SYSTEM REFERENCE MANUAL

4310, 4320 SERIES

Magnetic Data Recording System

SINGER
BUSINESS MACHINES

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PREFACE

The purpose of this manual is to explain the varied capabilities of the Series 4310/20 Magnetic Data Recording System. It is hoped that this information will enable the reader to visualize the configuration of Series 4310/20 equipment that is best suited to his specific application(s). Section 1.0 introduces the system as a whole and highlights its many advantages. Sections 2.0 through 7.0 offer a more detailed description of the capabilities, hardware and operation of the basic magnetic data recording unit and the available options. Appendices A through D contain reference information.

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TERMS AND ABBREVIATIONS

Character	One of the 64 recordable data symbols used in a field and/or record.
Field	The smallest subdivision of programmed data (made up of one or more characters) used to aid and/or control data transfer.
Record	The basic unit of data input; a record constitutes one line of input data and may consist of one or more fields.
File	A series of records handled as a single unit.
Program	A set of instructions that control the entry of each character into data memory.
LEFT ZERO	Program command code that causes a field to automatically be right-justified; also a control key on the keyboard.
DUP	Program command code that causes a field to be duplicated in every record of a file (except the first record); also a control key on the keyboard.
SKIP	Program command code that causes blank spaces to automatically be entered into the field; also a control key on the keyboard.
REL	Program command code that automatically terminates a record; also a control key on the keyboard.
Magnetic Tape	Tape with a magnetized coating on which data can be stored.
Pooling	An optional feature on the 4310/20 units that allows data from several terminals to be recorded on tape at a central recorder unit.
Check Digit	An optional feature on the 4320 units that allows specified numeric fields to automatically be checked for validity.
Printing Totalizer	An optional feature on the 4320 units that allows specified numeric fields to automatically be printed and totaled.
Data Communications	An optional feature on the 4310 units that allows data to be sent and received over public, private, leased, switched, or unswitched telephone lines.
AS/D	AUTO SKIP/DUP switch; a 4310/20 unit control switch.
P/D/W	PRINT/DUAL/WRITE TAPE switch; a 4310 unit control switch.
BOT	Beginning Of Tape; a reflective marker placed on magnetic tape by the manufacturer; it marks the point at which recording may begin.
EOF	End Of File; a special code recorded on magnetic tape marking the end of the file.
EOT Marker	End Of Tape; a reflective marker placed on magnetic tape by the manufacturer; it warns that the tape is running out, but records can be recorded beyond the EOT marker.
EOT Character	End Of Transmission; this character terminates a data communication transmission.

TERMS AND ABBREVIATIONS

C.P.I.	Characters Per Inch
I.P.S.	Inches Per Second
CPU	Central Processing Unit; the part of a computer which executes programmed instructions.
PCB	Printed Circuit Board
Modem	Device that converts data into signals that can be transmitted over a data communications network.
BSC	Binary Synchronous Communications; a set of industry standards governing data communications.
DAA	Data Access Arrangement; device used to interface a certain type of modem to telephone lines.
DSC	Device Selection Code; code generated by a computer that designates a particular device as the intended receiver of the computer's transmitted information.
EBCDIC	Extended Binary Coded Decimal Interchange Code
BCDIC	Binary Coded Decimal Interchange Code
USASCII	United States of America Standard Code for Information Interchange.
ICL	International Computers Limited
IC	Intergrated Circuit; component used in modern electronic equipment; a number of circuits are included on one small IC chip.
ROM	Read-Only Memory; an electronic storage element whose contents can be read, but not altered.
NRZI	Non-Return Zero Inverted; a method for recording data on magnetic tape.
PE	Phase Encoding; a method for recording data on magnetic tape.

1. INTRODUCTION

1.0 INTRODUCTION

1.1 Purpose and Capabilities

The Series 4310/20 Magnetic Data Recording Systems provide an efficient means of processing a large volume of data, from source document to computer-compatible magnetic tape. In addition to a wide range of data preparation capabilities, Series 4310 units can be equipped to communicate directly with a computer or remote terminal that may be located in any area serviced by a public, private, leased, switched or unswitched telephone network.

The diverse capabilities and options available with the 4310/20 Series are outlined below:

Data can be entered at a keyboard and automatically recorded on magnetic tape.

- The keyboard is equivalent to standard IBM 029/059 keyboards. (Keyboards designed for foreign markets are also available.)
- Data is recorded in computer-compatible 7- or 9-track formats.
- Data on tape can be verified and, if necessary, corrected. (Verification can be done by the same operator during entry or can be done after entry is completed.)

Program control is available to allow more efficient recording of source data that contains repetitive information.

- Operator keys-in variable data only.
- Spaces and unchanging text (e.g., column headings) are inserted automatically.

Check digit analysis can be performed on selected numerical source data as it is entered or verified. Most errors that would slow down computer processing are detected and corrected before entering the computer. (Check Digit Option)

- Check digit analysis protects against both source data errors and operator errors.
- Various checking algorithms are available, allowing complete software compatibility with most computers.

One or two groups of numeric fields can be printed and accumulated during data entry or verification. Data totals are available – no waiting for computer processing. Totals can be checked before entering the computer. (Printing Totalizer Option)

- As data is entered at a magnetic data recorder, a printing calculator performs addition or subtraction on one or two sets of selected numeric fields.
- Hard-copy printout of totals is provided by the calculator.

Data from more than one keyboard or tape unit can be merged on one central magnetic tape. Less tape handling and computer processing time are required. Hardware costs are reduced since many key-to-tape units can be replaced by a single key-to-tape unit and several low-cost keyboard-only units. (Pooling Option)

- Data received at central pooling unit is automatically verified character-by-character to assure accurate transfer.
- The central pooling unit records all data received with one format and density (selectable at time of purchase).

Data can be output at a line printer. Data listings, management reports, payroll checks, invoices, etc., can easily be prepared. (External Device Option and Line Printer)

- Rapid high-quality printing (up to 450 lines per minute).
- Data can be sent to line printer directly from keyboard.
- Previously recorded data can be sent from the tape unit to the line printer.
- Both vertical and horizontal formatting are possible.

Data recorded on magnetic tape can be transmitted via a public, private, leased, switched or unswitched telephone network to a computer or remote terminal. (Data Communications Option)

- Communications proceed according to Binary Synchronous Communication (BSC) specifications, with or without reverse channel.
- Model 4335 data communications adapter includes automatic re-transmission feature.
- Line printer can be used with Model 4335 data communications adapter to provide hard-copy printout as data is being received and recorded on tape.
- Model 4335 data communications adapter is capable of most data communication functions performed by IBM 2770 terminals.
- Data can be transmitted or received in either the EBCDIC (Extended Binary Coded Decimal Interchange Code) or USASCII (United States of America Standard Code for Information Interchange) language.

Previously recorded data can be edited or corrected—another feature that reduces computer processing time. (Data Editing)

- Sort out selected records to be merged at central recorder or to be output at line printer. (File Explosion)
- Automatically correct or change data in every record of a file. (File Edit)
- Central recorder can append data to every record being merged. (Central Recorder Edit)
- Truncate records as they are merged at central recorder, as they are output to a line printer, or as they are transmitted via data communications. (End Stripping)
- Strip out selected fields prior to transmitting records via data communications. (Internal Stripping)
- Insert selected fields as they are received via data communications. (Internal Insert)

1.2 System Overview

There are four models in the 4310 and 4320 Series that may be selected along with a variety of options. Not all options, however, are compatible with each model; Table 1-1 lists the models and the options available with each. The entire 4310 and 4320 Series is pictured in Figure 1-1.

1.2.1 Series 4310 Models

The 4310 Series includes two models:

- 4311 Magnetic Data Recorder
- 4314 Magnetic Data Central Pooler

Both models include:

1. A 49-key alpha numeric keyboard equivalent to the IBM 029 keypunch.
2. A control panel to select operating conditions.
3. A display panel which displays the contents of the current character position in memory.
4. A tape unit which automatically records data entered at the keyboard.

1.2.1.1 Model 4311 Magnetic Data Recorder

The 4311 is a magnetic data recording station with all components housed in a single, stand-alone cabinet (see Figure 1-1).

The 4311 unit is capable of performing a variety of operations:

- Allows formatted (program controlled) or unformatted data to be entered and/or verified.
- Data as well as program tapes can be prepared.
- Records data on a 7 1/2-inch tape reel with a tape speed of 12.5 inches per second (ips).
- Data can be recorded in 7-track NRZI format at 200, 556 or 800 characters per inch (cpi) density (in BCDIC, Honeywell-EL, or ICL languages), or in 9-track NRZI format at 800 cpi density (in EBCDIC).
- Allows search procedures to find records previously recorded on tape.
- Contents of program and data memory can be examined without fear of altering them.
- Data can easily be edited or corrected.
- Capable of serving as central recorder, program interceptor or remote unit in a pooling chain (Model 4339 pooling adapter required).
- When serving as a central recorder, up to 8 remote units may be transferring data simultaneously (pooling adapter required).
- Capable of supporting a Model 4350 or 4352 line printer external device adapter required).

Table 1-1. A Summary of 4310/20 Series Options

<table>
<tr><th></th><th colspan="9">OPTION</th><th colspan="3">MAGNETIC TAPE RECORDING FORMATS</th></tr>
<tr><th>Model</th><th>Line Printer</th><th>Pooling (4339)</th><th>Data Communications (4335)</th><th>Check Digit (4337)</th><th>Printing Totalizer (4315)</th><th>External Device</th><th>Data Editing</th><th>Non-Vola-tility</th><th>*File Protect</th><th>9-Track NRZI</th><th>7-Track NRZI</th><th>9-Track P.E.</th></tr>
<tr><td rowspan="2">4311</td><td rowspan="2">Option Available</td><td rowspan="2">Option Available</td><td rowspan="2">Option Available</td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2">Option Available</td><td rowspan="2">Standard Feature</td><td rowspan="2">Option Available</td><td rowspan="2">Option Available</td><td colspan="2">12.5 ips</td><td rowspan="2"></td></tr>
<tr><td>Option Available</td><td>Option Available</td></tr>
<tr><td rowspan="2">4314</td><td rowspan="2">Option Available</td><td rowspan="2">Standard Feature</td><td rowspan="2">Option Available</td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2">Option Available</td><td rowspan="2">Standard Feature</td><td rowspan="2">Standard Feature</td><td rowspan="2">Standard Feature</td><td colspan="2">40 ips</td><td>37.5 ips</td></tr>
<tr><td>Option Available</td><td>Option Available</td><td>Option Available</td></tr>
<tr><td rowspan="2">4321</td><td rowspan="2">Option Available</td><td rowspan="2">Option Available</td><td rowspan="2"></td><td rowspan="2">Option Available</td><td rowspan="2">Option Available</td><td rowspan="2">Option Available</td><td rowspan="2">Standard Feature</td><td rowspan="2">Option Available</td><td rowspan="2">Option Available</td><td colspan="2">12.5 ips</td><td rowspan="2"></td></tr>
<tr><td>Option Available</td><td>Option Available</td></tr>
<tr><td>4322</td><td></td><td>Standard Feature</td><td></td><td>Option Available</td><td>Option Available</td><td></td><td></td><td></td><td></td><td colspan="2">No Tape Unit</td><td></td></tr>
</table>

*Allows "write permit" ring to be removed from back of tape reel to prevent inadvertently erasing or writing over data stored on magnetic tape.

- Capable of communicating over public, private, leased, switched or unswitched telephone network facilities with a compatible central processing unit (e.g., System Ten by Singer or IBM System 360/ Models 25 through 85), another Series 4310 unit or a compatible terminal, such as the IBM 2770 unit (Model 4335 data communication adapter required).

1.2.1.2 Model 4314 Magnetic Data Central Pooler

The 4314 is a magnetic data recording station with separate stand-alone cabinets for the keyboard and tape unit (see Figure 1-1).

The 4314 unit is also capable of performing a wide variety of operations:

- Allows formatted or unformatted data to be entered and/or verified.
- Data as well as program tapes can be prepared.
- Records data on 10 1/2-inch magnetic tape with tape speeds of 40 ips for NRZI recording and 37.5 ips for Phase Encoding (PE) recording.
- Data can be recorded in 7-track NRZI format at 200, 556 or 800 cpi density (in BCDIC, Honeywell-EL or ICL), 9-track NRZI format at 800 cpi density (EBCDIC), or 9-track P.E. format at 1600 cpi density (EBCDIC).
- Contains standard non-volatile program memory.
- Allows search procedures to find records previously recorded on tape.
- Contents of program and data memory can be examined without fear of altering them.
- Data can easily be edited or corrected.
- Equipped with file protect as a standard feature.
- Capable of serving as central recorder, program interceptor or remote unit in a pooling chain.

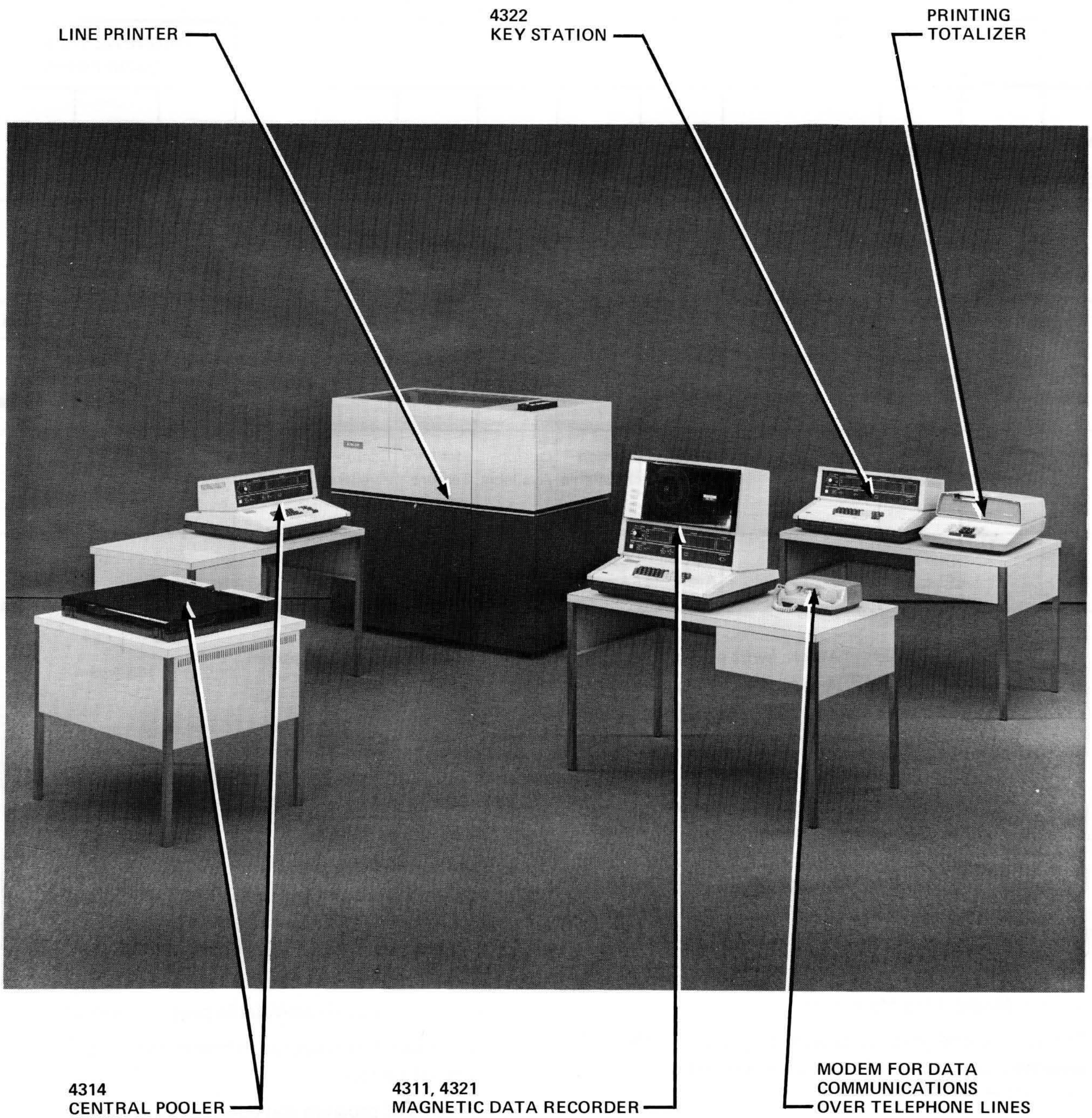


Figure 1-1. A Series 4310/20 Magnetic Data Recording System

- When serving as a central recorder, up to 64 remote units can be transferring data simultaneously.
- Capable of supporting a Model 4350 or 4352 line printer (external device adapter required).
- Capable of communicating over public, private, leased, switched or unswitched telephone network facilities, with a compatible central processing unit, another Series 4310 unit, or a compatible terminal (Model 4335 data communications adapter required).

1.2.2 Series 4320 Models

The 4320 Series includes two models:

- 4321 Magnetic Data Recorder
- 4322 Keyboard

1.2.2.1 Model 4321 Magnetic Data Recorder

Like the 4311, the 4321 is a magnetic data recording station with all components housed in a single, stand-alone cabinet (see Figure 1-1).

- Allows formatted (program controlled) or unformatted data to be entered and/or verified.
- Data as well as program tapes can be prepared.
- Records data on a 7 1/2-inch tape reel with a tape speed of 12.5 inches per second (ips).
- Data can be recorded in 7-track NRZI format at 200, 556 or 800 characters per inch (cpi) density (in BCDIC, Honeywell-EL or ICL languages), or in 9-track NRZI format at 800 cpi density (in EBCDIC).
- Allows search procedures to find records previously recorded on tape.
- Contents of program and data memory can be examined without fear of altering them.
- Data can easily be edited or corrected.
- Capable of serving as central recorder, program interceptor or remote unit in a pooling chain (Model 4339 pooling adapter required).
- When serving as a central recorder, up to 8 remote units can be transferring data simultaneously (Model 4339 pooling adapter required).
- Capable of supporting a Model 4350 or 4352 line printer (external device adapter required).
- Capable of supporting the check digit option (Model 4337 check digit kit required).
- Capable of supporting the printing totalizer option (Model 4315 printing totalizer kit required).

1.2.2.2. Model 4322 Keyboard

The 4322 is a low-cost keyboard-only unit, used only as a data input terminal during pooling operations.

The 4322 unit is capable of performing the following operations:

- Allows formatted or unformatted data to be entered.
- Allows the operator to both enter and verify data before transferring it to the central recorder (same operator verify feature).
- Contents of program and data memory can be examined without fear of altering them.
- Data can easily be edited or corrected.
- Capable of serving as a remote entry unit in a pooling chain.
- Capable of supporting the check digit option (Model 4337 check digit kit required).
- Capable of supporting the printing totalizer option (Model 4315 printing totalizer kit required).

1.3 Options

1.3.1 Pooling

The pooling option allows data from a number of units in a pooling chain to be recorded on one reel of tape at a unit operating in the central recorder mode.

1. Data can be entered at a number of keystations in the pooling chain and sent to the central recorder; data records are written on tape in random order and later exploded or merged, or;
2. Data that is stored on tape at a number of tape units in the pooling chain can be sent to the central recorder and merged onto one reel of tape; data records are written on tape at the central recorder in the same order as they appeared on tape at the remote tape units.

   Both operations result in less tape handling, as well as reduced computer processing time.

Any of the Series 4310/20 units can act as a remote keystation in a pooling chain (DATA ENTER mode, ONLINE), and all of the units except the Model 4322 can operate as a remote tape unit in a merging operation (DATA MERGE mode, ONLINE). Any of the models except the 4322 are capable of serving as the central recorder during either type of pooling operation.

Table 1-2 lists the maximum number of remote units that can be handled by a central recorder without causing operator delay.

Pooling terminals are cable-connected in a daisy chain as illustrated in Figure 1-2. The total of all connecting cables can be up to 1,000 feet.

Any of the remote units in a pooling chain (except 4322 units) can act as an alternate central recorder should the current central recorder become inoperative.

A remote unit (usually the first priority) can also serve as a program interceptor (optional) to transmit prerecorded programs (in the PROGRAM ENTER mode, ONLINE), to lower priority remote units requesting them (in the PROGRAM READ TAPE mode, ONLINE), without affecting those units that may still be transmitting data to the central recorder. Any of the Series 4310/20 units (except 4322 units) are capable of serving as a program interceptor.

Any Series 4310/20 unit (except 4322 units) can be connected to a Model 4350 or 4352 line printer, although in a pooling chain it is usually connected to the central recorder. Data cannot be sent to the line printer, however, while a pooling operation is in progress. Following the pooling operation, it is often desirable to transmit the data from the central recorder's tape to the line printer to obtain a hard-copy of all the pooled data.

Data may be edited as it is being "merged" or as it is being transmitted to the line printer.

The pooling option is fully explained in Section 5.0.

1.3.2 Check Digit

The check digit option (available for 4321 and 4322 units) allows selected numeric fields to be check digit verified automatically.

If an invalid digit is entered into a check digit field, an error is indicated and control reverts to the first character position of that field. The operator must reset the error and then re-enter the number correctly; if the source document is incorrect, the check digit field can be bypassed.

Nine standard check digit options (differentiated by the check digit formula they use) are available. Any two of the available options can be chosen for each Series 4320 unit (available options can easily be substituted at a later time by a service call); the operator uses a toggle switch on the control panel to select one of the two check digit options or to switch both options off.

The check digit option is operable in both the DATA ENTER and DATA VERIFY modes; this allows data to be check digit verified as it is entered at the keyboard, read from tape, sent to a central recorder, or output to a line printer.

The check digit option is fully explained in Section 3.0.

1.3.3 Printing Totalizer

The printing totalizer option allows one or two groups of numeric fields (termed the A and B fields) to be accumulated for a series of records, thus providing printout of key entered data and hash totals. This option utilizes

Table 1-2. Remote Units in a Pooling Chain

WHEN ACTING AS THE CENTRAL RECORDER	MAXIMUM NUMBER OF KEYBOARDS RECOMMENDED
4311	8
4314	64
4321	8
4322	Cannot be a central recorder

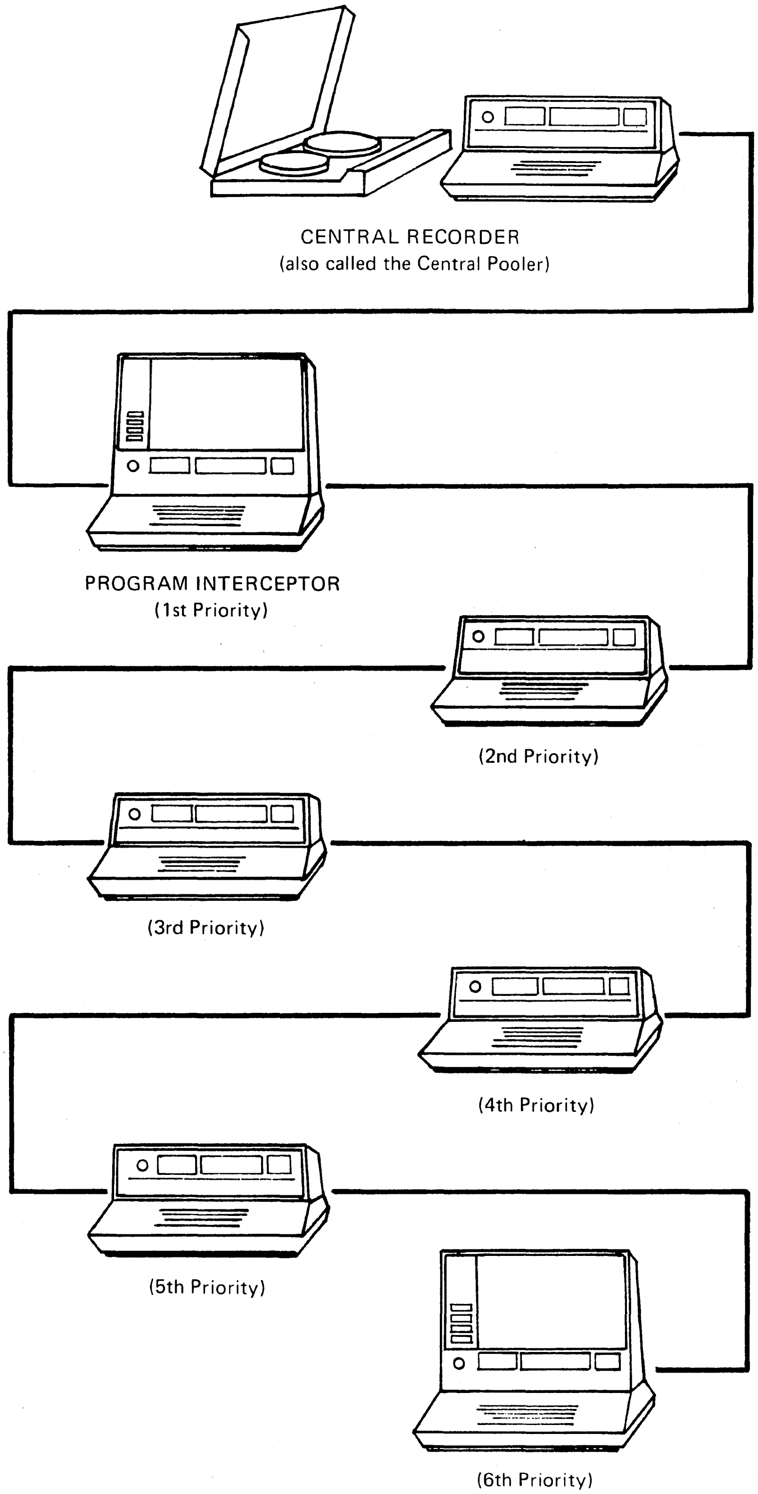


Figure 1-2. Series 4310/20 Units connected in a Pooling Chain

an electronic printing calculator cable-connected to a 4321 or 4322 unit. Like the check digit option, the printing totalizer option functions in both the DATA ENTER and DATA VERIFY modes (see Section 4.0).

The only restriction placed on the specification of a printing totalizer field is that it must have 13 or fewer digits; the digits need not be contiguous nor need they all lie in the same field of a record.

When not operating under control of a 4320 unit, the calculator can be operated as an independent business machine.

A field may be specified as both a check digit and a printing totalizer field. A number entered into such a field is first subject to check digit analysis, and is then printed and summed. Frequently an account number is specified as a check digit and printing totalizer field in order to obtain printout of account numbers adjacent to financial entries which are being totalized. For maximum efficiency, the fields should be separated by spaces when using the printing totalizer option.

The check digit and/or printing totalizer options are operable in Series 4320 units serving as remote units in a pooling chain. As the data is key-entered, it is first checked, printed, accumulated and then released to the central recorder. Neither of the options are operable in a 4321 unit serving as the central recorder.

1.3.4 External Devices (Line Printer)

The line printer can be included with a 4311, 4314 or 4321. Data can be transmitted:

- From keyboard to line printer.
- From magnetic tape to line printer.
- During data transmission over telephone lines to magnetic tape and/or line printer.

Simultaneously transfering data from the keyboard to both a magnetic tape and a line printer is available only on special order.

Files can be listed at the line printer with the printout format automatically controlled from the key-to-tape unit. Comments and headers from the keyboard can be interspersed with records. Data can also be edited as it is transferred to the printer.

In order to interface to the Model 4350 or 4352 line printer, a magnetic data recorder must include the external device adapter.

The line printer is discussed in Section 6.0.

1.3.5 Data Communications

The data communications option enables a Series 4310 unit to communicate via public, private, leased, switched or unswitched telephone lines with another Series 4310 unit, with a computer or with an IBM 2770 terminal. All information is sent and received according to BSC (Binary Synchronous Communications) specifications with or without reverse channel (switch selectable). To communicate over telephone lines the Series 4310 terminal must be interfaced to the communication lines through a modem and, in some cases a data access arrangement. The data communications adapter must also be present on any Series 4310 unit operating in a communications network. Reverse channel operation is an option to the data communications option.

Once a data link has been established and transmission begun, no further operator intervention is necessary until an entire file has been transmitted.

The data communications option allows data editing and includes an automatic re-transmission feature that causes a selected number of re-transmissions to be attempted automatically whenever a transmission error occurs.

Refer to Section 7.0 for a complete description of the data communications option.

2. MAGNETIC DATA RECORDER

2.0 MAGNETIC DATA RECORDER

2.1 Unit Overview

Each Series 4310/20 magnetic data recorder contains the basic functional components (with exceptions noted) as listed below. Figures 2-1 and 2-2 illustrate the functional components for Series 4310 and 4320 units, respectively.

- Keyboard
  - data keys
  - control keys
  - a total of 64 possible characters (the Kana unit, made for use in Japan, provides 47 additional Kana characters; see Section 2.2.5).
- Memory
  - semi-conductor hardware
  - a buffer with 200 memory locations; each location contains a data character (6-bits), two program codes (3-bits per code) and a single multiple-purpose bit for flagging special fields.
  - all memory locations are accessed through a single 13-bit access register.
- Tape Unit (except 4322 units)
  - interfaced to the keyboard unit through a tape adapter
- Control Panel
  - includes control switches and indicators for selecting operating conditions
  - displays the contents of the current character position in memory
- Control Logic
  - includes all required timing logic as well as a memory address counter.

The Series 4310/20 can also include various optional features that are interfaced to the basic unit through an appropriate adapter. The optional components are:

1. Pooling – allows data from various remote units to be recorded on one reel of tape at a central recorder (see Section 5.0).
2. Check Digit – enables specified numeric fields to be checked for validity. (Series 4320 units only); (see Section 3.0).
3. Printing Totalizer – permits one or two groups of specified numeric fields to be printed and totaled. (Series 4320 units only); (see Section 4.0).
4. Data Communications – enables the transfer of data via telephone lines between two remote units or between a computer and remote units. (Available on Series 4310 units only); (see Section 7.0).
5. External Device – enables an external device such as a line printer to be used with a Series 4310/20 unit (except 4322 units); (see Section 6.0).

2.2 Keyboard

The basic keyboard on Series 4310/20 units is equivalent to the IBM 029 keypunch. There are a total of 49 keys (including 14 control keys) and a space bar that are capable of generating 64 data characters or symbols and a 8 program command codes; each of the control keys also provides additional control functions when pressed separately or in combination with other control switches or keys.

The 49 keys are grouped according to a color scheme that is standard throughout the industry; the 14 control keys are blue, the 12 keys that are valid in both numeric and alpha shifts are light grey, and all other keys are dark grey.

NOTE: To assure complete compatibility throughout the international market, 13 different types of keyboards are available; each type generates codes for those graphic symbols that are standard for various tape languages in different countries. Appendix A contains a photograph of each of the different keyboards; gives the nations in which they are compatible and lists the binary codes for the tape languages and corresponding internal machine language.

2.2.1 Data Keys

A total of 64 data characters or symbols can be generated by the data keys (except for the Kana keyboard; see Section 2.2.5). Each time a data key is pressed, a unique 6-bit internal machine language binary code is generated in the keyboard circuitry and sent to the access register

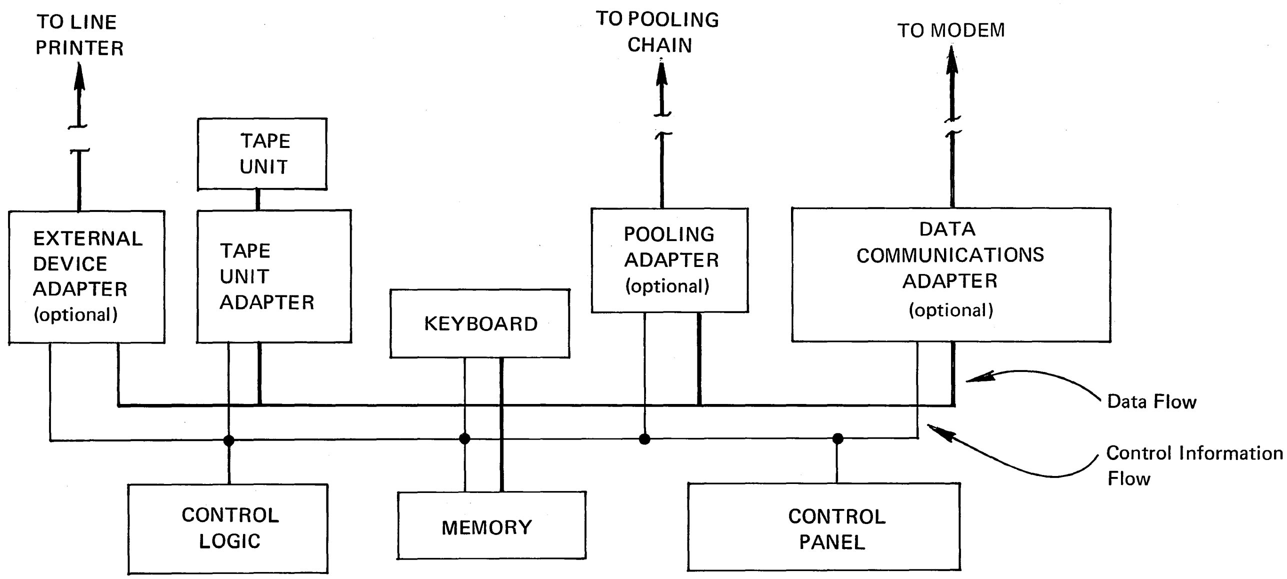


Figure 2-1 Major Functional Components of 4311 and 4314 Units

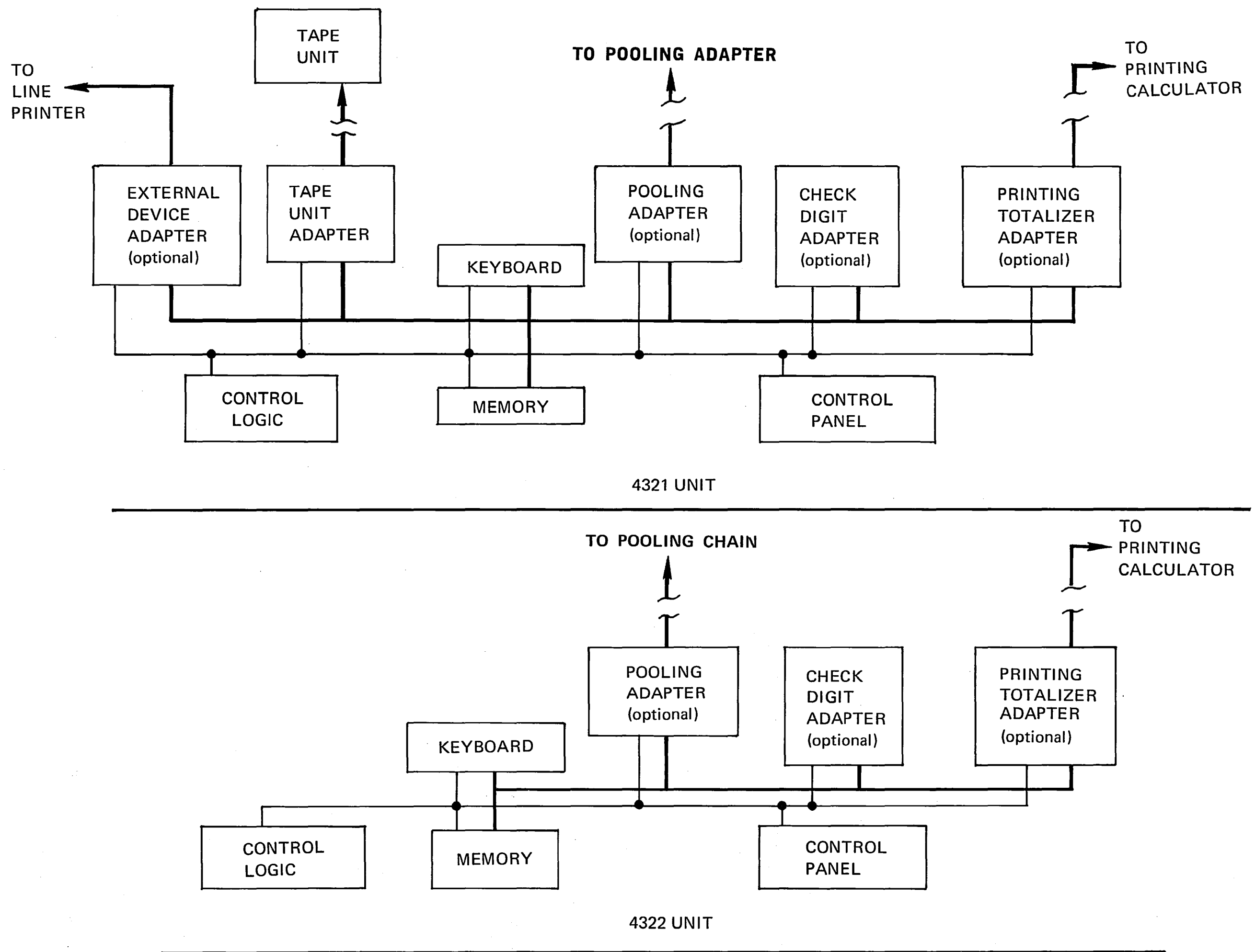


Figure 2-2. Major Functional Components of 4321 and 4322 Units.

of memory. The character, whose binary code is produced, is dependent on the keyboard shift, upper case (numeric) or lower case (alpha), as well as the particular key that is pressed. For example, pressing the key that has a U printed on it will only result in the binary code for U if the keyboard is in the alpha shift; in the numeric shift depression of that same key results in the binary code for 1.

When the data represented by the 6-bit internal machine language is transferred to the tape unit adapter it is translated into a 7 or 9-bit (including parity) tape language and written on tape (see Section 2.5.2).

The data keys for A and Z are only valid in the alpha shift; if either of these keys are pressed when the keyboard is in numeric shift, the KEY error indicator and audible alarm are activated (no binary code is sent to the access register).

The dark grey keys on the keyboard operate normally when the keyboard is in alpha shift (that is, pressing a key results in a binary code representing the lower case character shown on the key); however, to produce the upper case character for these keys (with the exception of the A and Z keys), the NUM control key must be manually pressed for each character. Pressing the NUM key causes the control logic to place the keyboard in the numeric (upper case) shift.

The space bar has different purposes in the various modes. Pressing the space bar during a data entry operation (in the DATA ENTER mode or the entry phase of some other data mode, see Section 2.4.1) or when entering an identifier in the DATA SEARCH mode causes the access register to be loaded with the binary code for a space character. This space character binary code is subsequently loaded into the appropriate memory location replacing the character from the previous record. In the DATA SEARCH mode, space characters in an identifier are non-compare characters. Pressing the space bar during a DATA VERIFY operation causes the space character binary code to be compared with the character in the appropriate memory location. Pressing the space bar during a READ MEMORY or PROGRAM ENTER operation advances the address counter without altering the contents of memory.

If an extremely fast operator presses a data key before releasing the previous key, the binary code for the first character will be produced; however, pressing the second key results in a signal that activates the KEY error indicator and audible alarm. If the rollover option is present, no error signal is generated by the second key; instead, control logic waits until the first key is released, then if the second key is still depressed, the appropriate binary code for this second character is generated. Figure 2-3 illustrates the rollover option.

2.2.2 Control Keys

The 14 control* keys on the keyboard are:

MINUS
BACKSPACE
RESET
NUM
LTR
SKIP
RETURN
LEFT ZERO
CORR CHAR
CORR FIELD
DUP
PROG 1
REL
PROG 2

* The graphic word printed on top of each control key may be different for keyboards designed for use in a country other than the United States; however, the control function of the key remains the same.

2.2.2.1 Program Control

The Control keys can generate eight different program command codes listed in Table 2-1.

The various fields that can be defined by the program command codes are summarized in Table 2-2.

