buffer and I/O check conditions result in an EOT response to the block-checking sequence.

Example: Receiving-Terminal Buffer or I/O Check

```
       S       E b b
RECV   T Text  T c c
       X       B c c


                    E
TRANS               O
                    T
```

TIMEOUT CONTROLS

Two or more terminals, in a ready to transmit condition and using the same communications line, can bid for the line simultaneously. When this contention-for-the-line condition occurs, neither terminal recognizes the request of the other(s). Therefore, timeout controls are provided by the basic 2780 terminal. These timeout controls are used to establish priority when a contention-for-the-line condition exists, thereby preventing the transmission line from being tied up unnecessarily under certain adverse conditions.

NOTE: All 2780 terminals are shipped as primary terminals (1 second timeout). Terminals can be altered for secondary operation by an IBM Customer Engineer at the time of installation.

### One-Second Timeout

This timeout is used when operating point-to-point on a contention basis. It is the period of time that a primary terminal allows a secondary terminal to reply to the Enquiry (ENQ) character. The primary terminal automatically retransmits the ENQ character after the one-second timeout.

### Two-Second Timeout

A receiving terminal must respond to a block-checking operation within two seconds. If unable to do so, the receiving terminal remains in receive mode and waits for the transmitting terminal to send an ENQ character to solicit the response.

### Three-Second Timeout

This timeout is used when operating point-to-point on a contention basis. It is the period of time that a secondary terminal allows a primary terminal to reply to an ENQ character. At the end of this time-out the ENQ character is automatically encoded again and sent to the primary terminal.

A transmitting terminal will wait three seconds for a response to a block-checking operation. If a reply is not received, an ENQ is automatically encoded and sent to the receiving terminal to solicit the response.

A receiving terminal initiates a three-second timeout upon receiving a sync pattern (SYN SYN). It must receive an STX character or another sync pattern within this time. If none is received, the terminal abandons synchronization and waits for another sync pattern. Upon receiving an STX character, another three-second timeout is initiated. If a block-end character or a sync pattern is not received within this time, synchronization is abandoned.

When operating terminal-to-terminal over leased lines, one terminal must be designated the primary terminal and the other the secondary terminal. This enables the primary terminal to gain control of the line if both terminals bid for the line simultaneously. This designation is not necessary when operating terminal-to-terminal over switched (dial) line facilities, since the operators control the priority of the terminals. In a terminal-to-CPU (contention mode) operation, the 2780 is always the primary terminal. The CPU will wait for the 2780 to send the second ENQ character if the CPU receives an ENQ response to its ENQ character. This condition could exist if both the 2780 and the CPU send ENQ characters at approximately the same time.

If, in a terminal-to-CPU operation, the CPU transmits for longer than one second without a turnaround, the CPU must send sync patterns at one-second intervals.

### Extended ENQ Retry Feature (48-Second Timeout)

The Extended Enquiry (ENQ) Retry Transmission feature is required only when 2780 terminals are used with a System/360 that is processing data transmitted over many communications lines. Under these circumstances the CPU may experience difficulty in responding to a specific 2780 communications line within the present 12-second timeout limitation. The availability of this feature is limited to 2780 Model 1 and 2 terminals using the EBCDIC code.

### Standard 2780 Operation

A block check response other than DLE 0, DLE 1, NAK, EOT, or RVI causes the transmitting 2780 to send an ENQ (Enquiry) character. The ENQ character is also transmitted if the transmitting 2780 receives no response at all within three seconds. The ENQ character serves as a request to the receiving CPU to repeat the last block check response. A maximum of three retry ENQ characters are transmitted by a standard 2780 terminal. Failure to receive a recognized response after three ENQ's causes the transmitting 2780 to send an EOT character and time out. The EOT character is transmitted three seconds after the last ENQ is transmitted.

### 2780 Operation with Extended Enquiry Retry Transmission Feature Installed

The purpose of the Extended Enquiry (ENQ) Retry Transmission feature is to allow the transmitting 2780 to count up to a maximum of 15 retry ENQ's in an effort to recognize a response prior to sending an EOT character and timing-out with an error condition. Since three seconds elapse between each retry, and also between the last ENQ and EOT character, a total of forty eight seconds elapse before an EOT character is transmitted ending the transmission.

The main-line switch, when on, controls the primary power source to the IBM 2780 Terminal. This switch is located on the right-end cover of the card read/punch base on all 2780 models.

CARD READ/PUNCH CONTROLS (MODELS 1, 2, AND 4)

The following switches, keys, and indicator lights are on the operator panel adjacent to the card-feed hopper (Figure 24). Some of these switches, keys, and lights are on the printer-operator panel on the IBM 2780 Model 3 (print-only terminal), as noted in the text (see Figure 26).

Switches

Mode Switch

The setting of this six-position rotary switch controls the operational mode of the terminal. A power-on reset of all indicators occurs when the setting of this switch is changed (except Model 3). A power-on reset for Model 3 is accomplished by pressing the Machine Reset key. The power-on reset sets the 2780 to an initial status. Do not rotate the Mode switch or press the Machine Reset key until all mechanical print operations have stopped; failure to do so may stop the typebar when it is out of position. The six positions of the switch are:

TSM (Transmit). This switch setting permits the terminal to transmit. However, when the terminal is not actually transmitting, the printer can receive data if it is in a ready condition and is selected. When the Multipoint Line Control special feature is used, the printer (if ready) can be addressed without polling the reader first (see "Operating Procedures" for a detailed description of switch settings).

TSM TRSP (Transmit Transparent). This setting is identical to the Transmit setting except that text is transmitted in transparent mode. This setting is effective only if the EBCDIC Transparency special feature is installed (see "Special Features" section in this manual).

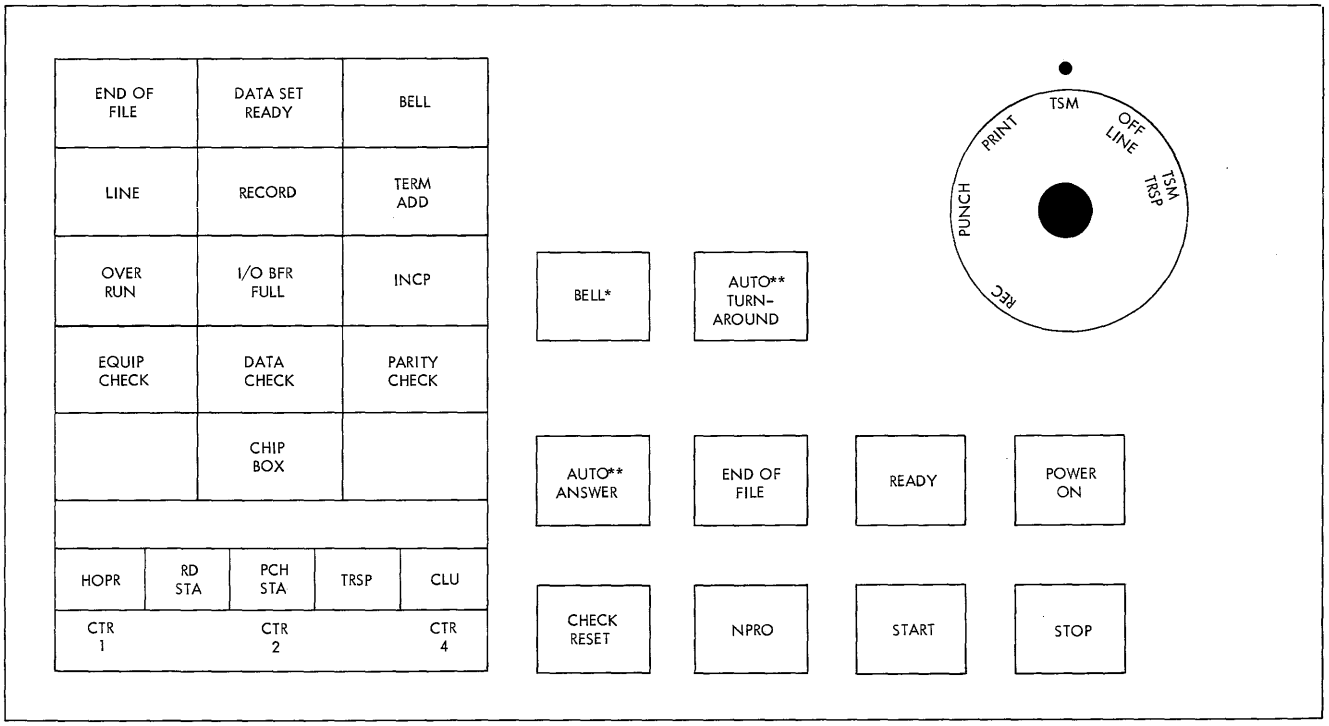



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Figure 24. Card Read/Punch Operator Panel (Models 1, 2, and 4)

REC (Receive). Either the punch or printer can be operative in this mode depending on the component selection sequence in the data record.

Off-Line. This position allows the 2780 to perform an off-line card-listing operation. In this mode, the only active carriage skip is an automatic overflow from channel 12 to channel 1.

Print. This setting causes all information received by the terminal to be printed when operating on a point-to-point basis without component-selection sequences. However, printer vertical forms control sequences can still be used.

Punch. This position permits the terminal to punch all the information received when operating on a point-to-point basis. Component-selection sequences have no effect and need not be used.

Keys

Start Key

The start key is used to initially run in and register cards at the read or punch station (depending on terminal operation), provided the power is on, the card path is empty, cards are in the hopper, and the chip box is in place and not full. Operating this key also resets the Incomplete indicator.

NOTE: The start key should be held down until the ready light turns on. The start key is located on the printer-operator panel on the IBM 2780 Model 3.

Stop Key

When operated, the stop key removes the card read/punch from ready status and also turns off the audible alarm. On Models 1 and 2, operating the stop key also removes the printer from ready status at the completion of the print cycle. The stop key is located on the printer-operator panel on the IBM 2780 Model 3.

NPRO (Non-Process Run-Out) Key

After cards have been removed from the hopper, this key is used to run out, but not process, the remaining cards in the card read/punch. The key operates only when the card read/punch has been removed from ready status and no cards are in the hopper.

Bell Key

The bell key is present only on machines operating on a terminal-to-terminal basis. Operating this key causes the BEL character to be transmitted and is used to signal the remote terminal operator that voice communication is desired. The operation of this key has no effect when the terminal is transmitting or receiving data (text mode).

The BEL character, when received, causes the bell light to turn on and the audible alarm to sound at the remote terminal. The remote terminal operator then presses the bell key which causes the bell light and audible alarm to turn on at the originating terminal (stop key should also be operated to turn alarm off at the remote terminal). This indicates to the originating terminal operator that the remote terminal operator is now ready to switch to voice mode. The originating terminal operator should operate the stop key to turn his alarm off before talking to the remote terminal operator. After voice communication has been terminated, each terminal operator should perform a power-on reset to turn off the bell light.

The bell key is located on the printer-operator panel on the IBM 2780 Model 3.

End-of-File Key

This key is operated only after the last group of cards to be processed are placed in the hopper. Operating this key turns on the end-of-file light and causes an ETX control character to be transmitted after the hopper is emptied and the last card has been processed. If the end-of-file key is not operated, the last card is read and transmitted; however, an STX ENQ sequence is transmitted instead of the ETX character. Operating the stop key resets the end-of-file condition and turns off the light.

Check Reset Key

Operating this key resets the following indicators:

| | |
|---|---|
| Bell | Test Check |
| Data Check * | Terminal Addressed |
| Equipment Check * | Overrun |
| Parity Check * | Record Check |

For the 2780 Model 3, the check reset key is on the printer-operator panel. Operating this key resets the following indicators:

| | |
|---|---|
| Bell | Overrun |
| Parity Check | Record Check |
| Terminal Addressed | Sync Check |

* Operate NPRO key prior to operating the Check Reset key.

Indicator Lights

Power-On Light

The power-on light indicates that the main-line switch is on and that power is being supplied to the terminal.

Ready Light

This indicator light, when on, indicates that the card read/punch is prepared to operate under the control of the Binary Synchronous Adapter and buffer, and that the following conditions are satisfied:

- Power on
- Card registered at read/punch station
- Cards in hopper
- Interlocks satisfied
- Stacker not full
- Feed-check lights off (HOPR, RD STA, PCH STA, TRSP, and CLU)
- Chip box indicator light off

Bell Light

The bell light turns on and the audible alarm sounds when the BEL character is received. The light is turned off by performing a power-on reset (see discussion on "Mode Switch" in this section of the manual). The bell key and light are on the printer-operator panel of the Model 3.

Chip-Box Light

This light, when on, indicates that the punch chip box is full or has been removed. This condition will prevent the card read/punch from attaining a ready status. Once the card read/punch has become operational, a full chip box will cause a stop condition. The light is turned off when either the chip box is emptied or placed in position.

HOPR (Hopper) Light

This light turns on when a card fails to feed from the hopper. The light is turned off when the remaining cards in the transport are fed into the stacker by operating the NPRO (Non-Process Run-Out) key.

RD STA (Read Station) Light

This light turns on when a misfeed, a read-station jam, or a photo transistor malfunction is detected. The light turns off when the remaining cards in the transport have been run out, after the hopper has been emptied, by operating the NPRO key (removing jam if necessary).

PCH STA (Punch Station) Light

This light, when on, indicates a misfeed or a jam at the punch station. The light turns off when cards are removed from the hopper and the remaining cards in the transport have been run out by operating the NPRO key (removing jam if necessary).

TRSP (Transport) Light

When on, this light indicates a jam in the stacker transport. Removing cards from the hopper, removing the jam, and operating the NPRO key turns the light off.

CLU (Clutch) Light

When on, this light indicates that the card-feed clutch failed to latch, thereby causing an extra feed cycle to be taken. Removing cards from the hopper and running the remaining cards out into the stacker by operating the NPRO key turns the light off.

Parity-Check Light

The parity-check light turns on whenever even-parity data is detected when using the Six-Bit Transcode or USASCII codes, or when a buffer check is detected when using the EBCDIC code. The light is turned off by pressing the check reset key following the operation of the NPRO key. The parity-check light is on the printer-operator panel on Model 3.

Data-Check Light

When this light turns on during a card-read cycle, it may indicate that the card is sufficiently off registration (because of previous punching or feeding) to prevent accurate reading of the data. This light also turns on when more than one punch in digit positions 1-7 of a card column have been detected. Operating the check reset key following a NPRO operation turns the data-check light off.

NOTE: An attempt to read any of the following control characters also causes the data-check light to turn on unless operating in transparency mode: US, ETB, EOT, NAK, or ENQ.

EQUIP (Equipment) Check Light

When turned on during a read cycle, this light indicates that 80 columns of a card, which does not con-

tain an EM (end-of-media) or ETX character, were not read. When turned on during a punch cycle, this light may indicate that the punch-echo data did not match the data to be punched. It may also indicate that more than one punch was punched in digit positions 1-7 of a card column. Operating the check reset key after operating the NPRO key turns the light off.

CTR (Counter) 1, 2, 4 Lights

These indicator lights are used by the terminal operator during the execution of error-recovery procedures. At a transmitting terminal they indicate the number of complete records in the line buffer. At a receiving terminal they indicate the number of complete records transferred to the I/O buffer. The number of records in each case is determined by adding the sum of the lights that are on; for example, three records would be indicated by the 1 and 2 lights being on. The counter lights are reset either upon successful transmission of the message, or by changing the setting of the mode switch, which causes a power-on reset. The indicator lights are on the printer-operator panel of Model 3. On Model 3 these indicators are reset upon sucessful transmission of the message or by operating the machine reset key.

Line Light

This light turns on as the result of a line-redundancy-check error or receipt of the WACK sequence. At the transmitting terminal, this light turns on when no response to block checking, a WACK response, no response to a line bid, or any response other than the specific DLE 0 or DLE 1 required for the record transmitted is received. An STX ENQ sequence causes this light to turn on at the receiving terminal. The line light is reset by a successful transmission and check cycle, or when the proper response is received following a WACK sequence. The line light is on the printer-operator panel on Model 3.

Data Set Ready Light

When on, this light indicates that the data set attached to the terminal has power applied and is operational. This light is on the printer-operator panel on Model 3.

TERM ADD (Terminal-Addressed) Light

This light turns on and the audible alarm sounds when the terminal is addressed by a remote terminal or CPU and the selected output device is not ready. The light also turns on if the output device is ready but does not recognize the component selection sequence. The indicator light is turned off by the check reset key and the alarm is turned off by operating the stop key. The terminal-addressed light is on the printer-operator panel on Model 3.

Overrun Light

When on, this light indicates that one of the following conditions exist:

- A received block has exceeded the capacity of the line buffer.
- A received block contains too many records (two records are allowed in the basic terminal and seven with the Multiple Record special feature)
- One record contains 170 or more characters
- More HT (horizontal tab) characters are received than were specified in the horizontal format record
- The mode switch is set to REC (receive) and transparent data is received without a preceding component selection sequence.

The light is turned off at the receiving terminal by a successful retransmission of the message, or at the transmitting terminal by operating the check reset key. This light is on the printer-operator panel on Model 3.

Record Light

When the Record light turns on at the transmitting terminal, it indicates the loss or duplication of a record, or the receipt of the WACK sequence. The light turns on when the alternating record responses (DLE 0 or DLE 1) of the transmitting and receiving terminals do not agree or the WACK sequence is received in response to an ETB and block-check-character sequence. The light turns off when the check reset key is pressed, the correct DLE response is received, or when the proper response is received following the WACK sequence.

INCP (Incomplete) Light

When on, this light indicates that the other terminal or CPU has abandoned transmission. When on at the receiving terminal, it indicates the receipt of an EOT character, without a preceding ETX character.

When on at the transmitting terminal, the light indicates the receipt of an EOT character as the response to a checking sequence, or the receipt of an EOT character following a WACK sequence. The INCP light is turned off at the receiving terminal when the STX character is received, and turned off at the transmitting terminal by operating the start key. The INCP light is on the printer-operator panel on Model 3.

End-of-File Light

This light turns on when the end-of-file key is operated if cards are in the hopper and the mode switch is set to TSM (transmit). The light also turns on when using the EBCDIC code and an auto-turnaround occurs when operating in Transmit Transparent mode. Operating the stop or NPRO key turns the light off.

I/O BFR (Buffer) Full Light

This light indicates that a complete record is in the I/O buffer. The light is turned off either when the record in the I/O buffer is successfully punched or printed, or by changing the setting of the mode switch, which causes a power-on reset. This light is on the printer-operator panel on Model 3.

Audible Alarm

The audible alarm alerts the operator that manual intervention is required. Therefore, the terminal should not be expected to operate unattended. The alarm is inoperative when performing an off-line card reader-to-printer listing operation. The alarm is turned on by any of the following conditions:

Transmitting Terminal

- When transmitting the EOT control character.
- When an EOT control character is received in response to a transmitted block of data (because of a not-ready condition or message abort by the receiving terminal).
- When the Mode switch is set to TSM (Transmit), the reader is not ready, and the terminal is polled. If the operator has no data to transmit, the alarm can be disabled (if desired) by setting the Mode switch to the REC (Receive) position. When the terminal is polled, the alarm will not sound.
- When a timeout disconnect occurs with the auto-answer special feature installed.
- When a normal job-end occurs (transmit ETX EOT sequence).
- When three bids to transmit are made on a contention system (2780-to-2780 or 2780-to-CPU) and the receiving terminal is not ready, the alarm sounds but no indicator lights are turned on.

Receiving Terminal

- When responding with an EOT control character due to an abort condition.
- When the BEL character is received.
- When a normal job-end sequence (ETX EOT) is received and the card reader is not-ready. The alarm may be prevented in the preceding case by installing the Alarm Disable Jumper option. This option is available on all machines at Engineering Change level 308291 and above. (The Engineering Change level can be determined by the local IBM Customer Engineer.)
- If the auto-answer feature is installed and a disconnect sequence occurs.
- When a component of the 2780 terminal is selected and that component is not-ready.

The audible alarm is turned off: (1) when an ENQ is received; (2) by operating the stop key, or (3) by performing a power-on reset. (See discussion on "Mode Switch" in this section of the manual.)

NOTE: The high/low setting of the alarm can be controlled by the operator (see discussion on Audible Alarm Hi/Low Switch in "Additional Switches, Keys, and Lights" section of this manual.

PRINTER CONTROLS (MODELS 1 AND 2)

The following keys and indicator lights are on the operator panel located at the right front corner of the top cover (Figure 25).

Keys

Start Key

Operating the start key places the printer in a ready status if all interlocks are satisfied and power is on. The interlocks that must be satisfied are:

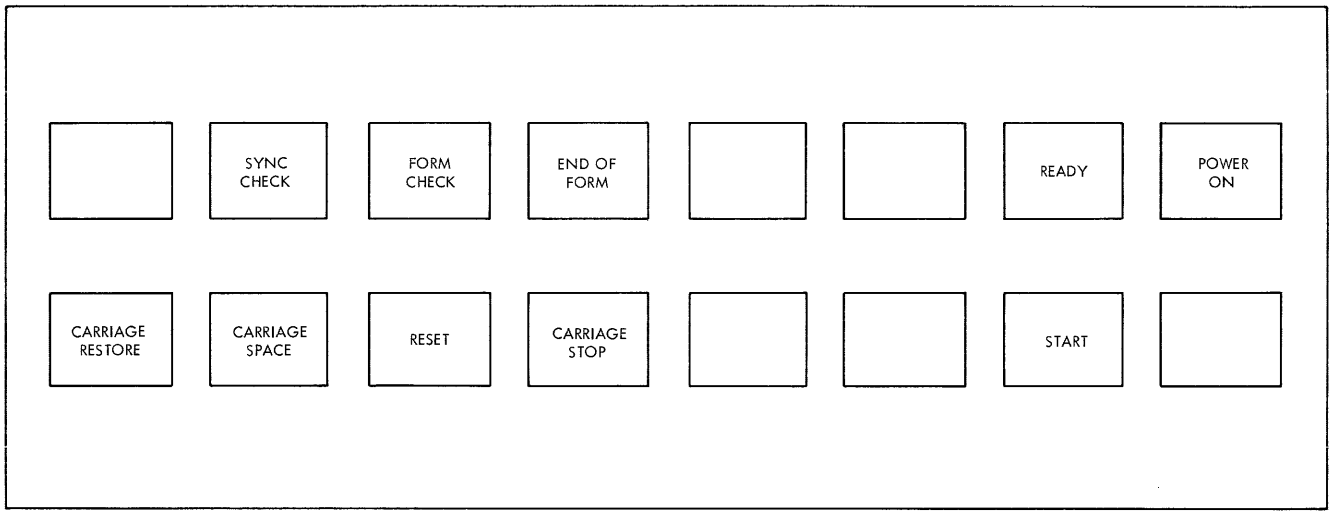


Figure 25. Printer Operator Panel (Models 1 and 2)

- Form guides closed.
- Typebar in position.
- Carriage-tape brush assembly closed.
- 6-8 linespace-drive-mechanism cover closed.
- End-of-forms switch closed.

The start key resets the Line Check and Incomplete indicators on the Model 3.

Carriage Restore Key

When operated, this key causes the carriage to skip to channel 1. This key is operative only when the printer is in a not-ready status.

Carriage Space Key

Each operation of this key advances the paper one line space if the printer is in a not-ready status.

Carriage Stop Key

Operating this key stops the carriage and places the printer in a not-ready status.

NOTE: Do not use this key to stop the printer. An overprint of the previous line may occur on a restart operation.

Reset Key

Operating this key turns the sync-check light off.

Indicator Lights

Power-On Light

When on, this light indicates that the main-line switch is on and that power is being supplied to the terminal.

Ready Light

This light, when on, indicates the printer is in a ready status; that is, all interlocks are satisfied and the start key has been operated.

Sync (Synchronize) Check Light

This light, when on, indicates the typebar is out of synchronization. When this occurs, the printer is removed from a ready status. The reset key turns off the light.

Forms-Check Light

When on, this light indicates that one of the following conditions exists:

- A forms-check switch is operated due to improper seating of one of the top paper guides (possibly due to a jammed form).
- The carriage-tape brush holder is not fully seated in its operating position.
- The 6-8 linespace-drive-mechanism cover is not closed.

Correcting the condition resets the light.

End-of-Form Light

When on, this light indicates that approximately four inches of the last form remains in the printer. However, after the light turns on, printing will continue automatically until a hole is sensed in channel 1 of the carriage tape. The light turns off when the supply of forms is replenished.

## PRINTER CONTROLS (MODEL 3)

Since the Model 3 is a print-only terminal, the terminal controls normally located on the card read/punch operator panel are now located on the printer-operator panel with the printer controls already described for Models 1 and 2 (Figure 26). The "Card Read/Punch Controls (Models 1, 2, and 4)" section of this manual describes the additional controls on the printer-operator panel.

Machine Reset Key

This key, when operated, causes a power-on reset to occur. This reset is the same as the power-on reset that occurs when the setting of the mode switch is changed on Models 1, 2, and 4 (see "Mode Switch" in this section of the manual).

The machine reset key also performs the same functions as the Reset key on the printer-operator panel of the Models 1 and 2.

Additional Switches, Keys and Lights

The following switches and lights are located on the Customer Engineering Test panel which is located directly below the card read/punch operator panel.

BSA (Binary Synchronous Adapter) Test Switch and Check Light

The BSA Test checks the circuitry of the Binary Synchronous Adapter and the test-check/compare circuits when operating in an off-line servicing mode. The test is primarily a customer engineering tool. However, in the case of a terminal malfunction, the test can be run by the 2780 operator prior to the arrival of the customer engineer. If the test runs correctly, the malfunction encountered is probably due to a malfunction at the other terminal or due to a line failure.

To Run the BSA Test (Models 1, 2, and 4):

- Turn Operate/Test switch (located directly above BSA Test switch) to the Test position.
- Set Operate/Test switch, located on data-set connector, to Test position.

NOTE: Power must be supplied to the data set when performing the BSA test.

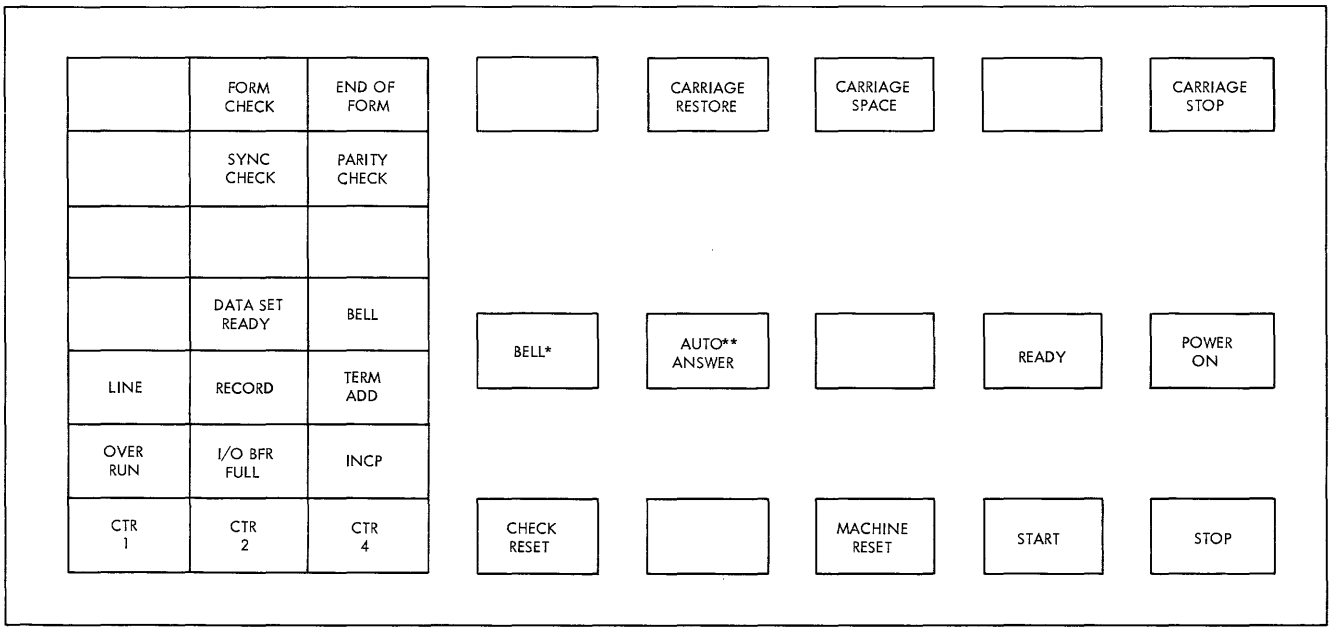


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Figure 26. Printer Operator Panel (Model 3)

- Turn Mode switch to TSM (Transmit) position (if already setting at TSM position, perform a power-on-reset by turning to some other position and then back to TSM position.
- Set BSA Test switch to ON position.
- Place BSA test deck in hopper (test deck supplied with machine).
- Press start key on card read/punch until two cards are fed into the 2780.
- The 2780 is now performing the BSA test.

The BSA test has run error free if all cards are fed from the hopper, the BSA check light (located adjacent to the BSA Test Switch) is off, the audible alarm sounds, and all indicator lights are off except Data Set Ready. If a failure occurs during the test, the BSA Test Check Light will turn on. If this occurs, take note (for the customer engineer) of any other indicator light(s) that may also be on and also count the number of cards in the stacker. At the completion of the test, restore the Operate/Test switch to the Operate position, restore the BSA Test switch to the OFF position, and restore the switch on the data set connector to the Operate position.

To Run the BSA Test (Model 3 Only):

- Turn Operate/Test switch (located directly above BSA Test switch) to the Test position.
- Set Operate/Test switch, located on data-set connector, to Test position.

NOTE: Power must be supplied to the data set when performing the BSA test.

- Set BSA Test switch to ON position.
- Insert a BSA Test Tape in carriage. Since the 2780 Model 3 is a printer-only terminal, input data for the test is punched in the carriage control tape. BSA Test Tapes are supplied with the machine.
- Press Carriage Restore key to register column 1 of the tape under the brushes.
- Press Machine Reset key (power-on-reset).
- Turn the Data Enter switch on (located on CE Test panel).
- Press the Carriage Restore key (this loads the data punched in the tape into 2780 storage and starts the BSA test).
- The BSA test has run correctly if the BSA test check light is off, the audible alarm has sounded, and all indicator lights are off except Data Set Ready.
- If a failure occurs during the test, the BSA Test Check Light will turn on. If this occurs, take note (for the customer engineer) of any other indicator light(s) that may also be on.
- Repeat this procedure until all BSA Test Tapes have been run.

At the Completion of the Test:

- Restore the Operate/Test switch on CE panel to Operate.
- Restore the Operate/Test switch on data-set connector to Operate.
- Set BSA Test switch to OFF position.
- Remove BSA Test Tape from carriage.
- Turn Data Enter switch to OFF position.

Audible Alarm Hi/Low Switch

This two-position toggle switch is used by the operator to control the intensity of the audible alarm. The setting depends upon the environment in which the 2780 terminal is operating.

## MULTIPOINT LINE CONTROL

This special feature allows a number of 2780 terminals to operate with a CPU over a nonswitched communications line. The CPU is the centralized master terminal and controls the operation of each 2780 terminal. A polling or selection operation is initiated when the master terminal (CPU) transmits a three-character sequence; the first character is terminal address, the second character is component selection, and the third character is an ENQ that ends the addressing sequence. The following component-assignment characters are used:

| Character | Component |
|---|---|
| 3 | Printer |
| 4 | Punch |
| 6 | Reader |

Any alphabetic character (either upper or lower case) can be specified for a 2780 terminal address, and is set by an IBM Customer Engineer at the time of installation.

No general (broadcast) polling character or selection character is provided with this feature. The desired terminal and component must be selected and the polling or addressing sequence is recognized only when the characters are contiguous, for example EOT PAD SYN SYN A3 ENQ. The PAD character is not required when using Six-Bit Transcode. A three-character sequence using a 3 or 4 for component assignment is called a selection sequence. A three-character sequence using a 6 for component assignment is called a polling sequence. The polling and selection format follows:

### Polling

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| POLLING CPU | E O T | A6 | E N Q | | | | | | D L1 E | | | | | | | |
| POLLED TERMINAL | | | | S T X | Text 1 | | E b b T c c B c c | | | S T X | Text 2... | | | | | |

### Responses to Polling

E
O--Terminal not ready to transmit.
T

S
T--Positive response, data follows if the
X terminal is ready to transmit.

A CPU timeout will occur if the polled terminal is off-line.

### Selection

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SELECTING CPU | E O T | A3 | E N Q | S T X | Text | | E b b T c c X c c | | E O T | B3 | E N Q | S T X | Text... | | | |
| SELECTED TERMINAL | | | | D L0 E | | | | | D L1 E | | | D L0 E | | | | |

### Responses to Selection

D
L0--Positive response, selected component is
E ready to receive.

N
A--Negative response, selected component not
K ready to receive.

A CPU timeout will occur if the selected terminal is off-line.

When the Multipoint Line Control special feature is used, the basic component-selection feature (ESC plus follower code to select the punch or printer) is inoperative. Selection is controlled by the address sequence of the Multipoint feature only. However, ESC sequences can still be used for vertical forms or horizontal-format-control.

When power is initially turned on, a 2780 terminal is in a nonaddressed receive-text mode, and as such is unable to recognize any control information that may be on the communications line. The terminal remains in this state until an EOT is recognized. The terminal then goes into control mode and abandons synchronization.

When in control mode, the terminal will recognize its addressing sequence following a sync pattern, or it will recognize an STX character that follows a sync pattern. If the terminal recognizes its address while in control mode, it responds as previously explained in responses to polling and selection. If the terminal recognizes an STX following a sync pattern, it reverts back to the nonaddressed receive-text mode.

Example: Multipoint Terminal Responding to Addressing after Power Is Initially Turned On.

```
          S S S Ep  S S S    E p          S S S S
MASTER... Y Y Y O a Y Y Y A3 N a          Y Y Y T Text...
TERM      N NN T d  N N N    Q d          N N N X
                                 S S S D p
MULTIPOINT                       Y Y Y L0 a
TERM                             N N N E  d
```

When the Multipoint Line Control feature is used, the mode switch functions are modified so that they merely define the I/O devices that can be operated.

## PRINTER HORIZONTAL FORMAT CONTROL

This feature provides an electronic tab function for the printer which is identical to the tab function on a typewriter. This feature greatly increases throughput by eliminating the requirement to send spaces within the text to format a record. A format record, defined by the prefix ESC HT and containing an HT character in each location where a stop is required, is stored and used to format following records. The format record must be the first record in a transmission in order to properly facilitate error recovery procedures. The format record is retained in storage until a new format is received, a card is read, or a card is punched. However, if the Six-Bit Transmission Code is used, the format is retained until a new format is received. If power is removed from the terminal, the format record should be reloaded in storage to ensure proper operation. This feature is inoperative when performing an off-line listing operation. Figure 27 illustrates the format record for a typical horizontal-format-control operation.