If the key or keys necessary to produce a specific program command code are pressed during the PROGRAM ENTER mode operation, a 3-bit binary code that uniquely represents that particular program command code is generated and sent to memory. The binary code is transferred to the program portion (three of the last six bits as determined by the PROGRAM toggle switch) of the appropriate memory location (as determined by the address counter; see Section 2.3.2).

Whenever data is to be sent to the access register during a data mode operation, the two 3-bit binary program codes that are stored in the memory location into which the new data character is to be loaded are transferred to the access register along with the data character from the

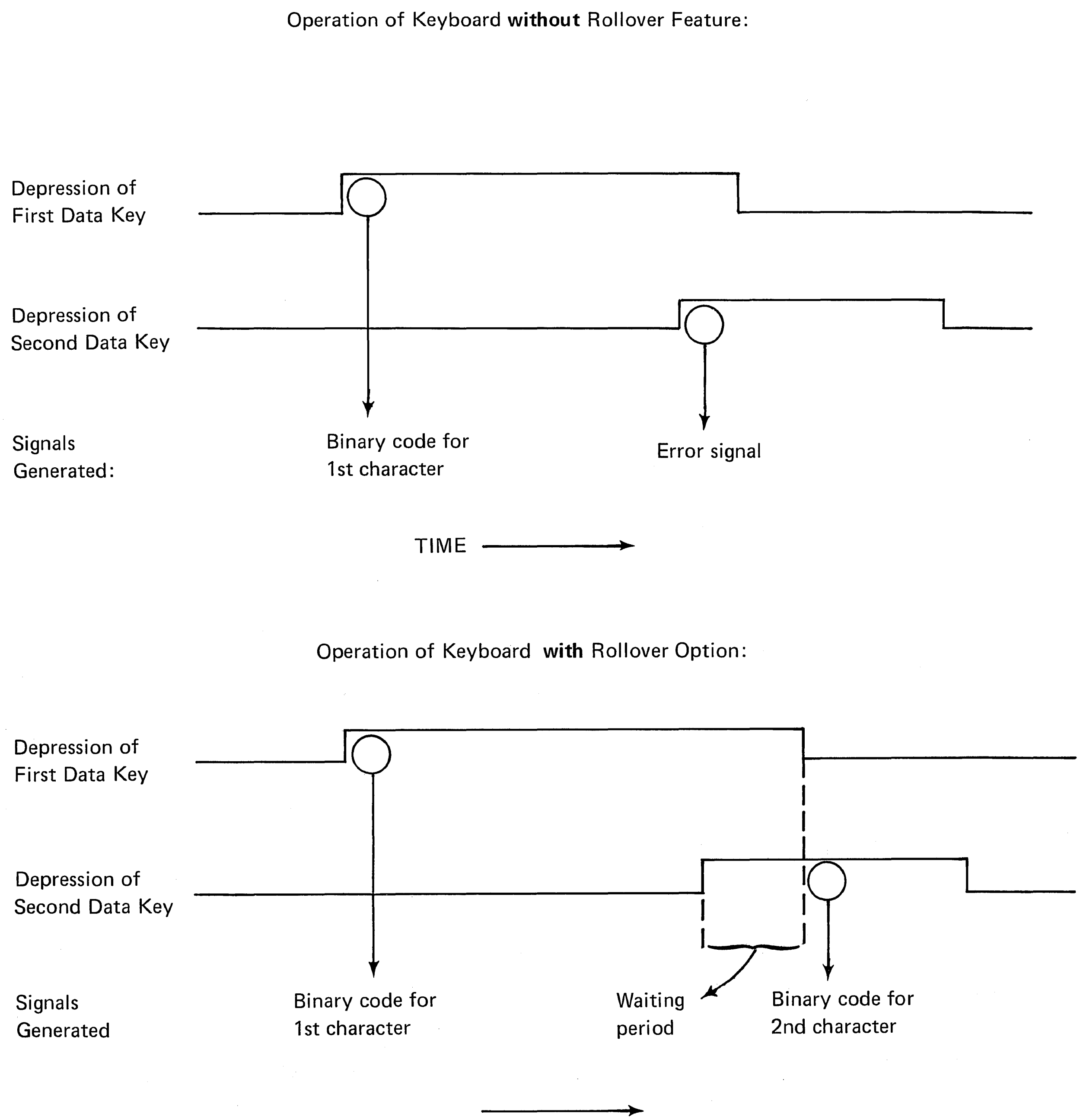


Figure 2-3. Rollover Option

Table 2-1. Program Commands

Program Command	Mnemonic	Keys Used	Control Function
Numeric Start	NUMST	RESET-NUM	defines start of a numeric field.
Letter Start	LTRST	RESET-LTR	defines start of an alphabetic field.
Duplicate	DUP	DUP	defines field to be duplicated; also used in data editing.
Skip	SKIP	SKIP	defines field to be skipped; also used with check digit and in data editing.
Left Zero	LZ	LEFT ZERO	defines field to be right justified.
Numeric	NUM	NUM	defines a numeric field.
Letter	LTR	LTR	defines an alphabetic field.
Release	REL	REL	defines end of record.

previous record. The data replaces the character from the previous record but the program codes remain unchanged. If the PROGRAM toggle switch is set to the PROGRAM 1 or PROGRAM 2 position, the appropriate program command code automatically performs a specific control function (see Table 2-2), in the entry, verification or editing of the data character.

2.2.2.2. Operator Control

In addition to generating program command codes in the PROGRAM ENTER mode, the control keys provide the operator with a wide range of control capabilities that are initiated by pressing the appropriate key (s) during data mode operations.

Pressing the NUM or LTR key places the keyboard in the numeric (upper case) or alpha (lower case) shifts, respec-

Table 2-2. Program Fields

Field Type	Description	Examples
Alphabetic	The first character position of the field is defined by the letter start $\begin{pmatrix}\text{L}\\\text{T}\\\text{R}\\\text{ST}\end{pmatrix}$ code; remaining character positions are defined by letter $\begin{pmatrix}\text{L}\\\text{T}\\\text{R}\end{pmatrix}$ codes. This field places the keyboard in alphabetic (lower) shift.	Six character alphabetic field: LLLLLL TTTTTT RRRRRR S T
Numeric	The first character position of the field is defined by the numeric start $\begin{pmatrix}\text{N}\\\text{U}\\\text{M}\\\text{ST}\end{pmatrix}$ code; remaining character positions are defined by numeric $\begin{pmatrix}\text{N}\\\text{U}\\\text{M}\end{pmatrix}$ codes. This field places the keyboard in numeric (upper) shift.	Five character numeric field: NNNNN UUUUU MMMMM S T
Dup*	The duplicate command code is programmed in the first and last positions of a field to be duplicated; in dup fields of 3 or more characters, positions between the first and last characters are filled with numeric codes.	Four character dup field: DNND UUUU PMMP
	Any character entered into a dup field during first record entry is automatically duplicated in all subsequent records of the field, if the AS/D switch is in the AUTO SKIP/DUP position. When the duplicate command is automatically executed, control is returned to the operator in the first character position of the next field that is not a dup or skip field. In a first record condition, automatic duplication is inhibited to permit initial entry or verification of the data to be duplicated. Also used for editing.	Two character dup field: DD UU PP One character dup field: D U P

*Automatic entry of data or space codes occurs at a rate of 100,000 char./sec.

Table 2-2. (Continued)

Field Type	Description	Examples
Skip*	The skip (S K I P) command code is programmed in the first and last positions of a field to be skipped; in skip fields of 3 or more characters, positions between the first and last are filled with numeric codes. When a skip command is executed, it causes automatic entry of space codes into all positions of the skip field, and an automatic advance to the first character position of the next field that is not a dup or skip field. Also used for editing and check digit.	Five character skip field: SNNNS KUUUK IMMMI P P Two character skip field: SS KK II PP One character skip field: S K I P
Left Zero	A left zero field is defined by a left zero (L Z) command code in the first character position of the field, followed by numeric (N U M) codes in the remaining character positions of the field. If, during data entry, the number of digits entered into a left zero field is less than the number of character positions allocated for that field, the entry is right justified, that is, the digits are shifted to the rightmost character positions and the unused leftmost positions are filled with zeros, when the LEFT ZERO key is pressed.	Six character left zero field: LNNNNN ZUUUUU MMMMM (Keying in 368256 would record 368256; keying in 3682 would record 003682).
Release	The release (R E L) command code marks the end of a record; it is used when the record is to be less than 80 or 200 characters. When a record is being entered under program control and a release (R E L) code is encountered, the data record is automatically released to tape (or pooling chain or line printer). In the absence of release codes, the record is not automatically released until the maximum number of characters (as specified by the Record Length switch) are entered. The release command code is also used for record end stripping during editing.	

*Automatic entry of data or space codes occurs at a rate of 100,000 char. / sec.

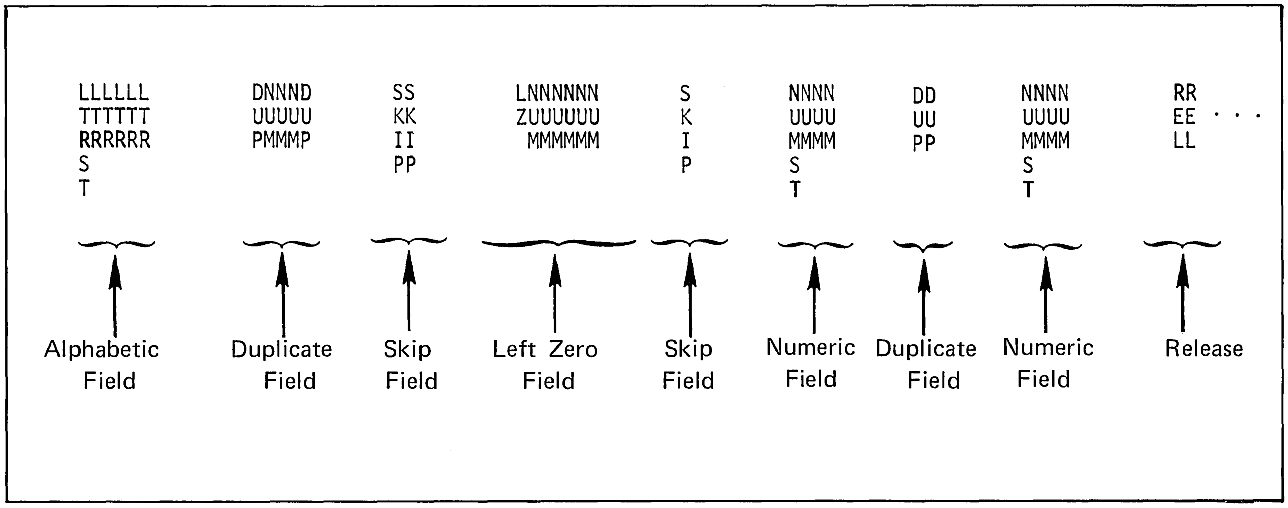


Figure 2-4. A Typical Program

tively. Manual depression of either of these keys overrides a program command code while the key is held down. In free form, the shift is locked with each shift depression.

Like the NUM and LTR keys, the DUP, SKIP, LEFT ZERO, and REL keys have a separate control function in data entry operations, as well as entering program command codes in the PROGRAM ENTER mode.

Pressing the DUP key during a data entry operation causes the binary code for a data character from the previous record to remain in the appropriate memory location, instead of being replaced by a new character. During first record entry, however, the DUP key is disabled by the control logic. Thus, whenever the DUP key is pressed during subsequent record entry, characters are duplicated from the previous record.

Pressing the SKIP key during a data entry operation or when entering an identifier in the DATA SEARCH mode causes the access register to be loaded with the binary code for a space character; this space character binary code is subsequently loaded into the appropriate memory location replacing the character from the previous record. This action is automatically repeated for each character in the field such that the entire field is filled with space codes. Pressing the SKIP key or space bar during a READ MEMORY or PROGRAM ENTER operation advances the address counter without altering the contents of memory.

When entering or verifying a number in a left zero field, the LEFT ZERO key must be pressed before it is possible to exit the field. Depression of the key causes the number to be right-justified, that is, the binary codes, representing the digits that were keyed in, are transferred to those memory locations that correspond to the rightmost character positions of the left zero field as defined by program control. Binary codes representing zeros are automatically loaded into memory locations that correspond to unused, leftmost character positions in the field.

NOTE: When the left zero field verification jumper feature is present, it is not necessary to press the LEFT ZERO key to exit a left zero field that is being verified.

Pressing the REL key during a data entry operation causes the data portion (the first 6 bits) of the remaining memory locations to be filled either with the binary code that represents a space character or, in the case of dup fields, with the dup field data.

The BACKSPACE, PROG 1, PROG 2 and RESET keys provide the operator with additional control capabilities.

The BACKSPACE key decrements the address counter, without affecting the contents of the buffer memory. By pressing this key, the operator can gain access to any memory location that has already been passed by the address counter. No binary code is generated when BACK-SPACE is pressed. It should be noted that if a skip or dup field (under program control) is encountered while back-spacing, the entire field is immediately "jumped over". The BACKSPACE key allows the memory to be rewritten in the DATA ENTER or PROGRAM ENTER mode.

During operations involving the keyboard, the PROG 1 and PROG 2 keys enable the operator to switch control to the alternate program. For example, if the PROGRAM select switch is in the PROGRAM 2 position, pressing the PROG 1 key transfers control to program 1. Control automatically reverts back to program 2 when the data record is completed or whenever the PROG 2 key is pressed. When data is being entered, verified or corrected under program control, the control logic only interprets one of the two program command codes stored in each memory location; the PROGRAM select switch and/or the PROG keys determine which of the two program commands the control logic is to interpret and perform. The PROG 1 and PROG 2 keys are disabled during non-keyboard modes.

Pressing the RESET key generates a signal that usually deactivates all of the error indicators as well as the audible alarm; during certain operations, however, another procedure must be performed in conjunction with the RESET key to clear the error condition (e.g., to deactivate the audible alarm after a data communication operation is complete, the mode select switch must be rotated and the RESET key must be pressed). The RESET key is also used during pooling to interrupt merging operations (e.g. to insert a record, see Section 4).

Several control functions are only enabled when a particular control key or switch is pressed while the RESET key is held depressed. These interlocking combinations are discussed in Section 2.2.4.

2.2.3 Negative Digits – Use of the Minus Key

The MINUS key operates as a special shift key. When the keyboard is in numeric shift, pressing a numeric character key while holding the MINUS key depressed causes the binary code for a specific alphabetic character to be generated, translated and written on tape. When a computer is processing numeric data, the computer is programmed to recognize certain alphabetic characters that represent negative digits and processes them accordingly. The dual use of the same binary codes for negative digits as well as for certain alphabetic characters is standard throughout industry. The alphabetic graphic symbols assigned to each negative digit and the hexadecimal values of the corresponding EBCDIC tape codes are listed below.

NOTE: When the 0 and MINUS keys are pressed on a Series 4310/20 keyboard, the six bit internal machine code (MDRS) for an exclamation point (011010) is generated. This 6-bit code is subsequently translated by the tape adapter into the EBCDIC tape language code value (D0) for a negative zero (see Table 2-8). IBM's EBCDIC code, however, does not assign the code value for a negative zero (D0) to the ! symbol; in EBCDIC, D0 represents the } symbol. Even though Series 4310/20 equipment assigns the graphic symbol ! to the binary code for negative zero and IBM assigns the graphic symbol }, there is no incompatibility since both result in the same binary tape code value (D0). It is an arbitrary matter which graphic symbol is assigned to the code for negative zero; different manufacturers assign various symbols. For example, the binary code for negative zero is assigned to the symbol – (dash) by Honeywell-H and to the symbol ↑ (arrow) by ICL.

Negative Digit:	-0	-1	-2	-3	-4	-5	-6	-7	-8	-9
Alphabetic Graphic:	!	I	J	K	L	M	N	O	P	Q
EBCDIC Code (HEX):	(D0)	(C9)	(D1)	(D2)	(D3)	(D4)	(D5)	(D6)	(D7)	(D8)

2.2.4 Interlocking Keys

The keyboard circuitry is such that the CORR FIELD, CORR CHAR, and RETURN keys perform no function when pressed alone; however, when pressed while holding the RESET key depressed, several control operations are enabled. Several other keys or switches that are functional when used alone, perform additional operations when used with the RESET key. The interlocking circuitry between certain keys serves as a precaution against an operator inadvertently erasing or writing over data by accidently pressing the wrong key.

Each possible interlocking combination is described below:

RESET-RETURN:

The RESET-RETURN combination always returns the address counter to the first memory location (also referred to as the first character position), as well as generating a signal that clears most error conditions. For most of the mode select switch settings, pressing the RETURN key while holding the RESET key depressed produces a control signal which initiates that particular mode operation. In addition, the RESET-RETURN keys will re-activate the keyboard if it has automatically been locked after encountering an end of tape (EOT) mark (see Section 2.5).

RESET-CORR CHAR and RESET-CORR FIELD:

When correcting data during a verification operation, pressing the CORR CHAR or CORR FIELD key while holding the RESET key depressed generates a series of signals that alert the unit to the fact that a character or field is to be corrected. After correcting the field, the address counter automatically returns to the first character position of the field and the VRFY lamp on the control panel lights; the field must be key verified again. After the entire record has been successfully verified, the tape unit backspaces the tape one record. The corrected record is loaded onto the data bus and sent to the tape unit where it is written on tape, a character at a time.

RESET-REL:

The REL key and RESET key are electronically connected in such a way that pressing the REL key while holding the RESET key depressed causes the data record in the buffer memory to be transferred (but not erased) to the data bus and sent to the tape unit or one of the optional adapters where the record can be recorded on tape. The RESET-REL combination is used to attempt another write tape operation after the first automatic attempt has failed or to release a program pair in memory to be written on tape.

RESET-EOF:

During key-to-tape data entry operations, a one character EOF record (designating the end of a file) is written on tape by pressing the EOF switch on the tape unit control panel while holding the RESET key depressed. The binary code for this unique character is loaded into memory in the normal fashion before being placed on the data bus and sent to the tape unit (see Section 2.5). If multiple EOF marks are desired, the mode select switch must be rotated away and back to its position and the RESET-EOF switches must be pressed for each additional mark.

RESET-DELETE:

In the DATA VERIFY or DATA SEARCH modes, pressing the DELETE switch on the tape unit control panel while holding the RESET key depressed conditions the control logic for the deletion of the current record (the DELETE lamp on the tape unit control panel lights). When the last character in the record is reached, the record is erased from tape and the next record is erased from tape and the next record is read into memory.

If, after the DELETE lamp lights, but before the last character in the record is reached, the operator wishes to cancel the delete operation, she can do so by pressing only the DELETE switch.

RESET-SKIP:

In the DATA VERIFY mode, an operator may press the SKIP key while holding the RESET key depressed to skip to the end of a record without finishing verification. This key combination advances the address counter to the end of the record without altering the contents of the buffer memory. The RESET-SKIP keys are often used to bypass key verification after the unit has been conditioned to delete that record by pressing the RESET-DELETE keys.

LOAD-REWIND:

If the LOAD and REWIND switches on the tape unit control panel are both pressed, the tape unit rewinds all of the resident tape onto the supply reel; if only REWIND is pressed, rewinding stops at the BOT reflective marker (see Section 2.5).

EOF-DELETE:

If the EOF and DELETE switches on the tape unit control panel are both pressed, the tape unit backspaces the tape one record (see Section 2.5).

2.2.5 The Kana Keyboard

The Kana keyboard, made for use in Japan, is capable of generating 47 Kana Characters, in addition to the 64 standard alphanumeric characters. The Kana keyboard generates a 7-bit internal machine code (instead of the normal 6-bit code) that is capable of representing the 111 possible characters.

The keyboard includes a KANA shift key and indicator. Pressing the KANA key places the keyboard in the Kana shift and lights the Kana indicator; the keyboard remains in Kana shift until the NUM or LTR keys are pressed or the record is completed. When operating under program control, the Kana shift overrides any numeric or letter program command codes.

Pressing any of the keys displaying a Kana character, while in the Kana shift, causes a 7-bit code for one of the 47 Kana characters to be generated and loaded into the buffer memory. The Kana character generated is not shown on the CHARACTER display panel; instead, a corresponding alphanumeric graphic is shown (see Table 2-3). When the record is released to tape, however, all data characters, including the Kana characters, are translated into unique tape language codes by the tape adapter and recorded.

Table 2-3.
Kana Characters and Character Display Graphics.

Kana Character	Graphic Displayed
ア	A
イ	B
ウ	C
エ	D
オ	E
カ	F
キ	G
ク	H
ケ	I
コ	¢
サ	<
シ	(
ス	+
セ	|
ソ	&
タ	J
チ	K
ツ	L
テ	M
ト	N
ナ	O
ニ	P
ヌ	Q
ネ	R
ノ	!
ハ	)
ヒ	;
フ	¬
ヘ	S
ホ	T
マ	U
ミ	V
ム	W
メ	X
モ	Y
ヤ	Z
ユ	-
ヨ	%
ラ	_
リ	>
ル	?
レ	:
ロ	#
ワ	@
ン	'
゛	=
゜	"

Table A-9 of Appendix A lists the 7-bit internal machine codes and the 8-bit tape language codes for each of the 47 Kana characters. Appendix A also includes a photograph of the Kana keyboard and its appropriate control panels (see Figure A-13).

2.3 Memory

All Series 4310/20 units have a buffer memory capable of storing 200 data characters (one data record), as well as two program codes and a multiple purpose flag bit for each of the 200 character positions, as illustrated in Figure 2-5.

Data or programs from the keyboard, tape unit or one of the optional adapters are entered into memory before being transferred to another component (e.g., keyboard-to-memory-to-tape), or may be loaded into memory to be verified, examined and/or corrected.

Information is entered into memory, a character at a time, through a one-character access register. This register is 13 bits long, and equivalent to one character position of the buffer memory; the first 6 bits store the binary code representing one of the 64 possible data characters, the seventh bit is a flag bit used for various control functions, and the last 6 bits store the binary codes for two of the eight possible 3-bit program command codes.

All transfers of program or data records are executed via the buffer memory (e.g., keyboard-to-memory-to-tape; tape-to-memory-to-pooling chain). The actual transfer of information between the buffer memory and a component of the magnetic data recorder proceeds via the bi-directional data bus.

Buffer memory on all units except the 4314 is volatile. The 4314 unit's buffer memory is non-volatile; that is,

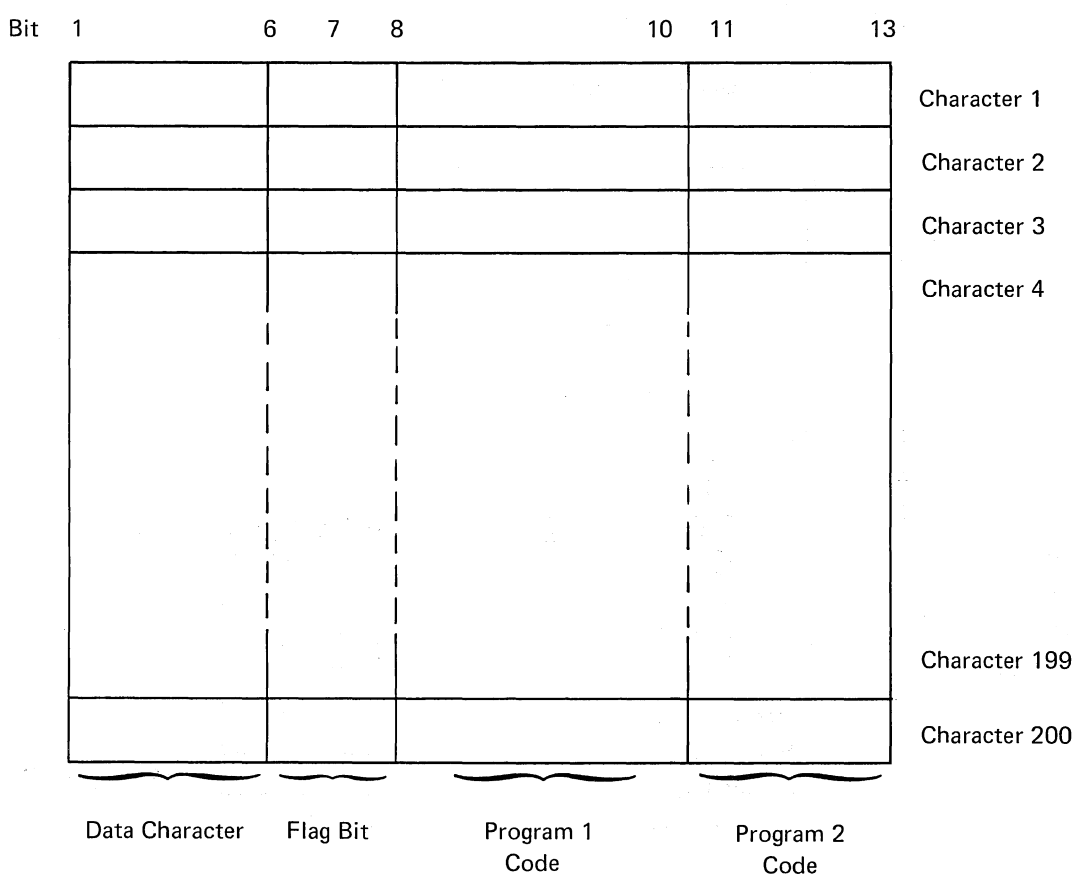


Figure 2-5. Buffer Memory

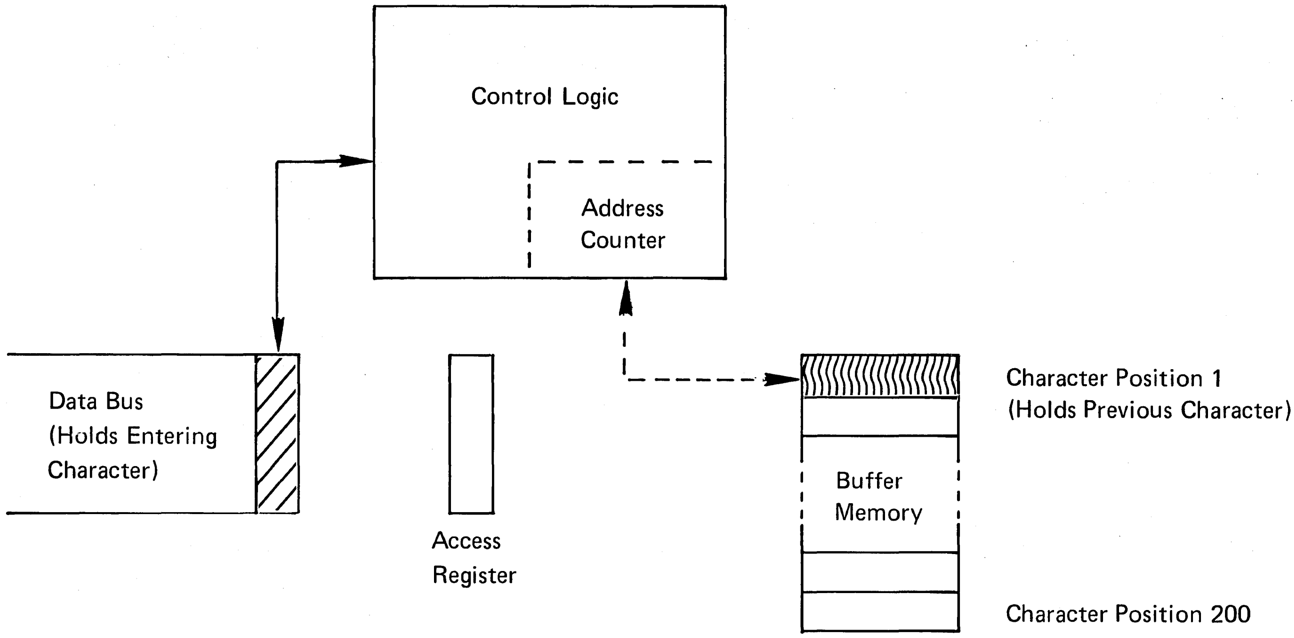


Figure 2-6. Data Transfer To Memory (Step 1).

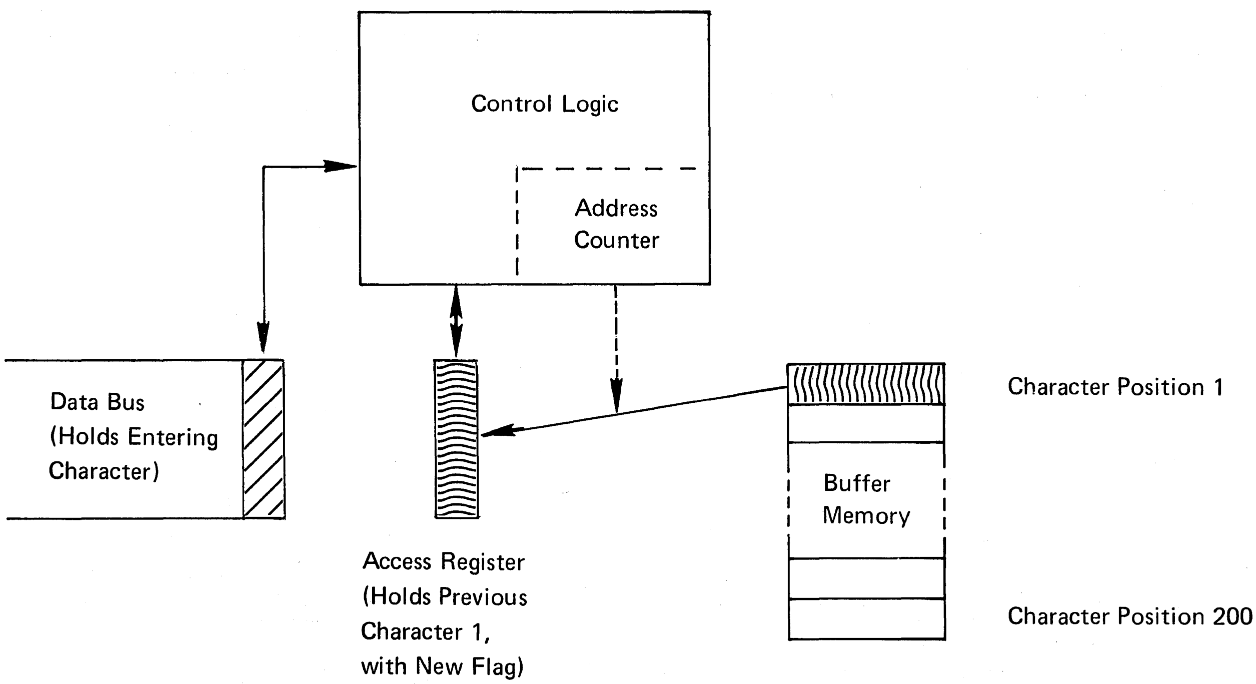


Figure 2-7. Data Transfer To Memory (Step 2).

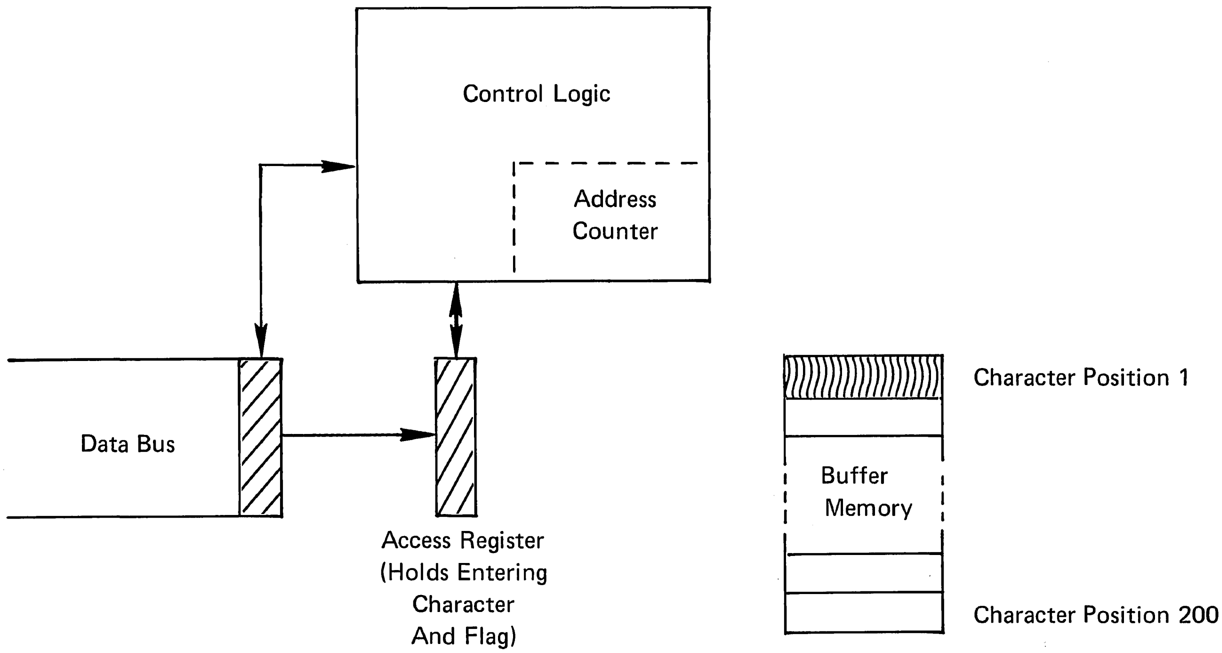


Figure 2-8. Data Transfer To Memory (Step 3).

the program contents of the buffer memory are not lost when power is turned off at the unit, providing the unit is powered through the line cord. If power is removed from the line cord, the contents of memory will not be lost for approximately 2-3 hours. Non-volatility may be installed as an option on the other models.

2.3.1 Data Memory

The keyboard, the tape unit or one of the optional adapters may place data on the data bus and direct it to memory. The buffer memory will contain the characters of the previous record unless the current record is the first to be entered since power was turned on at the unit.

As the first data character of a record is placed on the data bus, the address counter (a part of the control logic) determines that this character is to go into the first character position of the buffer memory (see Figure 2-6).

The contents of character position 1 (from the previous record) are loaded into the access register and the flag bit is cleared (see Figure 2-7).

The entering data is compared with the contents of character position 1 (which is now stored in the access register) as follows:

1. In some data modes (DATA ENTER, DATA VERIFY, or DATA SEARCH), the character bits (bits 1 to 6) are compared.
2. In a program mode (PROGRAM ENTER, PROGRAM READ TAPE), bits 8 to 10 are compared if PROGRAM 1 has been selected, and bits 11 to 13 are compared if PROGRAM 2 has been selected.

If the contents of the access register do not match the new incoming data, the flag bit is set; otherwise, it remains cleared.

The entering data is then transferred from the data bus to the access register (but the flag bit is retained as set in the compare) (see Figure 2-8).

The contents of the access register are then transferred to character position 1 in the buffer memory (replacing the character from the previous record) (see Figure 2-9).

The process begins again for the second data character and continues until an entire record has been loaded into the buffer memory. Once a record has been loaded, it may be verified, examined, and/or corrected depending upon the operating mode as set on the control panel.

If a record is to be transferred from memory to another component (again this is dependent of the control panel and/or control logic), the record is output from the buffer memory, a character at a time, through the access register. It is placed on the data bus, and directed via control logic to the appropriate component.

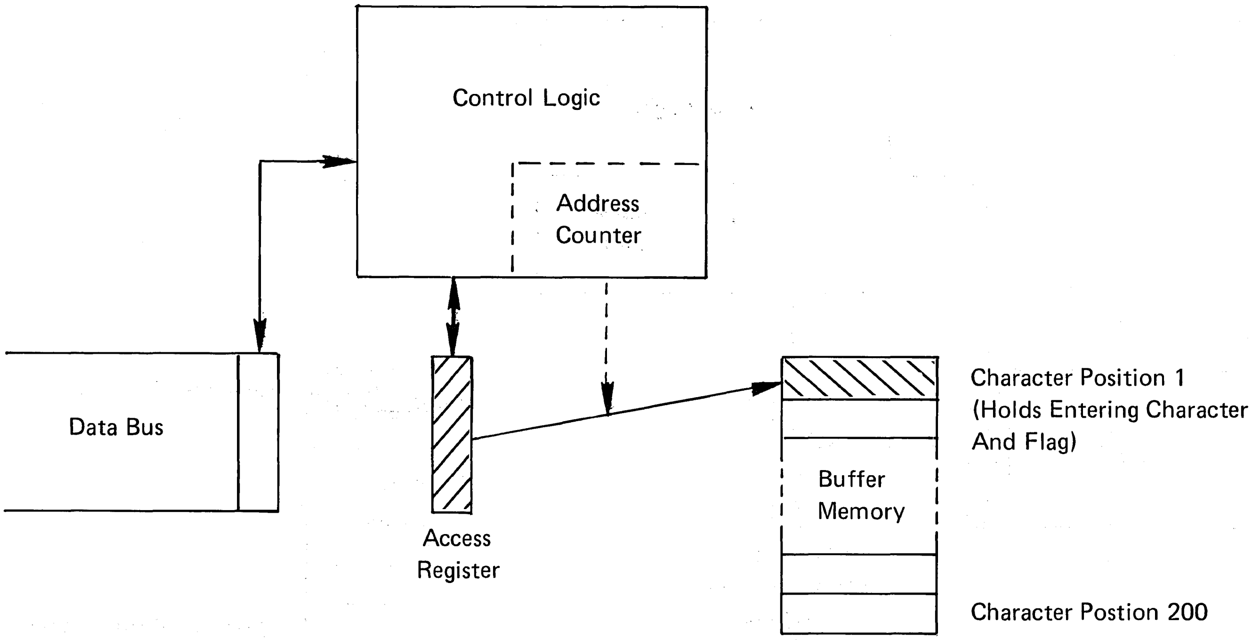


Figure 2-9. Data Transfer To Memory (Step 4).

This type of data flow, in and/or out of memory, is a necessary portion of all the data mode operations (ENTER, VERIFY, SEARCH, MERGE, SEND, RECEIVE, CENTRAL RECORDER, and READ MEMORY). The above description is not intended to be a complete discussion of the mode operations; it merely introduces one phase that is common to all data modes. The complete theory of operation is presented in Section 2.4.1.

2.3.2 Program Memory

The last six bits of every memory location contain two 3-bit program command codes. Thus, the buffer memory contains two complete programs, either of which can be selected to control the entry, verification, and editing of each character position in a data record.

Programs are only entered into or read out of the buffer memory in the PROGRAM ENTER or PROGRAM READ TAPE modes. The flow in or out is basically the same as for data, with the exception that when a program code is transferred from the access register to the buffer memory, it occupies 3 of the last 6 bits in a particular memory location, depending on whether PROGRAM 1 or PROGRAM 2 has been selected; data characters occupy the first 6 bits.

The function of program in data entry and verification are discussed in Section 2.4.1.

2.4. Control Panel

There are a number of switch/indicators and displays on the control panel that:

1. Enable the operator to choose the appropriate operating conditions;
2. Allow the operator to examine the contents of any particular memory location;
3. Indicate the current status of any operation.

Note: There is a different pair of control panels (one each for 4310 and 4320 series) for each type of keyboard. Appendix A shows the keyboards along with their appropriate control panels.

Table 2-4. Operating Modes

Mode	Function	Required Option	Available On These Units	Comments
DATA ENTRY	Key-to-tape	Standard	All except 4322	Data are recorded on magnetic tape as keyed in. Data may be formatted or unformatted.
	Key-to-Central Recorder tape	Pooling	All	Data keyed in at remote terminals in a pooling chain are recorded at the central recorder magnetic tape unit. Data may be formatted or unformatted. Remote terminals must be in the DATA ENTRY mode.
	Key-to-Printer	EXDA	All except 4322	Data that would normally be recorded on magnetic tape is diverted and printed on a line printer.
DATA VERIFY	Key-Verify records on	Standard	All except 4322	An entire file can be verified by re-entering records in DATA VERIFY mode.
	Key-Verify records on tape	Pooling	All except 4322	Tape read at a remote terminal in DATA VERIFY mode, ONLINE, is first key-verified, then transmitted down the pooling chain to the central recorder tape.
	Key and Verify	Standard	4322	A 4322 (keyboard only) unit in a pooling chain allows records to be entered in the DATA VERIFY mode. Records keyed in are immediately verified by the same operator, and are merged when released, if error free.
DATA MERGE	Remote unit Tape-to-Central Recorder tape	Pooling	All except 4322	Previously written tapes can be merged into one reel of tape at the central recorder.
DATA SEARCH	Key-to-Tape	Standard	All except 4322	Permits the entry and verification of identifier data to search on tape for identified record. In this mode unit cannot be placed ONLINE.
READ MEMORY	Display contents	Standard	All	The contents of program and data memory can be examined but not altered.
DATA SEND	Tape-to Line Printer	EXDA	All except 4322	Data recorded on magnetic tape is listed at a line printer.
	Tape-to-Remote Terminal	DCA	All 4310 Series	Data recorded on magnetic tape is transmitted over telephone lines to a remote terminal.
	Remote Terminal to Line Printer	EXDA & DCA	All 4310 Series	Data transmitted from a remote terminal may be listed at a line printer attached to a terminal in the DATA SEND mode.
DATA RECEIVE	Remote terminal to Tape and/or Line Printer	DCA (& EXDA if Line Printer)	All 4310 Series	A key-to-tape unit can receive data over telephone lines and record the data on magnetic tape, or list the data on a line printer, or both.
PROGRAM ENTER	Keyboard-to-Memory	Standard	All	Programs are keyed directly into program memory.
	Program interceptor-to-Key station memory	Pooling	All except 4322	A remote unit in a pooling chain is placed in PROGRAM READ TAPE mode to receive programs from the program interceptor which is in PROGRAM ENTER mode.

Table 2-4. Operating Modes (Continued)

Mode	Function	Required Option	Available On These Units	Comments
PROGRAM READ TAPE	Tape-to-Memory	Standard	All except 4322	Programs are read from magnetic tape into program memory.
	Central Recorder or Program Interceptor to Memory	Pooling	All	A remote unit in a pooling chain is placed in PROGRAM READ TAPE mode to receive programs from the program interceptor or central recorder units.
CENTRAL RECORDER	Key-stations-to-tape	Pooling	All except 4322	The central recorder unit in a pooling chain is placed in CENTRAL RECORDER mode to transmit programs to remote units.
	Central Recorder memory to Key-station	Pooling	All except 4322	The central recorder unit in a pooling chain is placed in CENTRAL RECORDER mode to transmit programs to remote units.

2.4.1 Modes

The mode select switch allows the operator to choose the appropriate operating mode. Rotating the switch to a particular position, however, does not in itself initiate the operation; the RETURN key must be pressed while holding the RESET key depressed. Thus, an operator can rotate the switch through a number of positions to a particular setting without affecting operating conditions. Table 2-4 summarizes mode operating information.

The various modes are discussed below:

2.4.1.1 Data Enter

When the mode select switch is in the DATA ENTER position, data may be entered at the keyboard and sent to the tape unit, central recorder or line printer. Entry may proceed under either program or operator control.

(A) Entry Under Program Control

Pressing the RESET-RETURN keys initiates the data enter operation; the address counter returns to the first character position and the contents of the first memory location are loaded into the access register. Two 3-bit program command codes occupy the last six bits of the register; the PROGRAM select switch or one of the PROG keys determines which of the two codes is to control entry of a data character. The selected program code automatically determines the shift of the keyboard (numeric or alpha) and/or performs a specified control function (duplicating, skipping, right-justification, etc.; see Section 2.2.2).

When the control logic interprets a skip command, the first six bits of the access register are automatically filled with the binary code for a space character (only if the AS/D switch is in the AUTO SKIP/DUP position).

During the entry of the first record in a file the dup command does not automatically duplicate (for the simple reason that there is nothing to duplicate yet). Data must be key entered. As a special precaution, the address counter always returns to the first character position of a dup field that has just been key entered and sends a signal that lights the VRFY lamp on the control panel. The unit automatically reverts to a verify phase; the dup field must be key verified by the operator before she can proceed with data entry. In subsequent record entry, the control logic automatically loads the character from the previous record back into the buffer memory whenever it encounters a duplicate command (again the AS/D switch must be in the AUTOSKIP/DUP position).

If, during first record entry, the RESET key is held depressed while keying data characters into a dup field, the flag bit (the seventh bit) in the access register is set for each character. In subsequent records each character in the field is automatically duplicated, regardless of the AS/D switch setting; such characters are referred to as special control field characters.

After keying the last digit to be entered into a programmed left zero field, the operator must press the LEFT ZERO key; this causes the control logic to automatically right-justify the field. The SKIP, DUP, or BACKSPACE key can only be pressed in the first character position of a left zero field; in other positions a KEY error results.

If a data character is to be entered under control of a programmed command other than the skip, duplicate or left zero commands, the operator must still press a data key to generate a particular character; the operator does not, however, have to take any action regarding the keyboard shift. If the operator wishes to override the numeric or letter command code, this can be done by holding down the NUM or LTR key while pressing the data key. If the alpha key locking option is present, the operator can press the LTR key hard enough to lock it; the keyboard will remain in alpha shift (overriding any numeric command codes) until the LTR key is pressed again.

When data has been entered into the maximum number of memory locations (80 or 200 as determined by the RECORD LENGTH switch), or whenever a release command code is encountered (or the REL key is pressed), the control logic automatically loads the entire record (a character at a time through the access register) onto the data bus and drives it to the tape unit, pooling adapter, or line printer.

(B) Entry Under Operator Control

When the PROGRAM toggle switch is set to the OFF position, the control logic ignores all program command codes. The keyboard is initially in the alphabetic shift. Each data character must be keyed-in and the operator is responsible for changing the keyboard shift. Once the NUM key is pressed, however, the keyboard is electronically locked in numeric shift until the LTR key is pressed or until the operator tries to press a dark grey key. To generate upper case characters with the dark grey keys, the operator must hold the NUM key pressed while keying each character. Pressing the LTR key electronically locks the keyboard in the alpha shift until the NUM key is pressed.

Certain control operations are still automatic during entry under operator control. Pressing the RESET-RETURN keys still clears all error conditions and returns the address counter to the first character position; the address counter automatically advances to the next memory location each time a character is entered. Pressing the SKIP key enters one space character into memory and pressing the DUP key causes the character from the previous record to be automatically duplicated in this record.

When data has been entered into the maximum number of character positions (80 or 200) or when the REL key is pressed, the entire record is automatically sent to the tape unit, pooling adapter, or line printer.

On Series 4320 units, the check digit and/or printing totalizer options are operable in the DATA ENTER mode (see Sections 3.0 and 4.0, respectively).

2.4.1.2 Data Verify

A number of operations are possible in the DATA VERIFY mode, under either operator or program control. Basically, data is read off tape into memory where it is key-verified, corrected, and deleted if necessary. On 4322 units data may be entered and key-verified by the same operator in the DATA VERIFY mode (same-operator-verify operation). On any Series 4310/20 unit (except 4322), operating as a remote terminal in a pooling chain, data can be read off the local tape, key-verified, and then sent to a central recorder, all in the DATA VERIFY mode, ONLINE.

On Series 4320 units, the check digit and/or printing totalizer options are operable in the DATA VERIFY mode (see Sections 3.0 and 4.0).

(A) Verification From Tape. OFFLINE

With the mode select switch in the DATA VERIFY position, pressing the RESET-RETURN keys causes the tape unit to read the first record from tape (it is not erased), place it on the data bus, and send it to memory. Each character of the record is automatically loaded into the buffer memory through the access register. When the entire record has been loaded into the buffer memory, the address counter automatically returns to the first character position. The operator begins keying in each character from the source document. If verification is under program control, skip fields are automatically verified (the control logic ascertains that each character position contains the binary code for a space character); dup fields must be key-verified in the first record. Recall that the address counter, as it advances to a new memory location, loads the contents of that location into the access register. When the operator presses a data key, the binary code for that character is compared with what is in the access register (in this case, a character from the record that has just been read off tape). If the two characters are not identical, the flag bit (the seventh bit in the register) is set and a signal, activating the KEY error indicator and audible alarm, is generated. The address counter does not advance to the next position. Pressing the RESET key clears the error condition; the operator should key in the character again to determine if she accidentally pressed the wrong key. If the characters do not match again, it means that the character was incorrectly keyed during data entry. Pressing the RESET-CORR CHAR or RESET-CORR FIELD keys alerts the unit that a correction is to be made on tape. The operator keys the correct character (s) which are then loaded into the buffer memory. If the instant reverify jumper has not been removed, the address counter automatically backspaces to the first character position of the corrected field and sends a signal that lights the VRFY lamp on the control panel. The corrected field must be key-verified before proceeding to the rest of the record. After a corrected record has been successfully verified, it is sent back to the tape unit (but not erased in memory); the tape automatically backspaces one record and the corrected record is written in place of the erroneous record.

If an entire record is successfully verified and no corrections are required, the record is not sent to the tape unit (it is not necessary since the record was not erased when it was read from tape).

After the first record has been verified and corrected, if necessary, the next record is automatically read from tape and loaded through the access register into the buffer memory. As each character is loaded into the access register, it is compared with the character from the previous record; if the two characters differ the flag bit is set (however, no signal is sent to the error indicator or audible alarm).

Note: This comparison between the character that is about to enter the access register and the character that is about to be replaced occurs whenever data flows into the memory (this test is built into the circuitry); however, it is only in the keying phase of a verify operation that setting the flag bit results in an error condition.

Each subsequent record is key-verified exactly as the first record except that when the control logic encounters a character in a programmed dup field, the flag bit is automatically checked; if the flag bit is not set (that is, it contains a 0), it means that the character is the same as in the previous record. (Remember that when each character was read into memory from tape, the flag bit was only set for those characters that differed from the previous record.) Thus, in all records under program control except the first record, dup fields, as well as skip fields, are automatically verified (if the AS/D switch is in the AUTO SKIP/DUP position).

The leftmost zeroes in a left zero field are automatically verified but the significant digits must be key verified by the operator. After verifying a left zero field, the LEFT ZERO key must be pressed to exit the field. (If the left zero field verification jumper feature is present, pressing the LEFT ZERO key is not required.)

In the DATA VERIFY mode, a record may be deleted by pressing the DELETE, switch on the tape unit control panel while holding the RESET key depressed.

If only certain fields in each record need to be verified, such as account numbers and monetary values, selective verification enables the unit to automatically skip over those fields that are not to be verified. All fields to be skipped over in verification are programmed as skip fields. If the AS/D switch is in the SEL VRFY/REL position, the address counter will only stop at those character positions that are not in skip fields. After successfully verifying a field, the counter automatically advances to the next non-skip field character and the operator key-verifies that field.

Verification under operator control is the same as under program control except that the operator must key-verify each character; nothing is automatically verified or skipped.

(B) Model 4322 Same Operator Verification

Since 4322 units do not have a tape unit, data entered at these units cannot be verified from tape at a later time. Therefore, the 4322 units are capable of a same-operator-verify operation. This operation occurs in the DATA VERIFY mode but it actually involves both an entry and a verification phase. Data is key-entered under control of program 1 in the normal fashion except that when the last character in a record has been entered, the address counter automatically returns to the first memory location. The unit switches to the verify phase of the operation and control automatically reverts to program 2. The record is verified and corrected (if necessary) just as described for verification from tape, OFFLINE, then it is automatically sent to the pooling adapter for transmission to the central recorder.

Program 2 can be programmed to allow for selective verification exactly as was done for verification from tape.

(C) Verification From Tape. ONLINE

Series 4310/20 units (except 4322), acting as remote units in a pooling chain, can read a record from tape into memory, key-verify and correct that record, and then send it to the pooling adapter for transmission to the central recorder. The entire operation is performed in the DATA VERIFY mode, ONLINE; the read-from-tape and verification-correction phases proceed as described in verification from tape, OFFLINE. When each record is successfully verified and corrected (if necessary) it is transferred from memory onto the data bus and driven to the pooling adapter where it is transmitted to the central recorder (see Section 5.0).

2.4.1.3 Data Search

Setting the mode select switch to DATA SEARCH position enables the operator to locate a record on tape. DATA SEARCH mode operations include a data entry phase and a verify phase, as well as a search phase. An identifier record is keyed into memory. As soon as the last character position is filled, the address counter automatically returns to the first character position and the unit reverts to the verify phase of the operation (the VRFY lamp on the control panel lights). The identifier record must be key-verified. Located records can be automatically erased by pressing the RESET-DELETE keys any time during the enter/verify phase of the identifier. After the entire record has been successfully verified the unit reverts to the search phase. A record is read from tape a character at a time. Each character from tape causes the address counter to advance to a new memory location. The address counter, as it advances, loads the contents of that location into the access register. The binary code for the character from tape is compared with what is in the access register (in this case, a character from the identifier record just entered). If the two characters are identical (or if the character from the identifier is a space), the flag bit is not set. If the two characters are not identical (and the character from the identifier is not a space), the flag bit is set. Any flags set in a data record indicate a mismatch. This reading from tape and comparing continues automatically until the control logic determines that no flags were set during a data record, indicating that the record matches the identifier exactly (excluding space characters), then the tape backspaces one record and stops.

If an EOF is detected before a match is found, continuation of the search with the same identifier is done by pressing the RESET-RELEASE keys. To begin a search with a new identifier, the operator must press the RESET-RETURN keys, and enter and verify the new identifier record.

Searching can be interrupted at any time by pressing the RESET key when the record counter indicates the desired pause point. After the record being compared is completed, searching halts, providing a search pause. The search can be terminated (if desired), to perform some other operation on the record, by rotating the mode select switch away from DATA SEARCH.

Search speed varies, depending on the tape speed, record length and recording density.

The time required to examine one record in a search operation is equal to the length of tape the record occupies divided by the tape speed. The length of tape occupied by a record is equal to the number of characters in the record divided by the recording density, plus the inter-record gap length.

Search speed/record =

$$\frac{\left[\frac{\text{(no. of characters in record)}}{\text{(recording density)}} + \text{(inter-record gap length)}\right]}{\text{tape speed}}$$

The inter-record gap length is 0.88 inch on 7-track tape and 0.75 inch on 9-track tape. Recording densities of 200, 556 and 800 characters per inch (cpi) are available on 7-track tape and recording densities of 800 and 1600 cpi are available on 9-track tape. Record lengths may vary from 20 to 200 characters. Tape speed on 4311 and 4321 units is 12.5 inches per second (ips); on 4314 units tape speed is 40 ips except when recording in 1600 cpi density for which it is 37.5 ips.

Figure 2-5 lists search times per record for record lengths of 80 and 200 characters.

2.4.1.4 Read Memory

Setting the mode select switch to the READ MEMORY position enables the operator to examine memory without altering the contents in any way. Pressing the RESET-RETURN keys clears all error conditions and returns the address counter to the first memory location. The contents of that memory location are displayed on the control panel. The data character represented in the first six bits of the register is shown on the CHARACTER display and one of the two program command codes stored in the last six bits of register is shown on the PROGRAM display (depending on the PROGRAM toggle switch setting; the setting can be changed to display the alternate program command). The address counter can be incremented or decremented by pressing the space bar or BACKSPACE key, respectively. Standard character advancement rate is 10 characters per second, but as an option the rate can be increased to 20 characters per second.

2.4.1.5 Data Merge and Central Recorder

The DATA MERGE mode enables several remote units in a pooling chain to merge files from their resident tapes onto one reel of tape at the central recorder. Record insert and editing features are also operable in this mode.

The CENTRAL RECORDER mode enables the central pooler unit in a pooling chain to receive data from a number of remote units and record that data on one reel of tape.

Both the DATA MERGE and CENTRAL RECORDER modes are described fully in Section 5.0.

2.4.1.6 Data Send and Data Receive

The DATA SEND and DATA RECEIVE modes enable Series 4310 units to transmit or receive data over public, private, leased, switched or unswitched, telephone network facilities. Data communications may proceed between two 4310 units, a 4310 unit and any compatible terminal, or a 4310 unit and any compatible computer.

The use of DATA SEND and DATA RECEIVE modes during data communications are discussed in Section 7.0.

The DATA SEND mode also allows Series 4310 and 4320 units to read data from tape and output it to a line printer (see Section 6.0).

2.4.1.7 Program Enter

In the PROGRAM ENTER mode, one or two programs are entered from the keyboard into the buffer memory. After keying-in the program (s) they can be released to the tape unit and written on tape.

During pooling operations, a central recorder or program interceptor unit in the PROGRAM ENTER mode, ONLINE can transmit programs to other remote units in the pooling chain (see Section 5.0).

(A) Program Entry from the Keyboard, OFFLINE

Since each memory location stores two program command codes for that character position, the operator

Table 2-5. Search Times/Record (Milliseconds)

MODEL (tape speed)	Record Length	7-Track			9-Track	
		200 cpi	556 cpi	800 cpi	800 cpi	1600 cpi
4311 or 4321 (12.5 ips)	80	102.2	81.5	78.4	68.0	----
	200	151.0	99.2	90.7	80.0	----
4314 (40 ips for 200, 556 & 800 cpi and 37.5 ips for 1600 cpi)	80	32.0	25.5	24.5	21.2	21.4
	200	46.8	31.0	28.2	25.0	23.2

must set the PROGRAM toggle switch to the PROGRAM 1 or PROGRAM 2 position to define exactly where the new program will be stored. When the RESET-RETURN keys are pressed, all error conditions are cleared and the address counter returns to the first character position. Each time the operator keys-in a program command code, the 3-bit binary code representing that command is sent to the access register and then to one of the two program positions in the last six bits of the appropriate memory location.

When the final command code (REL) is entered, the VRFY lamp lights and the unit switches to the verify phase of the operation. The address counter automatically returns to the first memory location; the operator must key-verify the entire program record.

(B) Writing a Program Pair on Tape

Before writing a program pair on tape, an identifier should be recorded on tape in the DATA ENTER mode. One or two programs are then entered and verified from the keyboard as described above.

NOTE: Two programs will always be written on tape as a pair, even if only one program is entered at the keyboard; in such a case, the other program will consist of whatever information was stored in the alternate program positions of the buffer memory.

When the operator presses the REL key while holding the RESET key depressed, the program just entered and verified is released to the data bus and driven to the tape unit where it is written on tape, immediately following the identifier record.

2.4.1.8 Program Read Tape

(A) OFFLINE Operation

The PROGRAM READ TAPE mode, OFFLINE is used to search a tape for a pair of programs and then load the selected pair into the buffer memory. This mode includes an entry and verify phase as well as a search and read-from-tape phase. The identifier record that will match the identifier immediately preceding the desired program pair is keyed into the buffer memory. As soon as the last character of the identifier is entered, the address counter returns to the first character position and the unit reverts to the verify phase. The identifier record must be key-verified. When the identifier has been successfully verified, the tape unit automatically starts reading records off tape without erasing them and sending them to memory. As in the DATA SEARCH mode, each character of a record is compared with the corresponding character of the identifier and then is discarded without altering the contents of the memory.

(NOTE: space characters are not ignored in a read-tape identifier.) The control logic "remembers" if each character of a record has matched the identifier. When a record is encountered that identically matches the contents of memory, the program pair immediately following that record on tape are loaded into the program portion (last six bits) of each memory location.

(B) ONLINE Operation

The PROGRAM READ TAPE mode, ONLINE allows a remote unit in a pooling chain to receive programs transmitted from the central recorder or program interceptor (see Section 5.0).

2.4.2 AUTO SKIP/DUP Switch

When operating under program control, the AUTO SKIP /DUP switch (referred to as the AS/D switch) enables a number of automatic operations. The AS/D switch has three settings:

1. AUTO SKIP/DUP
2. SEL VRFY/REL
3. OFF

Table 2-6 lists the functions of both "on" settings for each applicable mode of operation.

Automatic skipping and duplicating in the DATA ENTER mode are discussed in Section 2.4.1; automatic verification of skip and dup fields as well as selective verification are included in the discussion of the DATA VERIFY mode, also in Section 2.4.1.

The SEL VRFY/REL position of the AS/D switch also enables an early release operation. If the operator wishes to terminate a record before the programmed release code is encountered, this can be done by pressing the REL key. For example, if an operator is entering data under control of a program that has a release code in character position 100, she can terminate the record prior to encountering the release code, say character position 50, by pressing the REL key. If the AS/D switch is in the SEL VRFY/REL position, the record is terminated at character position 50; space codes do **not** fill positions 50 to 100 as they would if the AS/D switch were in another position.

2.4.3 PROGRAM 1/ OFF/2 Switch

The PROGRAM toggle switch defines which program is to exert control during data mode operations; the OFF position dictates that any operation is to proceed under operator control. In the PROGRAM ENTER mode, the PROGRAM toggle switch determines which of the two program positions in each memory location is to be used for storing the program being keyed in. Anytime that the PROGRAM toggle switch is rotated to an "on" position, a first record condition automatically results.

2.4.4 RECORD LENGTH Switch

The RECORD LENGTH switch allows the operator to control the maximum length of a record, either 8- or 200 characters. Whenever the maximum character position is reached, the record is automatically terminated. Records of variable lengths other than 80 or 200 character positions can be achieved through use of the REL key or a programmed release command code.

2.4.5 CHARACTER POSITION Display

The CHARACTER POSITION display indicates the current character position in Memory. This display is controlled by the address counter.

Table 2-6. The Functions of the AS/D Switch

Mode	Position of AS/D Switch	Function
DATA ENTER	AUTO SKIP/DUP	Causes skip fields to be skipped automatically (spaces are entered). Causes dup fields to be duplicated automatically (except in the first record).
	SEL VRFY/REL	Allows the early release of records without causing space codes to fill the remaining positions in the record.
DATA VERIFY	AUTO SKIP/DUP	Causes automatic verification of skip fields. Causes automatic verification of dup fields (except in first record).
	SEL VRFY/REL	Allows early release of records during same-operator-verify operation on 4322 units. Allows selective verification of data using programmed skip fields. For a Model 4322 unit, skip fields in program 2 will cause selective verification.
NOT APPLICABLE IN OTHER MODES		

NOTE: 1. The PROGRAM toggle switch must be set to the PROGRAM 1 or PROGRAM 2 position for the AS/D switch to function.

2. During first record entry, special control field characters can be entered into a programmed dup field by pressing the data key while holding the RESET key depressed. Special control field characters are duplicated after the first record regardless of the AS/D switch setting. The use of special control field characters in dup fields also permits the use of certain editing features during pooling and data communications.

3. Programmed skip fields that are used to designate check digit fields are never skipped.

2.4.6 CHARACTER Display

The CHARACTER display shows the data character that occupies the current character position in memory. Since the address counter always loads the contents of a particular memory location into the access register as it advances to that location, the CHARACTER display actually shows the character represented by the binary code stored in the first six bits of the access register.

2.4.7 PROGRAM Display

The PROGRAM display shows one of the two program command codes stored in the current character position of memory, as well as indicating whether program 1 or 2

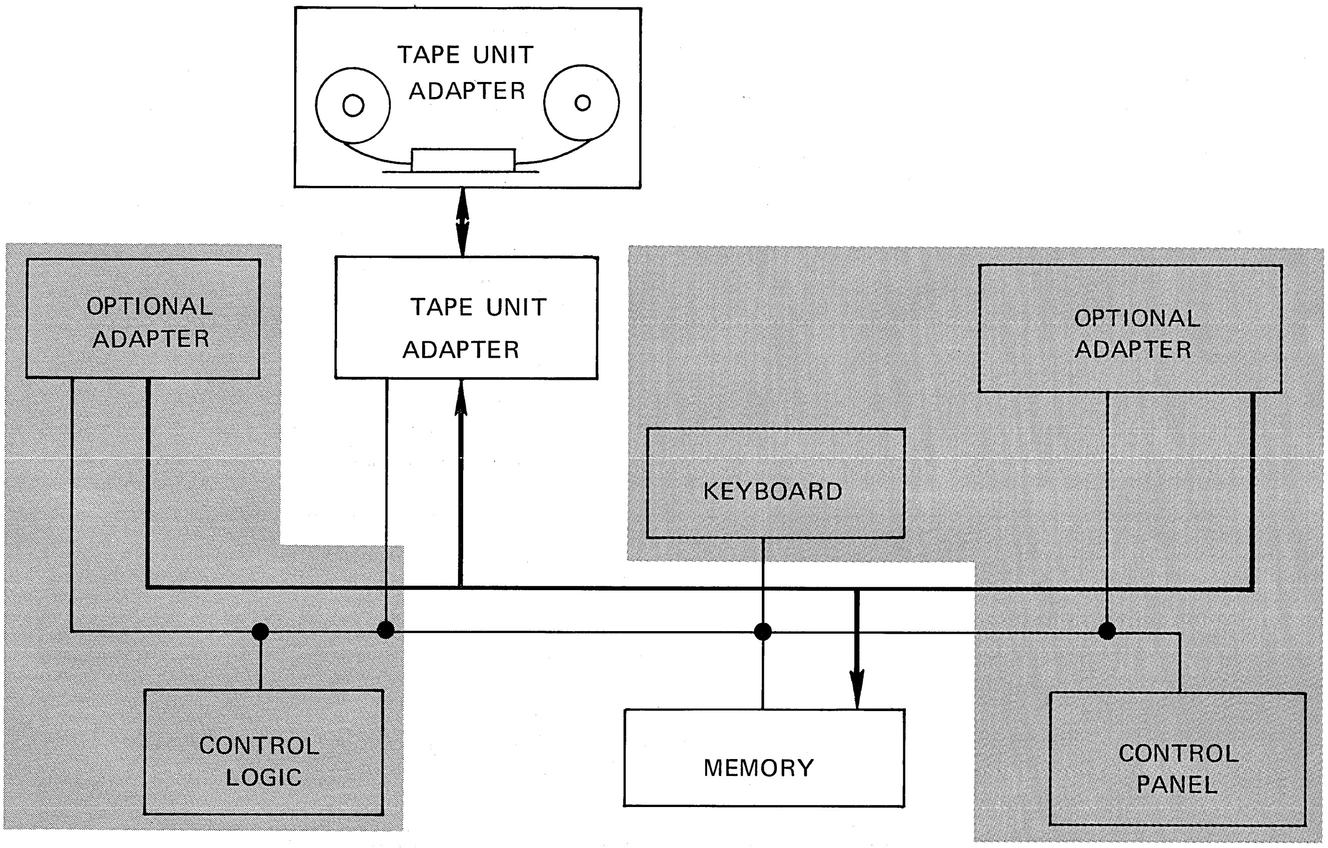


Figure 2-10. Flow of Data — To and From Tape Unit

is in control; the PROGRAM toggle switch and/or the PROG 1 or 2 keys determine which program is displayed. If the PROGRAM toggle switch is in the OFF position, neither program 1 nor 2 is indicated; however, the keyboard shift (numeric or alpha) is shown. Under operator control, the keyboard shift is chosen by use of the NUM or LTR keys.

2.5 Tape Unit

2.5.1 Recording Capacities and Characteristics

All Series 4310/20 units, except Model 4322, include a magnetic tape unit that is interfaced with the unit's internal communication lines (the data bus) through a tape unit adapter. All data flow in or out of this adapter proceeds through the memory; Figure 2-10 highlights this flow.

The tape unit for each model in the 4310/20 Series functions under the same theory of operation; however, there are a number of differences between models in such areas as tape speed, recording methods, densities and languages, tape capacity, rewind speed as well as physical appearance.

The tape unit standard specifications for each model are listed below:

Models 4311 and 4321 Magnetic Data Recorder

Tape Speed: 12.5 inches per second

Recording methods and densities:

NRZI, 7-track (200, 556, or 800 characters per inch),
NRZI, 9-track (800 characters per inch).

Tape Capacity: 7-inch diameter reels of 1/2 inch wide computer tape (600 feet of recording surface).

Rewind Time: 150 seconds for full 7-inch reel.

Tape Languages: On 7-track tapes — BCDIC, Honeywell-El and ICL

On 9-track tapes — EBCDIC

Models 4311 and 4321 are stand alone units with the tape deck mounted above the keyboard.

Model 4314 Magnetic Data Central Pooler:

Tape Speed: 40 inches per second (NRZI)
37.5 inches per second (Phase Encoding)

Recording methods and densities:
NRZI, 7-track (200, 556, or 800 characters per inch).

Tape Capacity: 10 1/2-inch diameter reels of 1/2 inch wide,
1 1/2 mils thick, computer grade magnetic tape

Rewind Speed: 150 inches per second, nominal

Tape Languages: On 7-track – BCDIC, Honeywell-EL and ICL
On 9-track – EBCDIC

Table 2-7. Recording Capacities and Capabilities for Series 4310/20 Key-To-Tape Units.

Tape Unit	Record Length	Number of Records on a Reel of Tape				
		NRZI				PE
		7-Track			9-Track	9-Track
		200 CPI	556 CPI	800 CPI	800 CPI	1600 CPI
4311	20	7400	7900	8000	9800	
	80	5600	7100	7400	8900	
or	120	4800	6600	7000	8300	
	132	4700	6500	6900	8200	
4321	200	3800	5800	6400	7500	
	20	28800	30900	31200	38400	38900
	80	22000	27600	28800	34800	37100
4314	120	19000	25700	27400	32700	35900
	132	18300	25200	27000	32200	35500
	200	14900	22700	24900	29300	33700

Allowed Recording Formats:
NRZI: 200, 556, or 800 CPI, 7-track or 800 CPI, 9-track.
PE: 1600 CPI, 9-track (4314 only)
HONEYWELL OR ICL: 200, 556, or 800 CPI, 7-track only

Record Length: 20 to 200 Characters

Tape Rewind Speed: 150 inches/sec., nominal for 4314.
50 inches/sec., nominal for 4311 and 4321.

Search Speed: 13 to 45 records/sec., (depending on unit and record length).

The tape unit on the 4314 is in a separate cabinet from the rest of the unit.

The tape unit on any of the Series 4310/20 units is capable of receiving data recorded in a number of formats and densities, and then translating that data into the format selected for that particular unit, before recording the data on tape.

Table 2-7 lists the recording capacities and characteristics of Series 4310/20 key-to-tape units.

2.5.2 Tape Operations

Once a reel of tape has been loaded into the tape unit, the LOAD and REWIND switches on the control panel are used to advance the tape to the Beginning Of Tape (BOT) marker or to rewind the tape onto the supply reel (see the discussion of the LOAD and REWIND switches in Section 2.2.4).

The BOT (Beginning Of Tape) is a reflective marker placed on the tape by the manufacturer. When a reel of tape is first loaded into the tape unit, the LOAD switch is pressed once to take up the slack and then pressed again to advance the tape to the BOT marker. A reel of tape must be loaded and advanced to BOT before the tape unit is ready to be used.

In the DATA ENTER, CENTRAL RECORDER, or DATA RECEIVE modes, the data characters in each memory location are automatically transferred (but not erased) from memory to the data bus and driven to the tape unit adapter (unless directed to one of the optional adapters; e.g., data may be sent to a line printer without also going to the tape unit) whenever the maximum number of characters has been entered (depending on the RECORD LENGTH switch), a release command code is encountered or the REL key is pressed. The tape unit adapter translates the internal machine language (MDRS) binary codes for each character into the tape language for that particular unit; the appropriate code for each character is then automatically recorded on magnetic tape.

Table 2-8 lists the internal machine language code (MDRS), the BCDIC tape code (for 7-track) and the EBCDIC tape code (for 9-track) for each of the 64 data characters. Tables 2-9 and 2-10 list the same information for the Honeywell-EL (7-track) and ICL (7-track) languages, respectively.

NOTE: See Appendix A for a listing of the codes generated by keyboards designed for use in countries other than the United States.

In the DATA VERIFY mode, only those records that have been corrected are sent to the tape unit to be rewritten. When a correction is made the tape backspaces one record; after the corrected record is successfully verified the record is automatically sent to the tape unit where it is rewritten, replacing the erroneous record.

In the PROGRAM ENTER mode, pressing the RESET-REL keys causes the program portion (the last six bits) of each memory location to be transferred to the data bus and driven to the tape unit where the two programs are translated, then written on tape.

Recall that two programs are written on tape even if only one program is entered at the keyboard; the other program consists of whatever information was stored in the alternate program positions of the buffer memory. Accordingly, Table 2-11 lists each of the 64 possible program pairs, as well as the 7-track, BCDIC and 9-track, EBCDIC tape codes for each pair. The tape language codes for the various program pairs are the same as those codes that represent the 64 possible data characters and symbols; Table 2-11 also lists the keyboard graphic that each program pair would represent if a program tape were interpreted as data rather than as program commands.

In any of the "read" modes (DATA VERIFY, DATA SEARCH, DATA MERGE, DATA SEND, and PROGRAM READ TAPE), the particular procedure that initiates the "read" operation sends a singal to the tape unit that starts forward tape motion. Each character of a record is read off tape, translated by the tape unit adapter into the equivalent 6-bit (7-bit for Kana units) internal binary code and sent via the data bus to memory. If a TAPE error occurs, four re-tries at "reading" the tape are attempted before the operator is alerted.

If the tape unit adapter encounters an EOF record (A one-character record signaling the end of a file; the EOF record is written on tape when the file is initially recorded), tape forward motion stops. To continue reading the next file on tape, certain special procedures must be followed; the exact procedure depends on the operating mode.

Table 2-8. MDRS, BCDIC and EBCDIC Codes

Graphic/Control Symbol	MDRS Internal Machine Code	7-Track BCDIC Code	9-Track EBCDIC Code (Shown w/o Parity)
	0 1 2 3 4 5	B A 8 4 2 1	0 1 2 3 4 5 6 7
0	1 1 0 0 0 0	8 2	1 1 1 1 0 0 0 0
1	1 1 0 0 0 1	1	1 1 1 1 0 0 0 1
2	1 1 0 0 1 0	2	1 1 1 1 0 0 1 0
3	1 1 0 0 1 1	2 1	1 1 1 1 0 0 1 1
4	1 1 0 1 0 0	4	1 1 1 1 0 1 0 0
5	1 1 0 1 0 1	4 1	1 1 1 1 0 1 0 1
6	1 1 0 1 1 0	4 2	1 1 1 1 0 1 1 0
7	1 1 0 1 1 1	4 2 1	1 1 1 1 0 1 1 1
8	1 1 1 0 0 0	8	1 1 1 1 1 0 0 0
9	1 1 1 0 0 1	8 1	1 1 1 1 1 0 0 1
–	1 0 1 0 1 0	B	0 1 1 0 0 0 0 0
&	0 1 0 0 0 0	B A	0 1 0 1 0 0 0 0
A	0 0 0 0 0 1	B A 1	1 1 0 0 0 0 0 1
B	0 0 0 0 1 0	B A 2	1 1 0 0 0 0 1 0
C	0 0 0 0 1 1	B A 2 1	1 1 0 0 0 0 1 1
D	0 0 0 1 0 0	B A 4	1 1 0 0 0 1 0 0
E	0 0 0 1 0 1	B A 4 1	1 1 0 0 0 1 0 1
F	0 0 0 1 1 0	B A 4 2	1 1 0 0 0 1 1 0
G	0 0 0 1 1 1	B A 4 2 1	1 1 0 0 0 1 1 1
H	0 0 1 0 0 0	B A 8	1 1 0 0 1 0 0 0
I	0 0 1 0 0 1	B A 8 1	1 1 0 0 1 0 0 1
J	0 1 0 0 0 1	B 1	1 1 0 1 0 0 0 1
K	0 1 0 0 1 0	B 2	1 1 0 1 0 0 1 0
L	0 1 0 0 1 1	B 2 1	1 1 0 1 0 0 1 1
M	0 1 0 1 0 0	B 4	1 1 0 1 0 1 0 0
N	0 1 0 1 0 1	B 4 1	1 1 0 1 0 1 0 1
O	0 1 0 1 1 0	B 4 2	1 1 0 1 0 1 1 0
P	0 1 0 1 1 1	B 4 2 1	1 1 0 1 0 1 1 1
Q	0 1 1 0 0 0	B 8	1 1 0 1 1 0 0 0
R	0 1 1 0 0 1	B 8 1	1 1 0 1 1 0 0 1
/	1 0 0 0 0 1	A 1	0 1 1 0 0 0 0 1
S	1 0 0 0 1 0	A 2	1 1 1 0 0 0 1 0
T	1 0 0 0 1 1	A 2 1	1 1 1 0 0 0 1 1
U	1 0 0 1 0 0	A 4	1 1 1 0 0 1 0 0
V	1 0 0 1 0 1	A 4 1	1 1 1 0 0 1 0 1
W	1 0 0 1 1 0	A 4 2	1 1 1 0 0 1 1 0
X	1 0 0 1 1 1	A 4 2 1	1 1 1 0 0 1 1 1
Y	1 0 1 0 0 0	A 8	1 1 1 0 1 0 0 0
Z	1 0 1 0 0 1	A 8 1	1 1 1 0 1 0 0 1
Space	0 0 0 0 0 0	A	0 1 0 0 0 0 0 0
¢	0 0 1 0 1 0	B A 8 2	0 1 0 0 1 0 1 0
•	0 0 1 0 1 1	B A 8 2 1	0 1 0 0 1 0 1 1
<	0 0 1 1 0 0	B A 8 4	0 1 0 0 1 1 0 0
(	0 0 1 1 0 1	B A 8 4 1	0 1 0 0 1 1 0 1
+	0 0 1 1 1 0	B A 8 4 2	0 1 0 0 1 1 1 0
|	0 0 1 1 1 1	B A 8 4 2 1	0 1 0 0 1 1 1 1
!	0 1 1 0 1 0	B 8 2	1 1 0 1 0 0 0 0*
$	0 1 1 0 1 1	B 8 2 1	0 1 0 1 1 0 1 1
*	0 1 1 1 0 0	B 8 4	0 1 0 1 1 1 0 0
)	0 1 1 1 0 1	B 8 4 1	1 0 1 1 1 1 0 1
;	0 1 1 1 1 0	B 8 4 2	0 1 0 1 1 1 1 0
¬	0 1 1 1 1 1	B 8 4 2 1	0 1 0 1 1 1 1 1
0-8-2	1 0 0 0 0 0	A 8 2	1 1 1 0 0 0 0 0
,	1 0 1 0 1 1	A 8 2 1	0 1 1 0 1 0 1 1
%	1 0 1 1 0 0	A 8 4	0 1 1 0 1 1 0 0
—	1 0 1 1 0 1	A 8 4 1	0 1 1 0 1 1 0 1
>	1 0 1 1 1 0	A 8 4 2	0 1 1 0 1 1 1 0
?	1 0 1 1 1 1	A 8 4 2 1	0 1 1 0 1 1 1 1
:	1 1 1 0 1 0	No equivalent	0 1 1 1 1 0 1 0
#	1 1 1 0 1 1	8 2 1	0 1 1 1 1 0 1 1
@	1 1 1 1 0 0	8 4	0 1 1 1 1 1 0 0
'	1 1 1 1 0 1	8 4 1	0 1 1 1 1 1 0 1
=	1 1 1 1 1 0	8 4 2	0 1 1 1 1 1 1 0
"	1 1 1 1 1 1	8 4 2 1	0 1 1 1 1 1 1 1

* This is not the standard EBCDIC code for a "!" graphic; it is assigned for use in the "Negative Decimal Digit" mode of operation (see Section 2.2.3).

Table 2-9. MDRS and Honeywell-EL Codes.