NOTE: When operating terminal-to-terminal, printer horizontal format control cannot be set beyond print position 78. When operating CPU-to-terminal, the number of positions of format control is limited only by the print line of the printer (80, 120, or 144 positions). The overrun light turns on if more HT characters are received than were specified in the horizontal format record. When data to be printed exceeds the capacity of the printer because of the tab functions involved, that data will be lost with no indication of such.

## SYNCHRONOUS CLOCK

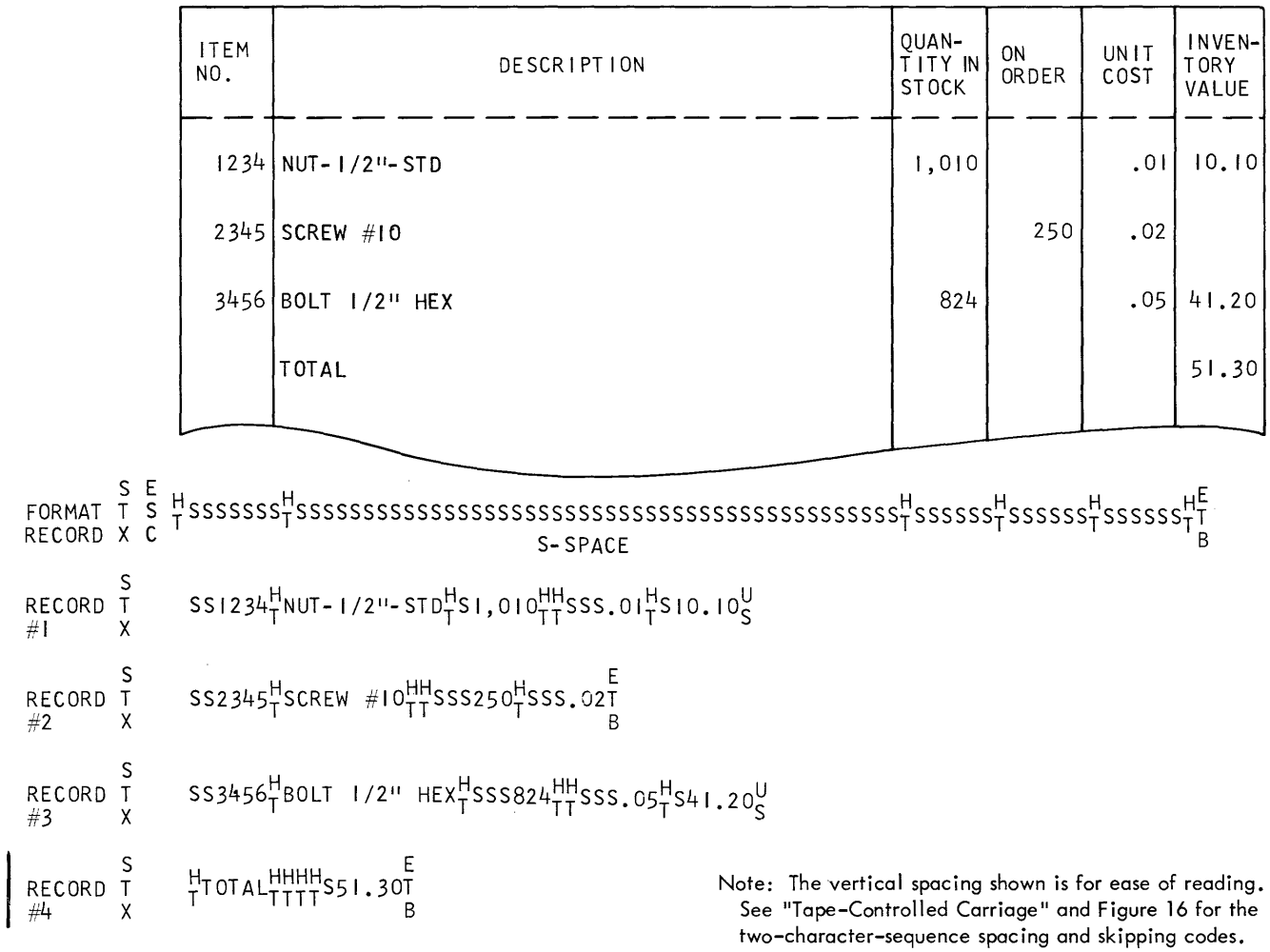
This feature provides the 2780 terminal with an internal synchronous clock. This clock enables the terminal to operate with data sets that do not provide clocking signals. With this feature installed, the terminal can operate with a data set over switched or private-line facilities at a data rate of 1200 bits per second (domestic installations only). See World Trade Features in the Special Features section for modems requiring this feature.

The Synchronous Clock is used primarily with Western Electric Data Sets 202C5 or 202D3, or equivalent. To provide alternate voice capability on the Western Electric Data Set 202D3, Data Auxiliary Set 804A is required. The data rate required must be specified when ordering. The terminal with which the 2780 terminal is communicating must also have a synchronous clock operating at the same bit rate.

When operating with the Synchronous Clock, the sync pattern at the beginning of each transmission is expanded from three SYN characters to seven SYN characters.

## AUTO ANSWER (DIAL-UP OPERATION ONLY)

This feature enables the 2780 terminal to automatically answer incoming calls from another terminal or a CPU. These calls can be initiated manually or automatically. (This feature still provides the audible alarm to alert the operator when manual intervention is required. Therefore, the terminal should not be expected to operate unattended.) When the 2780 auto-answer key is operated, it conditions the data set to answer incoming calls if the data set auto-answer key is operated and at least one unit (reader, punch, or printer) is ready to operate. The mode of operation will be transmit or receive depending on whether the operator is anticipating a call and has data to transmit, or is expecting to receive incoming data. The operator will set the mode switch either to transmit or receive and make the appropriate input/output unit "ready".




Note: The vertical spacing shown is for ease of reading. See "Tape-Controlled Carriage" and Figure 16 for the two-character-sequence spacing and skipping codes.

Figure 27. Typical Horizontal-Format-Control Operation

NOTE: The setting of the auto-answer key on both the data set and the 2780 terminal must be in agreement for this feature to operate properly. The first operation of the 2780 Auto-Answer key turns on the light of this back-lighted key and makes the feature operative. A succeeding operation of the key turns the Auto-Answer feature and light off. Repeated operations of this key make the feature functional and non-functional.

The line-control format follows:

Mode Switch of Called Terminal Set to Receive

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | E | S | E | | E | b | b | S | |
| CALLING TERM | N | T | S | ? Text | T | c | c | T... | |
| or CPU | Q | X | C | | B | c | c | X | |
| CALLED TERM | | D | | | | | D | | |
| | | L0 | | | | | L1 | | |
| | | E | | | | | E | | |

Mode Switch of Called Terminal Set to Transmit

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | E | E | D | | | | D | | |
| CALLING CPU | N | O | L0 | | | | L1 | | |
| | Q | T | E | | | | E | | |
| | * | D | E | S | | E | b | b | S |
| CALLED TERM | | L0 | N | T | Text | T | c | c | T... |
| | | E | Q | X | | B | c | c | X |

When the data set of an answering terminal answers an incoming call, a 20-second timeout is initiated. If this timeout is completed before a character is received from the originating terminal,

*The printer must be "ready" if a DLE 0 response is to be transmitted; otherwise a NAK response will be sent. On a 2780 Model 4, the response will always be a NAK.

the terminal called will initiate a disconnect sequence if its reader is not ready. If the reader is ready at the called terminal, the terminal will initiate a Line Bid sequence after the 20-second timeout has occurred. If a positive response to this Line Bid is not received, the audible alarm will turn on and a second 20-second timeout is started. If this timeout is completed before a character is received, the called terminal will disconnect. This prevents the called terminal from being left off-hook (left unterminated) by a call that is not intended for it (wrong number), by a system failure, or by the completion of normal transmission. This is not an error condition and is not indicated as such.

After the transmission has been completed, the originating terminal (if a CPU) ends the call by sending a DLE EOT, which causes the called terminal to disconnect automatically. If the originating terminal fails to transmit a record correctly within the allotted number of retransmissions (3), the originating terminal should end the operation. The normal disconnect sequence is as follows when a 2780 is communicating with a CPU:

```
                          D    D E
CALLING CPU               L0   L O
                          E    E T

                      E   E
CALLED TERM...Text    T   O
                      X   T
```

or:

```
                          E    D E
CALLING CPU ...Text       T    L O
                          X    E T

                            D
CALLED TERM                 L0
                            E
```

When operating point-to-point (2780 to 2780), the auto-answer terminal will disconnect automatically after receiving the EOT if there is no subsequent transmission within 20 seconds.

NOTE: When switching from receive to transmit mode on a 2780 terminal equipped with the Auto Answer feature and operating over a switched network, the operator must first press the Auto Answer key on the 2780 (turns Auto Answer feature off) prior to changing the Mode switch from Receive to Transmit. If this procedure is not followed, a power-on reset occurs which causes the data-set-ready condition to drop out. However, if the data-set-ready condition is dropped, it can be re-established by: (1) pressing the Auto Answer Key on the 2780 (if not already operated, turns Auto Answer feature off), (2) removing the receiver from the data set, (3) pressing the Talk button on data set, (4) pressing Data button on data set, and (5) replacing receiver. The data-set-ready condition will be re-established provided the calling station has not been disconnected.

## MULTIPLE-RECORD TRANSMISSION

This special feature allows up to seven records to be transmitted before a line turnaround occurs. However, if the 2780 is operating at 4800 bps line speed, no additional throughput can be expected when this feature is used. The specific number of records depends upon the length of each record (with a maximum total of 400 characters). If less than 80 characters are to be read, the record length is defined by use of the EM (End of Media) character. The US, ETB, or ETX control character will be transmitted following the transmission of the EM character. Full 80-character records will generate a US, ETB or ETX control character automatically.

The 400-character limitation includes all data; all component selection, vertical forms control, and horizontal forms control sequences; and all end-of-record characters--but it does not include the STX character that the 2780 encodes when transmitting. When the EBCDIC code is used, the transmitting and receiving terminal will consider the modified LRC check characters as part of the 400-character limitation. One modified LRC check character is generated for each record.

Line buffer overrun will not occur until more than seven records per block are received or the 400-character limitation is exceeded, when this feature is installed. The operation of the line and I/O buffer for handling a data record is not changed by this feature. The input and output counter capacity is increased to provide 7 record (maximum) capability.

The Multiple-Record Transmission feature operates in the following manner: Assume that the cards to be read are punched in all 80 columns. Cards 1 through 5 will be read and the US character will be generated automatically at the end of each card read.

- Card 1 is transmitted while card 2 is read and then transferred from the I/O buffer to the line buffer.
- After card 5 has been read, the 2780 machine logic determines that the data read cannot be accommodated by the 400- character buffer capacity; the US character generated at the end of card 4 is therefore retranslated to an ETB and transmitted. The ETB initiates a block check response, which causes a line turnaround from the receiver. Overrun prevents the counter from increasing to 5. No error condition exists. A stop-load condition exists, however, and causes the reading of cards to be momentarily suspended. Manual intervention by the operator is not required under these circumstances.

- When the positive acknowledgment to the ETB is received by the transmitter, information from card 5 (which is stored in the I/O buffer) is transferred to the line buffer; transmission begins again, and the card reader automatically restarts to read card 6 into the I/O buffer.

- If the End-of-File key has been operated, the 2780 control unit automatically encodes the ETX character following the information in the last card of the message; however, ETX could also be punched in the last card.

- A positive response to the ETX causes the transmitting terminal to encode an EOT. EOT relinquishes the communications line and turns on the audible alarm.

- The operator turns off the audible alarm by pressing the stop key or by rotating the mode switch.

NOTE: A throughput loss will result when punching data received at a 2780 terminal that is operating under the following conditions:

1. 2400 bps transmission speed
2. Six-bit transcode
3. Multiple-record transmission feature installed

The first block of data received that is to be punched (not printed), which is 400 characters long and consists of 7 card records, will operate satisfactorily. Any succeeding blocks of data received which are 400 characters long will cause a throughput loss in the same transmission cycle.

The throughput loss can be avoided by limiting the total number of punched characters to 364. The number of characters punched in each of the seven cards (records) can vary; however, the total number of characters punched cannot exceed 364.

When receiving from a CPU, the CPU program must block the records so that the capacity of the 400-character buffer of the receiving terminal is not exceeded. If the CPU is transmitting to a 2780 terminal equipped with EBCDIC, it must consider the LRC check characters that are accumulated by the 2780 terminal (for internal checking) as part of the 400-character limitation mentioned previously. One modified LRC check character is generated for each record.

When transmitting to a CPU or another 2780 terminal, the card reader continues to operate until the line buffer and I/O buffer are filled. This condition will stop the card reader until all records in the line buffer have been transmitted and a positive acknowledgment is received from the receiving terminal. Then the last record in the I/O buffer is transferred to the line buffer and transmitted while the card read/punch automatically restarts and reads the next record into the I/O buffer.

## EBCDIC TRANSPARENCY

The Transparency feature (controlled by the mode switch) allows all possible bit combinations in the EBCDIC code to be used as data. Therefore, all 256 card codes can be punched and read by the IBM 2780. A control character is treated as data unless it is preceded by the DLE character. A DLE character to be treated as data must be followed by another DLE character. The extra DLE character is automatically inserted by the transmitting terminal and does not have to be punched in the input media. One of the DLE characters is discarded by the receiving terminal.

Transparent-text-mode operation is initiated by a machine generated DLE STX sequence, and terminated by a DLE character that is followed by a record or a block character (US, ETB, or ETX). In transparent operation, two SYN characters must be transmitted following transmission of a US record-check sequence. After the US record character, transparent text mode is re-established by another machine-generated DLE STX sequence. A change from transparent text to normal text, or from normal text to transparent text, can occur only after a block-checking sequence (ETB, ETX). The line format is as follows:

```
S S S D S        D U b b S S D S        D E b b p
Y Y Y L T Text   L S c c Y Y L T Text   L T c c a Turnaround
N N N E X        E   c c N N E X       E B c c d
```

The DLE characters are inserted when the characters are transferred to the line from the line buffer, and are deleted at the receiving terminal before entering the line buffer by the Binary Synchronous Adapter. The SYN characters following the US sequence are required to maintain bit synchronism and character phase between records of text.

All transmitted records are 80 characters long--that is, an EM or ETX character read from the card will not cause reading to stop. The first column 80 read causes a US sequence to be encoded; the second column 80 read causes an ETB sequence to be encoded. With the end-of-file switch on, a DLE ETX will be encoded when the last card is read. Transmission of ETX as a message-end character can be caused only by the end-of-file function since an ETX read from the card will be treated as data.

The following conditions must be adhered to when operating in the transparent mode:

- When a punch is receiving text in transparent mode, the length of the record must be 80 characters.

- Data records transmitted to a printer in a terminal-to-terminal system are 80 characters in length. When operating in transparent mode and the printer is selected; a vertical-forms-control sequence (as the first two characters of a record) initiates a carriage function as in normal mode.

- Data records transmitted to a printer in a CPU-to-terminal operation must be equal to the print-span requirement.

- Records with vertical-forms-control sequences must be 82, 122, or 146 characters long to provide a record length of 80, 120, or 144 characters.

- Component selection and Printer Horizontal Format Control (special feature) will not operate with transparent text.

- Component selection (punch or printer) must be executed while operating in normal mode; however, once the selection has been made it remains in effect for all subsequent transparent blocks of text until another selection is made in normal mode or until an EOT is transmitted.

- The Multiple-Record special feature is operative in transparent mode; however, the records must be of fixed length as previously described.

## AUTO TURNAROUND

The Auto Turnaround feature enables the terminal automatically to switch to receive mode and ready the punch without operator intervention after completing a transmitted message. This reduces the line time normally required when the terminal is manually changed to a punch-ready mode. The card reader shifts to a punch-ready status automatically after sensing the first blank card that follows the data cards. Once punch-ready status is obtained and punching is completed, the card reader is made ready by operating the stop key or performing a power-on reset. Sensing a blank card also causes an ETX to be transmitted automatically. However, when the EBCDIC Transparency feature is used, 80 space characters in addition to the ETX control character are transmitted automatically. When the receiving terminal is performing a punch operation and the transmitting terminal performs an auto-turnaround, a blank card is fed into the stacker of the receiving terminal following the last card punched.

NOTE: When the EBCDIC code is used, an auto-turnaround causes the end-of-file light to turn on automatically.

Blank cards for the punching operation should follow the data cards in the card read/punch hopper. Because this feature will operate only in transmit or transmit-transparent mode, the punch must be selected.

NOTE: If desired, the printer can be selected instead of the punch by using one of the two-character sequence codes shown in Figure 16 in place of the ESC 4 sequence shown in the following example (which applies to the punch only).

The line-control sequence is as follows:

```
                S    E S    E  E  D          D
TRANS TERM  TTextT TTextT  O  L0 (punch)  L1
            X    B X    X  T  E          E
             (Data)  (Blank
                     card)

                D      D E  S  E      E  S
RECV TERM       L1     L0N  T  S 4 TextT  T...
or CPU          E      E Q  X  C      B  X
```

## TERMINAL IDENTIFICATION

This feature is available for all models of the 2780 when operating in EBCDIC or USASCII code over common-carrier switched telephone networks. The Terminal Identification feature enables the 2780 to transmit a two-character identification sequence prior to the transmission of data to the CPU. The same identification character is transmitted twice automatically. The CPU, under stored program control, can thereby identify a legitimate 2780 terminal user. The identification code can be used also to distinguish between types of remote compatible binary synchronous terminals and their associated I/O configurations and features.

When in identification mode, the 2780 transmits SYN SYN SYN X X ENQ PAD directly after a line connection has been established, or sends SYN SYN SYN X X DLE 0 or 1 PAD as a response. The X is the identification character specified by the user and assigned in the machine logics by an IBM Customer Engineer at the time of installation. When operating in USASCII code, the identification character can be any one of the upper or lower case alphabetic characters. When operating in EBCDIC code, the identification character can be any one of the upper or lower case alphabetic characters, or a numeric character. The 2780 treats any identification characters received as leading graphics and ignores them as data.