Graphic/Control Symbol	MDRS Internal Machine Code						7-Track Honeywell Code (Shown w/o Parity)					
	0	1	2	3	4	5	B	A	8	4	2	1
0	1	1	0	0	0	0						
1	1	1	0	0	0	1						1
2	1	1	0	0	1	0					2	
3	1	1	0	0	1	1					2	1
4	1	1	0	1	0	0				4		
5	1	1	0	1	0	1				4		1
6	1	1	0	1	1	0				4	2	
7	1	1	0	1	1	1				4	2	1
8	1	1	1	0	0	0			8			
9	1	1	1	0	0	1			8			1
–	1	0	1	0	1	0	B					
&	0	1	0	0	0	0		A				
A	0	0	0	0	0	1		A				1
B	0	0	0	0	1	0		A			2	
C	0	0	0	0	1	1		A			2	1
D	0	0	0	1	0	0		A		4		
E	0	0	0	1	0	1		A		4		1
F	0	0	0	1	1	0		A		4	2	
G	0	0	0	1	1	1		A		4	2	1
H	0	0	1	0	0	0		A	8			
I	0	0	1	0	0	1		A	8			1
J	0	1	0	0	0	1	B					1
K	0	1	0	0	1	0	B				2	
L	0	1	0	0	1	1	B				2	1
M	0	1	0	1	0	0	B			4		
N	0	1	0	1	0	1	B			4		1
O	0	1	0	1	1	0	B			4	2	
P	0	1	0	1	1	1	B			4	2	1
Q	0	1	1	0	0	0	B		8			
R	0	1	1	0	0	1	B		8			1
/	1	0	0	0	0	1	B	A				1
S	1	0	0	0	1	0	B	A			2	
T	1	0	0	0	1	1	B	A			2	1
U	1	0	0	1	0	0	B	A		4		
V	1	0	0	1	0	1	B	A		4		1
W	1	0	0	1	1	0	B	A		4	2	
X	1	0	0	1	1	1	B	A		4	2	1
Y	1	0	1	0	0	0	B	A	8			
Z	1	0	1	0	0	1	B	A	8			1
Space	0	0	0	0	0	0			8	4		1
¢	0	0	1	0	1	0		A	8		2	
•	0	0	1	0	1	1		A	8		2	1
<	0	0	1	1	0	0		A	8	4		
(	0	0	1	1	0	1		A	8	4		1
+	0	0	1	1	1	0		A	8	4	2	
|	0	0	1	1	1	1		A	8	4	2	1
!	0	1	1	0	1	0	B		8		2	
$	0	1	1	0	1	1	B		8		2	1
*	0	1	1	1	0	0	B		8	4		
)	0	1	1	1	0	1	B		8	4		1
;	0	1	1	1	1	0	B		8	4	2	
¬	0	1	1	1	1	1	B		8	4	2	1
≠	1	0	0	0	0	0	B	A	8		2	
,	1	0	1	0	1	1	B	A	8		2	1
%	1	0	1	1	0	0	B	A	8	4		
—	1	0	1	1	0	1	B	A	8	4		1
>	1	0	1	1	1	0	B	A	8	4	2	
?	1	0	1	1	1	1	B	A	8	4	2	1
:	1	1	1	0	1	0			8		2	
#	1	1	1	0	1	1			8		2	1
@	1	1	1	1	0	0			8	4		
'	1	1	1	1	0	1	B	A				
=	1	1	1	1	1	0			8	4	2	
"	1	1	1	1	1	1			8	4	2	1

Table 2-10. MDRS and ICL Codes

Graphic/Control Symbol	MDRS Internal Machine Code						ICL 7-Track Tape Code (Shown w/o Parity)					
	0	1	2	3	4	5	B	A	8	4	2	1
0	1	1	0	0	0	0	B	A	8	4		
1	1	1	0	0	0	1	B	A	8	4		1
2	1	1	0	0	1	0	B	A	8	4	2	
3	1	1	0	0	1	1	B	A	8	4	2	1
4	1	1	0	1	0	0	B	A	8			
5	1	1	0	1	0	1	B	A	8			1
6	1	1	0	1	1	0	B	A	8		2	
7	1	1	0	1	1	1	B	A	8		2	1
8	1	1	1	0	0	0	B	A		4		
9	1	1	1	0	0	1	B	A		4		1
-	1	0	1	0	1	0	B					1
&	0	1	0	0	0	0	B		8		2	
A	0	0	0	0	0	1		A	8	4		1
B	0	0	0	0	1	0		A	8	4	2	
C	0	0	0	0	1	1		A	8	4	2	1
D	0	0	0	1	0	0		A	8			
E	0	0	0	1	0	1		A	8			1
F	0	0	0	1	1	0		A	8		2	
G	0	0	0	1	1	1		A	8		2	1
H	0	0	1	0	0	0		A		4		
I	0	0	1	0	0	1		A		4		1
J	0	1	0	0	0	1		A		4	2	
K	0	1	0	0	1	0		A		4	2	1
L	0	1	0	0	1	1		A				
M	0	1	0	1	0	0		A				1
N	0	1	0	1	0	1		A			2	
O	0	1	0	1	1	0		A			2	1
P	0	1	0	1	1	1			8	4		
Q	0	1	1	0	0	0			8	4		1
R	0	1	1	0	0	1			8	4	2	
/	1	0	0	0	0	1	B				2	1
S	1	0	0	0	1	0			8	4	2	1
T	1	0	0	0	1	1			8			
U	1	0	0	1	0	0			8			1
V	1	0	0	1	0	1			8		2	
W	1	0	0	1	1	0			8		2	1
X	1	0	0	1	1	1				4		
Y	1	0	1	0	0	0				4		1
Z	1	0	1	0	0	1				4	2	
Space	0	0	0	0	0	0	B		8	4		
?	0	0	1	0	1	0	B	A			2	1
•	0	0	1	0	1	1	B				2	
]	0	0	1	1	0	0						1
(	0	0	1	1	0	1	B			4		
<	0	0	1	1	1	0	B	A				
+	0	0	1	1	1	1	B			4	2	1
↑	0	1	1	0	1	0					2	
>	0	1	1	0	1	1	B	A			2	
*	0	1	1	1	0	0	B			4	2	
)	0	1	1	1	0	1	B			4		1
;	0	1	1	1	1	0	B	A		4	2	1
←	0	1	1	1	1	1					2	1
£	1	0	0	0	0	0	B		8			
'	1	0	1	0	1	1	B					
%	1	0	1	1	0	0	B		8			1
=	1	0	1	1	0	1	B	A				1
'	1	0	1	1	1	0	B		8		2	1
!	1	0	1	1	1	1	B		8	4		1
$	1	1	1	0	1	0						1)
#	1	1	1	0	1	1	B		8	4	2	1
@	1	1	1	1	0	0		A	8	4		
:	1	1	1	1	0	1	B	A		4	2	
''	1	1	1	1	1	0	B		8	4	2	
[	1	1	1	1	1	1				4	2	1

1) Unallowable on even parity tape.

Table 2-11. Program Tape Codes

PROGRAM COMMANDS		TAPE CODES														KEYBOARD GRAPHIC
		7-Track (BCDIC)						9-Track (EBCDIC)								
PROG 1	PROG 2	B	A	8	4	2	1	0	1	2	3	4	5	6	7	
REL	REL		A					0	1	0	0	0	0	0	0	Space
REL	NUMST	B	A				1	1	1	0	0	0	0	0	1	A
REL	LTRST	B	A			2		1	1	0	0	0	0	1	0	B
REL	LZ	B	A			2	1	1	1	0	0	0	0	1	1	C
REL	LTR	B	A		4			1	1	0	0	0	1	0	0	D
REL	NUM	B	A		4		1	1	1	0	0	0	1	0	1	E
REL	DUP	B	A		4	2		1	1	0	0	0	1	1	0	F
REL	SKIP	B	A		4	2	1	1	1	0	0	0	1	1	1	G
NUMST	REL	B	A	8				1	1	0	0	1	0	0	0	H
NUMST	NUMST	B	A	8			1	1	1	0	0	1	0	0	1	I
NUMST	LTRST	B	A	8		2		0	1	0	0	1	0	1	0	¢
NUMST	LZ	B	A	8		2	1	0	1	0	0	1	0	1	1	•
NUMST	LTR	B	A	8	4			0	1	0	0	1	1	0	0	<
NUMST	NUM	B	A	8	4		1	0	1	0	0	1	1	0	1	(
NUMST	DUP	B	A	8	4	2		0	1	0	0	1	1	1	0	+
NUMST	SKIP	B	A	8	4	2	1	0	1	0	0	1	1	1	1	|
LTRST	REL	B	A					0	1	0	1	0	0	0	0	&
LTRST	NUMST	B					1	1	1	0	1	0	0	0	1	J
LTRST	LTRST	B				2		1	1	0	1	0	0	1	0	K
LTRST	LZ	B				2	1	1	1	0	1	0	0	1	1	L
LTRST	LTR	B			4			1	1	0	1	0	1	0	0	M
LTRST	NUM	B			4		1	1	1	0	1	0	1	0	1	N
LTRST	DUP	B			4	2		1	1	0	1	0	1	1	0	O
LTRST	SKIP	B			4	2	1	1	1	0	1	0	1	1	1	P
LZ	REL	B		8				1	1	0	1	1	0	0	0	Q
LZ	NUMST	B		8			1	1	1	0	1	1	0	0	1	R
LZ	LTRST	B		8		2		1	1	0	1	0	0	0	0	!
LZ	LZ	B		8		2	1	0	1	0	1	1	0	1	1	$
LZ	LTR	B		8	4			0	1	0	1	1	1	0	0	*
LZ	NUM	B		8	4		1	0	1	0	1	1	1	0	1	)
LZ	DUP	B		8	4	2		0	1	0	1	1	1	1	0	;
LZ	SKIP	B		8	4	2	1	0	1	0	1	1	1	1	1	¬
LTR	REL		A	8		2		1	1	1	0	0	0	0	0	0-8-2
LTR	NUMST		A				1	0	1	1	0	0	0	0	1	/
LTR	LTRST		A			2		1	1	1	0	0	0	1	0	S
LTR	LZ		A			2	1	1	1	1	0	0	0	1	1	T
LTR	LTR		A		4			1	1	1	0	0	1	0	0	U
LTR	NUM		A		4		1	1	1	1	0	0	1	0	1	V
LTR	DUP		A		4	2		1	1	1	0	0	1	1	0	W
LTR	SKIP		A		4	2	1	1	1	1	0	0	1	1	1	X
NUM	REL		A	8				1	1	1	0	1	0	0	0	Y
NUM	NUMST		A	8			1	1	1	1	0	1	0	0	1	Z
NUM	LTRST	B						0	1	1	0	0	0	0	0	-
NUM	LZ		A	8		2	1	0	1	1	0	1	0	1	1	,
NUM	LTR		A	8	4			0	1	1	0	1	1	0	0	%
NUM	NUM		A	8	4		1	0	1	1	0	1	1	0	1	—
NUM	DUP		A	8	4	2		0	1	1	0	1	1	1	0	>
NUM	SKIP		A	8	4	2	1	0	1	1	0	1	1	1	1	?
DUP	REL			8		2		1	1	1	1	0	0	0	0	0
DUP	NUMST						1	1	1	1	1	0	0	0	1	1
DUP	LTRST					2		1	1	1	1	0	0	1	0	2
DUP	LZ					2	1	1	1	1	1	0	0	1	1	3
DUP	LTR				4			1	1	1	1	0	1	0	0	4
DUP	NUM				4		1	1	1	1	1	0	1	0	1	5
DUP	DUP				4	2		1	1	1	1	0	1	1	0	6
DUP	SKIP				4	2	1	1	1	1	1	0	1	1	1	7
SKIP	REL			8				1	1	1	1	1	0	0	0	8
SKIP	NUMST			8			1	1	1	1	1	1	0	0	1	9
SKIP	LTRST	No equivalent						0	1	1	1	1	0	1	0	:
SKIP	LZ			8		2	1	0	1	1	1	1	0	1	1	#
SKIP	LTR			8	4			0	1	1	1	1	1	0	0	@
SKIP	NUM			8	4		1	0	1	1	1	1	1	0	1	'
SKIP	DUP			8	4	2		0	1	1	1	1	1	1	0	=
SKIP	SKIP			8	4	2	1	0	1	1	1	1	1	1	1	"

An EOT is a reflective marker placed on the tape by the manufacturer; EOT indicates that the end of a tape is very near. If an EOT marker is encountered while writing on tape, forward motion stops after the current record is recorded. The operator is advised to rewind the tape and load a new reel; however, additional records can be written on tape after the EOT marker. For example, the operator can write the last few records of a file before loading a new reel. As a precaution the keyboard is electronically locked when an EOT marker is encountered; to unlock the keyboard, the operator must press the RETURN key while holding the RESET key depressed, before beginning each additional record.

2.5.3 Tape Read/Write Speeds

The time required to write a record on tape or to read a record off tape is dependent on the magnetic data recorder, the number of characters in the record, the number of tape tracks and the recording density.

Read and write times (in milliseconds) for Model 4311, 4321 and 4314 units are listed in Table 2-12.

2.5.4 Tape Recording Methods

The usable portion of a magnetic tape begins with the BOT reflective marker and ends shortly after the EOT reflective marker. Magnetic tapes are available in either 7-track or 9-track form. Data that is received by the tape unit adapter is translated into the particular recording language (see Tables 2-8, 2-9, and 2-10) selected for that unit. Each coded character is then recorded on tape in parallel (i.e., all the bits of that particular binary code are simultaneously recorded with each bit being recorded in a separate track).

Two methods of recording data on magnetic tape are in common use; they are:

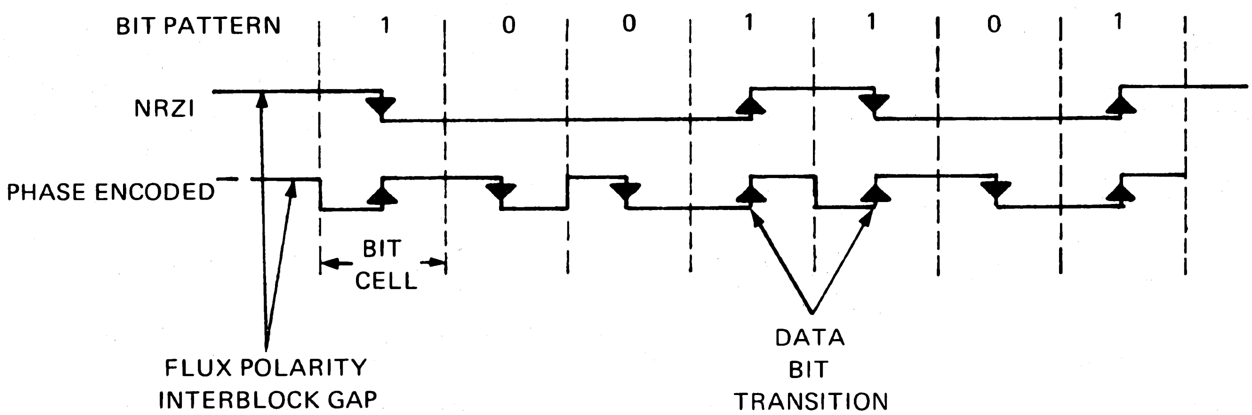
1) Non return-to-zero change on ones (NRZI)
2) Phase Encoding (PE)

These two techniques use the following methods to record data, as illustrated in Figure 2-11.

NRZI: A "one" bit on tape is represented by a flux polarity reversal, and a "zero" bit by no change of flux polarity.

Table 2-12. Times (in Milliseconds) to Read and Write One Record

Model	Record Length	7-TRACK						9-TRACK			
		200 CPI		556 CPI		800 CPI		800 CPI		1600 CPI	
		Read	Write	Read	Write	Read	Write	Read	Write	Read	Write
	20	120.8	293.2	115.02	274.75	115.6	272.8	90.8	237.6		
	40	128.8	327.2	117.90	283.39	117.6	278.8	92.8	243.6		
4311	80	114.8	365.2	123.65	300.65	121.6	290.8	96.8	255.6		
or	120	160.8	413.2	129.41	317.92	125.6	302.8	100.8	267.6		
4321	160	176.8	461.2	135.16	335.18	129.6	314.8	104.8	279.6		
	200	192.8	509.2	140.92	352.45	133.6	326.8	108.8	291.6		
	20	37.75	91.62	35.94	85.86	36.12	85.25	28.38	74.25	29.5	78.2
	40	40.25	99.23	36.84	88.56	36.75	87.12	29.00	76.12	29.8	79.2
4314	80	45.25	114.12	38.64	93.95	38.00	90.88	30.25	79.88	30.5	81.2
	120	50.25	129.12	40.44	99.35	39.25	94.62	31.50	83.62	31.2	83.2
	160	55.25	144.12	42.24	104.74	40.50	98.38	32.75	87.38	31.8	85.2
	200	60.25	159.12	44.04	110.14	41.75	102.12	34.00	91.12	32.5	87.2



NOTES:

NRZI – Any change in polarity is a "1" bit. No change is a "0" bit.

PHASE ENCODED – Data bit transition in direction of IBG is a "1" bit
– Data bit transition opposite in direction of IBG is a "0" bit

Figure 2-11. Phase Encoded and NRZI Recording Comparison

PE: A "one" bit is represented by a flux reversal at the center of a bit cell to the polarity of the inter-block gap (IBG) when reading in the forward direction. A "zero" bit is represented by a flux reversal at the center of a bit cell to the polarity opposite that of the IBG when reading in the forward direction.

NOTE: Since two flux changes are required for each bit if the data is all ones or all zeroes, 3200 fci (flux changes per inch) tape must be used with the PE recording method.

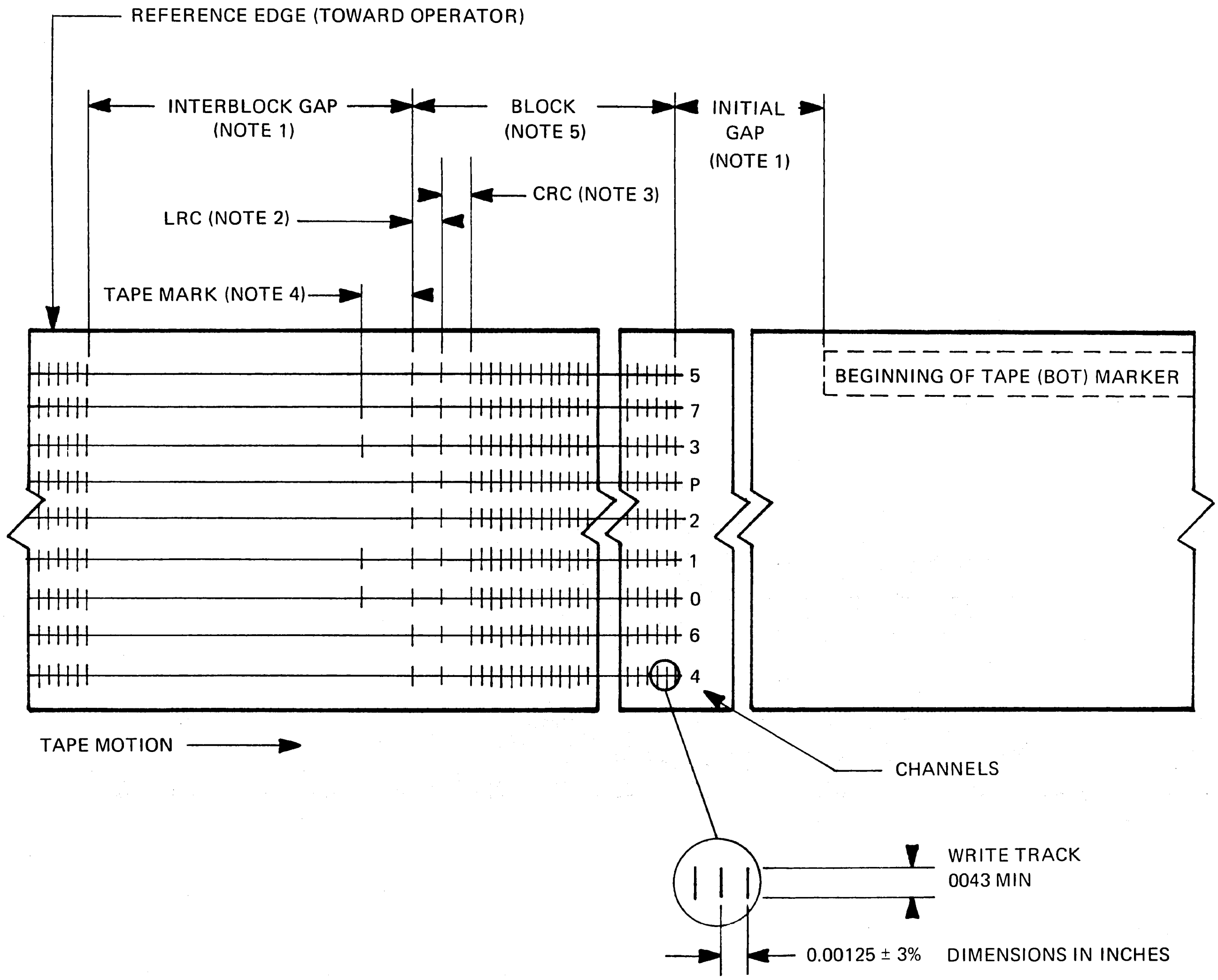
Gaps (spacing) of predetermined length separate different characters, records and files on one reel of magnetic tape. Each character in a record is separated from the characters immediately preceding and following it by a very small inter-character gap (length of inter-character gap varies with different recording densities). Similarly, each record in a file is separated from the records before and after it by an inter-block gap that is larger than the inter-character gap; the inter-block gap is 0.88 inch on 7-track tape and 0.75 inch on 9-track tape. Different files on tape are separated by an EOF mark as well as an inter-file gap.

NRZI and PE tape formats define records as follows:

NRZI: An NRZI record begins with the first byte sensed after an inter-record gap (IRG) and continues without interruption until the next gap is detected (see Figure 2-12).

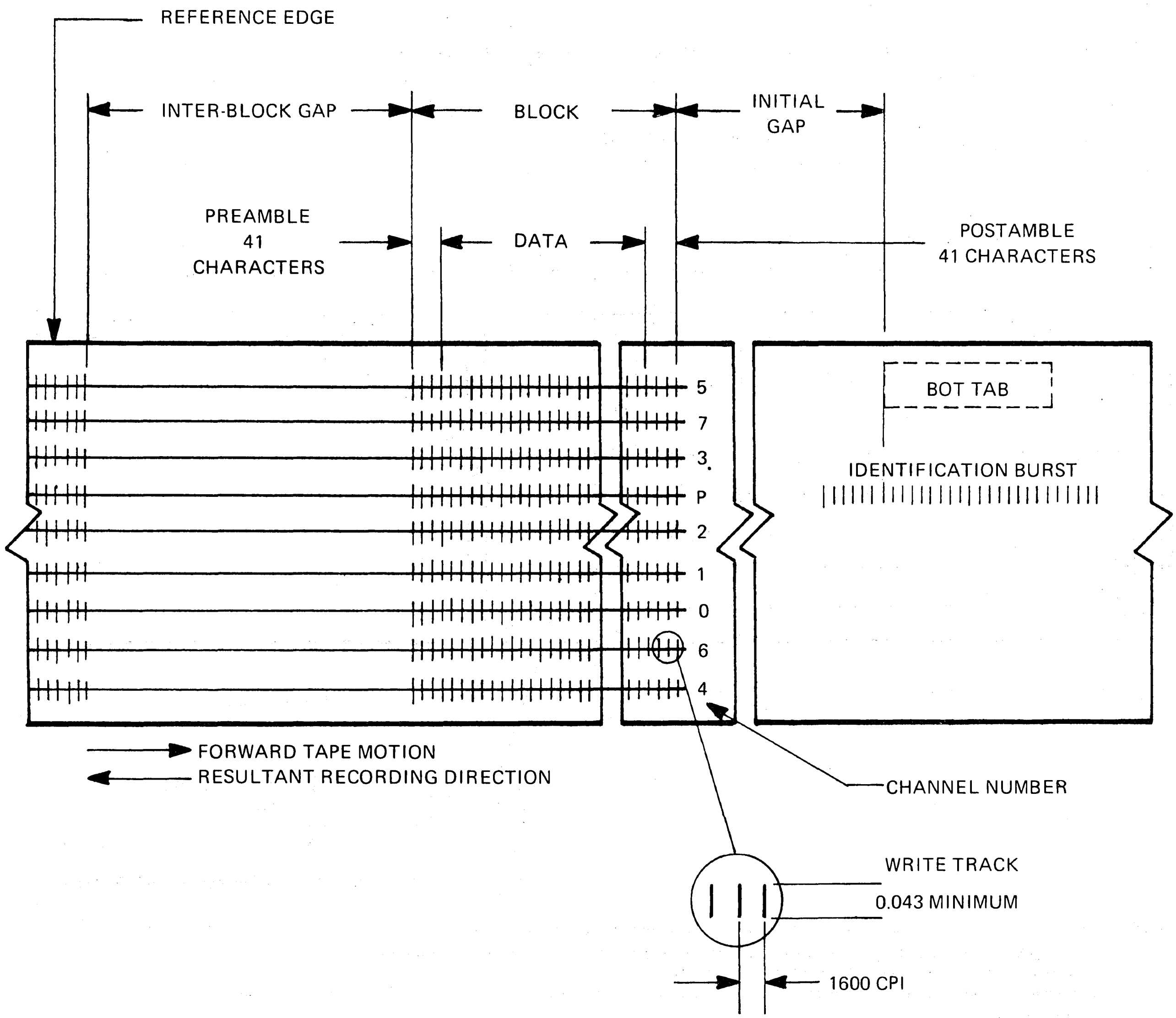
PE: A PE record contains 41 synchronizing bytes immediately before and after the data bytes. Reading of a PE record begins with the first byte of data following the initial 41 sync bytes (called preamble) and continues until the trailing sync bytes (called postamble) are recognized (see Figure 2-13).

In addition to data, the tape unit automatically writes certain parity checking characters. A vertical parity bit (VRCC) is written with each data character in one of the tracks not used for recording that particular data character's binary code. A longitudinal redundancy check character (LRCC) for both 7- and 9-track) and a cyclic redundancy check character (CRCC) (for 9-track NRZI only) are written at the end of each record. The parity bit and the check characters are used to ensure that records have been correctly "written" and "read".



NOTES:
(1) Tape to be fully saturated in the erased direction in the inter-block gap and the initial gap.
(2) A logitudinal redundancy check bit is written in any track if the longitudinal count in that track is odd. Character parity is ignored in the longitudinal redundancy check character.
(3) Cyclic redundancy check – parity of the CRC character is odd, if an even number of data characters are written, and vice versa.
(4) The tape mark is an optional special control block.
(5) The length of the data block (not including the check characters) is from 18 minimum ASCII characters to 2.048 maximum.

Figure 2-12. NRZI Recording (800 CPI).



NOTES: (1) Tape is shown with oxide side up.
(2) Tape to be fully saturated in the erased direction in the inter-block gap and the initial gap.
(3) The identification burst must extend past the end of the BOT marker.
(4) All dimensions are given in inches.
(5) There is a track placement tolerance of ± 0.003 for each track.

Figure 2-13. PE Recording (1600 CPI)

3.0 CHECK DIGIT OPTION

3.1 Capabilities

The check digit option (available for 4321 and 4322 units) automatically performs a validity check on selected numeric fields when key entered, or when read from tape in the DATA VERIFY mode. The check digit option rejects numbers that have been miskeyed for such reasons as:

1) Transposing two digits (e.g., if the number 3 2 1 7 5 is incorrectly entered as 3 2 7 1 5).
2) Entering an incorrect numeric digit in the field.
3) A character other than 0 through 9 has been entered.

A checking digit is usually appended to all numbers that are to undergo the validity check; for example, if for the number 65038, the checking digit 2 were generated, the new number would be 650382. A checking digit may be generated for any number by manipulating the individual digits of the number according to one of the check digit formulae.

During an entry or verify operation, the individual digits of the number, including the checking digit, are manipulated according to a modulus equation such that a predetermined remainder (usually zero) results. If this validity check results in a remainder other than the predetermined value, the KEY error lamp lights and the audible alarm sounds.

The check digit option is especially useful in checking identification numbers, such as account numbers, employee I.D. numbers, lot numbers, invoice numbers, part numbers, etc. The user no longer need worry about crediting funds to the wrong account or other such errors that resulted from an operator accidentally keying the wrong identification number.

There are a number of check digit methods prevalent in industry based on different moduli (MOD) calculations. The user may select any two of the MOD methods from among the numerous methods we offer (see Section 3.3) or may, by special request, select one or two less prevalent methods. The available MOD methods allow complete software compatibility with most computers.

3.2 Hardware

A Series 4320 unit must include a 4337 check digit kit before it is able to perform check digit operations. The kit is a printed circuit board (PCB) that contains all the additional hardware required to enable the check digit option. The PCB is installed inside the 4320 unit; no additional external hardware is required. The SELF CHECK 1/SKIP/2 switch (which is standard on all Series 4320 units, whether the check digit option is present or not) must be in the 1 or 2 positions to select the desired MOD calculation method and to activate the option; in the SKIP position the check digit option is disabled.

Three special integrated circuit chips (IC) are plugged into the printed circuit board. One IC serves as a read-only-memory (ROM) that contains all the information necessary to use various moduli calculation methods; the other two IC's allow access to those positions of the read-only-memory that enable the two methods selected at the time the option was acquired. If at some later date the user wishes to change his choice of moduli, a field service representative can quickly and easily make the necessary adjustment.

If a modulus not included in the nine standard moduli is desired, a special ROM chip can be provided to meet the special request.

A ROM chip contains 24 memory cells. Each cell corresponds to one digit in a check digit field and contains the results of a particular MOD calculation for each possible numeric entry (i.e., 0 through 9). Special ROM chips containing various combinations of different MOD methods are available. The number of possible combinations, however, is limited by the weighting factors of the particular MOD methods desired.

Each MOD method utilizes a weighting sequence, as described in Section 3.3. Each digit in a weighting sequence corresponds to one digit in a check digit field. The weighting sequence is an ordered set of numbers that, in most cases, repeats itself after a finite number of initial digits. For example, the weighting sequence for MOD 10 IBM is 1,2,1,2,1,2, etc. The ordered set of numbers that are repeated in the sequence are 1,2. Another example:The weighting sequence for MOD 7 is 4,3,2,6,4,5,1,3,2,6,5,4,1,3,2,6, etc. The ordered set of numbers that are repeated is 3,2,6,4,5,1. The initial cycle, however, is 4,3,2,6,4,5,1; note that the first digit (4) is not repeated in subsequent cycles.

Some MOD methods have non-repeating weighting sequences. For example, the weighting sequence for MOD 11 binary progression is 1,2,4,8,16,32,64,128,256, etc.

The weighting factor for a particular MOD method is the number of digits in the initial sequence before repetition begins. For the MOD 10 IBM, the weighting factor is 2, for the MOD 7 the weighting factor is 7 (even though only 6 digits are repeated in subsequent cycles). For the MOD 11 binary progression, the weighting factor is infinite; however, the weighting factor can be arbitrarily set by limiting the size of the check digit fields. One ROM memory cell is required for each digit in the initial sequence (i.e., number of memory cells required for a MOD method = weighting factor). By limiting the maximum size of check digit fields, only a finite number of memory cells are required. If, for example, a user wishes to use the MOD 11 binary progression and he knows his check digit fields will never exceed 12 characters, the first 12 numbers in the weighting sequence can each be assigned one memory cell. Thus the weighting factor, in this case, is arbitrarily set to 12.

A single ROM chip can support any combination of different MOD methods, as long as the sum of the weighting factors for the methods represented on the chip does not exceed 24.

NOTE: While the size of check digit fields used with MOD methods that have non-repeating weighting sequences is limited to the number of ROM memory cells assigned to that method, there is no limitation on check digit fields used with MOD methods having repeating weighting sequences, except that the field must fit into a record (i.e., the field must be 200 characters or less).

3.3 Moduli

The current standard moduli are listed below:

	MODULUS	WEIGHTING SEQUENCE
(1)	MOD 7	4,3,2,6,4,5,1,3,2,6 . . .
(2)	MOD 7 Division	1,3,2,6,4,5,2,3,2,6, etc.
(3)	*MOD 10 IBM	1,2,1,2, etc.
(4)	*MOD 10 Not IBM	1,2,1,2, etc.
(5)	MOD 10	1,3,1,3, etc.
(6)	*MOD 10	1,7,3,1,7,3, etc.
(7)	MOD 11 IBM/NCR	1,2,3,4,5,6,7,2,3,4 . . .
(8)	MOD 11 Arithmetic	1,2,3,4,5,6,7,8,9,10 . . .
(9)	Jelmoli MOD 10	1,2,3,4,7,8,0

There are two standard ROM's available; the methods marked with an asterisk (*) are common to both ROM's. One ROM contains the first seven MOD methods; the other ROM contains the three marked with an asterisk plus the MOD 11 Arithmetic and the Jelmoli MOD 10.

Example 1 and 2 demonstrate how the checking digit is generated and how the whole number, including the checking digit, is checked for validity by the two most common moduli, MOD 11 IBM/NCR and MOD 10 IBM. Example 3 illustrates how 7-digit numbers are checked for validity by the Jelmoli MOD 10 method.

EXAMPLE 1. (<u>MOD 11 IBM/NCR</u>):

The weighting sequence for MOD 11 IBM/NCR is:
1,2,3,4,5,6,7,2,3,4;

the checking digit has a weight of 1.

A) To generate a checking digit:

Take a basic account number	7	1	2	3	4	1	1
Multiply each digit by the corresponding weighting sequence digit - - - - - -	x	x	x	x	x	x	x
	2	7	6	5	4	3	2

Add these products - - 14 + 7 + 12 + 15 + 16 + 3 + 2 =

Result: 69

Divide this sum by 11: $69 \div 11 = 6$; $69 - 66 = 3$ Remainder

Subtract this remainder from 11: $11 - 3 = 8$

Checking Digit: <u>8</u>

Self Checking Account Number: 7 1 2 3 4 1 1 <u>8</u>

B) To check the validity of an account number:

Take an account number with check digit - - - - -	7 1 2 3 4 1 1 <u>8</u>
Multiply each digit by the corresponding weighting sequence digit - - - - -	x x x x x x x x
	2 7 6 5 4 3 2 1

Add these products - - 14 + 7 + 12 + 15 + 16 + 3 + 2 + 8 =

Result: 77

Divide this sum by 11: $77 \div 11 = 7$; $77 - 77 = 0$

There is no remainder; if there was, the number would be rejected.

EXAMPLE 2. (MOD 10 IBM):

The weighting sequence for MOD 10 IBM is:
1,2,1,2, etc.

the checking digit has a weight of 1.

A) To generate a checking digit:

Take a basic account number	6 7 4 3 1
Multiply each digit by the corresponding weighting sequence digit; if the product is greater than 10 subtract 10 from the product, then add 1 (e.g., 12 ➔ (1+2))	x x x x x
	2 1 2 1 2
Add these products - - - -	(1 + 2) + 7 + 8 + 3 + 2 =
Result:	23
Subtract this total from the next highest multiple of ten	30 −23 7
Self Checking Account Number:	6 7 4 3 1 **7**

B) To check the validity of an account number:

Take an account number with checking digit:	6 7 4 3 1 7
Multiply each digit by the corresponding weighting sequence digit; if the product is greater than 10, subtract 10 from the product and add 1 (e.g., 12 ➔ (1 + 2))	x x x x x x
	2 1 2 1 2 1
Add these products	(1 + 2) + 7 + 8 + 3 + 2 + 7 =
Result:	30
Divide this sum by 10	30 ÷ 10 = 3 −30 0
There is no remainder, if there was, the number would be rejected.	

Most other moduli follow a similar type of test calculation to check the validity of a number. Most tests are designed to result in a remainder of zero for all valid numbers. However, some moduli are designed to accept numbers that result in a predetermined remainder other than zero; for example, the Swiss-developed, Jelmoli MOD 10 may calculate remainders that are not zero for valid numbers.

EXAMPLE 3. (JELMOLI):

The weighting sequence for Jelmoli is:

1, 2, 3, 4, 7, 8, 0

the checking digit has a weight of 1.

To check the validity of an account number:

Take an account number with checking digit - - - - -	8 1 1 0 1 3 4
Multiply each of the six low order digits of the 7-digit entry by its corresponding weighting sequence digit:	x x x x x x x
	0 8 7 4 3 2 1
Add these products - - - -	0 + 8 + 7 + 0 + 3 + 6 + 4 =
Check Sum:	28
Divide this sum by 10	28 ÷ 10 = 2 −20
Remainder:	8 Remainder

The remainder is not zero, but it equals the highest order digit of the account number, therefore the number is valid.

Consider another account number:	3 1 1 0 1 3 6
	x x x x x x x
	8 7 4 3 2 1
	8 + 7 + 0 + 3 + 6 + 6 =
Check Sum:	30
	30 ÷ 10 = 3 −30
Remainder:	0

There is no remainder; therefore the number is valid.

With the Jelmoli method, an entry is considered to be valid if:

(1) There is no remainder OR

(2) There is a remainder, but the remainder equals the highest order digit of the entry.

Any number that produces a different result is rejected.

3.4 Theory of Operation

The 1 or 2 positions of the SELF CHECK 1/SKIP/2 switch activate the check digit option and determine which of the two selected moduli methods is to be used for validity checking. The SKIP position deactivates the option and allows programmed skip fields to function normally. When the check digit option is activated, check digit fields are specified by programmed skip (S K I P) fields. (Skipping can be achieved by entering space characters in programmed dup fields). During entry or verify operations, all check digit fields are automatically checked for validity by the selected modulus calculation method.

When the operator arrives at the last character in the check field (Figure 3-1), the presence of the skip code in the program enables an initializing pulse which sets the initial flip-flop (INFF). This produces a column address register clock (CARC) which loads the column address register with the starting column. The starting column that is loaded is determined by the MOD that has been selected.

When the operator enters the last digit, field start is detected and the self check go (SCGO) flip-flop is set which enables the ROM and starts the checking operation.

When SCGO is set, a character backspace is forced and the last digit entered is brought in on the BUS lines. The digit on the BUS lines combined with the column address register, determines the precise location of the ROM that is addressed.

When the memory busy (MBSY) signal goes away, the backspace flip-flop is reset, CBSK (character backspace) is dropped and the signal ADD is generated. At this time the ROM remainder that was addressed is present at the remainder comparator. The ADEX flip-flop is then set enabling the accumulator clock signal (ACLK), and the remainder counter and accumulator begin to count up.

The accumulator will count up until its count is equal to the MOD selected. It is then reset and begins its count again. The remainder counter counts up until its count is equal to the ROM output. This generates RADX and the ADEX flip-flop is reset, disabling ACLK. Fetch next column address (FNCA) will then be set and row zero of the present column of the ROM is addressed to obtain the next column address.

If field start (FLDS) is not present then the cycle will be repeated until all the digits in the field have been operated on. When FLDS is present, the signal EXIT is generated indicating the end of the check field.

When the output of the accumulator is zero (except for Jelmoli Mod 10) the signal VLID (valid) is developed. If VLID is present when EXIT is generated a selective skip (SLSK) will be forced to advance to the next field. At the same time the anti-repeat (ARPT) flip-flop is set to prevent SCGO from coming on at the beginning of the next field.

If VLID is not present when EXIT is generated it indicates that the accumulator count was not zero and the self-check number was not valid. The key error (KERR) signal is generated and SLSK is not developed. The operator must then depress the RESET key and re-enter the field.

3.5 Using Check Digit During Verifying Operations

The check digit option is operable during both entry and verify operations. When verifying data from tape, check digit fields are automatically checked for validity if the SELF CHECK 1/SKIP/2 switch is in the 1 or 2 position. It should be noted that selective verification is disabled when check digit fields are being used, (except during same operator verify operations with 4322 units). If the check digit fields are checked during the initial entry operation, it is recommended that the SELF CHECK switch be placed in the SKIP position (deactivating check digit) to allow selective verification to be used during a verification from tape operation (4321 units only).

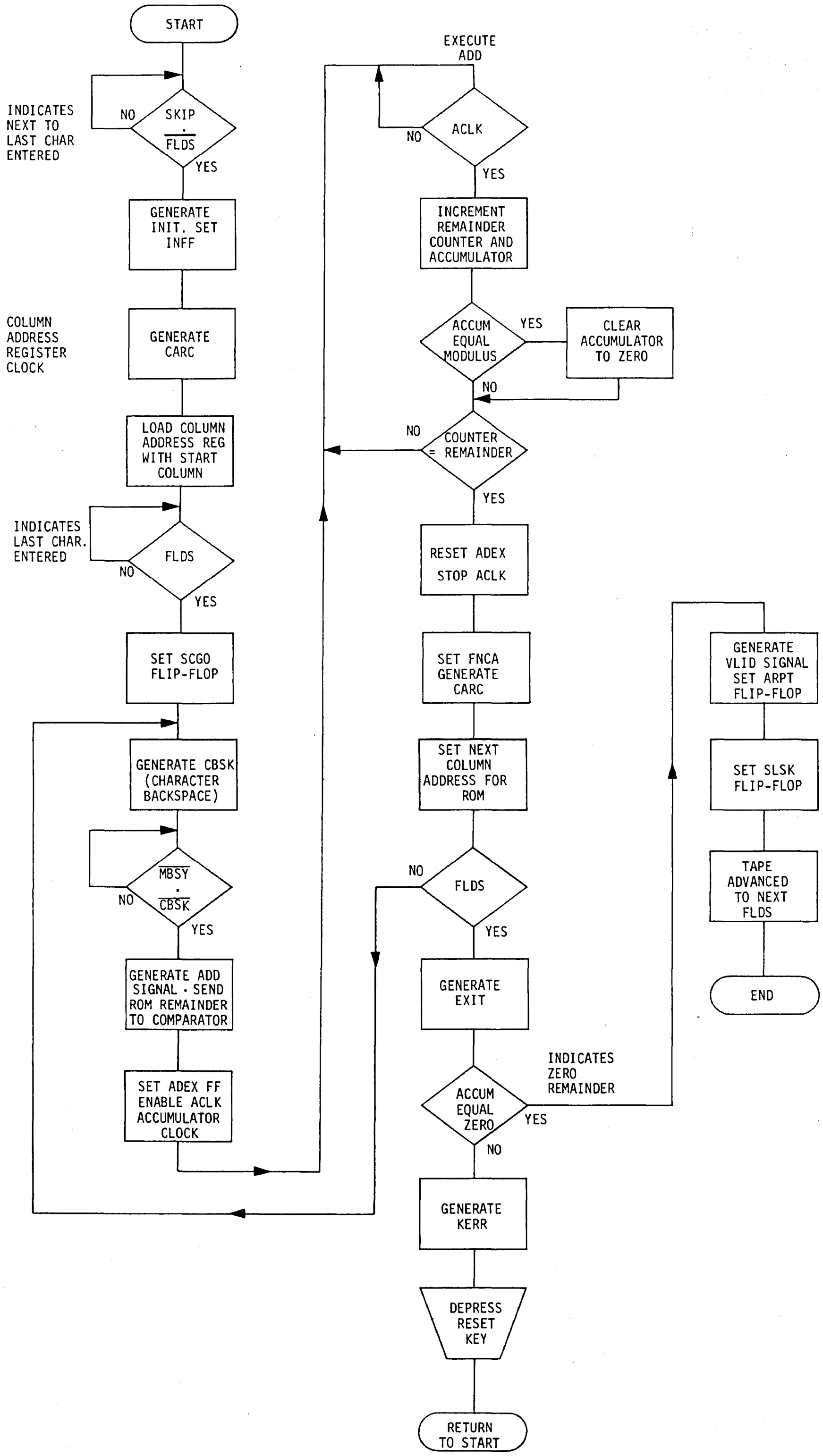


Figure 3-1. Check Digit Flow Chart.

If the check digit option is active and an invalid number is detected, the number may be corrected by the operator. If a check digit field gives a persistent error because it is incorrect on the source document, the operator may bypass the field by:

(a) pressing the SKIP key while in the first character position of the field; this fills the check digit field with space codes.
(b) pressing the REL key and blank-filling the record.

(c) pressing RESET/RETURN keys, do not enter the record, and mark the source document.

3.6 Compatibility with other Options

Data fields can be designated as both check digit and printing totalizer fields. The data is first check digit verified and then printed and accumulated. The printing totalizer option is explained in Section 4.0.

When a Series 4320 unit is serving as a remote entry unit in a pooling chain (in the DATA ENTER or VERIFY modes), data can be check digit verified (and/or printed and accumulated) before it is released to the central recorder. Neither the check digit nor the printing totalizer options, however, are operable in a 4321 unit serving as the central recorder.

Check digit verification (as well as use of the printing totalizer option) is also possible as data is being output (in the DATA ENTER mode) to a line printer (4321 units only).

4.0 PRINTING TOTALIZER OPTION

4.1 Capabilities

The printing totalizer option enables one or two groups of properly defined numeric fields to be printed and accumulated within each record, as well as, from record to record.

Each printing totalizer field is referred to as being either an A or a B field; however, there may be one or more A fields and/or one or more B fields in each record. The A fields are accumulated separately from the B fields (see Figure 4-1).

The printing totalizer option allows data to be printed (see Figure 4-2) and accumulated as it is key-entered (DATA ENTER mode) or as it is read from tape (DATA VERIFY mode).

The printing totalizer option can be used in any application requiring running hash totals and/or a hard-copy printout of data.

Only the characters 0 through 9 and minus 1 through minus 9 are valid characters in a printing totalizer field. Invalid entries result in a KEY error. Each field can have up to, but not more than 13 digits, excluding the sign.

Thus, any type of numeric entry, not exceeding 13 digits, can be printed and accumulated using this option.

The printing totalizer option is only available with 4321 and 4322 units.

4.2 Hardware

The printing totalizer option uses a Friden Printing Calculator in combination with a Series 4320 unit. Interfacing is achieved via a special printed circuit board (PCB) inside the Series 4320 unit and another special PCB within the Printing Calculator connected together via a sheathed, 3-foot cable that permits the 4320 keyboard to simulate the calculator keyboard. The two PCB's are included in the 4315 printing totalizer kit. The PCB's provide all the timing, control and data handling logic necessary to interface the two units.

When power to the Series 4320 unit is turned off, the printing calculator can be operated as an independent business machine. Likewise, when the calculator is off, the Series 4320 unit operates independently.

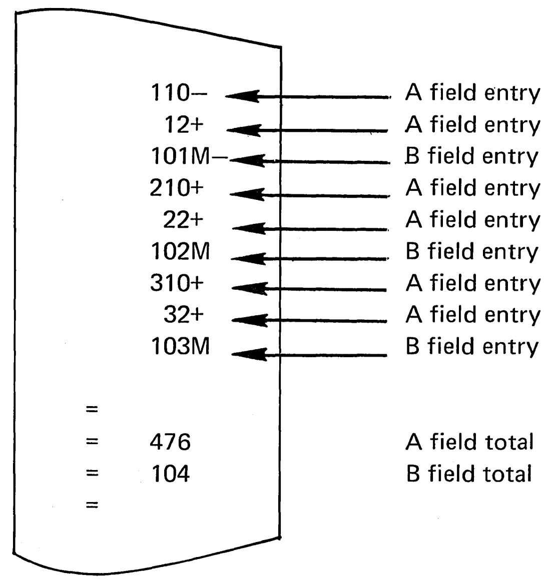
The printing calculator has a keyboard for entering data and a printer which provides all output.

		1st "A" Field		2nd "A" Field		"B" Field	
RECORD 1		−110		12		−101	
RECORD 2		210		22		102	
RECORD 3		310		32		103	

$$\text{Total of A fields} = \underbrace{-110 + 12}_{\text{from RECORD 1}} + \underbrace{210 + 22}_{\text{from RECORD 2}} + \underbrace{310 + 32}_{\text{from RECORD 3}}$$

$$\text{Total of B fields} = -101 + 102 + 103$$

Figure 4-1. Accumulation of Printing Totalizer Fields



NOTE: B field entries are printed with an M (or M–) following the last digit.

Figure 4-2. Printout for Printing Totalizer Option.

4.2.1 Printing Calculator

The printing calculator is a desk-size 10-key machine that provides a hard-copy printout of all entries and tables. In addition to the 10 digit keys, there are 12 operating keys, a decimal point key and a decimal point thumbwheel (see Figure 4-3). The calculator executes all operations in a stack of four registers (R1, R2, R3, R4) and a memory storage register (RS) (see Section 4.3).

4.2.1.1 Keyboard

1) DIGIT KEYS

Numbers are entered serially, digit by digit, using the digit keys. The decimal point, if present, occupies the space of one digit.

2) DECIMAL POINT THUMBWHEEL

This wheel controls the number of digits to be printed after the decimal point. It does not affect the decimal point position for numbers being keyed-in.

The + position on the decimal point thumbwheel is used in all printing totalizer operations and places the machine in the add mode, which does not use a decimal point.

3) OPERATING KEYS

The functions of the operating keys are listed in Table 4-1.

4.2.1.2 Printer

The helical printer is the output mechanism of the printing calculator. Each printed number is accompanied by a symbol which represents the operation that was executed with or on that number. Printing is accomplished by striking the back of the paper with the print hammer when the desired character on the rotating print wheel is in front of the paper.

The print speed is 47 characters per second (CPS). Printing action is from right to left with symbols printed first and then the number, starting with the least significant digit. A single line of print can contain up to 13 digits, a decimal point, two symbols, and up to four spaces between high order bits to represent thousands; leftmost zeroes are not printed. Character spacing is 10 characters per inch, and line spacing is 6 lines per inch. For greater clarity, there is additional spacing between the symbol(s) and the first digit of the number.

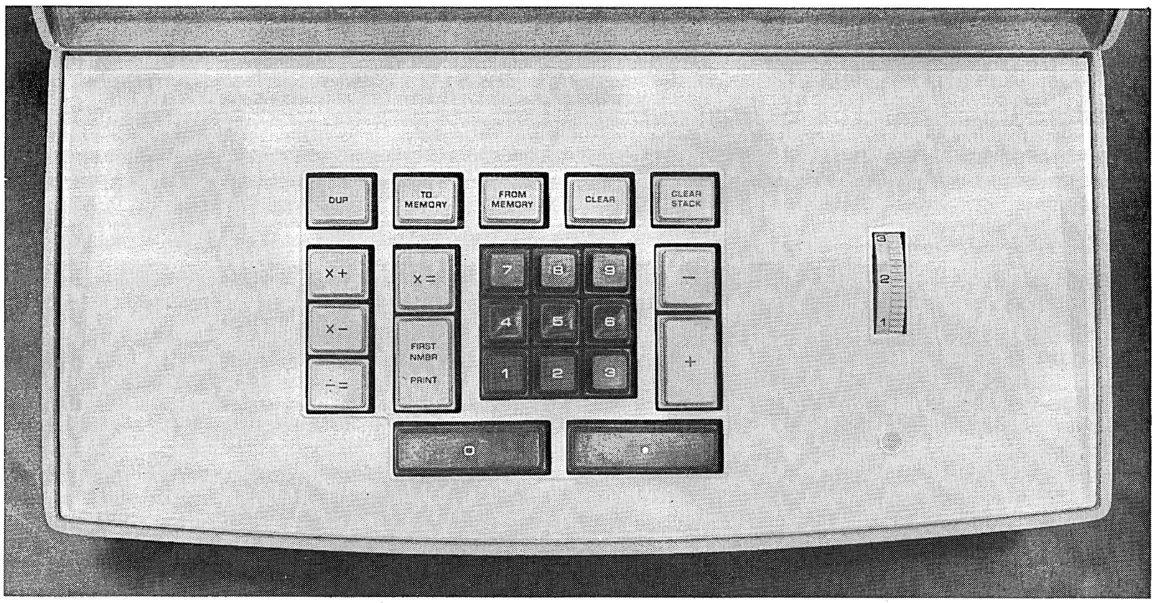


Figure 4-3. Calculator Keyboard.

Table 4-1. Operating Key Functions

KEY	FUNCTION
+ (ADD)	Pressing this key causes two numbers (R1, R2) to be added together. When the add operation is complete, the original numbers are replaced by one number in R1 which is the sum of the two. The answer does not print out except on demand (see FIRST NUMBER PRINT key).
– (SUB.)	Pressing this key causes one number (R1) to be subtracted from another number (R2). When the subtract operation is complete, the original numbers are replaced by one number in R1 which is the difference between the two. The answer does not print out except on demand (see FIRST NUMBER PRINT key).
= (DIVIDE)	Pressing this key causes one number (R2) to be divided by another number (R1). When the divide operation is complete, the original numbers are replaced by one number in R1 which is the quotient of the two. The answer prints out.
X = (MULT.)	Pressing this key causes one number (R1) to be multiplied by another number (R2). When the multiply operation is complete, the original numbers are replaced by one number in R1 which is the product of the two. The answer prints out.
X + (ACCUM. MULT.)	Pressing this key causes a normal multiplication (R1 x R2) immediately followed by an addition. This results in the multiply answer being added to a previously entered number (R3). or a previously obtained answer (R3). This is often termed accumulative multiply. The product prints out but the addition does not, except on demand (see FIRST NUMBER PRINT key).
X – (ACCUM. NEG. MULT.)	This key differs from the X+ key only in that multiplication is followed immediately by subtraction.
TO MEMORY	Pressing this key causes the number in R1 to be moved into RS, which is also known as the constant storage register. The number that was in R1 is also printed out, followed by the character "T". At the same time R4, R3 and R2 numbers are moved down in the stack to R3, R2 and R1. R4 is filled with zeroes.
FROM MEMORY	Pressing this key causes R1, R2 and R3 to move up in the stack to R2, R3 and R4. The number in RS is duplicated in R1 without destroying or otherwise changing the number in RS. The number in RS is also printed out, followed by the character F.
CLEAR	Pressing this key moves the R4, R3 and R2 numbers down in the stack to R3, R2 and R1. R4 fills with zeroes.
CLEAR STACK	Pressing this key causes all numbers in registers R1 through R4 to be destroyed and replaced with zeroes. When the calculator is turned on, this key must be pressed before the RESET key on the 4320 can be used to clear the key error.
FIRST NUMBER PRINT	This key has more than one function. When it is pressed just after using digit keys, it results in the number that entered the data chain in R1 being printed out. When it is pressed after the add (+) or subtract (—) key, it results in the number that is in R1 being printed out; when it is depressed a second time without any other operation occurring between depressions, it results in the stack R1—R2—R3—R4 being print out, with R4 first and R1 last.
DUP	Pressing this key causes the number in R1 to be duplicated in R2 without changing the number in R1. At the same time the numbers in R2 and R3 move up in the stack to R3 and R4, respectively. The number in R4 is lost.

4.3 Field Definition

When using the option in DATA ENTER mode, valid digits in numeric, left zero or check digit fields (as specified by the program in the program 1 memory) are defined by the program in the program 2 memory to be printing totalizer A and/or B field digits. Left zero shifting (right-justification) or check digit verification occurs before the entries are printed and accumulated.

Printing totalizer A and B fields are defined by a program in the program 2 memory of the Series 4320 unit. A fields are defined in program 2 by keying left zero (L Z) codes for every digit of the field; B fields are defined by keying numeric (NUM) codes for every digit of the field.

When using the printing totalizer option in verification-from-tape operations (DATA VERIFY mode), all fields in program 1 must be programmed as skip (SKIP) fields.

Key verifying is not possible when using printing totalizer fields; the verification-from-tape operation is used only to print and accumulate printing totalizer fields as data is read from tape. This can be done selectively by programming skip (SKIP) fields into program 2 for those fields that are not to be accumulated. The AS/D switch must be in the SEL VRFY/REL position to cause selective verification of all fields.

NOTE: When key entering data, it is advisable not to program two printing totalizer fields adjacent to one another since this may reduce the speed of the operation. The operator is inhibited from entering the second field until the first field is printed; (approximately 1/2 second) if an entry is attempted a KEY error is indicated.

4.4 Theory of Operation

The printing calculator utilizes a four register stack (R1, R2, R3, R4) and one memory storage register. Before the first record containing a printing totalizer field is entered at the Series 4320 unit, the operator presses the CLEAR STACK key on the printing calculator; this fills each of the registers with zeroes (see Figure 4-4).

Between records or after B entry operations, the A sub-total is stored in R3, the B sub-total is stored in R2, and R1 and R4 contain zeroes. This is the primary idle state.

R4	ZERO
R3	A SUB-TOTAL
R2	B SUB-TOTAL
R1	ZERO

From this idle state, both A and B entries can be processed.

4.4.1 A Field Operation

When a printing totalizer A field is detected (Figure 4-4), control immediately executes a CLEAR operation which down-shifts the stack, and a TO MEMORY operation which down-shifts the stack and stores the B sub-total in the memory register. The A sub-total is in R1 with zeroes in R2, R3 and R4.

R4	ZERO
R3	ZERO
R2	ZERO
R1	A SUB-TOTAL
Memory Register (RS)	B SUB-TOTAL

All control steps are executed by the two printed circuit boards (Model 4315 printing totalizer kit) which simulate the proper key strokes and supress the normal print and line feed operations when necessary.

When the digits of the A field are entered at the Series 4320 unit, (from keyboard or tape), the equivalent key strokes are simulated at the printing calculator. The first digit entered causes the stack to shift up, thereby vacating R1 where the A entry is stored.

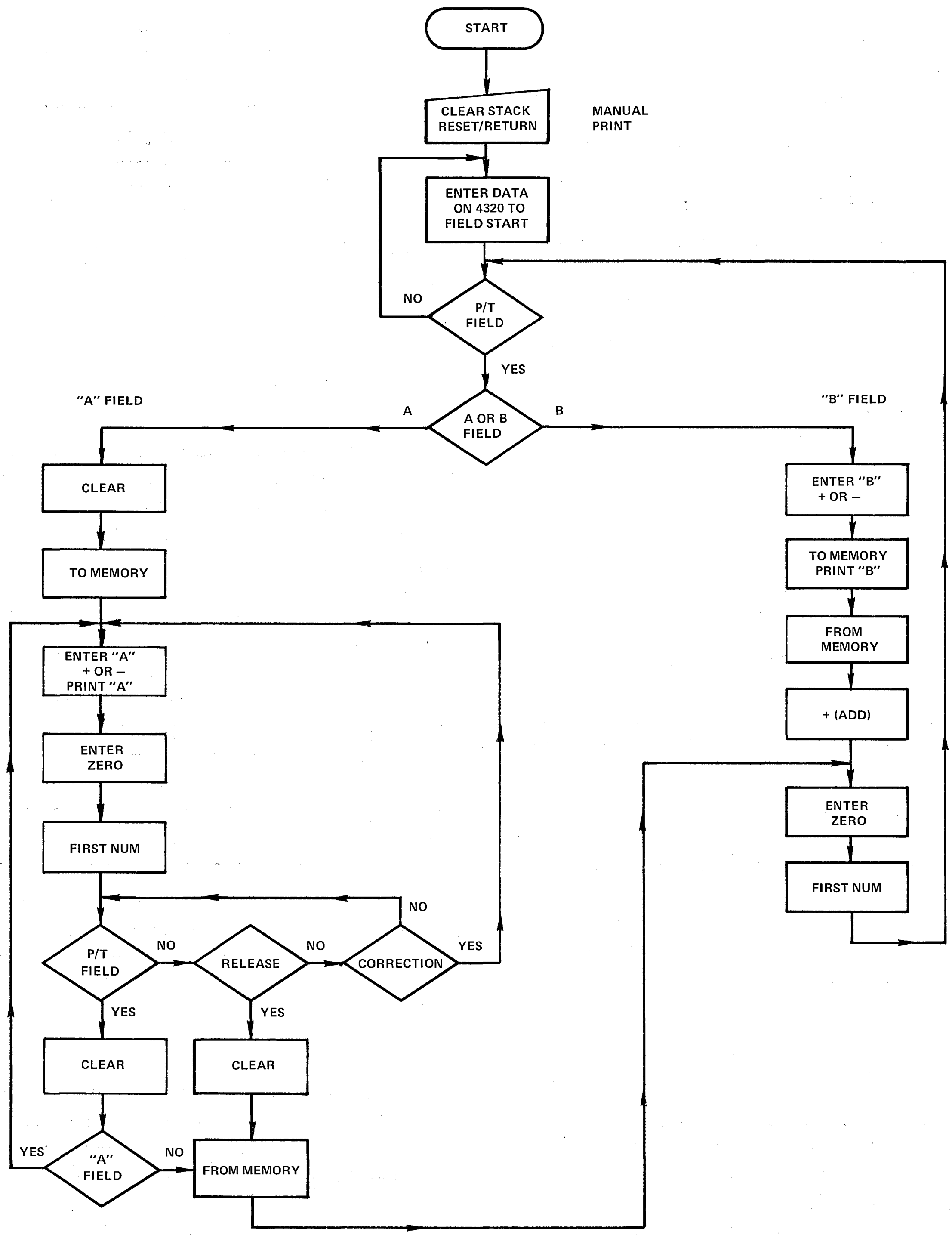


Figure 4-4. Printing Totalizer Flow Diagram.

R4	ZERO
R3	ZERO
R2	A SUB–TOTAL
R1	A ENTRY

When the A field entry is completed, control executes a + operation for positive numbers or a - operation for negative entries. The A entry in R1 is printed with appropriate sign (e.g., 1234+ or 1234-), and is added to or subtracted from the previous A sub-total in R2. The new A sub-total is stored in R1.

R4	ZERO
R3	ZERO
R2	ZERO
R1	NEW A SUB-TOTAL

Immediately after the print and arithmetic operation, control enters zeroes into R1, shifting the A total up to R2. Control then terminates A field entry by performing a FIRST NUMBER PRINT operation. This places control in the minor idle state. In this state, the operator may correct an improper A entry, if necessary.

R4	ZERO
R3	ZERO
R2	NEW A SUB-TOTAL
R1	ZERO

After a correction or if no correction occurs, a CLEAR operation is performed when a record release or the next printing totalizer field is detected. The CLEAR operation down-shifts the stack. If the new printing totalizer field is an A field, control repeats the A field operation. For a new B field or a record release, control executes a FROM MEMORY operation which moves the B sub-total from memory to R1 and the A sum to R2. Then zeroes are entered into R1 shifting the B sub-total to R2 and the A sum to R3. A FIRST NUMBER PRINT operation terminates this sequence and control returns to the primary idle state.

R4	ZERO
R3	NEW A SUB-TOTAL
R2	B SUB-TOTAL
R1	ZERO

4.4.2 B Field Operation

B field entry begins in the primary idle state (Figure 4-4). The first digit shifts the stack up so that the A sub-total is in R4 and the B sub-total is in R3, with zeroes in R2. The B number is entered into R1.

R4	A SUB-TOTAL
R3	B SUB-TOTAL
R2	ZERO
R1	B ENTRY

After the B field is entered into R1, control executes a + (or - if the number was negative) operation. This adds R2 + R1 (zero + B entry), stores the result (B entry) in R1 and shifts the B sub-total into R2 and the A sub-total into R3. R4 contains zeroes.

R4	ZERO
R3	A SUB-TOTAL
R2	B SUB-TOTAL
R1	B ENTRY

Immediately thereafter, a TO MEMORY operation is executed. The B entry is shifted into the memory storage register and printed. The B entry printout is followed by an M or M- if negative (e.g., 34567 M or 34567 M-).

R4	ZERO
R3	ZERO
R2	A SUB-TOTAL
R1	B SUB-TOTAL

Memory Register (RS)	B ENTRY

Next a FROM MEMORY operation is executed to restore the B entry in R1, the B sub-total in R2 and the A sub-total in R3. A + (or -) operation then adds (or subtracts) the B entry and the B sub-total. The new B sub-total is stored in R1 with the A sub-total shifted down into R2. R3 and R4 contain zeroes.

R4	ZERO
R3	ZERO
R2	A SUB-TOTAL
R1	NEW B SUB-TOTAL

Next a zero digit is entered into R1 shifting up the B sum and the A sum. Control terminates the B field operation with a FIRST NUMBER PRINT operation. At the completion of this sequence control is again in the primary idle state from which an entry correction can be made or the next A or B field operation can be initiated.

R4	ZERO
R3	A SUB-TOTAL
R2	NEW B SUB-TOTAL
R1	ZERO

Between records or after entering the last record, the operator can printout the A and B sub-totals by pressing the FIRST NUMBER PRINT key on the calculator.

The printout appears as follows:

```
                    =
(A Field Sub-Total) =    12345
(B Field Sub-Total) =   345678
                    =
```

If one of the printing calculator registers overflows (contains more than 13 digits), a KEY error is indicated at the Series 4320 unit. The operator can clear this condition by pressing the CLEAR STACK key on the calculator; all previous entries are lost.

4.5 Printing and Totalizing Check Digit Fields

When operating in the DATA ENTER mode, check digit fields may be accumulated as printing totalizer fields by programming the check digit fields in a program stored in the program 1 memory and programming those same fields as printing totalizer B fields in the program stored in the program 2 memory. Frequently an account number will be specified as both a check digit and printing totalizer field in order to obtain a printout of account numbers adjacent to financial entries which are being totalized.

If all fields in data records are check digit fields, those fields may be verified, as well as printed and totalized as they are read from tape (DATA VERIFY mode operation). This is usually done to obtain a printed copy of all the check digit data.

In both entry and verification operations, a check digit field is not printed or totaled until after it is verified as a check digit number. (The check digit option is explained in Section 3.0).

5.0 POOLING OPTION

5.1 Capabilities

The pooling option enables two types of operations:

1. Data that is entered at a number of remote entry units (in the DATA ENTER or DATA VERIFY mode) can be sent down a pooling chain and recorded on tape at a unit operating in the central recorder mode. Data records are randomly interspersed on the central recorder's tape.

2. Data that is stored on tape at a number of remote entry units can be read off tape (in the DATA MERGE mode) and sent down a pooling chain where the records are merged on a single reel of tape at the central recorder. Data records are recorded on the central recorder's tape in the same order as they were read off tape at the remote entry units. Data can also be edited during the merging operation.

A pooling chain consists of a central recorder connected to a number of remote entry units (see Table 5-1). All units in a pooling chain are cable-connected in a daisy-chain fashion as shown in Figure 5-1. It is advisable to put the fastest operator at the head of the chain (highest priority).

Any Series 4310/20 unit, except Model 4322, can operate as the central recorder, and all of the Series 4310/20 units can serve as remote entry units in a pooling chain.

Any unit operating in a pooling chain must be equipped with a Model 4339 Pooling Adaptor (standard on Models 4314 and 4322).

The standard co-axial cable (RG58C/U) for connecting any two units in the chain is 15 feet long ; the combined cable length required for an entire pooling chain may not exceed 1,000 feet.

Any unit that is capable of operating as a central recorder can serve as a program interceptor unit without requiring additional hardware. Prerecorded programs can be transferred from the program interceptor (in the PROGRAM ENTER mode) to any of the remote entry units (in the PROGRAM READ TAPE mode) without interrupting the pooling operation. A program interceptor transfers programs to only those remote units of a lower priority in the chain, therefore, the interceptor is usually the first remote unit in the pooling chain (see Figure 5-1).

It should be noted that a pooling operation is not terminated if a remote unit goes OFFLINE or has it's power removed; the pooling adapter contains a relay that allows the unit to be bypassed. The system can be reconfigured by either making the pooling chain circular or reassigning priorities.

Table 5-1 summarizes the pooling capabilities of each Series 4310/20 unit.

The pooling option provides more efficient data preparation and storage, helps reduce computer processing time and greatly increases the overall flexibility of the data recording system. For instance, it is much less expensive to buy one key-to-tape unit and many keyboard-only-units that can pool their data at the one tape unit, than it is to buy many key-to-tape units, that can only operate alone. Also, it is usually more desirable to have all the data for one large job pooled onto one reel of tape, than it is to have portions of that job recorded on a number of separate, partially filled tapes.

It is not necessary for the data being pooled from a number of keyboards to all be from the same job. The different types of data will be randomly interspersed, as they are recorded on tape; however, the various groups of data jobs can be separated during a subsequent merging operation by utilizing an editing feature, called file explosion. This feature selects and transmits only those records that contain a particular identification field. Thus, if each type of data job contains a different identifier, the various types can be "exploded" and recorded on separate reels of tape.

5.2 Theory of Operation

5.2.1 Program Entry

Pre-recorded programs can be loaded into a remote unit from the central recorder or from a program interceptor. The program transfer proceeds from the buffer memory of the central recorder or interceptor to the buffer memory of the remote unit. The programs can by key-entered or read from tape and then automatically sent to a remote unit that is in the PROGRAM READ TAPE mode, ONLINE. The transfer proceeds via the co-axial cable.

Table 5-1. Operating Modes for Pooling

Model	OPERATING MODE				
	Central Recorder	Data Enter or Data Verify	Data Merge	Program Enter	Program Read Tape
4311	Can serve as central re-corder for up to 8 remote units.	Can serve as remote entry unit.	Can serve as remote entry unit.	Can serve as program interceptor.	Can receive programs
4314	Can serve as central re-corder for up to 64 remote units.	Can serve as remote entry unit	Can serve as remote entry unit.	Can serve as program interceptor.	Can receive programs.
4321	Can serve as central re-corder for up to 8 remote units.	Can serve as remote entry unit.	Can serve as remote entry unit.	Can serve as program interceptor.	Can receive programs.
4322	(Non-functional)	Can serve as remote entry unit.	(Non-functional)	(Non-functional)	Can receive programs.

By using the program interceptor, a remote unit may be programmed while other remote units are still pooling data at the central recorder. For example, if one remote unit completes the pooling of a file and wishes to transfer the next file under control of a new program:

A. The supervisor loads a program pair into the interceptor's buffer memory in an OFFLINE operation either by keying in the programs (DATA ENTER mode) or reading the pair from tape (PROGRAM READ TAPE mode).

B. The supervisor then returns the interceptor to the PROGRAM ENTER mode, ONLINE.

5.2.2 Data Entry and Verification

Data can be loaded into a remote unit's buffer memory and then sent to the central recorder by:

1) Keying in the data in the DATA ENTER mode, ONLINE.
2) Reading records off a local tape and verifying those records in the DATA VERIFY mode, ONLINE.

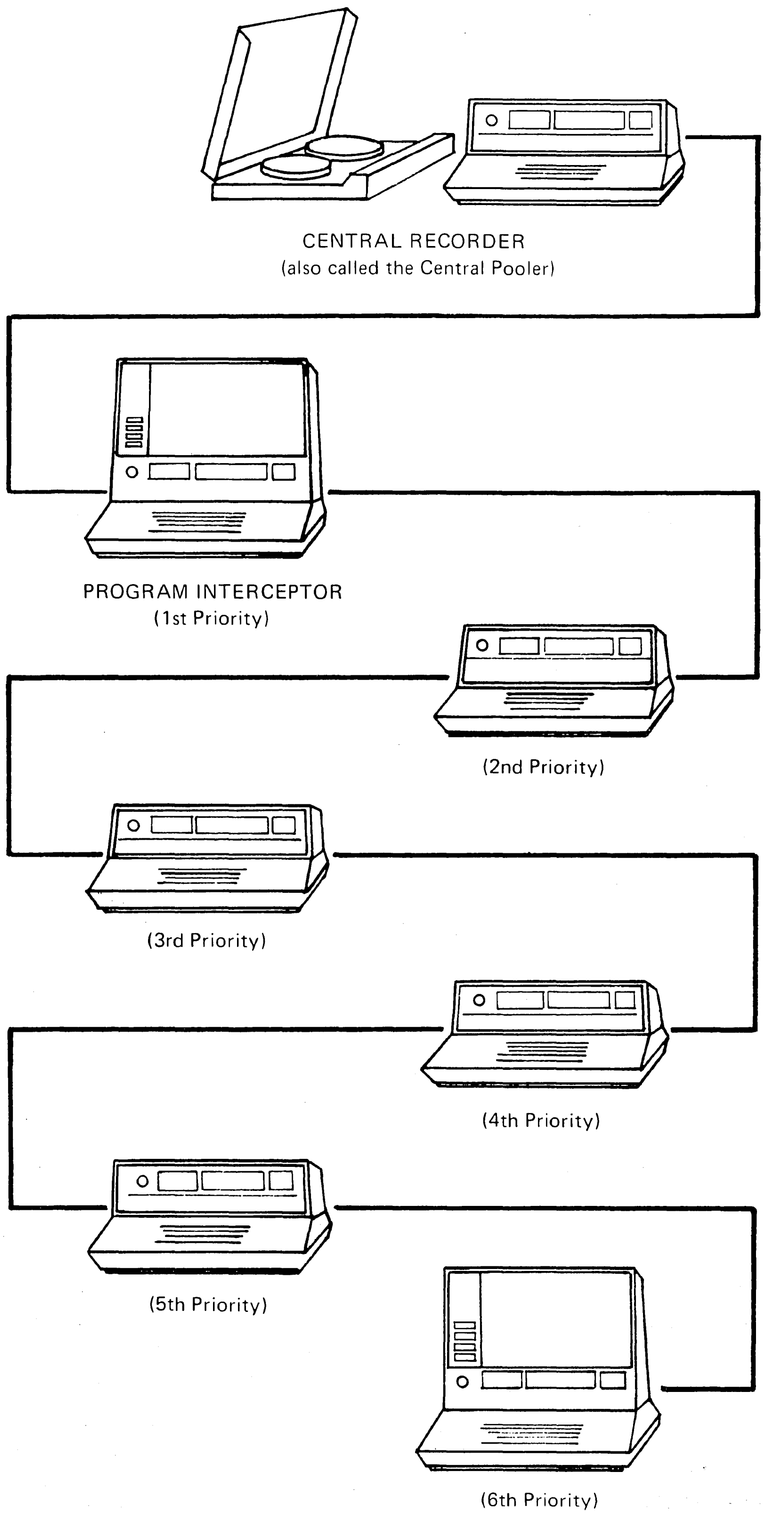


Figure 5-1. Series 4310/20 Units Connected in a Pooling Chain

3) Keying in a record then verifying it before releasing it to the central recorder in the DATA VERIFY mode, ONLINE (only possible on 4322 units, in a same operator verify operation).

After each record is entered (and/or verified), it is transferred from the remote unit's buffer memory (without erasing its contents) to the central recorder's buffer memory. When the record is loaded into the buffer memory of the central recorder, a character-by-character "echo" of the record is sent back to the remote unit. If the "echo" exactly matches the contents of the remote unit's memory, the remote unit sends back an acknowledgement signal and the central recorder writes the record on tape. If a mismatch occurs, the operator must press RESET and REL to try again. The transmission of data, echoes, and acknowledgements occur at electronic speeds ($\approx$50 μsec/character); the operator is not aware of any delay.

After the central recorder receives the signal acknowledging that the echo it sent matched the contents of the remote unit's buffer memory, the record is transferred from the central recorder's buffer memory to its tape unit (via the data bus) where it is written on tape. If a TAPE error occurs the tape unit will attempt four re-tries at writing before alerting the operator.

If an error is encountered when verifying data before transmission, corrections can be made following normal OFFLINE verification procedures. If the data being verified is read off tape, the record on the local tape is corrected before the data is released to the central recorder.

In pooling, keyboard entry of data can occur simultaneously at a number of remote units. However, data is transferred to the central pooler from only one remote unit at a time. If more than one remote unit attempts to transfer data at the same time, one unit is given preference over the others. This priority relationship between remote units corresponds to the positions the units occupy in the chain. The closer a unit is to the central recorder, the higher the priority (see Figure 5-1).

Each operator enters data to the buffer memory of her remote unit without considering the pooling activity taking place at other units in the chain. If, when a record is ready to be released to the central pooler, no higher priority unit is transferring data or is ready to transfer, the record is sent to the pooling adapter and propagated down the pooling chain to the central recorder.

If a higher priority unit gains the attention of the central recorder first, the lower priority unit waits in the ready state until no higher priority unit is using the co-axial cable.

During the period a unit is waiting for a higher priority unit to complete its pooling transfer, the keyboard at the waiting unit locks so that the operator cannot destroy the record in memory before it is released to the central recorder. Priority in the pooling chain is controlled by signals generated by the pooling adapters at each remote unit. If a remote unit (in the DATA ENTER or DATA VERIFY modes) is unable to gain priority within 2-3 seconds, a POOL error is indicated.

5.3 Data Merge

Records pooled from remote units in the DATA ENTER or DATA VERIFY modes are written on tape in random order as they are received at the central recorder. Data from tapes at a number of remote units may also be merged at the central recorder a file at a time. During merging operations (remote units are in the DATA MERGE mode, ONLINE) one unit transmits an entire file of records to the central recorder where they are written on tape in the same order as they appeared on the remote tape. Unless an error causes a pause, the complete file must be transferred before the next unit in priority is allowed to send its file.

In a typical file merging sequence, merging begins with the transmission of the first file from the highest priority ONLINE terminal to the central recorder. Transmission stops at the EOF record that terminates the file; the EOF record is not sent to the central recorder. Merging resumes with the transmission of the first file from the next highest priority ONLINE terminal. The first file of each subsequent terminal in the chain is merged in the same manner until the lowest priority terminal has completed its transfer.

Once the supervisor has placed all the terminals in a pooling chain ONLINE, the first file on each tape will be merged without further operator intervention.

If tapes contain a number of files, data transmission must be restarted for each new file. If a supervisor wishes to transmit all files from one unit before accepting any files from the next (lower priority) unit, the terminals should be prepared for data transmission one at a time.

During merging, a record is read from remote unit's tape into the unit's buffer memory and then transmitted to the buffer memory of the central recorder. Each time the central recorder receives a record, it sends an "echo" of the transmission to the remote unit; if the "echo" exactly matches the contents of the remote unit's memory, the remote terminal responds with an acknowledgement signal. When the central recorder receives acknowledgement, the record is transferred to the tape unit where it is written on tape.

Merging may be interrupted at any time by pressing the RESET key at the remote unit currently transmitting when the record counter indicates the desired pause point. This causes the record in the terminal's memory to be sent to the central recorder, after which transmission from this terminal halts, providing a "merge pause". During this pause an operator may key in records at any remote terminal after rotating mode switch to DATA ENTER while holding down RESET. As records are released, they will be transmitted to the central recorder and written on tape. Merging may be resumed by rotating mode switch back to MERGE and pressing the RESET-RETURN keys at the appropriate remote terminal. The operation is referred to as "record insert".

If a unit that is merging develops a POOL error (an error resulting from an unsuccessful transmission attempt), the unit next in priority will clear the error and pool its data. If a TAPE error (resulting from an unsuccessful attempt to write data on tape) is indicated at the central recorder, the central unit will try to write the record four times. After the fourth unsuccessful attempt, the central recorder will have to be manually checked by the supervisor to ascertain the exact cause (e.g., damaged tape). This error condition will stop all pooling operations. If any unit requests the central recorder for receiving or sending during the error condition, the remote unit will get a POOL error indication after a 2-3 second delay. When the error condition at the central recorder is cleared, the remote unit can proceed.

5.4 Data Conversions and Merging Rates

Data may be recorded on tape in a number of formats (i.e., recording method, code and/or density of characters may differ). Whenever data, regardless of format, is read off a tape, it is translated by the tape adapter into the internal-machine code (MDRS) used by all Series 4310/20 units. The data, represented by the internal-machine code, is then transmitted from the remote unit's buffer memory to the buffer at the central recorder. When the data is transferred from the buffer to the tape unit, the tape adapter translates the internal-machine code (MDRS) into the appropriate format, before the data is merged on tape. The recording method, code, and density are selected when a unit is first acquired. Data at a remote terminal does not have to be recorded on the local tape in the same format as data is recorded at the central recorder. For example, the remote tape may be recorded in Phase Encoding, 1600 CPI, format and then subsequently merged at the central recorder in a NRZI, 800 CPI format.