The 2780 enters identification mode only upon establishing a line connection. Identification mode is terminated when the 2780 enters text mode, or when transmitting or receiving an EOT with the Line indicator light off. (The line light may have been turned on previously by the receipt of the WACK sequence.)

The identification characters are not included in the check character accumulation.

## DUAL COMMUNICATIONS INTERFACE

This special feature is available for all models of the 2780. It provides two independent data set cables and associated circuitry, to enable the machine operation to be transferred from its assigned primary communications path to a secondary path in the event of a line or data set failure.

This feature operates with any one of the three available codes over either two switched networks, two leased lines, two privately owned lines, or any two line-combinations thereof. A two-position switch, located on the customer engineering test panel, is used to switch from one communications path to the other.

Data sets with internal clocking (clocking within the data set) must be provided by the user.

NOTE: The Synchronous Clock and Multipoint Line Control special features are not available, and the Auto Answer and Terminal Identification special features (if installed) operate only on switched networks when the Dual Communications Interface special feature is installed.

## 120-CHARACTER PRINT LINE

This special feature provides an extra 40 print positions for the 2780 printer, giving it a total of 120 positions. These extra positions will print all characters available in the character set. Character density will be 10 to the inch, thus providing a 12-inch printing line.

This feature is generally used on 2780's operating with a CPU since a 2780 can only transmit records with a maximum of 80 characters.

## 144-CHARACTER PRINT LINE

This feature provides 24 additional print positions for a printer with the 120-Character Print Line special feature. The print line is expanded to 14.4 inches, each position of which can print all characters in the character set.

This feature is generally used on 2780's operating with a CPU since a 2780 can only transmit records with a maximum of 80 characters.

NOTE: The 120-Character Print Line and 144-Character Print Line special feature can be used only with a 2780 equipped with the terminal-to-terminal specify feature when prime communications are alternately with a CPU and another 2780 via a switched network. In those cases, the 2780 can not have the Transparency special feature installed.

## SELECTIVE CHARACTER SET

This feature is required for the use of any typebar other than the standard bar in EBCDIC and Six-Bit Transcode (Figure 15).

### EBCDIC Code

With this code, 39- and 63-character sets are available with the Selective Character Set feature.

### Six-Bit Transcode

With this code, a 39-character set is available with the Selective Character Set feature.

### USASCII Code

The Selective Character Set special feature is a prerequisite when using the USASCII code. Only one character set (63 characters) is available for this code.

## WORLD TRADE FEATURES

The following features are unique to, and available for, World Trade machines only. These features supplement the special features previously described (which are available for both Domestic and World Trade machines). For use of other than the modems named, consult the local IBM World Trade Marketing Representative.

### Modem Attachment (IBM 3976 Model 3 Modem)

This feature permits the attachment of the IBM 3976 Model 3 Modem for point-to-point operation (2780 to 2780, 2780 to 2701 or 2703, or 2780 to 2025 via the Integrated Communications Attachment) or multipoint operation (2780's to 2701 or 2703 or 2780's to 2025 via the Integrated Communications Attachment) over either privately leased, privately owned, or common-carrier switched telephone network facilities at 600 or 1200 bps. The Synchronous Clock special feature is a prerequisite for this modem attachment feature to be installed.

### Modem Attachment - Leased Lines (IBM 3977 Model 1 and 2 Modem)

The IBM 3977 Model 1 Modem can be attached to the 2780 for point-to-point operation (2780 to 2780,

2780 to 2701 or 2703, or 2780 to 2025 via the Integrated Communications Attachment), or multipoint operation (2780's to 2701 or 2703, or 2780's to 2025 via the Integrated Communications Attachment) over leased communications lines, at 600 or 1200 bps.

The IBM 3977 Model 2 Modem can be attached to the 2780 for point-to-point operation (2780 to 2780, 2780 to 2701 or 2703, or 2780 to 2025 via the Integrated Communications Attachment) at 600, 1200, 2000, or 2400 bps, or multipoint operation (2780's to 2701 or 2703, or 2780's to 2025 via the Integrated Communications Attachment) at 600 or 1200 bps over leased communications lines. The Synchronous Clock special feature is a prerequisite when either of these modems is used.

Modem Attachment - Leased Lines (GPO Datel 1 Model 5 Modem)

This feature permits the attachment of the GPO Datel 1 Model 5 Modem for point-to-point operation (2780 to 2780, 2780 to 2701 or 2703, or 2780 to 2025 via the Integrated Communications Attachment) or multipoint operation (2780's to 2701 or 2703, or 2780's to 2025 via the Integrated Communications Attachment) over leased communications lines at 600 or 1200 bps. The Synchronous Clock special feature is a prerequisite when this modem attachment feature is installed.

Modem Attachment-Switched Telephone Network (GPO Datel 1 Model 5 Modem)

This feature permits the attachment of the GPO Datel 1 Model 5 Modem for point-to-point operation (2780 to 2780, 2780 to 2701 or 2703, or 2780 to 2025 via the Integrated Communications Attachment) over switched telephone networks at 600 or 1200 bps only. The Synchronous Clock special feature is a prerequisite for this modem attachment feature to be installed. The Auto Answer and Speed Selector Switch special features can be used with this modem attachment feature, if desired.

Modem Attachment-Leased Lines (PTT GH-2002 B or C Modem)

This feature permits the attachment of the PTT GH-2002B Modem for point-to-point operation (2780 to 2780, 2780 to 2701 or 2703, or 2780 to 2025 via the Integrated Communications Attachment), over leased lines at 600 or 1200 bps. The PTT GH-2002B or C Modem can be used also for multipoint operation (2780's to 2701 or 2703 or 2780's to 2025 via the Integrated Communications Attachment) over leased lines at 600 or 1200 bps.

Modem Attachment-Switched Telephone Network (PTT GH-2002A Modem)

This feature permits the attachment of the PTT GH-2002A Modem for point-to-point operation (2780 to 2780, 2780 to 2701 or 2703, or 2780 to 2025 via the Integrated Communications Attachment) over switched telephone networks at 600 or 1200 bps only. This modem generally provides internal clocking; if not, the Synchronous Clock special feature is required. The Auto Answer and Speed Selector Switch special features can be used with this modem attachment feature, if desired.

Modem Attachment-Leased Lines PTT D1200S (GH-2011 Model 5) Modem

This feature permits the attachment of the PTT D1200S (GH-2011 Model 5) Modem for point-to-point operation (2780 to 2780, 2780 to 2701 or 2703, or 2780 to 2025 via the Integrated Communications Attachment), or multipoint operation (2780's to 2701 or 2703, or 2780's to 2025 via the Integrated Communications Attachment) over leased lines at 600 or 1200 bps. The Synchronous Clock special feature is a prerequisite when this modem attachment feature is installed.

Modem Attachment-Switched Telephone Network PTT D1200S (GH-2011 Model 5) Modem

This feature permits the attachment of the PTT D1200S (GH-2011 Model 5) Modem for point-to-point operation (2780 to 2780, 2780 to 2701 or 2703, or 2780 to 2025 via the Integrated Communications Attachment) over switched telephone networks at 600 or 1200 bps only. The Auto Answer and Synchronous Clock special features are prerequisites for this modem attachment feature to be installed. The Speed Selector Switch special feature can be used with this modem attachment feature, if desired.

Speed Selector Switch

This feature provides a two-position switch (located on the CE panel) which enables the operator to select a transmission speed of 600 or 1200 bits per second when operating with modems for switched telephone network (dial-up) operation. If difficulty is experienced with the transmission line while attempting to operate at 1200 bps, switching to 600 bps speed may allow the transmission to proceed with less frequent transmission line errors and give a better overall performance.

## BASIC LINE CONTROL

The IBM 2780 basic line control allows the terminal to operate on a point-to-point system with another 2780 or a CPU.

### Serializer Synchronization

Each transmission begins with a sync pattern of three consecutive SYN characters. To obtain synchronization (or character phase), a receiving terminal must receive at least two consecutive SYN characters A terminal, ready to transmit, must first determine that the remote unit is able to receive. This request to transmit is made by the transmission of an ENQ. On receipt of the ENQ, a remote unit will respond with DLE 0 if it is ready to receive data, or with NAK if it is not ready to receive data.

Example: Simple Point-To-Point Operation

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | E | S | | E | S | | E | E | | | | | | | | |
| TRANSMIT | N | T | Text | T | T | Text | T | O | | | | | | | | |
| | Q | X | | B | X | | X | T | | | | | | | | |
| | | | (Odd) | | | (Even) | | | | | | | | | | |
| | | D | | | D | | | D | | | | | | | | |
| RECEIVE | | L0 | | | L1 | | | L0 | | | | | | | | |
| | | E | | | E | | | E | | | | | | | | |

Any response other than DLE 0 or NAK to a request to transmit will result in a retransmission of the ENQ.

If a negative reply to an ENQ occurs, the ENQ will be repeated until a positive reply occurs, or until three inquiries have been sent. If the reply to the third ENQ is still negative, an EOT is sent. In a point-to-point configuration, one terminal can be designated the primary terminal and the other the secondary terminal (see "Timeout Controls" section of this manual). In a terminal-to-CPU operation, the terminal is always the primary terminal. A primary terminal is the terminal that will transmit date first if both stations try to initiate transmission at the same time. A primary terminal will wait one second for a response to its ENQ before retransmitting the ENQ.

A secondary station will wait three seconds for a response to its ENQ before sending ENQ again. If the secondary station receives an ENQ as a response to its ENQ, it will respond as if it had never tried to initiate transmission--i.e., with DLE 0 or NAK, depending on its readiness to receive. However, it will initiate the request for transmission of its data after it receives an EOT from the primary terminal. If both stations send ENQ at the same time, neither will respond to the other's bid. The primary station will then gain control of the line with a second ENQ before the secondary's second ENQ. DLE 0 is always the positive reply to a line-bid ENQ. There is no alternation as in the checking procedure. NAK is the negative reply.

After an EOT appears on the line, both terminals go into control mode. Any ENQ in control mode is interpreted as a line bid. Both stations go into text mode with the appearance of an STX on the line. Text mode is maintained until an EOT appears again. In text mode, an ENQ is interpreted as a request for a response to checking.

NOTE: The mode switch must be set at the TSM (Transmit) position.

Example: Point-to-Point Line-Control Sequence

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | E | | | E | S | | | E | E | D | | | | D | | | | | | | | | | | | | | |
| PRI- | N | (1 sec) | | N | T | Text | | T | O | L0 | | | | L1 | | | | | | | | | | | | | | |
| MARY | Q | | | Q | X | | | X | T | E | | | | E | | | | | | | | | | | | | | |
| | | | | | (Odd) | | | | | | | | | | | | | | | | | | | | | | | |
| | E | | | D | | | | D | E | S | | | E | E | | | | | | | | | | | | | | |
| SECON- | N | | | L0 | | | | L1 | N | T | Text | | T | O | | | | | | | | | | | | | | |
| DARY | Q | | | E | | | | E | Q | X | | | X | T | | | | | | | | | | | | | | |
| | | | | | | | | | | (Odd) | | | | | | | | | | | | | | | | | | |

### Format, Responding to Transmission of Text

Positive Response

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | S | | | E | b | b | | S | | | | | | | | | | | | | | | | | | | | |
| TERM A | T | Text | | T | c | c | | T | Text... | | | | | | | | | | | | | | | | | | | |
| or CPU | X | | | B | c | c | | X | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | D* | | | | | | | | | | | | | | | | | | | | | |
| TERM B | | | | | | | L1 | | | | | | | | | | | | | | | | | | | | | |
| or CPU | | | | | | | E | | | | | | | | | | | | | | | | | | | | | |

*DLE 0 or DLE 1

Negative Response

```
          S       E b b  S
TERM A    T Text 1 T c c  T Text 1 (Retransmission)
or CPU    X        B c c  X
                          N
TERM B                    A
or CPU                    K
```

Invalid or No Response

```
              S       E b b  E   E   E   E
TERMINAL A    T Text  T c c  N   N   N   O (Discon-
or CPU        X       B c c  Q   Q   Q   T nect)

TERMINAL B                   *   *   *   *
or CPU
```

*Invalid or no response

Format, EOT Response or Incomplete Transmission

EOT Response

```
              S       E b b
TERMINAL A    T Text  T c c  (Re-establish commun-
or CPU        X       B c c   ication)
                          E
TERMINAL B                O
                          T
```

Incomplete Transmission

```
              S       E   E
TERMINAL A    T Text  N   O (Re-establish
or CPU        X       Q   T communication)

                      N
TERMINAL B            A
                      K
```

Format, Error Conditions

Line Failure

```
              E    S       E b b   E    S
TERMINAL A    N    T Text1 T c c   N    T Text 2
or CPU        Q    X       B c c   Q    X

                D                 D    D   (Line fail-
TERMINAL B      L0                L0   L1  ure dur-
or CPU          E                 E    E   ing re-
                                           sponse;
                                           character
                                           1 changed
                                           to 0)
```

Out of Step

```
                E    S        E b b    S        E b b    E    E    E    E
TERMINAL A      N    T Text 1 T c c    T Text 2 T c c    N    N    N    O
or CPU          Q    X        B c c    X        B c c    Q    Q    Q    T

                  D              D              D    D    D    D
TERMINAL B        L 0            L 1            L 1  L 1  L 1  L 1
or CPU            E              E              E    E    E    E
```

Format, Retransmission

Negative Response

```
                E    S        E b b    S        E b b    S
TERMINAL A      N    T Text 1 T c c    T Text 1 T c c    T Text 2...
or CPU          Q    X        B c c    X        B c c    X

                  D              N              D
TERMINAL B        L 0            A              L 1
or CPU            E              K              E
```

Text will be retransmitted three times before stop condition when operating terminal-to-terminal.

No Response

```
                E    S        E b b      E      E      E      E
TERMINAL A      N    T Text 1 T c c      N      N      N      O
or CPU          Q    X        B c c      Q      Q      Q      T

                  D              Time-  Time-  Time-  Time-
TERMINAL B        L 0              out    out    out    out
or CPU            E
```

STX Missed (Out-of-Step Condition)

```
                E          E b b      E    S        E b b    S
TERMINAL A      N    Text 1 T c c      N    T Text 1 T c c    T Text 2...
or CPU          Q          B c c      Q    X        B c c    X

                  D            Time-  D              D
TERMINAL B        L 0            out  L 0            L 1
or CPU            E                   E              E
```

This section describes the procedures necessary to properly operate the IBM 2780 during an off-line listing, transmit, or receive operation. For the 2780 to be operational, the main-line switch must be turned on and all interlocks satisfied. When operating on-line, the 2780 must be connected to an operational data set. The following procedures assume that both terminals and their respective data sets are ready for operation.

## OFF-LINE OPERATION (MODELS 1 AND 2 ONLY)

When operating off-line, the card read/punch reads cards and prints them on the printer, one line per card. To operate in off-line mode:

Check

- That paper and carriage tape are properly positioned at channel 1.
- That all interlock conditions are satisfied.

Set

- The operation mode switch to off-line.
- Printer in ready status by pressing printer start key.

Clear machine by pressing NPRO key. Load the cards to be used into the feed hopper of the card read/punch and press the start key until the ready light turns on. Provided no check conditions arise, the 2780 terminal will now read cards and print until the machine runs out of cards or senses an ETX.

### Normal Stops

Hopper Empty

The ready light turns off (card read/punch panel) after the last card has been read and processed. If more cards are to be processed, load them into the hopper and press the start key.

Stacker Full

The ready light turns off when the stacker is full. To restart, remove cards from the stacker and press the start key on the card read/punch.

## TRANSMIT OPERATION (MODELS 1, 2, AND 4)

Before a transmit operation, the operator can run an off-line listing of the cards to be transmitted (Models 1 and 2 only). The operator can use the off-line listing to check the accuracy of the cards to be transmitted. The listing will also indicate any invalid characters. Any corrections necessary can then be made before the actual transmit operation, thus providing a more efficient and smoother transmit run. To operate in transmit mode:

Check

- That the data set ready light is on.

Set

- The operation mode switch to one of the two transmit modes: TSM (Transmit), or TSM TRSP (Transmit Transparent) if the transparency feature is used.

Clear machine by pressing NPRO key. Load the cards to be transmitted into the feed hopper. Press and hold down the start key until the ready light turns on. Press end-of-file key. Provided no error conditions arise, the operation will run to completion.

### Normal Stops

Hopper Empty

The alarm sounds and the ready light turns off (card read/punch panel) after the last card has been read and transmitted. If the end-of-file key was operated before placing the last group of cards in the hopper, a normal transmission-end will occur after the last card is transmitted. If the end-of-file key was not operated, refill the hopper and press the start key to resume the operation. In either case press the stop key to turn alarm off.

Stacker Full

The audible alarm sounds and the ready light turns off when the stacker is full. Press stop key to turn alarm off. To restart, remove cards from the stacker and press the start key on the card read/punch.

RECEIVE OPERATION

To operate the terminal as a receiver:

Check

- That paper and carriage tape are properly positioned at channel 1.
- That the data set ready light is on.

Set

- The operation mode switch to one of the three receive positions: punch (Models 2 and 4 only), print (Models 1 and 2 only), or receive (Model 2, only).

Clear machine by pressing NPRO key. Load blank cards into the feed hopper (Models 2 or 4 only). Press the start key on the card read/punch until the ready light turns on (Models 2 or 4 only). Press the start key on the printer.