Data is represented by the 6-bit (7-bit for Kana units) internal-machine code during data flow within a unit or between different units, except when transmitting over telephone lines during data communication operations (see Section 7.0).

The rate at which data records can be merged will vary depending on the recording formats (at both the remote and central recorder tape units), as well as on the record lengths and tape speeds. The time required to merge one record (T_M) is equal to the time required to read the record off the remote tape (t_r) plus the transmission time (t_t) plus the time required to write the record on the central recorder's tape (t_w); that is:

$$T_M = t_r + t_t + t_w$$

Read (t_r) and write (t_w) times vary according to the tape speed for a particular unit, the tape format (i.e., number of tracks), the recording density, and the record length. Read and write times are listed in Table 2-12 of Section 2.5.3.

The transmission time (t_t) includes the time it takes the remote unit to transmit a record down the pooling chain, receive an "echo" from the central recorder and acknowledge accurate transmission. The transmission time is approximately 50 μsec/character.

It is possible, using file explosion, to merge only correctly identified records at the central recorder.

		1 6
Data records on tape at remote unit:	RECORD # 1	149ABC84380321 . . .
	RECORD # 2	796XYZ32246385. . .
	RECORD # 3	145AHC73887287 . . .
	RECORD # 4	607XYZ20816528 . . .
	RECORD # 5	591RTL93023501. . .

Contents entered into data memory of remote unit:

1 6
SpSpSp $\underbrace{\text{XYZ}}_{\text{Identifier Field}}$ . . .

Contents entered into program memory of remote unit:

1 6
Dup NNNDND. . .
UUUUUU
MMM $\underbrace{\text{PMP}}_{\text{Dup Field}}$
S
T

Data records merged at central recorder:

1 6
796XYZ32246385. . .
607XYZ20816528. . .

Figure 5-2. File Explosion

5.5 Editing

During data merge operations, data can be edited in the following ways:

File Explosion:	sorts out identified data records for merging.
File Edit:	permits data to be automatically changed in every record of a file.
End Stripping:	causes all records sent or received to be terminated at some point before the actual end of a record.
Central Recorder Edit:	allows the central recorder to append data to each incoming record.

Sections 5.5.1 through 5.5.4 provide a complete description of each editing feature, including examples.

5.5.1 File Explosion

The file explosion feature allows selected data records to be sent to a central recorder. Only those records containing a particular identifier field are selected for transmission. The identifier field is keyed into memory positions that are programmed as a dup field (a skip field is used instead of a dup field if the identifier, itself, is to be stripped out before transmission). The identifier in memory must match, character by character, the identifier field in the data records. During merging, each record on tape is compared with the contents of memory; only those records which contain the identifier are transmitted and merged at the central recorder (see Figure 5-2).

File explosion is used to separate various types of data (e.g., data from different jobs) when many types have been pooled onto one reel of tape.

5.5.2 File Edit

File edit at a remote terminal permits data to be automatically changed in every record of a file during a merging operation. This is accomplished by entering (in the DATA ENTER mode) special control field characters into data memory positions that are programmed as a dup field. When data is read off tape and loaded into the buffer memory in the DATA MERGE, ONLINE mode, the special control field characters are automatically inserted in place of existing data in every record. This feature is useful, for example, for correcting an error duplicated in every record on the remote unit's tape (see Figure 5-3).

Data records on tape at the remote unit:

```
Record #1   ACC NO 875-3412 DEPT.078
Record #2   ACC NO 658-9732 DEPT.025
Record #3   ACC NO 575-8721 DEPT.036
```

Contents entered into program memory at remote unit:

```
1                              17    21    25
LLLLLLLLLLLLLLLL DNNNDNNNR
TTTTTTTTTTTTTTTT UUUUUUUUE
RRRRRRRRRRRRRRRR PMMMPMMML
S                               S
T                               T
                          Dup
                          Field
```

Contents of data memory at remote unit:

```
1   3   13    17    21
SpSpSp.....SpSpSpCODESpSpSp
                 Special Control
                 Field characters
```

Data records as recorded on tape at the central pooler:

```
Record #1   ACC NO 875-3412 CODE 078
Record #2   ACC NO 658-9732 CODE 025
Record #3   ACC NO 575-8721 CODE 036
                            Data that has
                            been changed
```

Figure 5-3. File Edit

5.5.3 Record End Stripping

End stripping causes all records sent or received to be terminated at some point before the actual end of the record. Before transmission, a release program command code is keyed into memory (in the character position where the records are to be ended) at either the remote terminal or the central recorder. This feature is often used to remove some identification information that was previously needed (see Figure 5-4).

Data records at remote unit:

```
            1              15                29
Record #1   ABC CORP. 875 MAIN ST., TOWN CC332
Record #2   DEF CORP. 231 EAST ST., TOWN CB564
Record #3   XYZ CORP. 511 WEST ST., TOWN CD731
```

Contents of program memory at either the remote unit or the central recorder:

```
1                 29
LLLLLLL     LLLLLLR
TTTTTTT ··· TTTTTTE
RRRRRRR     RRRRRRL
S
T                Rel
                 Code
```

Data records as recorded on tape at the central Pooler:

```
Record #1   ABC CORP. 875 MAIN ST., TOWN
Record #2   DEF CORP. 231 EAST ST., TOWN
Record #3   XYZ CORP. 511 WEST ST., TOWN
```

(Also see Figure 7-27 of Section 7.7.2)

Figure 5-4. Record End Stripping

5.5.4 Central Recorder Edit

Central recorder edit allows the central recorder to add data on at the end of each incoming record. This is accomplished by entering into the memory of the central recorder, in character positions programmed as a skip field, the data to be added to each record (see Figure 5-5).

Central recorder edit is useful for adding some form of identification (e.g., branch number) at the end of each record. This feature is also used to insert information that might not have been known when the data was initially key-entered; for example, the date is often added using central recorder edit.

5.6 Compatibility with Other Options

When a Series 4320 unit is utilized as a remote unit in a pooling chain (DATA ENTER or DATA VERIFY mode) the check digit and printing totalizer options can operate on separate or mutual fields, just as they do in OFFLINE operations. Both options, however, are disabled in a unit operating as the central recorder.

```
Data records sent to central recorder:
                1                       21
Record #1      ABCDEFGHIJK1234567890
Record #2      KJIHGFEDCBA0987654321
Record #3      FGHIJKABCDE5678901234

Contents of program memory at the central recorder:
      1                       21
      LLLLLLLLLLLLLLLLLLLLLSNSR
      TTTTTTTTTTTTTTTTTTTTTKUKE
      RRRRRRRRRRRRRRRRRRRRRIMIL
      S                    P P
      T                    Skip
                           Field

Contents of data memory at the central recorder:
   (Sp = SPACE CODE)
      1                        21
      SpSpSpSpSpSp   . . .   SpSpSpSp XYZ
                                      Special
                                      Control
                                      Field

Data records as recorded on tape at the central pooler:
Record #1      ABCDEFGHIJK1234567890 XYZ
Record #2      KJIHGFEDCBA0987654321 XYZ
Record #3      FGHIJKABCDE5678901234 XYZ
                                     Data that
                                     has been
                                     added
```

Figure 5-5. Central Recorder Edit

Any Series 4310/20 unit (except 4322 units) can be connected to a line printer; however, data cannot be output to the line printer while a pooling operation is in progress. Following the pooling operation, it is often desirable to transmit the data from the central recorder's tape to the line printer to obtain a hard-copy of all the pooled data.

A tape for data communications is often prepared by merging various other tapes or by pooling data from a number of keyboards. A unit cannot, however, simultaneously function in a data communications network while operating in a pooling chain.

6.0 LINE PRINTER

6.1 Capabilities

The Model 4350 or 4352 line printer is available as an option with any Series 4310/20 unit, except the 4322 keyboard-only-unit. In order to support the line printer, the magnetic data recorder must be equipped with an external device adapter.

The line printer is useful in any application requiring a printout of large amounts of data. Formatting capabilities allow automated preparation of payroll checks, billing statements, accounting records, sales or production reports, or any number of other applications.

When employed in conjunction with the data communications option, the line printer performs several extremly helpful functions. It may be desirable to have a printout of all data received in a data communication exchange. The data may be printed (as well as recorded on tape) while it is being received, or may be received, recorded on tape then printed following the completion of data communications. It is also possible to periodically print samples of data being received as a spot-check to assure that the correct information is being transmitted. The line printer is an especially helpful tool in diagnosing problems of data transmission or reception. In addition, the line printer (if adequately prepared) can be "forced" to receive information at an unattended terminal that was previously conditioned for sending. Utilizing the line printer in such forced-reception operations enables an operator (or computer) to print messages at an unattended, remote sending unit before or after the remote unit has transmitted its data. For example, an operator, after spot-checking the data being received, might recognize that the wrong tape was loaded for transmission at the remote unit; the operator can force the unattended unit to stop sending and print a message relating the error.

The remainder of this section is devoted entirely to the Model 4350. Information on Model 4352 will be provided at a later date as a supplement to this manual.

6.2 Hardware

The Model 4350 is a drum line printer; the print character set is contained on a cylindrical drum, which rotates at 540 RPM. Paper is fed by a traction mechanism between sets of hammers and the drum. An inked ribbon moves between the paper and the drum. A character is printed when the appropriate hammer strikes the paper, forcing it against the inked ribbon and making contact with a selected character on the drum. Characters are printed a complete line at a time, and the paper is automatically advanced one or more line positions after each line is printed.

The Model 4350 line printer character set (when equipped with the U.S. printing drum), is listed in Table 6-1. Note that additional characters are available at slower printing speeds, and some characters are not the same as shown on the key-to-tape unit keyboard.

Table 6-2 lists the functions of the line printer's controls and indicators.

The Model 4350 line printer can feed single-part forms of 14 (minimum) to 20 (maximum) pound paper, or six-part forms (up to five carbons) with 15 to 20 pound originals, 9 to 12 pound copy forms, and 7-½ pound carbon paper. The paper used can be from 3-½-inches to 18 inches wide and from 7 inches to 14 inches long between perforations.

The Model 4350 line printer must be equipped with a line printer adapter to provide the logic circuitry required for interfacing with a Series 4310/20 unit and its external device adapter.

The line printer adapter has two main functions:

1) Translates the Series 4310/20 unit's internal machine code to the modified USASCII or EBCDIC code of the line printer.
2) Interprets format command codes.

A Series 4310/20 unit and a line printer are connected by a cable that should not exceed eighty feet in length (the standard cable is 20 feet long).

6.3 Theory of Operation

6.3.1 Printing

During OFFLINE operations, data may be routed to the line printer from the keyboard (DATA ENTER mode) or from a magnetic tape (DATA SEND mode). In ON-LINE data communication operations, information

Table 6-1. Model 4350 Line Printer Character Set

Line Printer Character	Comment
A to Z 0 to 9	Upper case only
. ' - $ / + * #	450 lpm
: □ I ( )	300 and 225 lpm only[2]

Line Printer Character	Comment	
& " < >	300 and 225 lpm only[2]	
% @ ? ! ;		
\	0-8-2 at 4310/20[1]	225 lpm only[3]
[	¢ at 4310/20[1]	225 lpm only[3]
]	| at 4310/20[1]	225 lpm only[3]
←	— at 4310/20[1]	225 lpm only[3]
↑	¬ at 4310/20[1]	225 lpm only[3]

1. These characters are not printed as they appear on the 4310/20 unit keyboard.
2. When these characters are used, printing speed is reduced to 300 or 225 lines/minute.
3. When these characters are used, printing speed is reduced to 225 lines/minute.

being received can be routed to the line printer and/or magnetic tape. Simultaneously writing data on tape and printing it at the line printer during any type of operation other than data communications is available only on special order.

Figure 6-1 illustrates the possible sources of data flow into the line printer.

Regardless of the source of data (keyboard, tape, or data communications network), each data record is loaded into the Series 4310/20 unit's buffer memory prior to transmission to the line printer. Data is then transferred, a character at a time, from the magnetic data recorder's buffer memory (through the external device adapter and line printer adapter) to the line printer's buffer.

In the line printer adapter the data is translated from the Series 4310/20 internal machine code into the USASCII or EBCDIC code of the line printer, then loaded into the buffer.

Each of two buffers in the Model 4350 line printer contain 132 character positions, thus limiting the maximum length of one line of print to 132 characters. If a data record containing more than 132 characters is to be printed, the first 132 characters in the record are printed as one line of print, and the remaining characters are automatically printed as a second line of print.

Table 6-2. Line Printer Controls and Indicators

Switch/Indicator	Action	Meaning If Illuminated	Operational Mode(s)
POWER Switch	Turns printer power on and off.	Power is on.	Both
LOAD FORM Switch	Advances the paper to next load point hole in VFU tape.		Local
TOP OF FORM Switch	Advances the paper to next top-of-form hold in VFU tape.		Local
ONE LINE ADVANCE Switch	Advances the paper one line.		Local
ONE LINE PRINT Switch	Used only when correcting a POOL error.		
ONLINE Switch	Places the printer ONLINE if no feed check condition exists.	Printer is ONLINE.	Local
LOCAL Switch	Places the printer in local mode	Printer is in local mode.*	ONLINE
SELECTED Indicator		Printer is receiving data	Both
FEED CHECK ** Indicator		A feed check condition exists.	Both

* Equipment might return to local mode if printer malfunctions.
** Feed check conditions include:

- Out of paper
- Torn paper or paper jam
- VFU tape cover open

As a result, printing data records that exceed 132 characters is significantly slower than printing those of less than 132 characters. It is recommended, therefore, that data records be limited in length, whenever possible, to allow for more efficient printing.

After an entire record (or the first 132 characters of a longer record) has been transferred to the line printer's buffer, printing action begins. It should be noted that any transfer of information between a Series 4310/20 unit and a line printer proceeds over a special connecting cable at electronic speeds.

Data is transferred from a Series 4310/20 unit to the line printer at the rate of 0.5 millisecond (ms)/character; however, a data record involving more than 2 lines of print (see end of line format codes, Section 6.4.2), needs additional time. Since the line printer can only buffer 2 lines of print, an additional 133 ms. is required for each line of print above two. Thus, the time required for the line printer to process one record of data from the Series 4310/20's buffer is:

$$T_{PRNT} = [(0.5 \text{ ms/char})(\text{no. of char. in first two lines of print})] + [(\text{lines of print} - 2) \times (133 \text{ ms})]$$

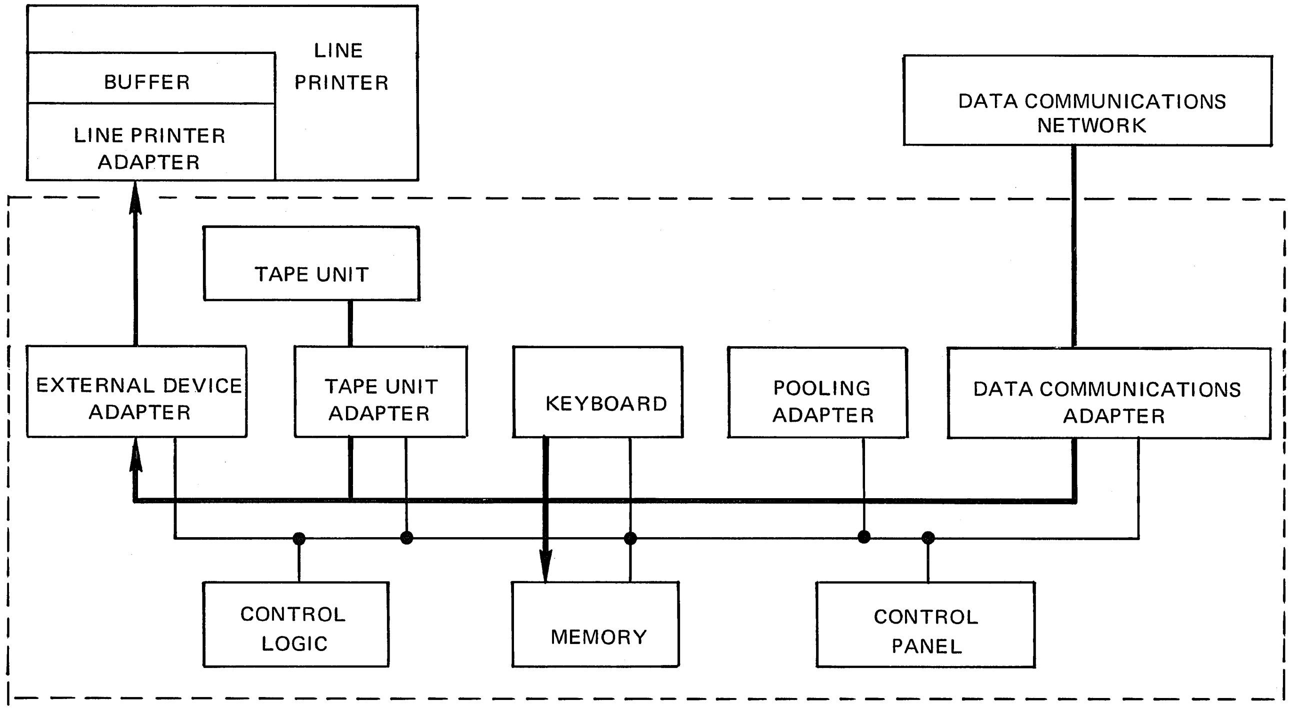


Figure 6-1. Data Flow into Line Printer

For example, consider the time required to process a 200 character record with an end of line format code in character positions 150 and 151. The first 132 characters comprise the first line of print, the next 18 characters comprise the second line of print and the final 48 characters comprise the third line of print. The record processing time is:

$$T_{PRNT} = [(0.5 \text{ ms/char})\ (150 \text{ char})] + [(1)\ (133 \text{ ms})] = 208 \text{ ms}$$

Printing proceeds one character at a time until one line of print (the contents of one of the line printer's buffers) is complete. The printing of each character is accomplished by comparing the contents of a buffer position with a code wheel, which indicates the next symbol on the print drum; when the character symbol on the print drum matches the character in the buffer, the hammer strikes the paper, forcing it against the inked ribbon and making contact with the selected character symbol on the print drum. As each character is printed, it is erased from the line printer's buffer. When a complete line is printed (and the buffer is filled with space codes), the characters for the next line of print are automatically loaded into the line printer's buffer and the paper advances one line.

(Multiple line spacing is possible using format command codes; see Section 6.4.1).

During tape-to-printer operations, the Series 4310/20 unit reads the next record into its buffer memory, while the line printer is printing the last line of print from the previous record. This overlap of phases reduces the total time required for a printing operation.

6.3.2 Vertical Format Unit (VFU)

The Model 4350 line printer contains a vertical format unit, which uses a coded paper tape to control vertical line spacing. In the absence of any format control, the line printer will advance one line after printing a record, or upon reaching the end of a line of print (132 characters).

The VFU uses a Mylar tape, 8 channels wide, with pre-perforated sprocket holes offset towards one edge of the tape. The VFU allows the following vertical format parameters to be set:

- Number of lines printed per page
- Load point
- Top of form
- Bottom of form (or multiple vertical tabbing)

There are ten sprocket hole punches per inch of VFU tape, and each represents one printed line. The tape must be cut, formed into a loop and spliced in such a manner that the number of sprocket holes in the loop corresponds exactly to the number of printed lines being accounted for.

The load point is set by punching a hole in channel one of the VFU tape. When the LOAD FORM switch is pressed on the line printer control panel, the paper advances to the next load point line, as specified by the VFU tape.

The top of form hole is punched in channel seven of the VFU tape and must be located at the first printed line on a new form. When the TOP OF FORM switch is pressed on the line printer control panel, the paper advances to the next top of form line, as specified by the VFU tape.

The bottom of form hole is located in channel six, and defines the end of the printed page; the line printer automatically skips from the bottom of form line to the next top of form line. Multiple holes in channel 6 can be used for multiple-vertical tab operations if the automatic skip-over-perforation action is disabled (see Section 6.4.6).

When the line printer is initially loaded, the paper and the VFU tape are synchronized such that the load point, top of form, and bottom of form holes in the VFU tape correspond to the appropriate positions on the printing paper.

Figure 6-2 illustrates a typical relationship between holes in a VFU tape and positions on the printing paper.

6.4 Format Command Codes

In addition to the VFU, printing format can be controlled through the use of format command codes. Table 6-3 summarizes the available line printer format command codes. Each code is shown using:

- The keyboard, tape, or data communication characters with which the code sequence is generated. (KEY/TAPE).
- The equivalent USASCII binary synchronous data communication code sequence.
- The equivalent EBCDIC binary synchronous data communication code sequence.

The line printer must be equipped to receive data in either USASCII and EBCDIC. These are the two languages used in Series 4310 units for binary synchronous data communications. In order to use Table 6-3, first determine whether USASCII or EBCDIC has been specified for the line printer, then select the appropriate KEY/TAPE sequence for the required format command code.

NOTE: The USASCII and EBCDIC sequences listed in Table 6-3 are only mnemonics (abbreviated names) identifying a one-character binary code that uniquely represents a particular format command code. When a format code is transferred to the line printer adapter it is translated into the appropriate binary code (USASCII or EBCDIC).

Characters are not printed when they are part of a format code; in addition, when a line printer has been enabled to accept format codes, it can no longer print the 0-8-2 (or \) character at any time. Users who require this character can substitute certain other characters, in which case the 0-8-2 (or \) character may be printed, but the substituted character cannot.

The other keyboard characters that can be substituted for the 0-8-2 character are: / S T U V W X Y Z – , % >

6.4.1 Formatting Operations

Format command codes are transferred to the line printer along with the data to be printed; however, the format codes are not loaded into the line printer buffer. The line printer adapter recognizes a format command and sets the necessary logic circuitry to perform the specified task. The circultry in the line printer adapter "remembers" the command until the appropriate time for execution. Some commands are executed at the character position in which they were entered; others are not executed until the current line of print or record has been printed (see Table 6-3). A format command code, itself, is never printed; it merely initiates a particular control function.

Figure 6-3 illustrates in flow diagram form, the operations involved in recognizing and executing the format codes listed in Table 6-3.

Format command codes may be generated by a Series 4310/20 unit, or may be generated by a computer or remote terminal in a data communications operation and transferred to the line printer via a Series 4310 unit.

6.4.2 End of Line (New Line)

The end of line format command code is used to create multiple line records. The line printer ends the line with the character position preceding the command and

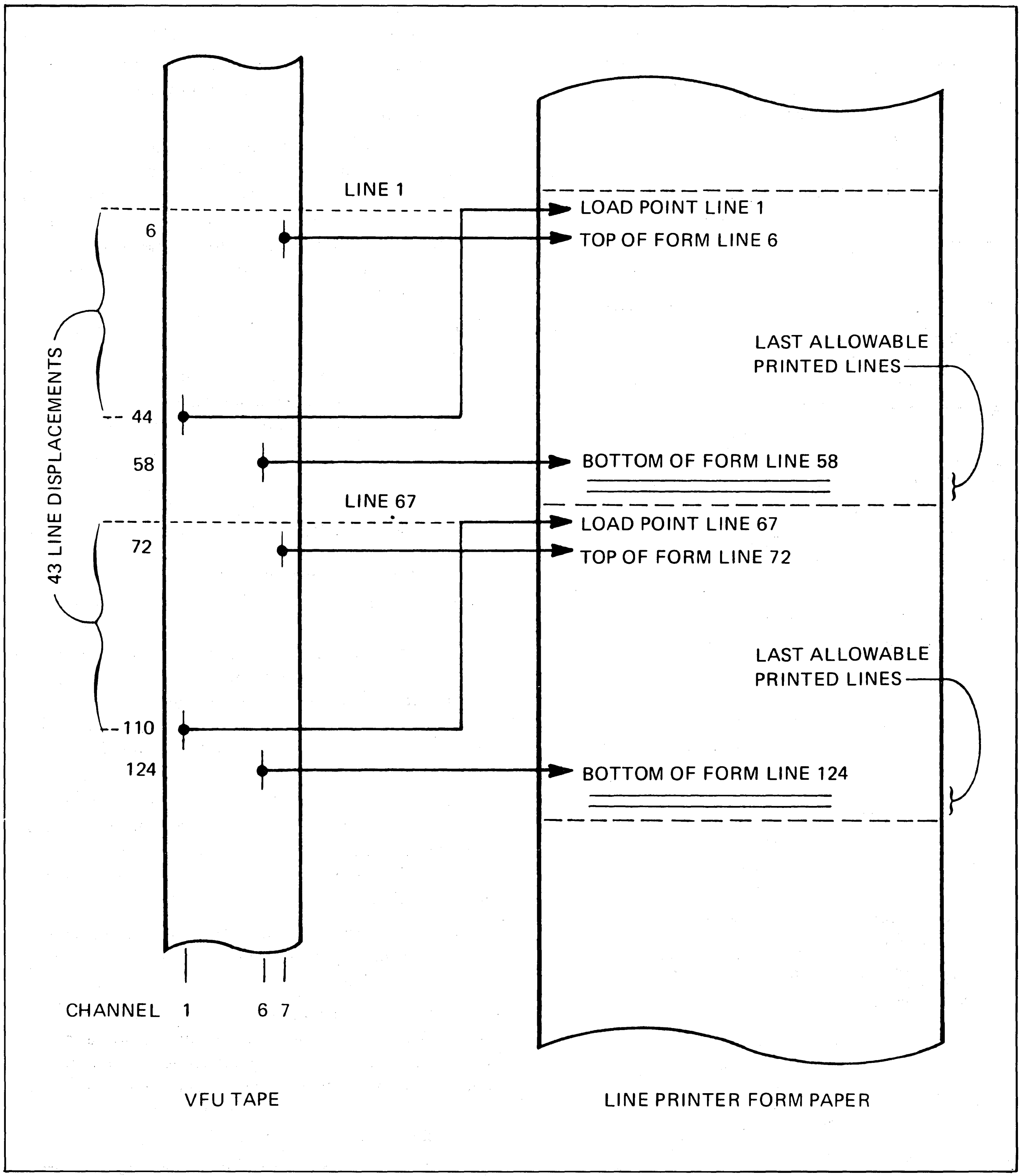


Figure 6-2. A VFU Tape (Typical)

Table 6-3. Summary of Format Command Codes

Format Command	Key/Tape	USASCII	EBCDIC	Comment
Single Space	0 8 ¬ Q 2 0 8 ¬ / 2	ESC Q	ESC /	Place code at the start of a record or line of print, which is to end with a single space line printer paper advance.
Double Space	0 8 ¬ R 2 0 8 ¬ S 2	ESC R	ESC S	Place code at the start of a record or line of print, which is to end with a double space line printer paper advance.
Triple Space	0 8 ¬ S 2 0 8 ¬ T 2	ESC S	ESC T	Place code at the start of a record or line of print which is to end with a triple space line printer paper advance.
End of line (NEW LINE)	0 8 N 2		NL	Causes preceding data to be printed as soon as the command is encountered. Consecutive commands cause line advance(s).
Line Feed	0 8 N 2	LF	LF	See NEW LINE.
Carriage Return	0 8 M 2	CR	CR	See NEW LINE.
Record Separator	0 8 P 2	RS		See NEW LINE.
Inter-Record Separator	0 8 P 2		IRS	See NEW LINE.
Top of Form	0 8 ¬ A 2	ESC A	ESC A	Place code at start of record or line of print. After the record or line of print containing this code has been printed, the line printer advances paper to the next top of form.

Table 6-3. Summary of Format Command Codes (continued)

Format Command	Key/Tape	USASCII	EBCDIC	Comment
Form Feed	0 8 K 2	FF	FF	Place code at start of record or line of print. As soon as this code in encountered, the line printer advances paper to the next load point.
Escape B[1]	0 8 ¬ B 2	ESC B	ESC B	Place code at start of record or line of print. After the record or line of print containing this code has been printed, the line printer advances paper to the next bottom of form. Three more lines can be printed before an automatic advance to the next top of form will occur.
Vertical Tab[1]	0 8 R 2	VT	VT	Place code at start of record or line of print. As for Escape B; the paper advance occurs where the Vertical Tab code is encountered.
Horizontal Tab	0 8 Q 2	HT	HT	Allows the equivalent of horizontal tabbing at the line printer
HT Header	0 0 8 ¬ 8 Q 2 2	ESC HT	ESC HT	Place code at start of record or line of print. Used to specify horizontal tab points.

1. These codes also allow multiple vertical tabbing.

starts the next line with the character following the command. Consecutive end of line codes can be used to produce multiple spacing between lines of print; each line advance requires approximately 60 milleseconds. If an end of line format code appears at the end of a record, it causes an extra line advance (see Figure 6-4). The line feed, carriage return, record separator, and inter-record separator command codes perform the same function as the end of line command code (see Table 6-3).

6.4.3 Single, Double and Triple Spacing

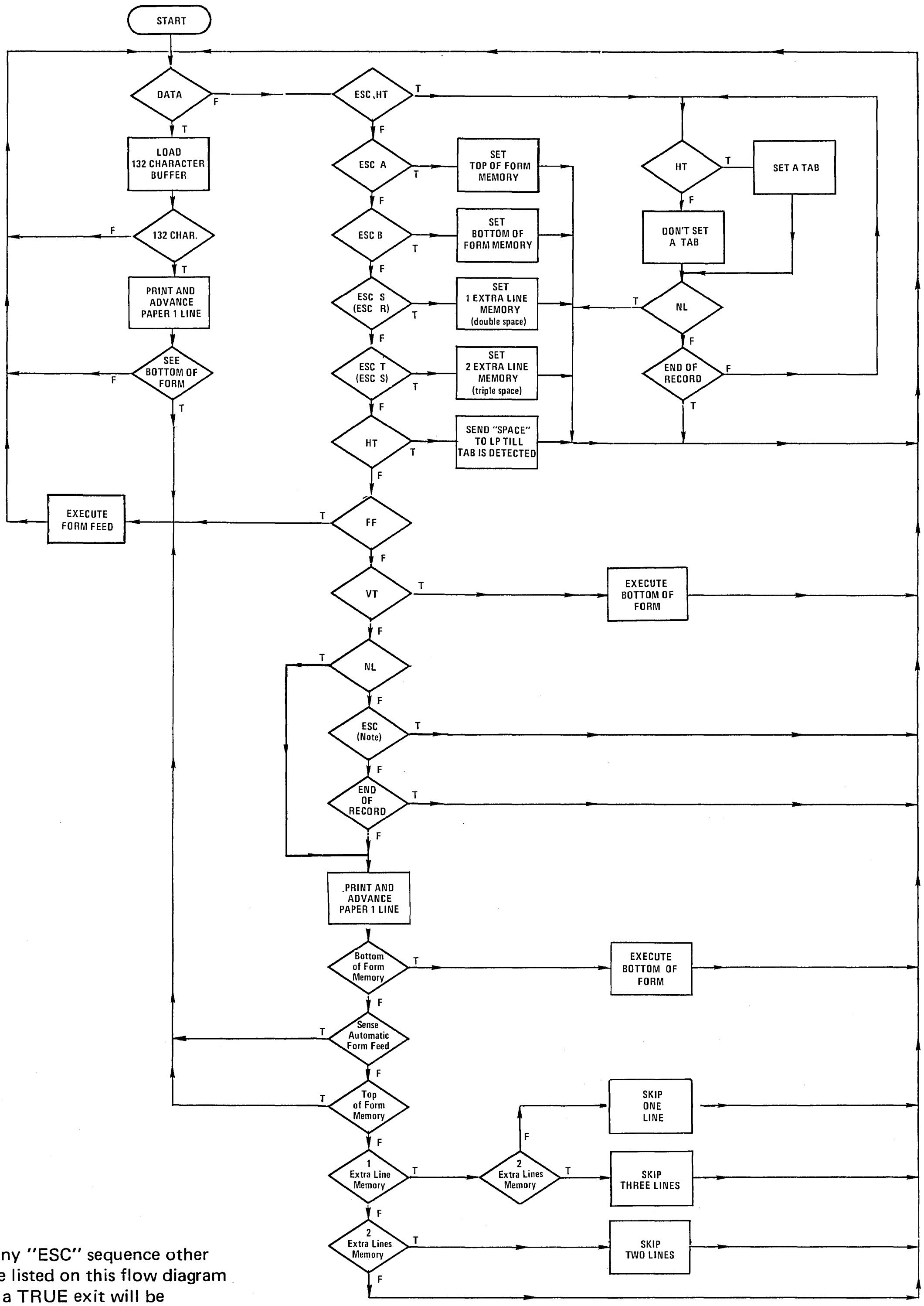
These three format codes cause appropriate line spacing to occur after an end of line code or after the record containing the code has been printed. The line printer automatically advances paper one line after printing a record. If a single space format code is present, the line printer will advance one line just as if no format code were present. For this reason, the single space format code is redundant on the line printer. Many other line printers (including those that are part of the IBM 2770 and 2780 terminals) do not have automatic line advance; if no spacing format code is present, no line advance will occur.

Line spacing is illustrated in Figure 6-5.

Whenever spacing format codes are used with a data stream that is longer than 132 characters, the requested spacing will not occur after a line overflow condition but only after the end of line command code or the end of the record.

6.4.4 Top of Form

This format code advances the paper to the next top of form line as controlled by the VFU tape.



NOTE: If any "ESC" sequence other than the one listed on this flow diagram is detected, a TRUE exit will be made from the decision state.

Figure 6-3. Execution of Line Printer Format Command Codes

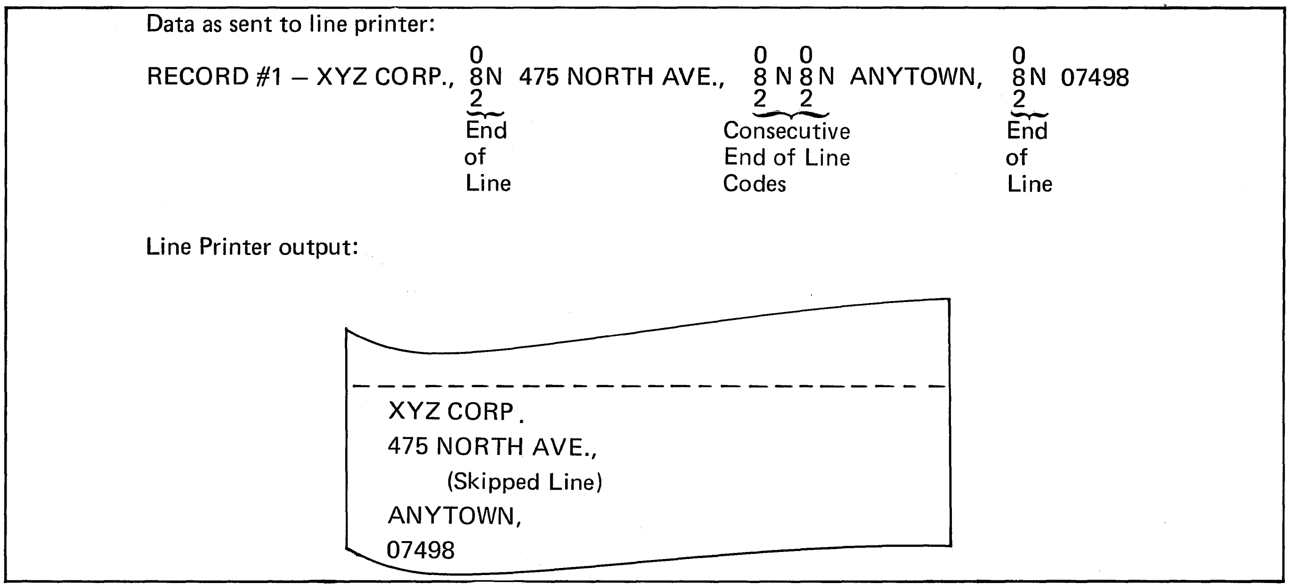


Figure 6-4. End of Line Format Code

The top of form code is always placed at the beginning of a record or line of print (or after an end of line code.) The paper advance to the next top of form occurs as soon as the next end of line format code is read or when the end of the record is reached. All text between the top of form code and end of the line will be printed before the top of form command is executed (see Figure 6-6).

6.4.5 Form Feed

As soon as this format code is encountered, the line printer advances the paper to the next load point, as controlled by the VFU tape. The form feed code is always placed at the beginning of a record or line of print after an end of line code (see Figure 6-7).

Paper advance caused by a form feed format code proceeds at a rate of 16.6 inches per second.

6.4.6 Escape B and Vertical Tab Format Codes

The escape B and vertical tab format codes can each perform two separate operations depending on the skip-over-perforation-action. The two functions that each performs are:

1) Advance to the bottom of the form as determined by channel 6 of the VFU tape (if the skip-over-perforation-action is enabled).
2) Advance to the next multiple-vertical tab setting as determined by channel 6 of the VFU tape (if the skip-over-perforation-action is disabled).

The escape B format code executes its operations after the record or line of print in which it occurs is printed. The vertical tab format code executes its operations immediately.

Paper advances caused by the escape B or vertical tab format codes proceed at a speed of 16.6 inches per second.

6.4.6.1 Bottom of Form Operation with Escape B Code

The escape B format code causes an advance to the next bottom of form line, as controlled by the VFU tape. The advance occurs as soon as the current line has been printed. These lines can be printed following the bottom of form line, after which an automatic jump occurs to the next top of form line (see Figure 6-8).

6.4.6.2 Bottom of Form Operation with Vertical Tab (VT) Code

As soon as this format code is encountered, the line printer advances paper to the next bottom of form line, as controlled by the VFU tape. The vertical tab code serves the same purpose as the escape B code except that the vertical tab command is executed as soon as it is encountered. Thus a vertical tab code at the start of a line causes a

Data as sent to line printer:

(Format codes are KEY/TAPE representations of the USASCII code.)

RECORD #1 $\underbrace{\begin{smallmatrix}0\\8\\2\end{smallmatrix}\neg Q}_{\text{Single Space Command}}$ SMITH, A. 123-45-6789 40 3.50 5 5.00

RECORD #2 $\underbrace{\begin{smallmatrix}0\\8\\2\end{smallmatrix}\neg R}_{\text{Double Space Command}}$ 165.00 30.00 00.00 2.40 32.40 132.60

RECORD #3 $\underbrace{\begin{smallmatrix}0\\8\\2\end{smallmatrix}\neg Q}_{\text{Single Space Command}}$ JONES, C. 777-77-7777 40 3.50 0 5.00

RECORD #4 $\underbrace{\begin{smallmatrix}0\\8\\2\end{smallmatrix}\neg S}_{\text{Triple Space Command}}$ 140.00 25.00 00.00 2.00 27.00 113.00

RECORD #5 $\underbrace{\begin{smallmatrix}0\\8\\2\end{smallmatrix}\neg R}_{\text{Double Space Command}}$ TOTAL WAGES 305.00 $\underbrace{\begin{smallmatrix}0\\8\\2\end{smallmatrix} N}_{\text{End of Line}}$ NET WAGES 245.60

Line Printer output:

```
SMITH, A.  123-45-6789   40  3.50    5   5.00
165.00  30.00   00.00    2.40   32.40  132.60
             (skipped line)
JONES, C.  777-77-7777   40  3.50    0   5.00
140.00  25.00   00.00    2.00   27.00  113.00
             (skipped line)
             (skipped line)
TOTAL WAGES  305.00
             (skipped line)
NET WAGES  245.60
             (next line to be printed)
```

Figure 6-5. Line Spacing Format Codes.

Data as sent to a line printer:

(Format codes are KEY/TAPE representations of the USASCII code.)

RECORD #1 ABC CORP., 475 NORTH AVE, ANYTOWN $\underbrace{\overset{0}{\underset{2}{8}}\text{N}}_{\text{End of Line}}$ C.D. JONES

RECORD #2 PROJECT ENGINEER $\underbrace{\overset{0}{\underset{2}{8}}\text{N}}_{\text{End of Line}}$ $\underbrace{\overset{0}{\underset{2}{8}}\neg}_{\text{Top of Form}}$ A PROJECT A $\underbrace{\overset{0}{\underset{2}{8}}\text{N}}_{\text{End of Line}}$ DEF CORP.

RECORD #3 521 SOUTH AVE., ANYTOWN $\underbrace{\overset{0}{\underset{2}{8}}\text{N}}_{\text{End of Line}}$ A.B. SMITH

Line printer output:

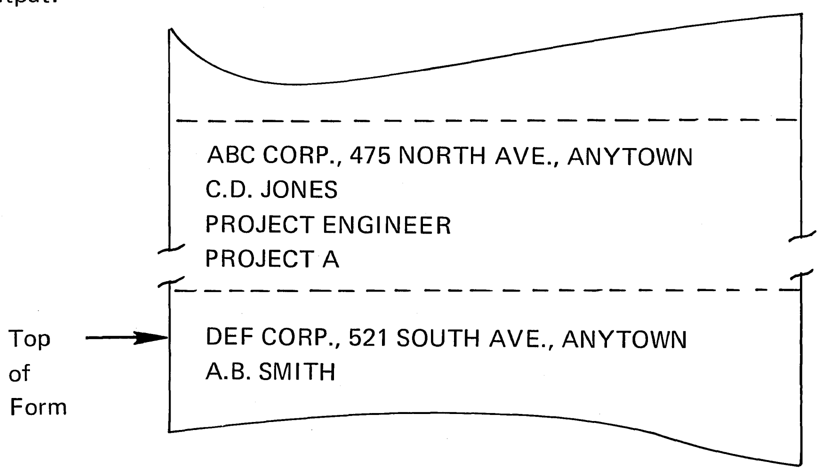


Figure 6-6. Top of Form Format Code.

paper advance to the next bottom of form BEFORE the line is printed; an escape B code at the start of a line causes a paper advance to the next bottom of form AFTER the line is printed (see Figure 6-8).

Vertical tab codes should be placed at the start of a record or line of print (or after an end of line code).

6.4.6.3 Multiple-Vertical Tabbing Option

A field service representative can make certain optional adjustments to the line printer, disabling the automatic skip-over-perforation-to-top-of-form action. As a result, an advance to the top of form line will not automatically occur three lines after an advance to the bottom of form line. Vertical tabbing can then be affected by punching holes in appropriate positions of channel six (channel used for designating bottom of form lines) of the VFU tape. Each time the escape B code is encountered, the current record will be printed, paper will advance to the next bottom of form line, as controlled by channel six of the VFU tape, and there the next line will be printed. Also, each time the vertical tab code is read, paper will immediately advance to the

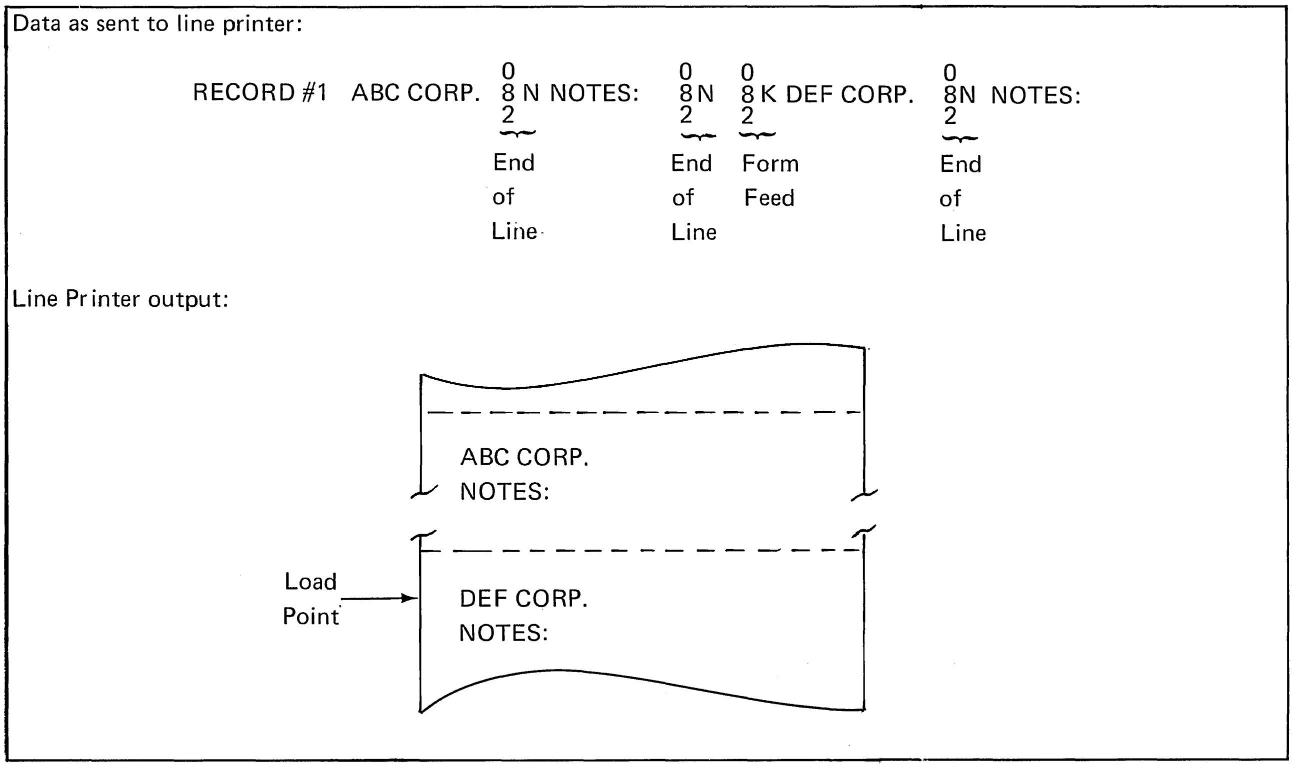


Figure 6-7. Form Feed Format Code.

next bottom of form line (as controlled by channel six of the VFU tape) and there the next line will be printed. The top of form code or the form feed code must be used to reach the top of the next page whenever this feature is present (see Figure 6-9).

6.4.7 Horizontal Tab Option

Horizontal tabbing allows lines of text to be broken into two or more parts, with the printout of each part starting at a fixed, preset character position:

Tab 1	Tab 2	Tab 3	Tab 4
Smith, John E.	Accounting	124-73-6651	Salary
Snyder, Ralph J.	Purchasing	447-12-8234	Salary
Spense, Mary P.	Payroll	421-77-6662	Hourly

When power is turned on at a Model 4350 line printer, horizontal tab points are automatically set at character positions 20, 40, 60, 80, 100 and 120. By using the horizontal tab header format code (and a horizontal tab header record), tab points can be reset at any other character positions. Subsequent records that are to be tabbed should contain horizontal tab format codes at the tab break points; each time a horizontal tab format code is encountered in a record, the next character of the record is printed at the next tab character position of the line. If there are no more tabs set on the line, printing resumes at the first character position of the next line.

NOTE: A horizontal tab header record may be transmitted to the line printer in the same way as any other record; that is:

1) It may be keyed at the keyboard and transmitted directly to the line printer.

2) It may be recorded on magnetic tape, and transmitted to the line printer along with other records.

3) It may be transmitted via a data communications network.

Data as sent to line printer:

(Format Codes are KEY/TAPE representations of USASCII code.)

```
                0
RECORD #1       8¬R  ABC CORP., 1076 MAIN ST., ANYTOWN, 07499
                2
          Double Space

                0
RECORD #2       8¬B  XYZ CORP., 475 NORTH AVE., ANYTOWN, 07498
                2
             Escape B

RECORD #3       PQR CORP., 889 SOUTH RD. ANYTOWN, 07498
RECORD #4       IJK CORP., 228 EAST ST., ANYTOWN, 07498
RECORD #5       LMN CORP., 841 WEST ST., ANYTOWN, 07498
RECORD #6       ANY CORP., 888 - 5TH AVE., ANYTOWN, 07498
                                          0    0
RECORD #7       END OF ADDRESS LIST       8 N  8 R ABCD
                                          2    2
                                         End   Vertical
                                          of     Tab
                                         Line
```

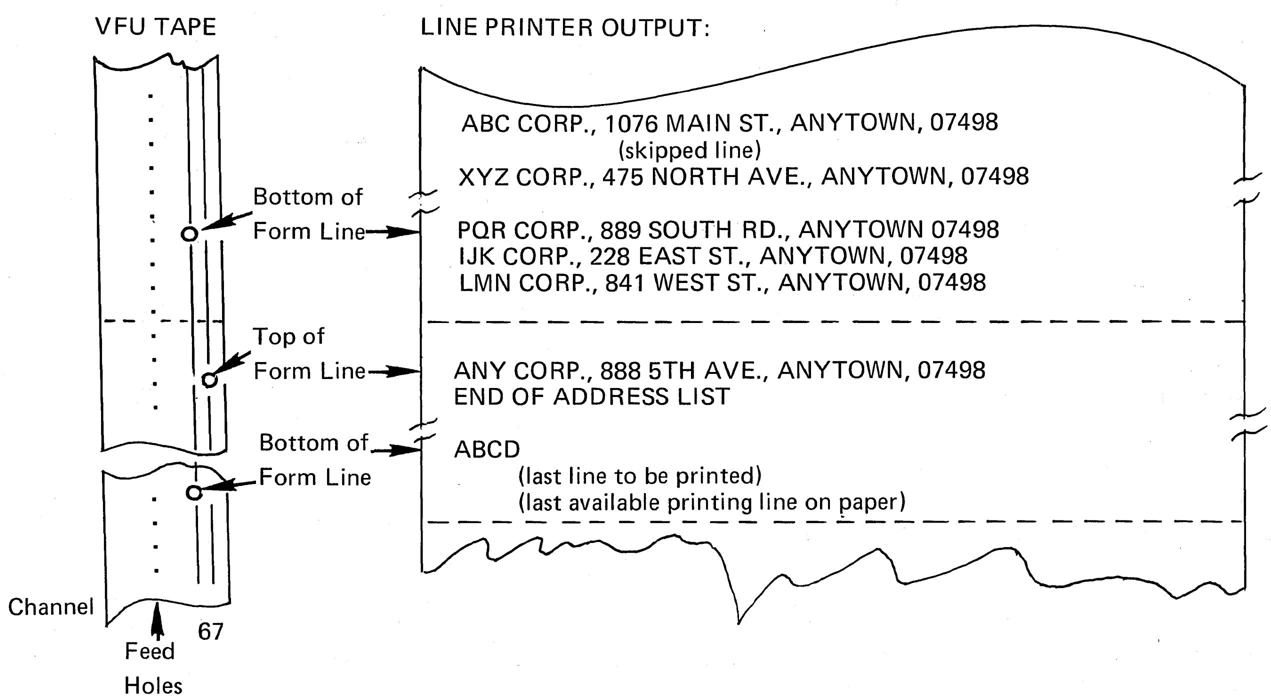


Figure 6-8. Escape B and Vertical Tab Format Codes.

Data as sent to line printer:

```
              0
RECORD #1     8 ¬ B   ABC CORP., 1075 MAIN ST.
              2
              Escape B

              0
RECORD #2     8 ¬ B   XYZ CORP., 475 NORTH AVE.
              2
              Escape B

RECORD #3     PQR CORP., 899 SOUTH RD.

                                      0    0
RECORD #4     IJK CORP., 226 EAST ST. 8 N  8 R  DEF CORP., 21 GOLD ST.
                                      2    2
                                      End  Vertical
                                      of     Tab
                                      Line

              0
RECORD #5     8 ¬ A   LMN CORP., 921 WEST ST.
              2
               Top
                of
               Form
```

VFU Tape:
If channel six of the VFU tape is punched such that bottom of form lines are specified at lines 12, 18 and 24 of the printing paper, the line printer output will appear as follows:

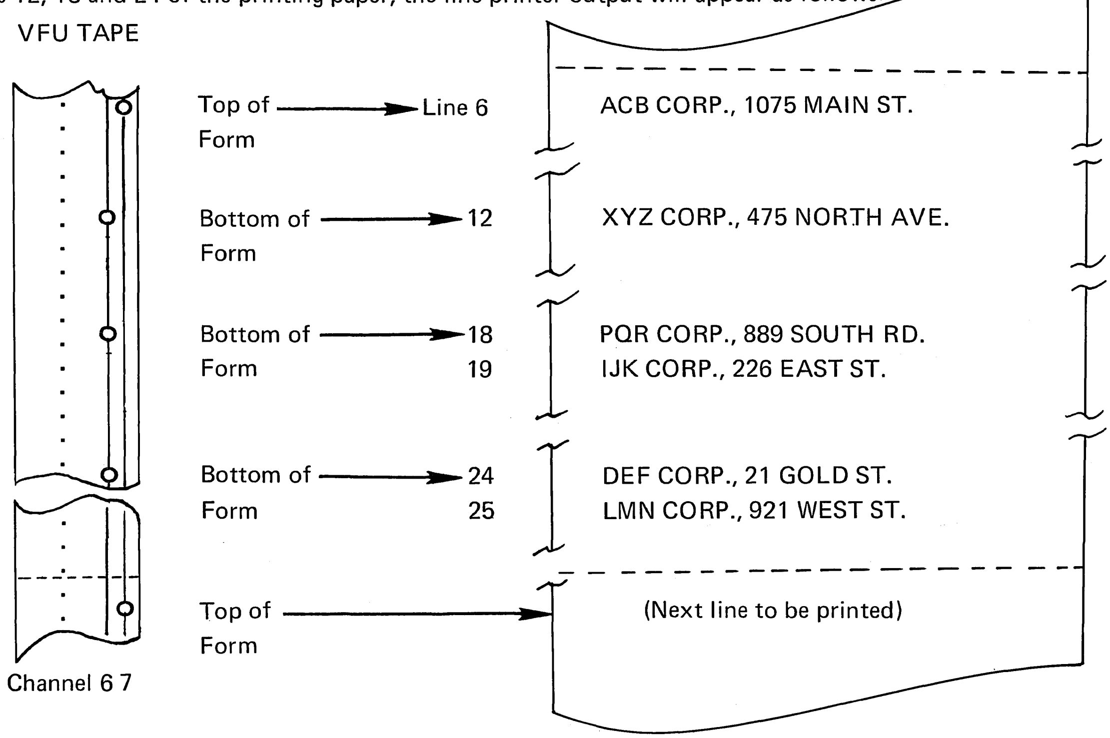


Figure 6-9. Multiple-Vertical Tabbing

Horizontal tab header record (HTH records) may be transmitted to the line printer any number of times; each time the record is transmitted it resets tab points as specified. In the event of a power failure, or anytime the line printer returns to local mode, the standard tab points (character positions 20, 40, 60, 80, 100 and 120) are reset. A horizontal tab header record must be transmitted to re-establish tab points other than the standard points.

The line printer has a special 132-character buffer that accepts an HTH record. The horizontal tab header code ($\overset{0}{\underset{2}{8}}\neg\overset{0}{\underset{2}{8}}$ Q) that begins each HTH record directs the logic circuitry to load the remainder of the HTH record into the special buffer; the horizontal tab header code, itself, is not loaded into any buffer. The horizontal tab codes ($\overset{0}{\underset{2}{8}}$ Q) in the HTH record set tabs at specified character positions in the special buffer (see Figure 6-10).

NOTE: The KEY/TAPE sequence for a horizontal tab code consists of two characters ($\overset{0}{\underset{2}{8}}$ Q); however, like all other format command codes, it is translated by the line printer adapter into the appropriate one-character binary code (USASCII or EBCDIC) and loaded into one character position in the special buffer.

The following HTH record (see Figure 6-10), when transmitted to the line printer, will automatically be loaded into a special buffer but will cause no printout; it will set tabs at character positions 15, 30, 50 and 100.

Once the horizontal tab header record has been entered into the line printer's special buffer, it is possible to print subsequent data records according to the tabbing format by inserting horizontal tab format codes ($\overset{0}{\underset{2}{8}}$ Q) at each desired tab break point in the data records.

When a horizontal tab format code is encountered in a data record it causes the line printer to enter space codes until the next tab as set in the special buffer. The character following the horizontal tab format code is then printed (see Figure 6-11).

Any attempted tab settings beyond character position 132 are ignored.

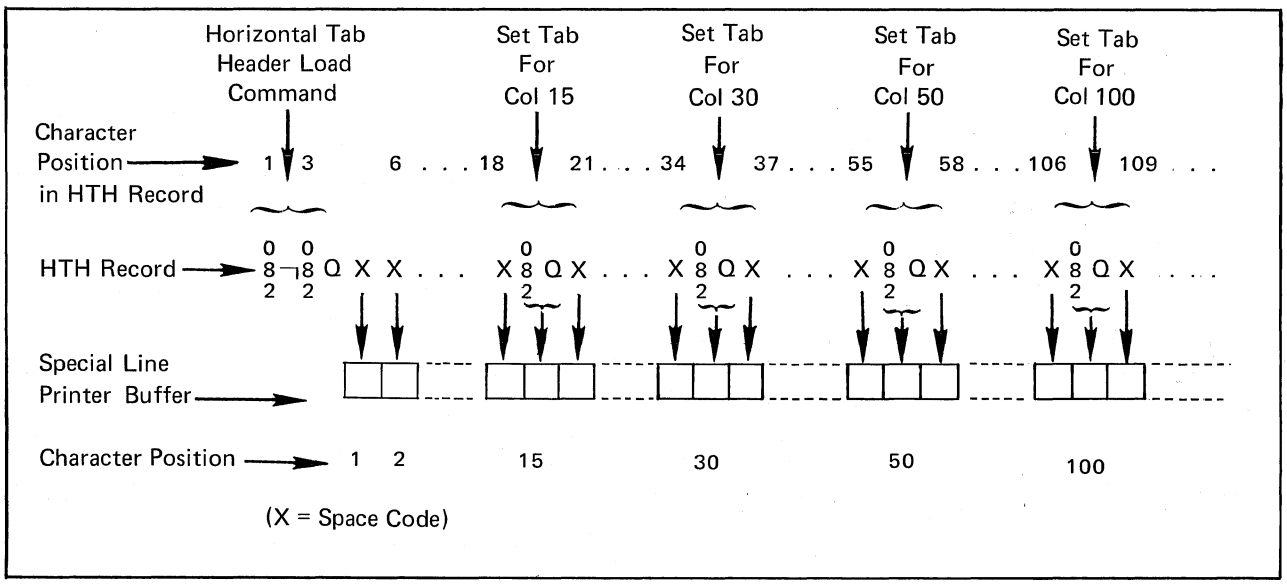


Figure 6-10. Horizontal Tab Header Record

Data records sent to line printer:

```
                                 0               0  0             0
RECORD #1    JONES, A.B.    8Q  123-45-6789  8Q 8Q  1257.83  8Q  A-121
                                 2               2  2             2
                                 0               0  0             0
RECORD #2    SMITH, D.C.    8Q  777-77-7777  8Q 8Q  0986.54  8Q  A-731
                                 2               2  2             2
                                 0               0  0             0
RECORD #3    DOE, H.        8Q  987-65-4321  8Q 8Q  3216.21  8Q  A-521
                                 2               2  2             2
                        Horizontal       Consecutive     Horizontal
                           Tab           Horizontal         Tab
                                            Tab
```

Assume that the special buffer of the line printer holds the HTH record from Figure 6-10; tabs are set at character positions 15, 30, 50 and 100.

Line Printer output:

Character Position	1	15	*50	100
	JONES, A.B.	123-45-6789	1257.83	A-121
	SMITH, D.C.	777-77-7777	0986.54	A-731
	DOE, J.	987-65-4321	3216.21	A-521

* NOTE that the consecutive horizontal tab codes caused the line printer to advance to the tab set at character position 50, ignoring the tab set at character position 30.

Figure 6-11. Horizontal Tab Format Code.

6.5 Compatibility with other Options

A Model 4350 line printer can be connected to any unit operating in a pooling chain (except 4322 units); however, data cannot be routed to the line printer during the actual pooling operation. A line printer is usually connected to the central recorder so that after all pooled or merged data has been recorded on tape, the data can be read off tape and sent to the line printer to output a printed copy of all data received.

A line printer can simultaneously print data as it is received by a Series 4310 unit operating in a data communications network. Data being received may be routed to the line printer and/or the magnetic tape unit (see Section 7.0).

The presence of the check digit and/or printing totalizer option(s) in no way inhibit the use of a line printer.

7.0 DATA COMMUNICATIONS

7.1 Capabilities

The data communications option enables a Series 4310 unit to transmit or receive data via private, public, leased, switched or unswitched telephone network facilities with or without reverse channel operation. A Series 4310 unit, equipped with a model 4335 data communications adapter, is capable of communicating with:

- Another Series 4310 unit, also equipped with a data communications adapter.
- IBM 2770 terminals.
- IBM System 360/Models 25 through 85, equipped with IBM 2701/2703 Data Adapter Units.
- IBM System 370/Model 135, equipped with the IBM 2701/2703 units.
- IBM System 3, equipped with the BSC adapter.
- System Ten*Computer by Singer, equipped with a synchronous communications adapter.
- Or any other compatible computer or terminal (see Tables 7-1 and 7-2).

All information is sent or received according to BSC (binary synchronous communications) specifications. Once a data link has been established and transmission has begun, no further operator intervention is necessary until an entire file has been transmitted.

To ensure that all data is successfully communicated with a minimum of operator intervention, the data communications option has a retransmission feature that causes automatic retransmissions to be attempted whenever a transmission error occurs; if the error condition still exists after the prescribed number of attempts, the operator is alerted. The selectable retransmission feature allows 3, 15, or an indefinite number of re-tries; this feature is chosen when the unit is acquired (see Section 7.8).

Tables 7-1 and 7-2 present information concerning the compatibility of Series 4310 data communication terminals with various central processing units (CPU) and terminals. Table 7-1 lists those factors that affect compatibility with computers, and Table 7-2 lists those factors that affect compatibility with other terminals. In both tables the compatibility factors are presented as questions; answers (if available) are also listed for a number of different units. If a manufacturer can answer "yes" to each of the questions, complete compatibility can be assumed; however, a negative response does not necessarily rule out the possibility of limited compatibility (i.e., compatibility within certain applications). While a positive answer to each question assumes that complete compatibility is possible, compatibility cannot be assured until after a particular CPU or terminal is tested with a Series 4310 terminal in a data communications network. Those units that have been tested and found compatible are marked with an asterisk (*). The factors listed in the two tables apply to any processor or terminal; because of space limitations these tables list only a few of the many CPU's and terminals that are available for use in data communications.

*Trademark of the Singer Co.

7.2 Hardware

7.2.1 The Model 4335 Data Communications Adapter

To operate as a data communications terminal, a Series 4310 unit must be equipped with a Model 4335 data communications adapter. The adapter is a printed circuit board (PCB) that performs the following operations:

- Translates telephone sequence codes (EBCDIC or USASCII) into the 4310's internal machine language (MDRS) and vice versa.
- Recognizes line printer format codes (e.g., new line, double space, etc.).
- Detects errors of either parity or block check nature.
- Recognizes and initiates execution of BSC control instructions (e.g., reverse-interrupt signal (RVI), wait-for acknowledgement signal (WACK), etc.). The data communications adapter at the receiving station also strips out the BSC control characters; only data is recorded on tape (or sent to line printer).

When the data communications adapter includes the optional reverse channel capability, a switch on the rear of the Series 4310 unit enables selection between reverse channel and standard operation.

7.2.2 Modem

To communicate over telephone lines, the Series 4310 unit must be interfaced to the communications network through a modem (also called a data set). The modem performs most functions pertaining to the transmission, signaling, or control properties of the telephone network.

Table 7-1. Computer Compatibility

Factors Affecting Compatibility	*IBM 360/ Models 25-85	IBM 370/ Model 135	*IBM System 3	*System Ten Computer	Honeywell Series 200 or 2000	NCR Century	Burroughs B2500/ B3500
Does the CPU have Binary Synchronous Communication (BSC) capabilities?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Can the CPU communicate with IBM 2770 unit?	Yes	Yes	Yes	Yes	Yes		
IBM 2780 unit?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Can the CPU communicate in the EBCDIC language?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
USASCII language?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Can transmission and reception be limited to 200 characters or less?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Can the CPU operate in a non-transparent mode? (Transparency is the ability to receive and transmit 256 unique characters as data, including control characters)	Yes	Yes	Yes	Yes	Yes	Yes	
Can the CPU operate with remote stations that are not in a conversational mode? (Conversational mode is the ability to transmit one record files from a keyboard.)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Can the CPU operate in a mode that does not require End-of-Intermediate-Transmission-Block (ITB) control characters within the data blocks?	Yes	Yes	Yes	Yes			
Can the CPU operate as the master station in a multipoint network with IBM 2770 terminals?	Yes	Yes	No				Yes

* The CPU's have been tested and found to be compatible with Series 4310 equipment.

Table 7-1. Computer Compatibility (continued)

Factors Affecting Compatibility	*IBM 360/ Models 25-85	IBM 370/ Model 135	*IBM System 3	*System Ten Computer	Honeywell Series 200 or 2000	NCR Century	Burroughs B2500/ B3500
Can the CPU generate "in text" device selection codes (DSC's)?	Yes	Yes					No
Can the CPU accept variable block sizes?	Yes	Yes	No				
Does the CPU allow transmission of format control codes of a line printer?	Yes	Yes					No

* These CPU's have been tested and found to be compatible with Series 4310 equipment.

There are numerous modems available, and their compatibility with Series 4310 terminals varies with the features and capabilities of different manufacturers' equipment. In addition to the Telesignal 888R modem supplied by Singer Business Machines, other modems can be obtained from the telephone company or from a number of independent (non-common carrier) manufacturers.

In general, a modem should have at least the following:

1. Transmit-receive capability
2. Serial transmission mode
3. EIA Interface RS232 (see Table 7-3)
4. 600 to 9600 baud rate
5. Half-duplex operation
6. Less than 200 ms turnaround time
7. Either type CDT or DBS Data Access Arrangement if using a non-common carrier modem (see Section 7.2.3).

Depending on the particular situation and application, other modem features to consider include:

1. Automatic answering capability (for unattended operation)
2. Telephone handset
3. Selection of VOICE or DATA modes
4. Reverse channel

Externally supplied modem timing is not used for Series 4310 data communications. The internal clock feature, available for Series 4310 units, does not supply timing signals to a modem; timing control remains internal within the Series 4310 unit.

Appendix B contains a list of those modems that have been tested and approved for use with Series 4310 equipment.

7.2.3 Data Access Arrangement

If a modem being used on a common carrier line is not a common carrier device, the modem must be interfaced to the communication network through a data access arrangement (DAA). The DAA ensures that the electrical signals from the non-common carrier modem do not exceed the power level restrictions of the public telephone network. DAA's are supplied by the Bell System at a nominal charge. There are two models, the CDT and the CBS, available for use with a Series 4310 unit. A CBS data access arrangement allows automatic answer and disconnect, as well as manual operation. The CDT type allows only manual origination, answer and disconnect.

Figure 7-1 illustrates the physical relationship between Series 4310 unit, modem, and DAA.

7.2.4 Communications Network

A communications common carrier is a company whose services are offered for public hire for handling interstate or foreign communications by electrical means.

The major common carrier providing interstate communications services are the Bell System and the Western Union Telegraph Company. The American Telephone and Telegraph Company (AT & T) heads the Bell System and coordinates the operations of its wholly or partly owned operating companies. In addition, there are a number of independent telephone companies, the largest of which is the General Telephone and Electronics Company. In general, the independent telephone companies offer the same types of services as the Bell System, although rates and exact services vary to some extent. Some of the smaller companies have limited capabilities, and care must be taken when planning data communications facilities within their areas. It is important to check with the local telephone company representative to determine the exact services available.

7.2.5 Classes and Types of Facilities

The facilities offered by the common carriers can logically be divided into three classes:

1. Narrowband Facilities
2. Voiceband Facilities
3. Broadband Facilities

- Narrowband Facilities: These facilities provide data communications capabilities at up to 300 bits per second.
- Voiceband Facilities: These facilities make use of communications channels having effective bandwidths of about 3,000 Hz. Equipment is currently available from the common carriers for data transmission at up to 7,200 bits per second over leased voiceband facilities, and from independent manufacturers for transmission at up to 9,600 bits per second. Equipment is available from the Bell System for transmission at up to 3600 bits per second over the public telephone network.
- Broadband Facilities: These facilities provide data communication at rates higher than voiceband facilities. Current facilities can provide transmission rates up to several million bits per second.

Table 7-2. Terminal Compatibility

Factors Affecting Compatibility	*IBM 2770	*IBM 2780	Mohawk 2400	NCR Series 735/736
Does the terminal have Binary Synchronous Communication (BSC) capabilities?	Yes	Yes	Yes	Yes
Can the terminal communicate with an IBM 2770 unit?	Yes	Only in transparent mode.	No	
IBM 2780 unit?	Only in transparent mode.	Yes	Yes	Yes
Can the terminal communicate in the EBCDIC language?	Yes	Yes	Yes	Yes
USASCII language?	Yes	Yes	Yes	Yes
Can transmission and reception be limited to 200 characters or less?	Yes	Yes	Yes	Yes
Can the terminal operate in a non-transparent mode? (Transparency is the ability to receive and transmit 256 unique characters as data, including control characters)	Yes	Yes	Yes	Yes
Can the terminal communicate with a remote station that is not in a conversational mode? (Conversational mode is the ability to transmit one record files from a keyboard).	Yes	Yes	Yes	Yes
Can the terminal operate in a mode that does not require End-of-Intermediate-Transmission-Block (ITB) control characters within the data blocks?	Yes	Yes	Yes	

*These terminals have been tested and found to be compatible with Series 4310 equipment.

Table 7-3. Series 4310 Unit — Modem Interface.

Connector Pin	RS232 Designation	Lead	Description
1	AA	Protective Ground	This lead is an electrical equipment frame and a-c power ground.
2	BA	Transmitted Data (Primary)	This lead contains the signals that originate in the 4310 terminal equipment and are to be transmitted by the data modem to a distant station. An input to the modem.
3	BB	Received Data (Primary)	This lead contains the signals that are generated by the data modem in response to signals from a distant station. An output from the modem.
4	CA	Request-to-Send	An "on" condition on this lead indicates that the 4310 terminal equipment is ready to transmit primary data. An input to the modem.
5	CB	Clear-to-Send	An "on" condition on this lead indicates that the data modem is ready to transmit data from the 4310 terminal equipment to a distant terminal. An output from the modem.
6	CC	Data Set Ready	An "on" condition on this lead indicates that the telephone connection has been made and that the modem or data access arrangement is in the DATA mode (not VOICE or TALK). An output from the modem.
7	AB	Signal Ground	This lead establishes the common ground reference potential for all circuits except protective ground.
8	CF	Data Carrier Detector	This lead provides an indicator that data carrier signals from the remote station are being received. An output from the modem.
15		Transmitter Signal Clock	Signals on this circuit are used to provide the 4310 terminal equipment with signal element timing information. An output from the modem.
17	DD	Receiver Signal Clock	Signals on this circuit are used to provide the 4310 terminal equipment with signal element timing information. An output from the modem.
20	CD	Data Terminal Ready	Signal on this lead indicates that 4310 terminal equipment is ready to receive ring indicator signal. Modem input.
22	CE	Ring Indicator	Signal on this lead indicates modem location has been called. Modem input.
23	CH	Data Signal Rate Selector	Signals on this circuit are used to select between the two data signaling rates. An "on" condition indicates that the 4310 is in the 1200 bps position. An input to the modem.
25	- - -	- - - - - - - - -	Special use for 4310 terminal equipment testing.

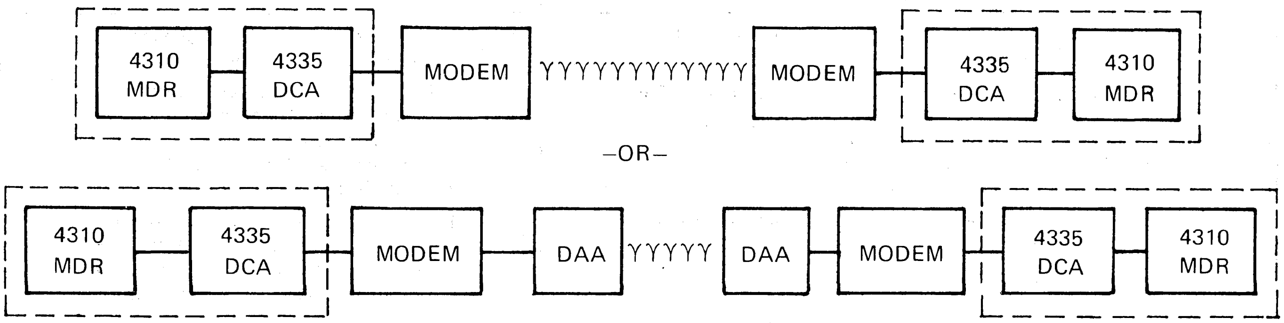


Figure 7-1. Series 4310 Units, Modems, and DAA

Within a particular class of common carrier communications facilities, a number of different types of service can be obtained. The three general types of service include:

1. Leased Service: provides the user with exclusive use of a communications line. In general, service is provided on a 24-hour-a-day, 7-day-a-week basis and billed at a flat monthly rate.
2. Public Switched Service: provides the user with access to a communications network. Access to this network is available to the general public. In general, charges are based on usage.
3. Multistation Leased Systems: provides the user with a private communications network accessible only by stations installed by that user. The majority of the multistation leased systems offered are for narrow-band communications networks.

NOTE: In analyzing the costs involved for a particular situation, consideration should be given to the fact that the cost of line time can be more expensive than the actual send/receive hardware involved.

7.2.5.1 Public Switched Telephone Network

The public switched telephone network, which is operated by companies of the Bell System and by independent telephone companies, is available for the transmission of digital data, currently at practical rates of up to 3,600 bits per second. In the Bell System this type of service is called Data-Phone Service. Many of the independent telephone companies provide similar services and often use Bell System components.

The primary advantage offered by the public telephone network for data communications is the ease with which a widespread data communications network can be implemented. Virtually every area of the United States is served by the Bell System or an independent telephone company with connections to the Bell System, and hence is a potential location for a data communications terminal. Another advantage of the public telephone system is the multiple paths which are usually available between any two points; a line malfunction usually results in the loss of only the time required to re-initiate the call.

All features available with normal telephone service are usable with data communications, among them:

DDD	(Direct Distance Dialing)
WATS	(Wide Area Telephone Service)
PBX	(Private Branch Exchange) services
FX	(Foreign Exchange) service

NOTE: It is advisable not to conduct data communications on a line running through a switchboard. The switchboard usually adds line noise to the transmission and there is always the possibility of an accidental disconnect.

7.2.5.2 Private and Leased-Line Operation

Those characteristics of private and leased-line services that affect operation of a Series 4310 data communications system are listed below:

- The baud rate (speed of data transfer) can be increased considerably (600 to 9600 baud).

- Four-wire service, which increases throughput rates (see Section 7.6), is only available on leased-lines. Four-wire service provides a pair of dedicated lines in each direction (send or receive).

NOTE: Full-duplex operation allows simultaneous transmission and reception. Although a Series 4310 unit can both transmit and receive, it cannot do both simultaneously. Therefore, even on 4-wire lines, Series 4310 data communications are a half-duplex operation. Throughput rates for Series 4310 units, however, are enhanced on four-wire lines; having dedicated lines in both the sending and receiving directions eliminates turnaround time delays.

- Multipoint configurations (see Section 7.5.4) are possible.
- Data access arrangements are not needed.
- Handsets and dialing capabilities are not always necessary. (Where handsets are not used, placing the terminal ONLINE begins the operation.)

7.3 Data Codes

Recall that data may be recorded on 7-track tape in BCDIC, Honeywell-EL, or ICL codes and on 9-track tape in EBCDIC; all data within a Series 4310 unit is represented in the Series 4310's internal machine language (MDRS), and data communications over telephone lines proceed in either the EBCDIC or USASCII language. There is no incompatibility between these different codes, however, since the codes are automatically translated by the sending and receiving units. For example: Consider a Series 4310 unit in San Francisco that wishes to transmit data over the telephone lines to another Series 4310 unit in New York. Assume that data on tape at the San Francisco unit is recorded in the Honeywell language, the unit in New York City records data on its tape unit in the ICL language, and both units are equipped to perform data communications in EBCDIC. The data codes are translated as follows:

1. The tape unit of the San Francisco terminal translates its data from Honeywell into MDRS as data is read off tape into the Series 4310's buffer memory.
2. The Model 4335 data communications adapter in the San Francisco terminal translates the data from MDRS to EBCDIC as the data is transferred from buffer memory to the telephone network.
3. The New York City terminal's Model 4335 data communications adapter translates the data coming in over the phone lines from EBCDIC back into MDRS.
4. The tape unit of the New York City terminal translates the data from MDRS into ICL as it is recorded on tape.

Although four different codes were used in the transfer of data, at no point were the codes incompatible with each other. It should be noted, however, that if the New York terminal had been equipped to perform data communications in USASCII instead of EBCDIC, the operation would not have been successful. Terminals that are to communicate in a data communications network must all be capable of sending and receiving data in the same language — all EBCDIC or all USASCII. The choice of languages is made when the Model 4335 data communications adapter is acquired.

Whenever data is read off tape it is translated from the tape language into MDRS by the tape adapter. Conversely, data that is to be written on tape is translated from MDRS into the appropriate tape language. Tables 2-8, 2-9, and 2-10 of Section 2.5.2 list the internal machine language with the corresponding tape languages: EBCDIC, BCDIC, Honeywell-EL, and ICL.

Before transmitting data via a communications network, the data must be translated from MDRS into one of the data communication languages, EBCDIC or USASCII. Table 7-4 lists the conversions (from MDRS to EBCDIC and USASCII) that take place in the data communications adapter of a Series 4310 transmitting terminal.

As data is received from the telephone network, it must be translated from EBCDIC or USASCII back into MDRS. EBCDIC and USASCII are 8-bit and 7-bit respectively, while MDRS is only a 6-bit code. Consequently, more code combinations are possible with the data communications languages (i.e., larger character sets) than with the internal machine language; 256 possible codes with EBCDIC and 128 possible codes with USASCII compared to only 63 possible codes with MDRS. Every character that is received, however, must be converted to one of the MDRS characters. As a result, a single MDRS code may be generated by more than one EBCDIC or USASCII code (e.g., reception of either an A or an a in USASCII results in the MDRS code for A). Tables 7-5 and 7-6 list the data code conversions (from EBCDIC and USASCII to MDRS) that take place in the data communications adapter of a Series 4310 receiving terminal.

A complete listing of the EBCDIC and USASCII languages (including control codes) is given in Appendix C.