NOTE: If the received data is to be punched and not printed, only the first three steps are necessary. If the received data is to be printed and not punched, only the last step is necessary. If the received data is to be punched or printed (component selected by the component-select character), all steps are necessary after the operation mode switch is set to the receive position.

Normal Stops (Punch Operation)

Hopper Empty

The alarm sounds, and the ready light turns off when the last card leaves the hopper. The last two cards are held at the punch and read stations. Press stop key to turn alarm off. To restart, load blank cards into the feed hopper and press the start key on the card read/punch.

Stacker Full

The audible alarm sounds and the ready light turns off when the stacker is full. Press stop key to turn alarm off. To restart, remove cards from the stacker and press the start key on the card read/punch.

Receive Only (2780 Model 3)

When a 2780 Model 3 terminal is used with a CPU over a leased private line on an individual or multipoint basis, the terminal must be addressed (under control of the CPU program routine) in order to receive and print data. The Ready status of the terminal must be maintained by the operator. When operating over a switched network, the operator can dial the CPU, shift to voice mode for coordination of terminal and CPU requirements, and then manually switch to data mode. If the Auto Answer feature is installed on the 2780 Model 3 and its associated data set (and Auto Dial is installed on the CPU multiplexer), voice communication is not required as an intermediate step in the procedure just described.

When a 2780 Model 3 is used with a CPU on a switched network, it is recommended that the Auto Answer feature not be installed on the multiplexer and its associated data set. However, if 2780 Model 3's are intermixed with other models of the 2780, the Auto Answer feature can be used, but the operator(s) of the model 3(s) should not call the CPU. The 2780 Model 3 terminal cannot generate (transmit) an ENQ or a terminal identification sequence to the CPU. Therefore, the CPU program does not know the 2780 configuration and whether a request to transmit or receive is desired or functionally possible.

Alternate Transmitting and Receiving (Models 1, 2, and 4)

The operating procedures, when alternately transmitting and receiving, are the same (except for the setting of the Mode switch) as when transmitting or receiving independently. The Mode switch setting for the various models of the 2780, when alternately transmitting and receiving, is as follows:

Card Read and Print (Model 1.)

Set Mode switch to the TSM (Transmit) or TSM TRSP (Transmit Transparent) position. The switch can be left at this setting throughout the entire operation (transmitting and receiving). When receiving, the printer must be selected by using one of the two-character selection sequences shown in Figure 16. The printer must also be in a Ready status. This setting of the Mode switch is also used when operating on a multipoint basis. In order to receive, the printer must be addressed and in a Ready status (see Multipoint Line Control under Special Features).

Card Read, Card Punch, and Print (Model 2)

When alternately transmitting and receiving, the Mode switch is set to the TSM or TSM TRSP position when transmitting. If the punch is to be used exclusively when receiving, the Mode switch is set to the PUNCH position and no component selection is required. If the printer is to be used exlusively when receiving, the Mode switch is set to the PRINT position and no component selection is re-

quired. If the received data is to be punched or printed, the Mode switch is set to the REC (Receive) position and the punch or printer must be selected. When operating on a multipoint basis, the punch or printer must be addressed.

The operator and programmer should be aware of the following situation when using a 2780 Model 2. In receive mode, with its printer ready and punch not ready (or vice-versa), the 2780 Model 2 will respond to an ENQ with a DLE 70 (positive response). The transmitter (CPU or terminal), not knowing which output unit or units are ready, begins sending its message containing an ESC selection sequence for the not-ready device (printer or punch). The receiving 2780 Model 2 responds with an EOT indicating that the selected I/O unit is not ready. This turns on the audible alarm and the Term Add indicator to signal the operator to intervene. If the transmitter sends an ENQ before the operator intervenes or is aware of the condition requiring intervention, the audible alarm will be turned off and the receiving 2780 Model 2 will make no response until a POR (Power on Reset) is executed. Depending on the line speed, the audible alarm can be very brief or even nonexistent.

### Card Read and Card Punch (Model 4)

Set the Mode switch to the TSM or TSM TRSP position when transmitting. Set the Mode switch to PUNCH when receiving. With the Mode switch set to PUNCH, no component selection is required when operating point-to-point. The punch must be addressed when operating multipoint.

If the Auto Turnaround special feature is used, the Mode switch can be left in the TSM or TSM TRSP setting when receiving; however, the punch must be selected (see Auto Turnaround under "Special Features").

The following describes the various error conditions possible during a transmit or receive operation along with the line responses and correction procedures.

## SUMMARY OF RESPONSES TO ERRORS

### NAK

Four error conditions cause the receiving terminal to respond with a NAK:

1. An incorrect CRC or VRC/LRC check.
2. A response to an ENQ after detecting an EOT in text.
3. Receipt of a block with too many records, or overrun of the line buffer.
4. Transmission not completed (no US, ETB, or ETX received).

### EOT

An EOT response to a block of data is sent if any of the following check conditions occur at the receiving terminal:

Hopper--Feed failure or empty.
Punch Station--Misfeed or jam.
Read Station--Misfeed or jam.
Transport--Jam in stacker transport.
Feed Clutch--Extra feed cycle.
Equipment Check--Incorrect punch or invalid punch combinations.
Overrun--Record exceeding 170 characters.
Buffer Parity Error--Both line and I/O buffer.
Sync Check--Typebar out of synchronization.
Forms Check--Jam, interlocks not made, etc.
End-of-Forms Check--End of forms and channel 1 sensed.
Component-Selection Error--Selection of not-ready component when only one component ready.
Miscellaneous Loss of Printer or Punch Ready--Punch or printer stop key pressed, stacker full, or chip box full or not in position.

### STX, ENQ

When any of the following checks occur at the transmitting terminal, the good records in the line buffer at that time are transmitted as a block (ETB inserted after last record):

Hopper Check--Failure to feed.
Punch Station--Misfeed or jam.
Read Station--Misfeed, jam, or defective photo transistor.
Transport--Stacker-transport jam.
Feed Clutch--Extra feed cycle.
Data Check--Cards off registration; invalid combination of punches in cards; or US, ETX, EOT, NAK, or ENQ character read from card.
Equipment Check--Failure to read all 80 columns with no EM or ETX.
Overrun--I/O buffer overrun.
Buffer Parity Check--In I/O buffer.
Miscellaneous Loss of Reader Ready--Stacker full, hopper empty, stop key pressed, or chip box full or not in position.

After receiving a positive response to the good records in the line buffer that were transmitted as a block, the transmitting terminal encodes the STX, ENQ characters.

### ENQ

When transmitting, the 2780 encodes the ENQ character at the time the error occurs for the following conditions:

Buffer Parity Check--Line buffer for all codes.
Buffer Overrun--Line buffer.

## ERROR-RECOVERY PROCEDURES FOR TERMINAL OPERATOR

Charts in Figures 28 and 29 illustrate the various error-recovery procedures that can be executed by each terminal operator when operating 2780-to-2780. Charts in Figures 30 and 31 illustrate the various error-recovery procedures that can be executed by the 2780 operator when operating with a CPU.

## SUGGESTED PROGRAMMING CONSIDERATIONS FOR THE VARIOUS ERROR RESPONSES WHEN OPERATING WITH A CPU

### NAK

Retransmit N times as designated by the user--a minimum of three is recommended. If a positive response is not received by the CPU after N retransmissions, the user may elect: (1) to retry N more times; (2) to disconnect and redial; (3) to encode EOT and return to control mode and try later; (4) to phone terminal operator to establish status; or (5) to

service other terminals by polling or selection and reselect error terminal later.

The user should be aware that part of the block may have been successfully processed by the terminal. Therefore the error block should be retransmitted once communication is re-established with the terminal. Upon receiving the retransmitted block, the terminal will output that part of the block not previously processed. If the user does not retransmit the error block but sends a different block of data, he is exposed to possible loss of records or parity checks.

In some cases a user might want to transmit another job before completing the job in which the error condition occurred, or he may want to restart the same job at a different starting point. For this operation, the terminal operator's error-recovery procedure varies from the normal procedure as defined in the charts. The number of cards equal to the counter lights, less one if the I/O buffer light is on, should be discarded. The mode switch should momentarily be turned off-position to reset the terminal. Any block then received would be processed completely.

If this procedure of resetting the terminal is followed and the printer was the device selected when the error occurred, a duplication of print lines can occur if the block of data containing the error is retransmittted. The number of lines equal to the counter lights, less one if the I/O buffer light is on, will be reprinted. For this type procedure it is recommended that the user retransmit the last page, and that the terminal operator discard the partially printed page.

When the terminal is transmitting to the CPU, the CPU controls the number of retransmissions of the terminal. If after N times the CPU responded with NAK, the program should encode an EOT. The user may elect to re-establish communication as previously outlined. Once communication is re-established, the 2780 will retransmit the last block and proceed in the normal manner.

The user should be aware that the last block is retained in the 2780 line buffer. If another job is to be performed (either transmitted or received) by the CPU, the normal terminal-operator error-recovery procedure is replaced by the following four steps: (1) remove cards from hopper; (2) run cards out of machine; (3) place the number of cards equal to the counter lights plus one, plus one more if the I/O buffer light is on, in front of the cards removed from the hopper; and (4) turn the mode switch off-position momentarily to reset the terminal.

EOT Response Received by CPU to a Transmitted Block

The user may instruct the program to disconnect for dial lines and redial after allowing the terminal operator sufficient time to restore the 2780 to operating status. The terminal operator should not answer until the terminal is restored to operating status.

Once communication is established, the last block transmitted that received the error indication (EOT) should be retransmitted. If the error block is not retransmitted, parity checks or wrong data may occur. The terminal operator must also be aware that certain conditions, such as the punch or printer dropping "ready," can cause duplication of records when the error block is retransmitted.

In auto-answer systems where another CPU or terminal might call the terminal that had the error condition, the 2780 operator error-recovery procedure applies, but with the following additions: (1) the number of punched cards indicated by the buffer counter lights, less one if the I/O buffer light is on, should be discarded; (2) the mode switch should be turned off-position momentarily, to reset the terminal including the counters. This prevents duplication of records when the original job is retransmitted, starting with the error block. It also leaves the terminal in a state that will allow the output of all records of a block if another CPU dials the terminal before the original caller makes connection.

When the output is sent to the printer, the same exposure of duplicating print lines exists as explained under the NAK response.

For leased lines, the user may attempt to re-establish communication with the terminal by sending the ENQ character, if a contention system; or he may attempt to select the 2780 if on a multipoint system. The user may also elect to service another terminal by polling or selection before retrying the error terminal, or to phone the terminal operator to establish status.

Once the CPU obtains communication with the terminal, the last block that has the error indication (EOT) should be retransmitted.

As discussed under the NAK response, if another job is to be performed before completing the message in which the error occurred, the terminal-operator error-recovery procedure is altered. The operator error-recovery procedure is the same as that written for the NAK. The exposure to duplication of print lines also exists.

The user should be cautioned that the EOT response might occur on the block following the block in which

the error occurred. For throughput efficiency, the line is turned around, and the positive acknowledgment sent, as soon as the last record of the block has been successfully transferred to the I/O buffer. If an error occurs while outputting this last record from the I/O buffer, it is too late to send the EOT. The first opportunity to send is after receiving the next block.

Normally no problem exists because this record is good and is maintained in the I/O buffer. After the error condition is corrected, the record is processed automatically when the output device becomes ready. If, however, the terminal is completely down, the record can be lost. Recovery requires operator intervention at the CPU and terminal to establish a restart point.

### STX, ENQ Received by CPU from 2780

The receipt of this sequence indicates a terminal error occurred while transmitting. The recovery procedures are the same as for NAK, except that N retransmissions do not occur.

### ENQ Received Within Text

The receipt of this character in text indicates an error condition and is handled the same as STX ENQ.

### Odd/Even Block-Check Failure

After three ENQ's are sent, if the odd/even block check is out of step or if there is no response, the program should post an error indication to the user. Operator intervention at the CPU and terminal is required to establish a restart point. Once established, normal startup procedures should be followed.

Users of these Error Recovery Procedure charts (Figures 28 through 31) should also refer to "Suggested Programming Considerations for the Various Error Responses When Operating with a CPU" in the preceding text.

| Trans. Term. Indicator | Recovery Procedure (Transmitting Terminal) | Rec. Term. Indicator |
|---|---|---|
| Equip Check (Failure to read all 80 columns if no EM character). | Press stop key.<br>Remove cards from hopper.<br>Press NPRO key to clear feed.<br>Press check reset key.<br>Remove last 2 cards from stacker and place in hopper.<br>Reload cards.<br>Press start key. | Line and Incp. |
| HOPR (No card was fed). | Press stop key.<br>Remove cards from hopper.<br>Press NPRO key to clear feed.<br>Correct damaged card(s), if necessary.<br>Reload cards.<br>Press start key. | Line and Incp. |
| Line (CRC check, lack of response, or incorrect response). | Press stop key.<br>Press start key. | Line and Incp. |
| Over Run (Data exceeds buffer capacity). | Press stop key.<br>Note CTR lights.<br>Remove cards from hopper.<br>Press NPRO key to clear feed.<br>Remove numbers of cards equal to CTR lights + 2 from back of stacker and reload in hopper.<br>Rotate mode switch (Power-On-Reset) to reset terminal.<br>Press start key. | Line and Incp. |
| Parity Check (Even parity is detected at buffer registers, or failure of check character to compare in EBCDIC). | Refer to Over Run recovery procedure. | Line and Incp. |
| Parity Check and Equip Check (Even parity is detected at buffer registers, or failure of check character to compare in EBCDIC). | Refer to Over Run recovery procedure. | Line and Incp. |
| PCH STA (Misfeed or jam). | Press stop key.<br>Remove cards from hopper.<br>Remove cards from feed transport.<br>Press NPRO key to clear feed.<br>Place cards, that have not passed read station, in the hopper.<br>Rotate mode switch (Power-On-Reset) to reset terminal.<br>Reload cards.<br>Press start key. | Line and Incp. |
| PCH STA and RD STA | Refer to PCH STA recovery procedure. | Line and Incp. |
| RD STA (Jam, misfeed, or defective photo transistor). | Refer to PCH STA recovery procedure. | Line and Incp. |
| TRSP (Jam in stacker transport). | Press stop key.<br>Remove cards from hopper.<br>Clear cards from stacker transport.<br>Press NPRO key to clear feed.<br>Remove last card from stacker and place in hopper.<br>Reload cards.<br>Press start key. | Line and Incp. |

Figure 28. Error Recovery Procedures--Transmitting Terminal Operator (2780-to-2780 Operation) (Part 1 of 2)

| Trans. Term. Indicator | Recovery Procedure (Transmitting Terminal) | Rec. Term. Indicator |
|---|---|---|
| CLU and Equip Check (Failure of card feed clutch). | Contact receiving terminal to determine restart point.<br>Remove cards from hopper.<br>Press NPRO key to clear feed.<br>Rotate mode switch (Power-On-Reset) to reset terminal.<br>Place cards from restart point in hopper.<br>Reload cards.<br>Press start key. | Line and Incp. |
| Data Check | Refer to Data Check and Equip Check recovery procedure. | Line and Incp. |
| Data Check and Equip Check (Card off registration, or invalid combination of punches). | Press stop key.<br>Remove cards from hopper.<br>Press NPRO key to clear feed.<br>Press check reset key.<br>Place last 2 cards from stacker in hopper after correcting the first card that entered the stacker on NPRO.<br>Reload cards.<br>Press start key. | Line and Incp. |
| Data, Equip, and Parity Check | Refer to Data Check and Equip Check recovery procedure | Line and Incp. |
| Record and Line (Failure of odd/even responses to compare). | Refer to Over Run recovery procedure. | Line and Incp, or Over Run. |
| INCP (EOT character received in response to block checking. This is probably due to a not-ready condition at the receiving terminal). | Press stop key to turn off audible alarm.<br>Press start key to continue transmission.<br>Note: If error reoccurs when start key is pressed, allow receiving terminal operator a short period of time to complete his recovery procedure before restarting. | Any one of the following:<br>End of Form<br>Equip Check<br>Form Check<br>Parity Check<br>Sync Check |

NOTE: Operator communication may be used as an alternate procedure for determining the restart point.

Figure 28. Error Recovery Procedures--Transmitting Terminal Operator (2780-to-2780 Operation) (Part 2 of 2)

Users of these Error Recovery Procedure charts (Figures 28 through 31) should also refer to "Suggested Programming Considerations for the Various Error Responses When Operating with a CPU" in the preceding text.

| Rec. Term. Indicator | Recovery Procedure (Receiving Terminal) | Trans. Term. Indicator |
|---|---|---|
| End of Form (Indicates approximately 4 inches of forms remain). | Press stop key.<br>Reload forms.<br>Press printer start key. | Incp. |
| Equip Check (Incorrect punch or invalid combination of punches). | Press stop key.<br>Remove cards from hopper.<br>Press NPRO key to clear feed.<br>Discard NPRO cards.<br>Reload cards.<br>Press check reset key.<br>Press start key. | Incp. |
| Form Check (Interlocks not made). | Press stop key.<br>Correct jammed forms.<br>Press printer start key. | Incp. |
| Overrun (Data overrun in I/O buffer. See description of overrun light if horizontal format or EBCDIC transparency feature is installed). | When Punching<br>Press stop key.<br>Remove cards from hopper.<br>Press NPRO key to clear feed.<br>Remove 2 blank cards from stacker.<br>Rotate mode switch (Power-On-Reset) to reset terminal.<br>Reload cards in hopper.<br>Contact transmitting station to established restart point.<br>Press start key.<br><br>When Printing<br>Press stop key.<br>Rotate mode switch (Power-On-Reset) to reset terminal (press machine reset key on Model 3).<br>Contact transmitting station to establish restart point.<br>Press printer start key. | Incp.<br><br>Incp. |
| Overrun and Incp. (Data overrun in line buffer, or number of records exceeds 2, or 7 if multiple record feature is installed). | No recovery procedure required, the 2780 will recover automatically.<br>If condition continues, contact transmitting station for possible error in formatting message or feature compatibility. | Line and Incp. |
| Parity with no CTR lights on and I/O BFR Full light on. (Even parity detected at buffer registers, or failure of check character to compare in EBCDIC). | When Punching<br>Press stop key.<br>Remove cards from hopper.<br>Press NPRO key to clear feed.<br>Rotate mode switch (Power-On-Reset) to reset terminal.<br>Remove and discard NPRO cards from stacker.<br>Reload cards.<br>Contact transmitting terminal to establish restart point, thereby avoiding loss of a record.<br>Press start key.<br><br>When Printing<br>Press stop key.<br>Rotate mode switch (Power-On-Reset) to reset terminal (use machine reset key on Model 3).<br>Delete duplicate print lines.<br>Contact transmitting terminal to establish restart point, thereby avoiding loss of a record.<br>Press printer start key.<br>Note: If job requirements are such that print lines cannot be deleted on the form, contact the transmitting terminal to establish restart point at the top of new form. | Incp.<br><br>Incp. |

Figure 29. Error Recovery Procedures--Receiving Terminal Operator (2780-to-2780 Operation) (Part 1 of 3)

| Rec. Term. Indicator | Recovery Procedure (Receiving Terminal) | Trans. Term. Indicator |
|---|---|---|
| Parity with CTR lights on and I/O BFR Full light on | When Punching<br>Press stop key.<br>Remove cards from hopper.<br>Press NPRO key to clear feed.<br>Discard number of cards in stacker equal to CTR lights plus 1.<br>Rotate mode switch (Power-On-Reset) to reset terminal.<br>Reload cards.<br>Press start key.<br><br>When Printing<br>Press stop key.<br>Delete print lines equal to CTR lights minus 1.<br>Rotate mode switch (Power-On-Reset) to reset terminal (use machine reset key on Model 3).<br><br>Press printer start key.<br>Note: If job requirements are such that print lines cannot be deleted on the form, contact the transmitting terminal to establish restart point at the top of new form. | Incp.<br><br>Incp. |
| Parity with or without CTR lights on and without I/O BFR Full light on. | When Punching<br>Press stop key.<br>Remove cards from hopper.<br>Press NPRO key to clear feed.<br>If CTR lights are on, discard number of cards in stacker equal to CTR lights plus 2.<br>If CTR lights are off, discard 2 cards from stacker.<br>Rotate mode switch (Power-On-Reset) to reset terminal.<br>Reload cards.<br>Press start key.<br><br>When Printing<br>Press stop key.<br>Delete print lines equal to CTR lights.<br>Rotate mode switch (Power-On-Reset) to reset terminal (use machine reset key on Model 3).<br>Press printer start key.<br>Note: If job requirements are such that print lines cannot be deleted on the form, contact the transmitting terminal to establish restart point at the top of new form. | Incp.<br><br>Incp. |
| Sync Check (Type bar out of synchronization). | Press stop key.<br>Delete print line.<br>Press printer reset key (check reset key on Model 3).<br>Press printer start key. | Incp. |
| Term Add (An attempt by a remote terminal to transmit to this terminal and selected output device is not ready, or no output device was selected). | Press stop key.<br>Press check reset key.<br>Make output device ready. | Audible Alarm |
| CLU and Term Add (Card feed clutch failure). | Press stop key.<br>Remove any partially punched or damaged cards (If this occurs contact transmitting station to determine restart point).<br>Press NPRO key to clear feed.<br>Press check reset key.<br>Reload cards.<br>Press start key. | Incp. |

Figure 29. Error Recovery Procedures--Receiving Terminal Operator (2780-to-2780 Operation) (Part 2 of 3)

| Rec. Term. Indicator | Recovery Procedure (Receiving Terminal) | Trans. Term. Indicator |
|---|---|---|
| HOPR and Term Add (No card was fed). | Press stop key.<br>Remove cards from hopper.<br>Remove damaged cards.<br>Press NPRO key to clear feed.<br>Press check reset key.<br>Press start key. | Incp. |
| PCH STA and Term Add (Misfeed, no card or jam in punch station). | Misfeed (No card in punch station)<br>Press stop key.<br>Remove cards from hopper.<br>Remove damaged cards between read and punch station.<br>Press NPRO key to clear feed.<br>Reload cards.<br>Press start key.<br><br>Jam (Card or cards jammed in punch station).<br>Press stop key.<br>Contact transmitting terminal to determine restart point.<br>Remove cards from hopper.<br>Remove jammed cards.<br>Press NPRO key to clear feed.<br>Rotate mode switch (Power-On-Reset) to reset terminal.<br>Place cards from restart point in hopper.<br>Reload cards.<br>Press start key. | Incp. |
| PCH STA, RD STA, and Term Add | Refer to PCH STA and Term Add recovery procedure. | Incp. |
| RD STA and Term Add (Jam, misfeed, or defective photo-transistor). | Refer to HOPR and Term Add recovery procedure. | Incp. |
| TRSP and Term Add (Jam in stacker transport). | Press stop key.<br>Remove cards from hopper.<br>Remove jammed card or cards from transport and correct.<br>Press NPRO key to clear feed.<br>Remove blank card from stacker that was fed on NPRO (See note).<br>Press check reset key.<br>Reload cards in hopper.<br>Press start key.<br>Note: If jammed cards are too badly damaged to be corrected, contact transmitting operator to determine restart point, and perform following steps:<br>Rotate mode switch (Power-On-Reset) to reset terminal.<br>Reload cards.<br>Press start key. | Incp. |
| Line and Incp. | No operator intervention required.<br>Note: Transmitting operator may contact you to determine restart point, depending upon type of error. | Any one of the following:<br>Equip Check<br>HOPR<br>Line<br>Over Run<br>Parity Check<br>PCH STA<br>RD STA<br>Parity and Equip Check<br>TRSP<br>CLU and Equip Check<br>Data Check<br>Data Check and Equip Check<br>Data Check, Equip Check, and Parity Check<br>Record and Line. |
| Line (No response to Line contention bid) | Press Stop<br>Press Start | |

Figure 29. Error Recovery Procedures--Receiving Terminal Operator (2780-to-2780 Operation) (Part 3 of 3)

Users of these Error Recovery Procedure charts (Figures 28 through 31) should also refer to "Suggested Programming Considerations for the Various Error Responses When Operating with a CPU" in the preceding text.

| 2780 Indicator | Recovery Procedure (2780) | Line Response |
|---|---|---|
| Equip Check (Failure to read all 80 columns if no EM character was read). | Press stop key.<br>Remove cards from hopper.<br>Press NPRO key to clear feed.<br>Press check reset key.<br>Remove last 2 cards from stacker and place in hopper.<br>Reload cards.<br>Press start key. | An ETB is sent by the 2780 at the end of the last good record in the buffer. After receiving good reply, 2780 sends STX, ENQ. |
| HOPR (No card was fed). | Press stop key.<br>Remove cards from hopper.<br>Press NPRO key to clear feed.<br>Correct card or cards, if damaged.<br>Reload cards.<br>Press start key. | Same as response for Equip Check. |
| Line (CRC check, lack of response or incorrect response). | Press stop key.<br>Press start key. | The result of a NAK response by CPU to 2780 after 3 attempts to transmit any single block. |
| Overrun (Data exceeds buffer capacity). | Press stop key.<br>Note Ctr. lights.<br>Remove cards from hopper.<br>Press NPRO key to clear feed.<br>Remove number of cards equal to ctr. lights +2 from back of stacker and reload in hopper.<br>Rotate mode switch (Power-On-Reset) to reset terminal.<br>Press start key. | I/O buffer overrun causes ETB to be sent after last good record. When good reply is received, 2780 sends STX, ENQ. Line buffer overrun causes an ENQ to be sent at the time the error is sensed. |
| Parity Check (Even parity is detected at buffer register, or failure of check character to compare in EBCDIC). | Refer to Overrun recovery procedure. | I/O buffer parity check causes ETB to be sent after last good record. When good reply is received, 2780 sends STX, ENQ. Line buffer parity check causes an ENQ to be sent at the time the error is sensed. |
| Parity Check and Equip Check (Same as parity check). | Refer to Overrun recovery procedure. | Same as parity check. |
| PCH STA (Misfeed or jam).<br><br>(The operator should visually check the machine transport area to determine which cards have passed under the read station) | Press stop key.<br>Remove cards from hopper.<br>Clear cards from feed transport.<br>Press NPRO key to clear feed.<br>Place cards that have not passed read station in the hopper.<br>Rotate mode switch (Power-On-Reset) to reset terminal.<br>Reload cards.<br>Press start key. | An ETB is sent after the last good record. When the good reply is received, the 2780 sends STX, ENQ. |
| PCH STA and RD STA | Refer to Punch Station recovery procedure. | Same as Punch Station. |
| RD STA (Jam, misfeed, or defective photo transistor). | Refer to Punch Station recovery procedure. | Same as Punch Station. |
| TRSP (Transport) (Jam in stacker transport). | Press stop key.<br>Remove cards from hopper.<br>Clear cards from stacker transport.<br>Press NPRO key to clear feed.<br>Remove last card from stacker and place in hopper.<br>Reload cards.<br>Press start key. | Same as Punch Station. |

Figure 30. Error Recovery Procedures--Transmitting Terminal Operator (2780 Transmitting to CPU) (Part 1 of 2)

| 2780 Indicator | Recovery Procedure (2780) | Line Response |
|---|---|---|
| CLU and Equip Check (Failure of card feed clutch). | Contact CPU operator to determine restart point.<br>Remove cards from hopper.<br>Press NPRO key to clear feed.<br>Rotate mode switch (Power-On-Reset) to reset terminal.<br>Place cards from restart point in hopper.<br>Reload cards.<br>Press start key. | Same as Punch Station. |
| Data Check | Refer to Data Check and Equip Check recovery procedure. | Same as Punch Station. |
| Data Check and Equip Check (Card off registration, or invalid combination of punches). | Press stop key.<br>Remove cards from hopper.<br>Press NPRO key to clear feed.<br>Press check reset key.<br>Place last 2 cards from stacker in hopper after correcting the first card that entered the stacker on NPRO.<br>Reload cards.<br>Press start key. | Same as Punch Station. |
| Data, Equip and Parity Check | Refer to Data and Equip Check recovery procedure. | Same as Punch Station. |
| Record and Line (Failure of odd/even responses to compare). | Refer to Overrun recovery procedure. | 2780 retries for correct response 3 times and then sends EOT and turns on error light. |
| INCP (Incomplete) (EOT character received in response to block checking. This is probably due to a not-ready or error condition at the CPU. | Press stop key to turn off audible alarm.<br>Press start key to continue transmission.<br>Note: If error occurs again when start key is pressed, allow receiving terminal operator a short period of time to complete recovery procedure. | EOT sent by CPU as a response to the last transmitted block causes this indication. When the 2780 start key is pressed, the entire block is retransmitted. |

Figure 30. Error Recovery Procedures--Transmitting Terminal Operator (2780 Transmitting to CPU) (Part 2 of 2)

Users of these Error Recovery Procedure charts (Figures 28 through 31) should also refer to "Suggested Programming Considerations for the Various Error Responses When Operating with a CPU" in the preceding text.

| 2780 Indicator | Recovery Procedure (2780) | Line Response |
|---|---|---|
| End of Form (Indicates approximately 4 inches of forms remain). | Press stop key.<br>Reload forms.<br>Press printer start key. | EOT is encoded as the response to the last block received. |
| Equip Check (Incorrect punch, or invalid combination of punches). | Press stop key.<br>Remove cards from hopper.<br>Press NPRO key to clear feed.<br>Discard NPRO cards.<br>Reload cards.<br>Press check reset key.<br>Press start key. | EOT is encoded as the response to the last block received. |
| Form Check (Interlocks not made). | Press stop key.<br>Correct jammed forms.<br>Press printer start key. | EOT is encoded as the response to the last block received. |
| Overrun (Data overrun in I/O buffer. See description of overrun light if horizontal format or EBCDIC transparency feature is installed). | When Punching<br>Press stop key.<br>Remove cards from hopper.<br>Press NPRO key to clear feed.<br>Remove 2 blank cards from stacker.<br>Rotate mode switch (Power-On-Reset) to reset terminal.<br>Reload cards in hopper.<br>Contact transmitting station to establish restart point.<br>Press start key.<br><br>When Printing<br>Press stop key.<br>Rotate mode switch (Power-On-Reset) to reset terminal (press machine reset key on Model 3).<br>Contact transmitting station to establish restart point.<br>Press printer start key. | EOT is encoded as the response to the last block received. |
| Overrun and Incp. (Data overrun in line buffer, or number of records exceeds 2, or 7 if multiple record feature is installed). | No recovery procedure required, the 2780 will recover automatically. If condition continues, contact transmitting station for possible error in formatting message or feature compatibility. | NAK is encoded as the response to the last block received. |
| Parity Check with no CTR lights on and I/O BFR Full light on. (Even parity detected at buffer registers, or failure of check character to compare in EBCDIC). | When Punching<br>Press stop key.<br>Remove cards from hopper.<br>Press NPRO key to clear feed.<br>Rotate mode switch (Power-On-Reset) to reset terminal.<br>Remove and discard NPRO cards from stacker.<br>Reload cards.<br>Contact transmitting terminal to establish restart point, thereby avoiding loss of a record.<br>Press start key.<br><br>When Printing<br>Press stop key.<br>Rotate mode switch (Power-On-Reset) to reset terminal (use machine reset key on Model 3).<br>Delete duplicate print lines.<br>Contact transmitting terminal to establish restart point, thereby avoiding loss of a record.<br>Press printer start key.<br>Note: If job requirements are such that print lines cannot be deleted on the form, contact the transmitting terminal to establish restart point at the top of new form. | EOT is encoded as the response to the last block received. |

Note: CPU Alternatives to 2780 error responses are listed under Summary of Responses to Errors in this section of the manual.

Figure 31. Error Recovery Procedures--Receiving Terminal Operator (2780 Receiving from CPU) (Part 1 of 3)

| 2780 Indicator | Recovery Procedure (2780) | Line Response |
|---|---|---|
| Parity Check with CTR lights on and I/O BFR Full light on. | When Punching<br>Press stop key.<br>Remove cards from hopper.<br>Press NPRO key to clear feed.<br>Discard number of cards in stacker equal to CTR lights plus 1.<br>Rotate mode switch (Power-On-Reset) to reset terminal.<br>Reload cards.<br>Press start key.<br><br>When Printing<br>Press stop key.<br>Delete print lines equal to CTR lights minus 1.<br>Rotate mode switch (Power-On-Reset) to reset terminal (use machine reset key on Model 3).<br>Press printer start key.<br>Note: If job requirements are such that print lines cannot be deleted on the form, contact the transmitting terminal to establish restart point at the top of new form. | EOT is encoded as the response to the last block received. |
| Parity Check with or without CTR lights on, and without I/O BFR Full light on. | When Punching<br>Press stop key.<br>Remove cards from hopper.<br>Press NPRO key to clear feed.<br>If CTR lights are on, discard number of cards in stacker equal to CTR lights plus 2.<br>If CTR lights are off, discard 2 cards from stacker.<br>Rotate mode switch (Power-On-Reset) to reset terminal.<br>Reload cards.<br>Press start key.<br><br>When Printing<br>Press stop key.<br>Delete print lines equal to CTR lights.<br>Rotate mode switch (Power-On-Reset) to reset terminal (use machine reset key on Model 3).<br>Press printer start key.<br>Note: If job requirements are such that print lines cannot be deleted on the form, contact the transmitting terminal to establish restart point at the top of new form. | EOT is encoded as the response to the last block received. |
| Sync Check (Type bar out of synchronization). | Press stop key.<br>Delete print line.<br>Press printer reset key (check reset key on Model 3).<br>Press printer start key. | EOT is encoded as the response to the last block received. |
| Term Add (An attempt by the CPU to transmit to this terminal, and the selected output device is not ready or no output device was selected). | Press stop key.<br>Press check reset key.<br>Make output device ready. | If neither output device is ready during initial bid, a NAK is sent in response to the ENQ. If a selection error occurs, an EOT is sent in response to block checking. |
| CLU and Term Add (Card feed clutch failure). | Press stop key.<br>Remove any partially punched or damaged cards (If this occurs contact transmitting station to determine restart point).<br>Press NPRO key to clear feed.<br>Press check reset key.<br>Reload cards.<br>Press start key. | EOT is encoded as the response to the last block received. |
| HOPR and Term Add (No card was fed). | Press stop key.<br>Remove cards from hopper.<br>Remove damaged cards.<br>Press NPRO key to clear feed.<br>Press check reset key.<br>Press start key. | EOT is encoded as the response to the last block received. |

Note: CPU Alternatives to 2780 error responses are listed under Summary of Responses to Errors in this section of the manual.

Figure 31. Error Recovery Procedures--Receiving Terminal Operator (2780 Receiving from CPU) (Part 2 of 3)

| 2780 Indicator | Recovery Procedure (2780) | Line Response |
|---|---|---|
| PCH STA and Term Add (Misfeed, no card or jam in punch station). | Misfeed (No card in punch station)<br>Press stop key.<br>Remove cards from hopper.<br>Remove damaged cards between read and punch station.<br>Press NPRO key to clear feed.<br>Reload cards.<br>Press start key.<br>Jam (Card or cards jammed in punch station).<br>Press stop key.<br>Contact CPU operator to determine restart point.<br>Remove cards from hopper.<br>Remove jammed cards.<br>Press NPRO key to clear feed.<br>Rotate mode switch (Power-On-Reset) to reset terminal.<br>Place cards from restart point in hopper.<br>Reload cards.<br>Press start key. | EOT is encoded as the response to the last block received. |
| PCH STA, RD STA and Term Add. | Refer to PCH STA and Term Add recovery procedure. | EOT is encoded as the response to the last block received. |
| RD STA and Term Add (Jam, misfeed, or defective photo-transistor). | Refer to HOPR and Term Add recovery procedure. | EOT is encoded as the response to the last block received. |
| TRSP and Term Add (Jam in stacker transport). | Press stop key.<br>Remove cards from hopper.<br>Remove jammed card or cards from transport and correct.<br>Press NPRO key to clear feed.<br>Remove blank card from stacker that was fed on NPRO. (See note)<br>Press check reset key.<br>Reload cards in hopper.<br>Press start key.<br>Note: If jammed cards are too badly damaged to be corrected, contact transmitting operator to determine restart point, and perform following steps:<br>Rotate mode switch (Power-On-Reset) to reset terminal.<br>Reload cards.<br>Press start key. | EOT is encoded as the response to the last block received. |
| Line and Incp. | No operator intervention required. | |
| Line and CTRS<br>Line | See the discussion of NAK (in the preceding text) under "Suggested Programming Considerations for the Various Error Responses when operating with a CPU". | |

Note: CPU Alternatives to 2780 error responses are listed under Summary of Responses to Errors in this section of the manual.

Figure 31. Error Recovery Procedures--Receiving Terminal Operator (2780 Receiving from CPU) (Part 3 of 3)

| GRAPHIC | CARD CODE | | | TRANSMISSION BIT PATTERN | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 6-BIT | EBCDIC | USASCII | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | P |
| • | 0 | | | 0 | 1 | | | | | | P | |
| 0 • | | 0 | | 0 | 1 | 2 | 3 | | | | | |
| • | | | 0 | | | | | | 5 | 6 | | P |
| • | 1 | | | 0 | 1 | | | | 5 | | | |
| 1 • | | 1 | | 0 | 1 | 2 | 3 | | | | 7 | |
| • | | | 1 | | 1 | | | | 5 | 6 | | |
| • | 2 | | | 0 | 1 | | | 4 | | | | |
| 2 • | | 2 | | 0 | 1 | 2 | 3 | | | 6 | | |
| • | | | 2 | | | 2 | | | 5 | 6 | | |
| • | 3 | | | 0 | 1 | | | 4 | 5 | P | | |
| 3 • | | 3 | | 0 | 1 | 2 | 3 | | | 6 | 7 | |
| • | | | 3 | | 1 | 2 | | | 5 | 6 | | P |
| • | 4 | | | 0 | 1 | | 3 | | | | | |
| 4 • | | 4 | | 0 | 1 | 2 | 3 | | 5 | | | |
| • | | | 4 | | | | 3 | | 5 | 6 | | |
| • | 5 | | | 0 | 1 | | 3 | | 5 | P | | |
| 5 • | | 5 | | 0 | 1 | 2 | 3 | | 5 | | 7 | |
| • | | | 5 | | 1 | | 3 | | 5 | 6 | | P |
| • | 6 | | | 0 | 1 | | 3 | 4 | | P | | |
| 6 • | | 6 | | 0 | 1 | 2 | 3 | | 5 | 6 | | |
| • | | | 6 | | | 2 | 3 | | 5 | 6 | | P |
| • | 7 | | | 0 | 1 | | 3 | 4 | 5 | | | |
| 7 • | | 7 | | 0 | 1 | 2 | 3 | | 5 | 6 | 7 | |
| • | | | 7 | | 1 | 2 | 3 | | 5 | 6 | | |
| • | 8 | | | 0 | 1 | 2 | | | | | | |
| 8 • | | 8 | | 0 | 1 | 2 | 3 | 4 | | | | |
| • | | | 8 | | | | | 4 | 5 | 6 | | |
| • | 9 | | | 0 | 1 | 2 | | | 5 | P | | |
| 9 • | | 9 | | 0 | 1 | 2 | 3 | 4 | | | 7 | |
| • | | | 9 | | 1 | | | 4 | 5 | 6 | | P |
| • | 12-1 | | | | | | | | 5 | | | |
| A • | | 12-1 | | 0 | 1 | | | | | | 7 | |
| • | | | 12-1 | | 1 | | | | | | 7 | P |
| • | 12-2 | | | | | | | 4 | | | | |
| B • | | 12-2 | | 0 | 1 | | | | | 6 | | |
| • | | | 12-2 | | 2 | | | | | | 7 | P |
| • | 12-3 | | | | | | | 4 | 5 | P | | |
| C • | | 12-3 | | 0 | 1 | | | | | 6 | 7 | |
| • | | | 12-3 | | 1 | 2 | | | | | 7 | |
| • | 12-4 | | | | | | 3 | | | | | |
| D • | | 12-4 | | 0 | 1 | | | | 5 | | | |
| • | | | 12-4 | | | | 3 | | | | 7 | P |
| • | 12-5 | | | | | | 3 | | 5 | P | | |
| E • | | 12-5 | | 0 | 1 | | | | 5 | | 7 | |
| • | | | 12-5 | | 1 | | 3 | | | | 7 | |
| • | 12-6 | | | | | | 3 | 4 | | P | | |
| F • | | 12-6 | | 0 | 1 | | | | 5 | 6 | | |
| • | | | 12-6 | | | 2 | 3 | | | | 7 | |
| • | 12-7 | | | | | | 3 | 4 | 5 | | | |
| G • | | 12-7 | | 0 | 1 | | | | 5 | 6 | 7 | |
| • | | | 12-7 | | 1 | 2 | 3 | | | | 7 | P |
| • | 12-8 | | | | | 2 | | | | | | |
| H • | | 12-8 | | 0 | 1 | | | 4 | | | | |
| • | | | 12-8 | | | | | 4 | | | 7 | P |
| • | 12-9 | | | | | 2 | | | 5 | P | | |
| I • | | 12-9 | | 0 | 1 | | | 4 | | | 7 | |
| • | | | 12-9 | | 1 | | | 4 | | | 7 | |
| • | 11-1 | | | | 1 | | | | 5 | P | | |
| J • | | 11-1 | | 0 | 1 | | 3 | | | | 7 | |
| • | | | 11-1 | | | 2 | | 4 | | | 7 | |
| • | 11-2 | | | | 1 | | | 4 | | P | | |
| K • | | 11-2 | | 0 | 1 | | 3 | | | 6 | | |
| • | | | 11-2 | | 1 | 2 | | 4 | | | 7 | P |
| • | 11-3 | | | | 1 | | | 4 | 5 | | | |
| L • | | 11-3 | | 0 | 1 | | 3 | | | 6 | 7 | |
| • | | | 11-3 | | | | 3 | 4 | | | 7 | |

| GRAPHIC | CARD CODE | | | TRANSMISSION BIT PATTERN | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 6-BIT | EBCDIC | USASCII | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | P |
| • | 11-4 | | | | 1 | | 3 | | | P | | |
| M • | | 11-4 | | 0 | 1 | | 3 | | 5 | | | |
| • | | | 11-4 | | 1 | | 3 | 4 | | | 7 | P |
| • | 11-5 | | | | 1 | | 3 | | 5 | | | |
| N • | | 11-5 | | 0 | 1 | | 3 | | 5 | | 7 | |
| • | | | 11-5 | | | 2 | 3 | 4 | | | 7 | P |
| • | 11-6 | | | | 1 | | 3 | 4 | | | | |
| O • | | 11-6 | | 0 | 1 | | 3 | | 5 | 6 | | |
| • | | | 11-6 | | 1 | 2 | 3 | 4 | | | 7 | |
| • | 11-7 | | | | 1 | | 3 | 4 | 5 | P | | |
| P • | | 11-7 | | 0 | 1 | | 3 | | 5 | 6 | 7 | |
| • | | | 11-7 | | | | | | 5 | | 7 | P |
| • | 11-8 | | | | 1 | 2 | | | | P | | |
| Q • | | 11-8 | | 0 | 1 | | 3 | 4 | | | | |
| • | | | 11-8 | | 1 | | | | 5 | | 7 | |
| • | 11-9 | | | | 1 | 2 | | | 5 | | | |
| R • | | 11-9 | | 0 | 1 | | 3 | 4 | | | 7 | |
| • | | | 11-9 | | | 2 | | | 5 | | 7 | |
| • | 0-2 | | | 0 | | | | 4 | | P | | |
| S • | | 0-2 | | 0 | 1 | 2 | | | | 6 | | |
| • | | | 0-2 | | 1 | 2 | | | 5 | | 7 | P |
| • | 0-3 | | | 0 | | | | 4 | 5 | | | |
| T • | | 0-3 | | 0 | 1 | 2 | | | | 6 | 7 | |
| • | | | 0-3 | | | | 3 | | 5 | | 7 | |
| • | 0-4 | | | 0 | | | 3 | | | P | | |
| U • | | 0-4 | | 0 | 1 | 2 | | | 5 | | | |
| • | | | 0-4 | | 1 | | 3 | | 5 | | 7 | P |
| • | 0-5 | | | 0 | | | 3 | | 5 | | | |
| V • | | 0-5 | | 0 | 1 | 2 | | | 5 | | 7 | |
| • | | | 0-5 | | | 2 | 3 | | 5 | | 7 | P |
| • | 0-6 | | | 0 | | | 3 | 4 | | | | |
| W • | | 0-6 | | 0 | 1 | 2 | | | 5 | 6 | | |
| • | | | 0-6 | | 1 | 2 | 3 | | 5 | | 7 | |
| • | 0-7 | | | 0 | | | 3 | 4 | 5 | P | | |
| X • | | 0-7 | | 0 | 1 | 2 | | | 5 | 6 | 7 | |
| • | | | 0-7 | | | | | 4 | 5 | | 7 | |
| • | 0-8 | | | 0 | | 2 | | | | P | | |
| Y • | | 0-8 | | 0 | 1 | 2 | | 4 | | | | |
| • | | | 0-8 | | 1 | | | 4 | 5 | | 7 | P |
| • | 0-9 | | | 0 | | 2 | | | 5 | | | |
| Z • | | 0-9 | | 0 | 1 | 2 | | 4 | | | 7 | |
| • | | | 0-9 | | | 2 | | 4 | 5 | | 7 | P |
| | | | | | | | | | | | | |
| a • | | 12-0-1 | | 0 | | | | | | | 7 | |
| • | | | 12-0-1 | | 1 | | | | | 6 | 7 | |
| | | | | | | | | | | | | |
| b • | | 12-0-2 | | 0 | | | | | | 6 | | |
| • | | | 12-0-2 | | | 2 | | | | 6 | 7 | |
| | | | | | | | | | | | | |
| c • | | 12-0-3 | | 0 | | | | | | 6 | 7 | |
| • | | | 12-0-3 | | 1 | 2 | | | | 6 | 7 | P |
| | | | | | | | | | | | | |
| d • | | 12-0-4 | | 0 | | | | | 5 | | | |
| • | | | 12-0-4 | | | | 3 | | | 6 | 7 | |
| | | | | | | | | | | | | |
| e • | | 12-0-5 | | 0 | | | | | 5 | | 7 | |
| • | | | 12-0-5 | | 1 | | 3 | | | 6 | 7 | P |
| | | | | | | | | | | | | |
| f • | | 12-0-6 | | 0 | | | | | 5 | 6 | | |
| • | | | 12-0-6 | | | 2 | 3 | | | 6 | 7 | P |
| | | | | | | | | | | | | |
| g • | | 12-0-7 | | 0 | | | | | 5 | 6 | 7 | |
| • | | | 12-0-7 | | 1 | 2 | 3 | | | 6 | 7 | |
| | | | | | | | | | | | | |
| h • | | 12-0-8 | | 0 | | | | 4 | | | | |
| • | | | 12-0-8 | | | | | 4 | | 6 | 7 | |

• Dot indicates printable graphic

▨ Shaded area indicates that card code and translator are not available for that graphic

Figure 32. Composite Code Chart (Part 1 of 4)

| GRAPHIC | CARD CODE | | | TRANSMISSION BIT PATTERN | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 6-BIT | EBCDIC | USASCII | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | P |
| | | | | | | | | | | | | |
| i • | | 12-0-9 | | 0 | | | | 4 | | | 7 | |
| • | | | 12-0-9 | | 1 | | | 4 | | 6 | 7 | P |
| | | | | | | | | | | | | |
| j • | | 12-11-1 | | 0 | | | 3 | | | | 7 | |
| • | | | 12-11-1 | | | 2 | | 4 | | 6 | 7 | P |
| | | | | | | | | | | | | |
| k • | | 12-11-2 | | 0 | | | 3 | | | 6 | | |
| • | | | 12-11-2 | | 1 | 2 | | 4 | | 6 | 7 | |
| | | | | | | | | | | | | |
| l • | | 12-11-3 | | 0 | | | 3 | | | 6 | 7 | |
| • | | | 12-11-3 | | | | 3 | 4 | | 6 | 7 | P |
| | | | | | | | | | | | | |
| m • | | 12-11-4 | | 0 | | | 3 | | 5 | | | |
| • | | | 12-11-4 | | 1 | | 3 | 4 | | 6 | 7 | |
| | | | | | | | | | | | | |
| n • | | 12-11-5 | | 0 | | | 3 | | 5 | | 7 | |
| • | | | 12-11-5 | | | 2 | 3 | 4 | | 6 | 7 | |
| | | | | | | | | | | | | |
| o • | | 12-11-6 | | 0 | | | 3 | | 5 | 6 | | |
| • | | | 12-11-6 | | 1 | 2 | 3 | 4 | | 6 | 7 | P |
| | | | | | | | | | | | | |
| p • | | 12-11-7 | | 0 | | | 3 | | 5 | 6 | 7 | |
| • | | | 12-11-7 | | | | | | 5 | 6 | 7 | |
| | | | | | | | | | | | | |
| q • | | 12-11-8 | | 0 | | | 3 | 4 | | | | |
| • | | | 12-11-8 | | 1 | | | | 5 | 6 | 7 | P |
| | | | | | | | | | | | | |
| r • | | 12-11-9 | | 0 | | | 3 | 4 | | | 7 | |
| • | | | 12-11-9 | | | 2 | | | 5 | 6 | 7 | P |
| | | | | | | | | | | | | |
| s • | | 11-0-2 | | 0 | | 2 | | | | 6 | | |
| • | | | 11-0-2 | | 1 | 2 | | | 5 | 6 | 7 | |
| | | | | | | | | | | | | |
| t • | | 11-0-3 | | 0 | | 2 | | | | 6 | 7 | |
| • | | | 11-0-3 | | | | 3 | | 5 | 6 | 7 | P |
| | | | | | | | | | | | | |
| u • | | 11-0-4 | | 0 | | 2 | | | 5 | | | |
| • | | | 11-0-4 | | 1 | | 3 | | 5 | 6 | 7 | |
| | | | | | | | | | | | | |
| v • | | 11-0-5 | | 0 | | 2 | | | 5 | | 7 | |
| • | | | 11-0-5 | | | 2 | 3 | | 5 | 6 | 7 | |
| | | | | | | | | | | | | |
| w • | | 11-0-6 | | 0 | | 2 | | | 5 | 6 | | |
| • | | | 11-0-6 | | 1 | 2 | 3 | | 5 | 6 | 7 | P |
| | | | | | | | | | | | | |
| x • | | 11-0-7 | | 0 | | 2 | | | 5 | 6 | 7 | |
| • | | | 11-0-7 | | | | | 4 | 5 | 6 | 7 | P |
| | | | | | | | | | | | | |
| y • | | 11-0-8 | | 0 | | 2 | | 4 | | | | |
| • | | | 11-0-8 | | 1 | | | 4 | 5 | 6 | 7 | |
| | | | | | | | | | | | | |
| z • | | 11-0-9 | | 0 | | 2 | | 4 | | | 7 | |
| • | | | 11-0-9 | | | 2 | | 4 | 5 | 6 | 7 | |
| • | 12-3-8 | | | | | 2 | | 4 | 5 | | | |
| • • | | 12-3-8 | | | 1 | | | 4 | | 6 | 7 | |
| • | | | 12-3-8 | | | 2 | 3 | 4 | | 6 | | P |
| • | 12-4-8 | | | | | 2 | 3 | | | P | | |
| ¤ | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| • | 12 | | | | 1 | | | | | | | |
| & • | | 12 | | | 1 | | 3 | | | | | |
| • | | | 12 | | | 2 | 3 | | | 6 | | |
| | BLANK | | | | 1 | 2 | | 4 | | | | |
| Space | | BLANK | | | 1 | | | | | | | |
| | | | BLANK | | | | | | | 6 | | |

| GRAPHIC | CARD CODE | | | TRANSMISSION BIT PATTERN | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 6-BIT | EBCDIC | USASCII | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | P |
| • | 11-3-8 | | | | 1 | 2 | | 4 | 5 | P | | |
| $ • | | 11-3-8 | | | 1 | | 3 | 4 | | 6 | 7 | |
| • | | | 11-3-8 | | | | 3 | | | 6 | | P |
| • | 11-4-8 | | | | 1 | 2 | 3 | | | | | |
| * • | | 11-4-8 | | | 1 | | 3 | 4 | 5 | | | |
| • | | | 11-4-8 | | | 2 | | 4 | | 6 | | |
| • | 11 | | | 0 | | | | | | | | |
| - • | | 11 | | | 1 | 2 | | | | | | |
| • | | | 11 | | 1 | | 3 | 4 | | 6 | | P |
| • | 0-1 | | | 0 | | | | | 5 | P | | |
| / • | | 0-1 | | | 1 | 2 | | | | | 7 | |
| • | | | 0-1 | | 1 | 2 | 3 | 4 | | 6 | | |
| • | 0-3-8 | | | 0 | | 2 | | 4 | 5 | P | | |
| , • | | 0-3-8 | | | 1 | 2 | | 4 | | 6 | 7 | |
| • | | | 0-3-8 | | | | 3 | 4 | | 6 | | |
| • | 0-4-8 | | | 0 | | 2 | 3 | | | | | |
| % • | | 0-4-8 | | | 1 | 2 | | 4 | 5 | | | |
| • | | | 0-4-8 | | 1 | | 3 | | | 6 | | |
| • | 4-8 | | | 0 | 1 | 2 | 3 | | | P | | |
| @ • | | 4-8 | | | 1 | 2 | 3 | 4 | 5 | | | |
| • | | | 4-8 | | | | | | | | 7 | |
| • | 3-8 | | | 0 | 1 | 2 | | 4 | 5 | | | |
| # • | | 3-8 | | | 1 | 2 | 3 | 4 | | 6 | 7 | |
| • | | | 3-8 | | 1 | 2 | | | | 6 | | |
| | | | | | | | | | | | | |
| ¢ • | | 12-2-8 | | | 1 | | | 4 | | 6 | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| < • | | 12-4-8 | | | 1 | | | 4 | 5 | | | |
| • | | | 12-4-8 | | | | 3 | 4 | 5 | 6 | | P |
| | | | | | | | | | | | | |
| ( • | | 12-5-8 | | | 1 | | | 4 | 5 | | 7 | |
| • | | | 12-5-8 | | | | | 4 | | 6 | | P |
| | | | | | | | | | | | | |
| + • | | 12-6-8 | | | 1 | | | 4 | 5 | 6 | | |
| • | | | 12-6-8 | | 1 | 2 | | 4 | | 6 | | P |
| | | | | | | | | | | | | |
| ı • | | 12-7-8 | | | 1 | | | 4 | 5 | 6 | 7 | |
| • | | | 12-7-8 | | 1 | | | | | 6 | | P |
| | | | | | | | | | | | | |
| ¦ | | | | | | | | | | | | |
| | | | 12-11 | | | | 3 | 4 | 5 | 6 | 7 | |
| | | | | | | | | | | | | |
| ! • | | 11-2-8 | | | 1 | | 3 | 4 | | 6 | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| ) • | | 11-5-8 | | | 1 | | 3 | 4 | 5 | | 7 | |
| • | | | 11-5-8 | | 1 | | | 4 | | 6 | | |
| | | | | | | | | | | | | |
| ; • | | 11-6-8 | | | 1 | | 3 | 4 | 5 | 6 | | |
| • | | | 11-6-8 | | 1 | 2 | | 4 | 5 | 6 | | |
| | | | | | | | | | | | | |
| ¬ • | | 11-7-8 | | | 1 | | 3 | 4 | 5 | 6 | 7 | |
| • | | | 11-7-8 | | | 2 | 3 | 4 | 5 | | 7 | |
| | | | | | | | | | | | | |
| – • | | 0-5-8 | | | 1 | 2 | | 4 | 5 | | 7 | |
| • | | | 0-5-8 | | 1 | 2 | 3 | 4 | 5 | | 7 | P |
| | | | | | | | | | | | | |
| > • | | 0-6-8 | | | 1 | 2 | | 4 | 5 | 6 | | |
| • | | | 0-6-8 | | | 2 | 3 | 4 | 5 | 6 | | |
| | | | | | | | | | | | | |
| ? • | | 0-7-8 | | | 1 | 2 | | 4 | 5 | 6 | 7 | |
| • | | | 0-7-8 | | 1 | 2 | 3 | 4 | 5 | 6 | | P |
| | | | | | | | | | | | | |
| : • | | 2-8 | | | 1 | 2 | 3 | 4 | | 6 | | |
| • | | | 2-8 | | | 2 | | 4 | 5 | 6 | | P |

• Dot indicates printable graphic

▨ Shaded area indicates that card code and translator are not available for that graphic

Figure 32. Composite Code Chart (Part 2 of 4)

| GRAPHIC | CARD CODE | | | TRANSMISSION BIT PATTERN | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 6-BIT | EBCDIC | USASCII | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | P |
| ' • | | 5-8 | | | 1 | 2 | 3 | 4 | 5 | | 7 | |
| • | | | 5-8 | | 1 | 2 | 3 | | | 6 | | P |
| = • | | 6-8 | | | 1 | 2 | 3 | 4 | 5 | 6 | | |
| • | | | 6-8 | | 1 | | 3 | 4 | 5 | 6 | | |
| " • | | 7-8 | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | |
| • | | | 7-8 | | | 2 | | | | 6 | | P |
| [ | | | | | | | | | | | | |
| • | | | 12-8-2 | | 1 | 2 | | 4 | 5 | | 7 | |
| \ | | | | | | | | | | | | |
| • | | | 0-8-2 | | | | 3 | 4 | 5 | | 7 | P |
| ] | | | | | | | | | | | | |
| • | | | 11-8-2 | | 1 | | 3 | 4 | 5 | | 7 | |
| ` | | | | | | | | | | | | |
| | | | 1-8 | | | | | | | 6 | 7 | P |
| { | | | | | | | | | | | | |
| | | | 12-0 | | 1 | 2 | | 4 | 5 | 6 | 7 | P |
| } | | | | | | | | | | | | |
| | | | 11-0 | | 1 | | 3 | 4 | 5 | 6 | 7 | P |
| ~ | | | | | | | | | | | | |
| | | | 11-0-1 | | | 2 | 3 | 4 | 5 | 6 | 7 | P |
| NUL | | 12-0-1-8-9 | | | | | | | | | | |
| | | | 12-0-1-8-9 | | | | | | | | | P |
| | 12-1-9 | | | | | | | | | P | | |
| SOH | | 12-1-9 | | | | | | | | | 7 | |
| | | | 12-1-9 | | 1 | | | | | | | |
| | 12-2-9 | | | | | 2 | | 4 | | P | | |
| STX | | 12-2-9 | | | | | | | | 6 | | |
| | | | 12-2-9 | | | 2 | | | | | | |
| | 12-3-9 | | | 0 | | 2 | 3 | 4 | | P | | |
| ETX | | 12-3-9 | | | | | | | | 6 | 7 | |
| | | | 12-3-9 | | 1 | 2 | | | | | | P |
| PF | | 12-4-9 | | | | | | | 5 | | | |
| | 12-5-9 | | | 0 | | 2 | 3 | 4 | 5 | | | |
| HT | | 12-5-9 | | | | | | | 5 | | 7 | |
| | | | 12-5-9 | | 1 | | | 4 | | | | P |
| LC | | 12-6-9 | | | | | | | 5 | 6 | | |
| | 12-7-9 | | | 0 | 1 | 2 | 3 | 4 | 5 | P | | |
| DEL | | 12-7-9 | | | | | | | 5 | 6 | 7 | |
| | | | 12-7-9 | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | |
| SMM | | 12-2-8-9 | | | | | | 4 | | 6 | | |
| VT | | 12-3-8-9 | | | | | | 4 | | 6 | 7 | |
| | | | 12-3-8-9 | | 1 | 2 | | 4 | | | | |
| FF | | 12-4-8-9 | | | | | | 4 | 5 | | | |
| | | | 12-4-8-9 | | | | 3 | 4 | | | | P |
| CR | | 12-5-8-9 | | | | | | 4 | 5 | | 7 | |
| | | | 12-5-8-9 | | 1 | | 3 | 4 | | | | |

| GRAPHIC | CARD CODE | | | TRANSMISSION BIT PATTERN | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 6-BIT | EBCDIC | USASCII | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | P |
| SO | | 12-6-8-9 | | | | | | 4 | 5 | 6 | | |
| | | | 12-6-8-9 | | | 2 | 3 | 4 | | | | |
| SI | | 12-7-8-9 | | | | | | 4 | 5 | 6 | 7 | |
| | | | 12-7-8-9 | | 1 | 2 | 3 | 4 | | | | P |
| | 12-11-1-8-9 | | | | 1 | 2 | 3 | 4 | 5 | | | |
| DLE | | 12-11-1-8-9 | | | | | 3 | | | | | |
| | | | 12-11-1-8-9 | | | | | | 5 | | | |
| DC1 | | 11-1-9 | | | | | 3 | | | | 7 | |
| | | | 11-1-9 | | 1 | | | | 5 | | | P |
| DC2 | | 11-2-9 | | | | | 3 | | | 6 | | |
| | | | 11-2-9 | | | 2 | | | 5 | | | P |
| DC3 (TMX) | | 11-3-9 | | | | | 3 | | | 6 | 7 | |
| | | | 11-3-9 | | 1 | 2 | | | 5 | | | |
| RES | | 11-4-9 | | | | | 3 | | 5 | | | |
| | | | | | | | | | | | | |
| NL | | 11-5-9 | | | | | 3 | | 5 | | 7 | |
| | | | | | | | | | | | | |
| BS | | 11-6-9 | | | | | 3 | | | 5 | 6 | |
| | | | 11-6-9 | | | | | 4 | | | | |
| IL | | 11-7-9 | | | | | 3 | | | 5 | 6 | 7 |
| | | | | | | | | | | | | |
| CAN | | 11-8-9 | | | | | 3 | 4 | | | | |
| | | | 11-8-9 | | | | | 4 | 5 | | | P |
| | 11-1-8-9 | | | 0 | 1 | 2 | 3 | 4 | | | | |
| EM | | 11-1-8-9 | | | | | | 3 | 4 | | 7 | |
| | | | 11-1-8-9 | | 1 | | | 4 | 5 | | | |
| CC | | 11-2-8-9 | | | | | | 3 | 4 | | 6 | |
| | | | | | | | | | | | | |
| IFS | | 11-4-8-9 | | | | | | 3 | 4 | 5 | | |
| | | | | | | | | | | | | |
| IGS | | 11-5-8-9 | | | | | | 3 | 4 | 5 | | 7 |
| | | | | | | | | | | | | |
| RS | | 5-9 | | | | | 2 | 3 | | 5 | | 7 |
| | | | 11-6-8-9 | | | | 2 | 3 | 4 | 5 | | P |
| | 11-7-8-9 | | | | 1 | 2 | 3 | | 5 | P | | |
| US | | | | | | | | | | | | |
| | | | 11-7-8-9 | | 1 | 2 | 3 | 4 | 5 | | | |
| DS | | 11-0-1-8-9 | | | | | 2 | | | | | |
| | | | | | | | | | | | | |
| SOS | | 0-1-9 | | | | | 2 | | | | 7 | |
| | | | | | | | | | | | | |
| FS | | 0-2-9 | | | | | 2 | | | 6 | | |
| | | | 11-4-8-9 | | | | 3 | 4 | 5 | | | |
| BYP | | 0-4-9 | | | | | 2 | | 5 | | | |
| | | | | | | | | | | | | |
| LF | | 0-5-9 | | | | | 2 | | 5 | | 7 | |
| | | | 0-5-9 | | | | 2 | | 4 | | | P |

• Dot indicates printable graphic

Shaded area indicates that card code and translator are not available for that graphic

Figure 32. Composite Code Chart (Part 3 of 4)

| GRAPHIC | CARD CODE | | | TRANSMISSION BIT PATTERN | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 6-BIT | EBCDIC | USASCII | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | P |
| ETB | 0-6-9 | | | | | 2 | 3 | 4 | 5 | P | | |
| (EOB) | | 0-6-9 | | | | 2 | | | 5 | 6 | | |
| | | | 0-6-9 | | 1 | 2 | 3 | | 5 | | | P |
| ESC | 0-7-9 | | | 0 | | 2 | | 4 | | | | |
| (PRE) | | 0-7-9 | | | | 2 | | | 5 | 6 | 7 | |
| | | | 0-7-9 | | 1 | 2 | | 4 | 5 | | | P |
| | | | | | | | | | | | | |
| SM | | 0-2-8-9 | | | | 2 | | 4 | | 6 | | |
| | | | | | | | | | | | | |
| | 0-5-8-9 | | | 0 | | 2 | 3 | | 5 | P | | |
| ENQ | | 0-5-8-9 | | | | 2 | | 4 | 5 | | 7 | |
| | | | 0-5-8-9 | | 1 | | 3 | | | | | P |
| | | | | | | | | | | | | |
| ACK | | 0-6-8-9 | | | | 2 | | 4 | 5 | 6 | | |
| | | | 0-6-8-9 | | | 2 | 3 | | | | | P |
| | 0-7-8-9 | | | | | 2 | 3 | | 5 | | | |
| BEL | | 0-7-8-9 | | | | 2 | | 4 | 5 | 6 | 7 | |
| | | | 0-7-8-9 | | 1 | 2 | 3 | | | | | |
| | 2-9 | | | 0 | 1 | 2 | | 4 | | P | | |
| SYN | | 2-9 | | | | 2 | 3 | | | 6 | | |
| | | | 2-9 | | | 2 | 3 | | 5 | | | |
| | | | | | | | | | | | | |
| PN | | 4-9 | | | | 2 | 3 | | 5 | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| IRS | | 11-6-8-9 | | | | | 3 | 4 | 5 | 6 | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| UC | | 6-9 | | | | 2 | 3 | | 5 | 6 | | |
| | | | | | | | | | | | | |
| | 7-9 | | | | 1 | 2 | 3 | 4 | | P | | |
| EOT | | 7-9 | | | | 2 | 3 | | 5 | 6 | 7 | |
| | | | 7-9 | | | | 3 | | | | | |
| | | | | | | | | | | | | |
| DC4 | | 4-8-9 | | | | 2 | 3 | 4 | 5 | | | |
| | | | 4-8-9 | | | | 3 | | 5 | | | P |
| | 5-8-9 | | | 0 | 1 | 2 | 3 | | 5 | | | |
| NAK | | 5-8-9 | | | | 2 | 3 | 4 | 5 | | 7 | |
| | | | 5-8-9 | | 1 | | 3 | | 5 | | | |
| | 7-8-9 | | | | | 2 | 3 | 4 | | | | |
| SUB | | 7-8-9 | | | | 2 | 3 | 4 | 5 | 6 | 7 | |
| | | | 7-8-9 | | | 2 | | 4 | 5 | | | |
| | | | | | | | | | | | | |
| GS | | | | | | | | | | | | |
| | | | 11-5-8-9 | | 1 | | 3 | 4 | 5 | | | P |
| | | | | | | | | | | | | |
| IUS | | 11-7-8-9 | | | | | 3 | 4 | 5 | 6 | 7 | |
| | | | | | | | | | | | | |

• Dot indicates printable graphic

Shaded area indicates that card code and translator are not available for that graphic

Figure 32. Composite Code Chart (Part 4 of 4)

The following is a listing of the communications terms used in this manual. For a complete listing of all communications terms refer to the manual IBM Data Processing Techniques, Data Communications Glossary, Form C20-1666.

Addressing: The means whereby the originator or control station selects the unit to which it is going to send a message.

Answerback: The response of a terminal to remote control signals.

Baud: Unit of signalling speed. The speed in bauds is the number of discrete conditions or signal events per second. If each signal represents only one bit condition, baud is the same as bits-per-second.

Bid: An attempt to gain control of a dedicated line in order to send a message.

Bit: Contraction of "binary digit", the smallest unit of information in a binary system. A bit may be either a one or a zero.

Bit Rate: The speed at which bits are transmitted, usually expressed in bits-per-second.

Block: A group of one or more 2780 records that are transmitted as a unit and cause a line turnaround to verify the accuracy of the transmission.

Buffer: A storage device used to compensate for a difference in rate of flow data, or time of occurence of events, when transmitting data from one device to another.

Contention: A condition on a multidrop communication channel when two or more locations try to transmit at the same time. Unregulated bidding for a line by multiple users.

Data Set: A device which performs the modulation/demodulation and control functions necessary to provide compatibility between business machines and communications facilities.

Dedicated Line: See Private Line

Demodulation: The process of retrieving intelligence (data) from a modulated carrier wave; the reverse of modulation.

Full Duplex: Simultaneous two-way independent transmission in both directions.

Half-Duplex: Alternate, one-way-at-a-time, independent transmission.

Interface: Interconnection between two equipments having different functions.

Leased Line: See Private Line

Message: A group of one or more blocks that represent an entity of data.

Modulation: The process by which some characteristic of one wave is varied in accordance with another wave or signal. This technique is used in data sets to make business machine signals compatible with communications facilities.

Multiplexer: A device for collecting the input from many communications lines and transferring it to the CPU; also, for accepting information from the CPU and transferring it to one of many communications lines without forcing the CPU's timing to match that of the connected terminal(s).

Non-Switched Line: See Private Line

On Line: Associated with a processor either directly or through a communication system. The physical connection can be accomplished by either multiwire cable or a communications line.

Point-to-point transmission: Transmission of data directly between two points without the use of any intermediate terminal

Polling: A technique by which each of the terminals sharing a communications line is periodically interrogated to determine whether it requires servicing. The multiplexer or control station sends a poll which, in effect, asks the terminal selected, "Do you have anything to transmit?"

Primary Terminal: A primary terminal is the terminal that gains control of the line if both terminals bid for the line simultaneously.

Private Line: Denotes the channel and channel equipment furnished to a cumstomer as a unit for his exclusive use, without interexchange switching arrangements.

Record: A 2780 record consists of the data in a single card or a single line of print.

Secondary Terminal: A secondary terminal is the terminal that relinquishes the line to the primary terminal if both terminals bid for the line simultaneously.

Switched Line: Part of a switched network.

Terminal: Any device capable of sending and/or receiving information over a communications channel .

Time-out: The time interval allotted for certain operations to occur before system operation is interrupted and must be restarted.

# INDEX

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