Table 7-4. Data Conversions During Transmission — MDRS to USASCII or EBCDIC

Internal Machine Language (MDRS)		Data Communications				Line Printer
		USASCII		EBCDIC		
Char.	Bus Lines 0 1 2 3 4 5	Char.	Code 7 6 5 4 3 2 1	Char.	0 1 2 3 4 5 6 7	Char.
Space	0 0 0 0 0 0	Space	0 1 0 0 0 0 0	Space	0 1 0 0 0 0 0 0	
A	0 0 0 0 0 1	A	1 0 0 0 0 0 1	A	1 1 0 0 0 0 0 1	A
B	0 0 0 0 1 0	B	1 0 0 0 0 1 0	B	1 1 0 0 0 0 1 0	B
C	0 0 0 0 1 1	C	1 0 0 0 0 1 1	C	1 1 0 0 0 0 1 1	C
D	0 0 0 1 0 0	D	1 0 0 0 1 0 0	D	1 1 0 0 0 1 0 0	D
E	0 0 0 1 0 1	E	1 0 0 0 1 0 1	E	1 1 0 0 0 1 0 1	E
F	0 0 0 1 1 0	F	1 0 0 0 1 1 0	F	1 1 0 0 0 1 1 0	F
G	0 0 0 1 1 1	G	1 0 0 0 1 1 1	G	1 1 0 0 0 1 1 1	G
H	0 0 1 0 0 0	H	1 0 0 1 0 0 0	H	1 1 0 0 1 0 0 0	H
I	0 0 1 0 0 1	I	1 0 0 1 0 0 1	I	1 1 0 0 1 0 0 1	I
¢	0 0 1 0 1 0	[	1 0 1 1 0 1 1	¢	0 1 0 0 1 0 1 0	[
.	0 0 1 0 1 1	.	0 1 0 1 1 1 0	.	0 1 0 0 1 0 1 1	.
<	0 0 1 1 0 0	<	0 1 1 1 1 0 0	<	0 1 0 0 1 1 0 0	<
(	0 0 1 1 0 1	(	0 1 0 1 0 0 0	(	0 1 0 0 1 1 0 1	(
+	0 0 1 1 1 0	+	0 1 0 1 0 1 1	+	0 1 0 0 1 1 1 0	+
|	0 0 1 1 1 1	|	0 1 0 0 0 0 1	|	0 1 0 0 1 1 1 1	]
&	0 1 0 0 0 0	&	0 1 0 1 0 0 1	&	0 1 0 1 0 0 0 0	&
J	0 1 0 0 0 1	J	1 0 0 1 0 1 0	J	1 1 0 1 0 0 0 1	J
K	0 1 0 0 1 0	K	1 0 0 1 0 1 1	K	1 1 0 1 0 0 1 0	K
L	0 1 0 0 1 1	L	1 0 0 1 1 0 0	L	1 1 0 1 0 0 1 1	L
M	0 1 0 1 0 0	M	1 0 0 1 1 0 1	M	1 1 0 1 0 1 0 0	M
N	0 1 0 1 0 1	N	1 0 0 1 1 1 0	N	1 1 0 1 0 1 0 1	N
O	0 1 0 1 1 0	O	1 0 0 1 1 1 1	O	1 1 0 1 0 1 1 0	O
P	0 1 0 1 1 1	P	1 0 1 0 0 0 0	P	1 1 0 1 0 1 1 1	P
Q	0 1 1 0 0 0	Q	1 0 1 0 0 0 1	Q	1 1 0 1 1 0 0 0	Q
R	0 1 1 0 0 1	R	1 0 1 0 0 1 0	R	1 1 0 1 1 0 0 1	R
!	0 1 1 0 1 0	}	1 1 1 1 1 0 1	}	1 1 0 1 0 0 0 0	!
$	0 1 1 0 1 1	$	0 1 0 0 1 0 0	$	0 1 0 1 1 0 1 1	$
*	0 1 1 1 0 0	*	0 1 0 1 0 1 0	*	0 1 0 1 1 1 0 0	*
)	0 1 1 1 0 1	)	0 1 0 1 0 0 1	)	0 1 0 1 1 1 0 1	)
;	0 1 1 1 1 0	;	0 1 1 1 0 1 1	;	0 1 0 1 1 1 1 0	;
¬	0 1 1 1 1 1	¬	1 0 1 1 1 1 0	¬	0 1 0 1 1 1 1 1	↑
082	1 0 0 0 0 0	\	1 0 1 1 1 0 0	082	1 1 1 0 0 0 0 0	\
/	1 0 0 0 0 1	/	0 1 0 1 1 1 1	/	0 1 1 0 0 0 0 1	/
S	1 0 0 0 1 0	S	1 0 1 0 0 1 1	S	1 1 1 0 0 0 1 0	S
T	1 0 0 0 1 1	T	1 0 1 0 1 0 0	T	1 1 1 0 0 0 1 1	T
U	1 0 0 1 0 0	U	1 0 1 0 1 0 1	U	1 1 1 0 0 1 0 0	U
V	1 0 0 1 0 1	V	1 0 1 0 1 1 0	V	1 1 1 0 0 1 0 1	V
W	1 0 0 1 1 0	W	1 0 1 0 1 1 1	W	1 1 1 0 0 1 1 0	W
X	1 0 0 1 1 1	X	1 0 1 1 0 0 0	X	1 1 1 0 0 1 1 1	X
Y	1 0 1 0 0 0	Y	1 0 1 1 0 0 1	Y	1 1 1 0 1 0 0 0	Y
Z	1 0 1 0 0 1	Z	1 0 1 1 0 1 0	Z	1 1 1 0 1 0 0 1	Z
-	1 0 1 0 1 0	-	0 1 0 1 1 0 1	-	0 1 1 0 0 0 0 0	-
,	1 0 1 0 1 1	,	0 1 0 1 1 0 0	,	0 1 1 0 1 0 1 1	,
%	1 0 1 1 0 0	%	0 1 0 0 1 0 1	%	0 1 1 0 1 1 0 0	%
_	1 0 1 1 0 1	_	1 0 1 1 1 1 1	_	0 1 1 0 1 1 0 1	_
>	1 0 1 1 1 0	>	0 1 1 1 1 1 0	>	0 1 1 0 1 1 1 0	>
?	1 0 1 1 1 1	?	0 1 1 1 1 1 1	?	0 1 1 0 1 1 1 1	?
0	1 1 0 0 0 0	0	0 1 1 0 0 0 0	0	1 1 1 1 0 0 0 0	0
1	1 1 0 0 0 1	1	0 1 1 0 0 0 1	1	1 1 1 1 0 0 0 1	1
2	1 1 0 0 1 0	2	0 1 1 0 0 1 0	2	1 1 1 1 0 0 1 0	2
3	1 1 0 0 1 1	3	0 1 1 0 0 1 1	3	1 1 1 1 0 0 1 1	3
4	1 1 0 1 0 0	4	0 1 1 0 1 0 0	4	1 1 1 1 0 1 0 0	4
5	1 1 0 1 0 1	5	0 1 1 0 1 0 1	5	1 1 1 1 0 1 0 1	5
6	1 1 0 1 1 0	6	0 1 1 0 1 1 0	6	1 1 1 1 0 1 1 0	6
7	1 1 0 1 1 1	7	0 1 1 0 1 1 1	7	1 1 1 1 0 1 1 1	7
8	1 1 1 0 0 0	8	0 1 1 1 0 0 0	8	1 1 1 1 1 0 0 0	8
9	1 1 1 0 0 1	9	0 1 1 1 0 0 1	9	1 1 1 1 1 0 0 1	9
:	1 1 1 0 1 0	:	0 1 1 1 0 1 0	:	0 1 1 1 1 0 1 0	:
#	1 1 1 0 1 1	#	0 1 0 0 0 1 1	#	0 1 1 1 1 0 1 1	#
@	1 1 1 1 0 0	@	1 0 0 0 0 0 0	@	0 1 1 1 1 1 0 0	@
'	1 1 1 1 0 1	'	0 1 0 0 1 1 1	'	0 1 1 1 1 1 0 1	'
=	1 1 1 1 1 0	=	0 1 1 1 1 0 1	=	0 1 1 1 1 1 1 0	=
"	1 1 1 1 1 1	"	0 1 0 0 0 1 0	"	0 1 1 1 1 1 1 1	"

Table 7-5. Data Conversions During Reception – EBCDIC to MDRS.

EBCDIC graphic	EBCDIC CODE (Hex)	MDRS/ Keyboard graphic	EBCDIC graphic	EBCDIC CODE (Hex)	MDRS/Keyboard graphic
Space	40	Space		80	Space
	41	Space	a	81	A
	42	Space	b	82	B
	43	Not acceptable	c	83	C
	44	Not acceptable	d	84	D
	45	Not acceptable	e	85	E
	46	Space	f	86	F
	47	Space	g	87	G
	48	H	h	88	H
	49	I	i	89	I
¢	4A	¢		8A	¢
.	4B	.		8B	.
<	4C	<		8C	<
(	4D	(		8D	(
+	4E	+		8E	+
|	4F	|		8F	|
&	50	&		90	! (negative zero)
	51	Space	j	91	J
	52	Space	k	92	K
	53	Space	l	93	L
	54	Space	m	94	M
	55	Space	n	95	N
	56	Not acceptable	o	96	O
	57	Not acceptable	p	97	P
	58	Q	q	98	Q
	59	R	r	99	R
!	5A	! (negative zero)		9A	! (negative zero)
$	5B	$		9B	$
*	5C	*		9C	*
)	5D	)		9D	)
;	5E	;		9E	;
¬	5F	¬		9F	¬
-	60	-		A0	0-8-2 (\)
/	61	/		A1	Space
	62	Space	s	A2	S
	63	Space	t	A3	T
	64	Space	u	A4	U
	65	Not acceptable	v	A5	V
	66	Not acceptable	w	A6	W
	67	Not acceptable	x	A7	X
	68	Y	y	A8	Y
	69	Z	z	A9	Z
	6A	Space		AA	Space
,	6B	,		AB	,
%	6C	%		AC	%
_	6D	_		AD	_
>	6E	>		AE	>
?	6F	?		AF	
	70	Not acceptable		B0	0
F1	71	Space		B1	1
F2	72	Space		B2	2
F3	73	Space		B3	3
F4	74	Space		B4	4
F5	75	Not acceptable		B5	5
F6	76	Space		B6	6
F7	77	Space		B7	7
F8	78	8		B8	8
	79	9		B9	9
:	7A	:		BA	:
#	7B	#		BB	#
@	7C	@		BC	@
'	7D	'		BD	'
=	7E	=			
"	7F	"			

Table 7-5. Data Conversions During Reception — EBCDIC to MDRS (Continued)

EBCDIC graphic	EBCDIC CODE (Hex)	MDRS/Keyboard graphic
/	BE	=
\	BF	"
A	C0	Space
B	C1	A
C	C2	B
D	C3	C
E	C4	D
F	C5	E
G	C6	F
H	C7	G
I	C8	H
	C9	I
	CA	¢
	CB	.
⑀	CC	<
	CD	(
⑂	CE	+
	CF	|
	D0	! (negative zero)
J	D1	J
K	D2	K
L	D3	L
M	D4	M
N	D5	N
O	D6	O
P	D7	P
Q	D8	Q
R	D9	R
	DA	! (negative zero)
	DB	$
	DC	*

EBCDIC graphic	EBCDIC CODE (Hex)	MDRS/Keyboard graphic
	DD	)
	DE	;
•	DF	¬
\	E0	0-8-2
	E1	Space
S	E2	S
T	E3	T
U	E4	U
V	E5	V
W	E6	W
X	E7	X
Y	E8	Y
Z	E9	Z
	EA	Space
	EB	,
⑁	EC	%
	ED	_
	EE	>
	EF	?
0	F0	0
1	F1	1
2	F2	2
3	F3	3
4	F4	4
5	F5	5
6	F6	6
7	F7	7
8	F8	8
9	F9	9
	FA	:
	FB	#
	FC	@
	FD	'
	FE	=
	FF	"

7.4 BSC (Binary Synchronous Communications)

Series 4310 units transmit and receive all information according to BSC specifications. Binary synchronous communications is a data-link control system that defines a standard control vocabulary and timing system as well as a standard sequence of operations for a given set of conditions. Use of the BSC rules allows compatible data communications with a wide range of computers and terminals.

In BSC operations, a standard terminology is used to describe data groupings. The basic terms are defined as follows:

character — one of 64 recordable data symbols used in a record, or a transmission control sequence that does not appear as data.

record — the basic unit of data input; a record is that unit of input data that can be contained in the buffer of a Series 4310 terminal; thus, it can consist of 20 to 200 characters.

block — a segment of data that is transmitted as a unit and that causes a line turnaround; a block is framed by appropriate transmission control characters. Series 4310 units transmit data a record at a time; therefore, in Series 4310 data communications, a record is equivalent to a block.

text (message) — a group of one or more blocks that represent an entity of data. A text is framed by appropriate transmission control characters. In Series 4310 equipment the text is equivalent to a file of records.

The following is a glossary of control character mnemonics which are commonly used in describing operations in binary synchronous communications:

TABLE 7-6. Data Conversions During Reception — USASCII to MDRS

USASCII graphic	USASCII CODE (Hex)	MDRS/Keyboard graphic
Space	20	Space
!	21	!
"	22	"
#	23	#
$	24	$
%	25	%
&	26	&
'	27	'
(	28	(
)	29	)
*	2A	*
+	2B	+
,	2C	.
—	2D	—
.	2E	.
/	2F	/
0	30	0
1	31	1
2	32	2
3	33	3
4	34	4
5	35	5
6	36	6
7	37	7
8	38	8
9	39	9
:	3A	:
;	3B	;
<	3C	<
=	3D	=
>	3E	>
?	3F	?
@	40	@
A	41	A
B	42	B
C	43	C
D	44	D
E	45	E
F	46	F
G	47	G
H	48	H
I	49	I
J	4A	J
K	4B	K
L	4C	L
M	4D	M
N	4E	N
O	4F	O
P	50	P
Q	51	Q
R	52	R
S	53	S
T	54	T
U	55	U
V	56	V
W	57	W
X	58	X
Y	59	Y
Z	5A	Z
[	5B	¢
\	5C	0-8-2 (\ )
]	5D	! (Negative zero)
¬	5E	¬
—	5F	—
	60	Space
a	61	A
b	62	B
c	63	C
d	64	D
e	65	E
f	66	F
g	67	G
h	68	H
i	69	I
j	6A	J
k	6B	K
l	6C	L
m	6D	M
n	6E	N
o	6F	O
p	70	P
q	71	Q
r	72	R
s	73	S
t	74	T
u	75	U
v	76	V
w	77	W
x	78	X
y	79	Y
z	7A	Z
{	7B	(
	7C	Space
}	7D	! (negative zero)
	7E	Space
DEL	7F	Space

ACK0
ACK1 Affirmative Acknowledgement — These replies, in the proper sequence, indicate that the previous block was received without error and that the receiving terminal is ready to accept the next block transmission. ACK0 is used to indicate that an EVEN number of blocks have been successfully received or as a positive response to either a selection (multipoint) or line bid (point-to-point) sequence. ACK1 is used to indicate that an ODD number of blocks have been successfully received.

BCC Block Check Character — The block check character is used to verify the error-free status of a data block transmission. The BCC is sent immediately following an ETB or ETX character. The BCC represents an LRC (longitudinal redundancy check) character when using USASCII, and two CRC (cyclic redundancy check) characters when using EBCDIC.

ENQ Enquiry — The ENQ character is used to bid for the line by the sending terminal when using a point-to-point connection. It is also used to ask for repeat transmission of a response and to indicate the end of a poll or selection sequence.

EOT End of Transmission — This character indicates the end of a message transmission which may contain one or more blocks. It causes a reset of all stations on the line. EOT is used as a response to a poll sequence when the polled station has nothing to transmit, or an abort signal to indicate a system malfunction or operational situation that precludes continuation of message transmission.

ETB End of Transmission Block — the ETB character indicates the end of a block of data which was started with STX.

ETX End of Text — The ETX character indicates the end of a block of data started with STX. The ETX differs from the ETB in that it is used with the very last record/block of a file being sent.

ITB End of Intermediate Transmission Block — There are no provisions in the 4310 series to either transmit or receive this character.

LPAD Leading Pad — A synchronization pattern (8 bits of alternating 1's and 0's) used to establish bit synchronization when the data set does not supply a timing signal.

NAK Negative Acknowledgement — NAK indicates that the previous block was received in error and that the receiver is ready to accept a retransmission of that block.

RVI Reverse Interrupt — The reception of an RVI indicates that the receiving terminal wishes to send data. RVI has the highest priority. A Series 4310 terminal will respond to an RVI but has no capability of generating it.

STX Start of Text — This character precedes a block of data characters.

SOH Start of Heading — A 4310 terminal responds to a SOH control character just as it does to STX, but the SOH character cannot be generated by a 4310 unit.

SYN Synchronous Idle — This character is used to establish and maintain character synchronization, and as a time fill in the absence of any data or control characters.

WACK Wait Before Transmit Positive Acknowledgement — WACK is sent to indicate that the receiving station is temporarily not ready to receive more blocks. A Series 4310 unit will respond to a WACK but has no capability of generating it.

TTD Temporary Text Delay — TTD is sent to indicate that the sending station is temporarily not ready to transmit more data blocks. A Series 4310 unit will respond to a TTD with a NAK signal, but cannot itself generate the TTD signal.

Table 7-7 lists BSC character interpretations in both the control phase and message transfer phase of a data communication operation. The USASCII and EBCDIC control sequences are also listed in the far right-hand column.

BSC also defines the sequence of operations for any given condition. For example, the initial sequence of BSC characters in a normal message transmission is shown in Figure 7-2.

Transmission control sequences are described (with examples) in Section 7.5, theory of operation.

7.5 Theory of Operation

A Series 4310 unit can either transmit or receive data in a data-communications operation. The flow of data within the Series 4310 unit is very similar to the data flow

Table 7-7. BSC Character Interpretations

Char.	Name	Control Phase	Message Transfer Phase	Code Sequences EBCDIC	Code Sequences USASCII
*ENQ	Enquiry	"Can you accept transmission (point-to-point)? Or: "Respond to your address (multipoint)."	Between blocks: "Please respond or repeat last response." Terminating a block: "Discard this block and respond with NAK acknowledgement."	ENQ	ENQ
*ACK0	Even affirmative acknowledgement	"I can accept transmission."	"Even block was received and validated."	DLE (Hex '70')	DLE 0
*ACK1	Odd affirmative acknowledgement	None	"Odd block was received and and validated."	DLE/	DLE 1
STX or SOH	Start of Text / Start of Heading	"Change to message-transfer state and start computing block check value." (Treats SOH as STX, normally sends only STX.)	"Start computing new block check value." (Treats SOH as STX, normally sends only STX.)	STX	STX
NAK	Negative acknowledgement	"I cannot accept transmission."	"Block check not validated; cannot accept transmission."	NAK	NAK
*TTD	Temporary Text Delay	"Transmission will begin presently. Respond with NAK and wait."	"Transmission will continue presently. Respond with NAK and wait."	STX ENQ	STX ENQ
*WACK	Wait Before Transmit	"Enquire again later and delay transmission until an affirmative acknowledgement is received."	"Enquire again later and delay further transmission until an affirmative acknowledgement is received and validated."	DLE,	DLE;
* ETB	End of Text Block	None	"Block check value follows, then turnaround and response. Another text block to follow."	ETB	ETB
*ETX	End of Text	None	"Block check value follows, then turnaround and response. This completes the text but it does not release the data link."	ETX	ETX
*RVI	Reverse Interrupt	None	"Affirmative acknowledgement." Also means that receiving station wants sender to relinguish the line.	DLE@	DLE<
EOT	End of Transmission	"Drop synchronization and return to Control state."	"Drop synchronization and return to Control phase. Not valid in text."	EOT	EOT
LPAD	Leading Pad	"Establish bit synchronization."	"Establish bit synchronization."	(Hex 'AA')	Alternating Bits (01010101)
TPAD	Trailing Pad	"Turnaround time."	"Turnaround time."	All ones (Hex 'FF')	All ones
SYN	Synchronous Idle	"Establish or assure character synchronization or time-fill."	"Establish or assure character synchronization or time-fill."	SYN	SYN

*Causes line turnaround.

during non-data communications operations. Data proceeds from tape to buffer to data communications adapter (or adapter to buffer to tape) as described below.

7.5.1 Sending Terminal

Once the message-transfer-state has been achieved, data is read off tape (a record at a time) and transferred to buffer memory through the tape adapter, which translates the data from its tape code (BCDIC, Honeywell, ICL, or EBCDIC) into the Series 4310's internal machine language (MDRS – see Section 2.5). From the buffer the data is transferred to the data communications adapter where the proper BSC format codes are inserted and the data is translated into telephone code sequences (USASCII or EBCDIC) and sent to the modem for transmission over the telephone network. The data communications adapter also generates parity bits and block check characters that will be checked by the receiving unit's adapter to assure the successful transmission of data.

When using the 7-bit USASCII code, a parity bit (8th bit) is generated for each character (odd parity). An 8-bit LRC (longitudinal redundancy check) character is also generated for each block of data. The LRC character is an 8-bit accumulation for the block using the polynominal $X^8 + 1$.

When using the 8-bit EBCDIC code, two 8-bit CRC (cyclic redundancy check) block check characters are generated for each data block. The two CRC characters are a 16-bit accumulation using the polynomial $X^{16} + X^{15} + X^2 + 1$.

The LRC or CRC characters are represented in the transmission sequence examples by the block check character (BCC); see Figure 7-2.

If the checking procedures detect an error, a negative-acknowledgement (NAK) is sent back to the transmitting station, which will then retransmit the data block. Persistent detection of the same error causes a continuing series of NAK's and re-trys for as many times as the retransmission feature allows (see Figure 7-16 of Section 7.5.3).

7.5.2 Receiving Terminal

Each record is received by the modem serially, bit by bit. The BSC format characters are stripped; they do not enter memory. Data from the modem is checked and translated from the transmission sequence to MDRS by the data communications adapter, and is then transferred to the Series 4310's buffer memory. From the buffer the data is sent to the tape unit and/or line printer. If data is to go to both tape and printer, it is output to the printer first, then recorded on tape.

If an error occurs on tape, the receiving terminal automatically backspaces, erases the data and attempts to rewrite the record as many times as is necessary or allowed; retransmission is not necessary since the data record is still in the buffer.

After all records in a file have been successfully received, the transmitting station sends an end-of-transmission (EOT) signal. The transmitting station will attempt to automatically disconnect the data link 20 or 48 seconds after the EOT is sent (automatic disconnect is an optional feature on most modems).

Disconnect (whether automatic or manual) can be accomplished by either the calling station (i.e., the station that made the phone call) or the called station. If the calling station disconnects first, the phone connection is immediately lost (it cannot be recovered), and the phone line at the called station goes dead in 15-20 seconds. If the called station disconnects first, the phone connection is not lost for approximately 15 seconds (during this time it can be recovered); after the 15 second interval, however, the phone lines at both called and calling stations go dead.

NOTE: If the calling station is using a data access arrangement (DAA), automatic disconnect is only possible with the CBS type; otherwise the link must be manually disconnected by hanging up the phone.

If an end of transmission (EOT) signal, not preceded by an STX (data) ETX sequence (or dummy block – see Section 7.5.3), is received or the receiving terminal attempts to disconnect, the message transfer is incomplete (error condition); an end of file mark (EOF) is written on tape and the operator is alerted to the error (see Figure 7-16 and 7-17). This same condition occurs if either station reaches the end-of-tape marker.

Data flow from the modem of the sending terminal to the receiving unit's modem is governed by BSC specifications. The sequence of operation depends on the configuration (i.e., point-to-point or multipoint) as well as the operating conditions. Various transmission sequences for a point-to-point configuration (a single Series 4310 unit communicating with another terminal or a computer) are discussed in Section 7.5.3) while Section 7.5.4 is concerned with a multipoint configuration (more than

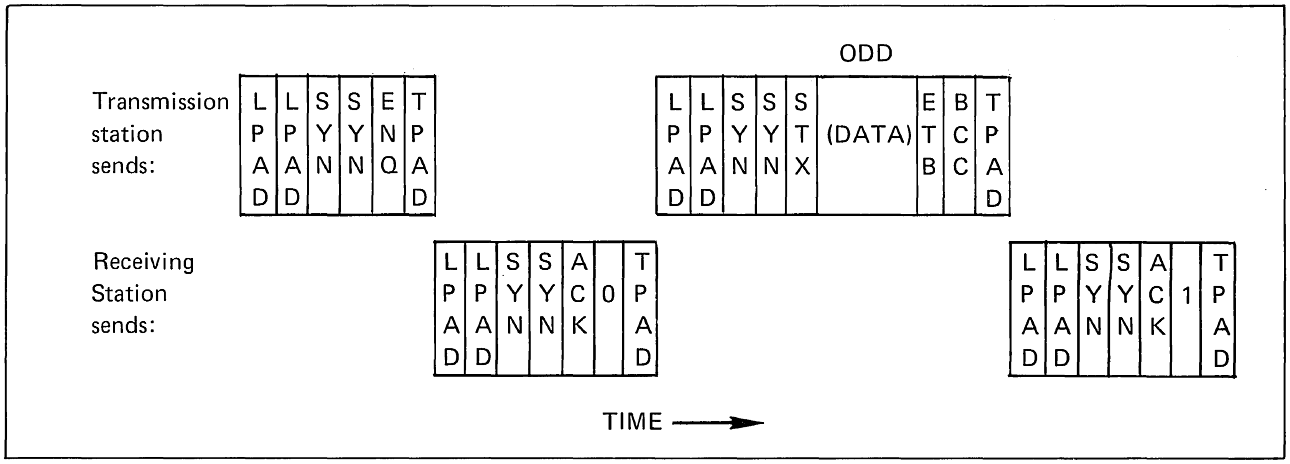


Figure 7-2. Example of BSC Sequence of Operations

one terminal communicating with a computer). In point-to-point communications, either station can initiate the transmission; in a multipoint operation, the computer must poll or select a terminal before transmission can begin.

NOTE: Section 7.5.3 includes examples of transmission sequences under various conditions. As a matter of convenience, transmission sequences are abbreviated in the examples. For instance:

ENQ represents: *

L	L	S	S	E	T
P	P	Y	Y	N	P
A	A	N	N	Q	A
D	D				D

STX (DATA) ETB represents:

*

L	L	S	S	S		E	B	T
P	P	Y	Y	T	(DATA)	T	C	P
A	A	N	N	X		B	C	A
D	D							D

ACK0 represents: *

L	L	S	S	A		T
P	P	Y	Y	C	0	P
A	A	N	N	K		A
D	D					D

ACK1 represents: *

L	L	S	S	A		T
P	P	Y	Y	C	1	P
A	A	N	K	K		A
D	D					D

*When the internal clock feature is present two additional LPAD signals are sent to establish bit synchronization.

EOT represents:

S	S	S	S	E	T
Y	Y	Y	Y	O	P
N	N	N	N	T	A
					D

7.5.3 Point-to-point Operations

A normal point-to-point operation consists of three phases:

1) Line-bid
2) Message transfer
3) Line-termination

During the line-bid phase, the transmitting station sends enquiry (ENQ) signals until the receiving station acknowledges (ACK0). Data blocks are transmitted and received during the message transfer phase; this phase usually ends when a data block containing an end of text (ETX) signal is acknowledged. The line termination phase usually begins when an end of transmission (EOT) signal is transmitted. During this phase the data link is disconnected; if automatic disconnect is present, the data link is terminated after a 20 or 48 second timeout.

Various transmission sequences are discussed below:

(A) Normal Message Transmission.

A normal message transmission begins with the transmitting terminal sending an ENQ signal. If the receiving unit acknowledges (ACK0), the transmitting station

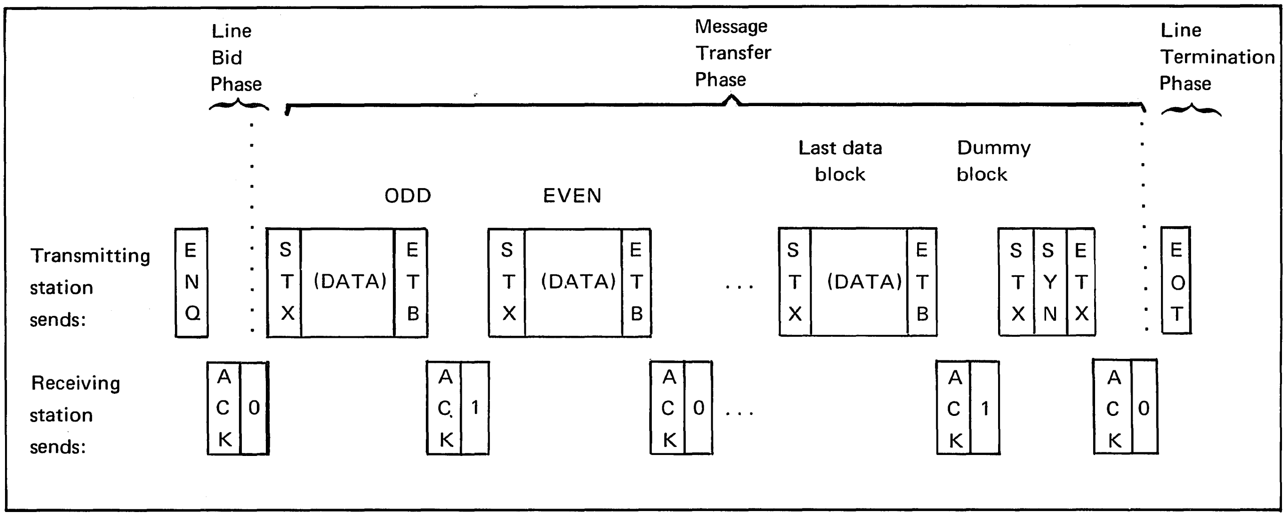


Figure 7-3. Normal Message Transmission (With Dummy Block)

begins sending data blocks with the receiving station acknowledging reception of both EVEN and ODD blocks (ACK0 for EVEN and ACK1 for ODD). Only data is recorded on tape (or sent to line printer); BSC characters are stripped out by the data communications adapter at the receiving unit.

Since a Series 4310 unit is a single buffer machine, it will not read the tape's EOF mark, signaling the last block of data, until after the last data block has been sent. An end of text signal (ETX), however, must be sent to inform the receiving station that the entire message has been transmitted. To achieve this, a Series 4310 unit will send a dummy block (STX SYN ETX) after sending the last data block. The dummy block contains no data and merely signals the end of a file (no record is written on tape at the receiving 4310 terminal). An EOT is sent after the dummy block to signal end of transmission and cause an end of file mark (EOT) to be written on tape. Automatic disconnect occurs 20 or 48 seconds after the EOT.

Figure 7-3 illustrates a normal message transmission sequence, including the dummy block.

(B) Contention of Master Status (Forcing Remote Sending Terminal to receive).

An unattended remote sending terminal can be forced to receive data on its line printer. The local terminal must also be conditioned as a sending terminal. When the data link is established, both units contend for master (transmitting) status by sending an ENQ followed by a 3-second timeout. If the local operator places the modem in DATA mode during the 3-second timeout, the terminal sends another ENQ, thus gaining master status; this ends the line bid phase. The remote station is automatically forced to receive data on its line printer. (If the line printer is not ONLINE, an error condition results and transmission is aborted.)

After the local terminal transmits its complete text, (the last block must contain an ETX signal) it sends an EOT and disconnects.

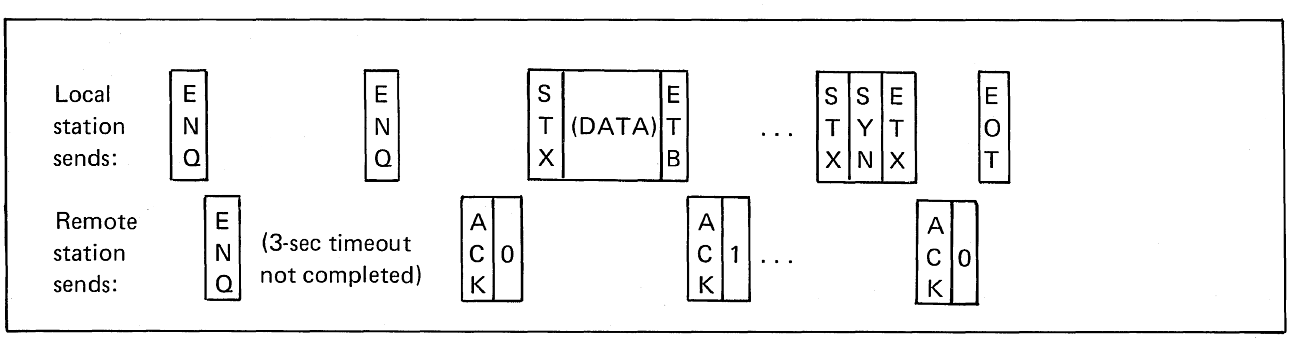


Figure 7-4. Contention for Master Status (Forcing Remote Sending Terminal to Receive)

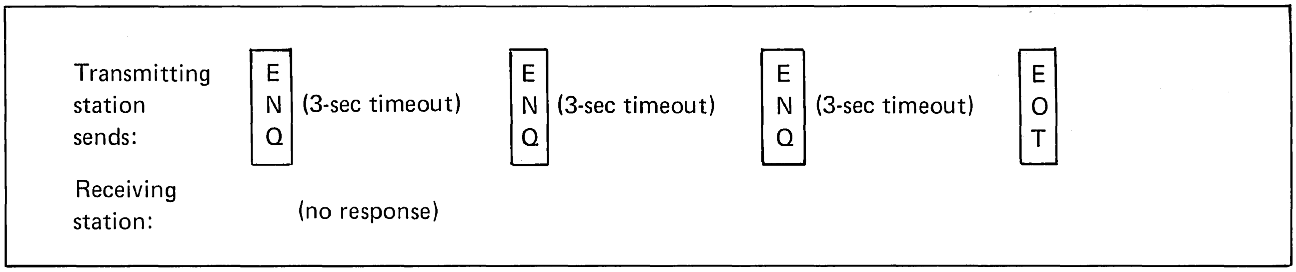


Figure 7-5. Unanswered Line Bid

Figure 7-4 illustrates the transmission sequence for this operation.

(C) Unanswered Line Bid.

If the receiving station does not respond, the transmitting station sends 3, 15 or an indefinite number of ENQ's (depending on retransmission feature) before automatically disconnecting. This is shown in Figure 7-5.

(D) Retransmission Accepted.

If a data block transmission is not successful, the sending terminal automatically retransmits the block a prescribed number of times (depending on which retransmission feature is selected). The receiving terminal responds with a NAK whenever a transmission error occurs (e.g., incorrect character parity is detected or wrong BCC character is received).

Figure 7-6 illustrates the acceptance of a retransmission.

(E) Retransmission Rejected

If the receiving station does not acknowledge successful transmission before the transmitting station (if it is a Series 4310 unit) retransmits the prescribed number of times (3 or 15), the transmitting station automatically backspaces one record and disconnects after the last retransmission. If at some later time communications are resumed, no data is lost since the sending terminal backspaced one record before disconnecting. Rejection after three retransmissions is shown in Figure 7-7.

(F) Terminal-to-Processor Retransmission Rejected (Indefinite Retransmission feature).

In general, it is the Series 4310 unit acting as the transmitting station that determines the number of retransmissions. However, if a Series 4310 unit with the indefinite retransmission feature is transmitting to a CPU, it is the computer that determines the number of retransmissions before disconnecting. The Series 4310 unit continues retransmitting until the CPU (actually the program within the CPU) decides to break the data link. This is illustrated in Figure 7-8.

(G) Processor-to-Terminal Retransmission Rejected.

Whenever a CPU is transmitting to a terminal, it is the CPU's program that determines the number of retransmissions before disconnecting; see Figure 7-9.

(H) Receiver-Initiated Transmission Delay.

If the receiving station is not ready to receive the next block of data (e.g., the receiving unit's buffer is not

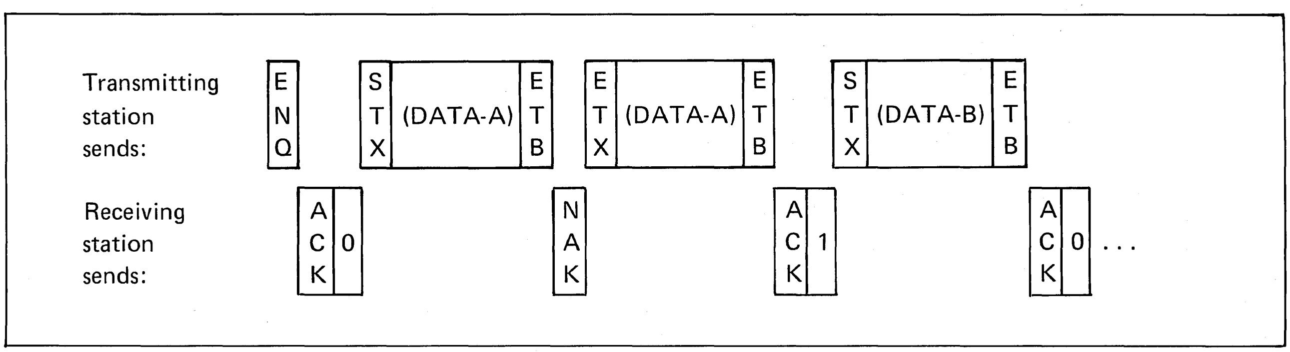


Figure 7-6 Retransmission Accepted

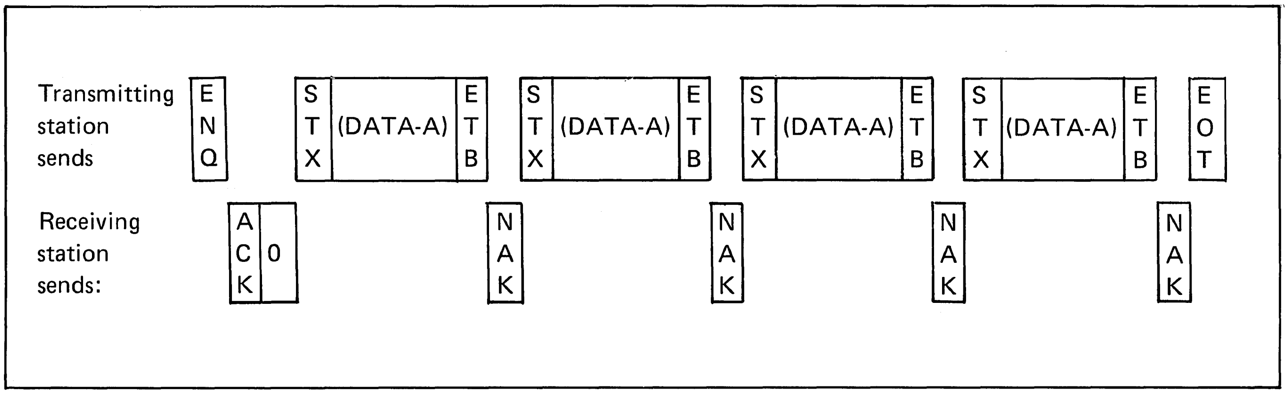


Figure 7-7 Retransmission Rejected (3 Retries)

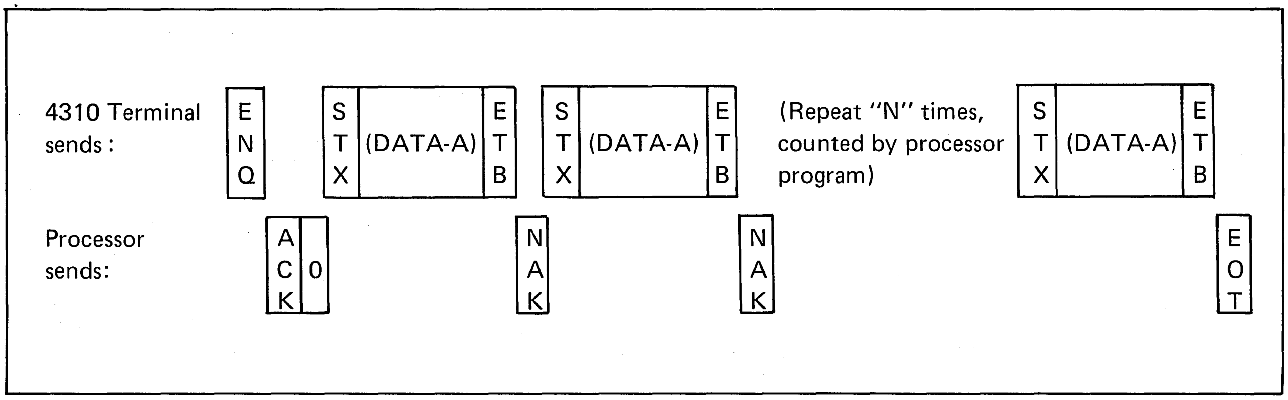


Figure 7-8 Terminal-to-Processor Retransmission Rejected (Indefinite Retransmission Feature)

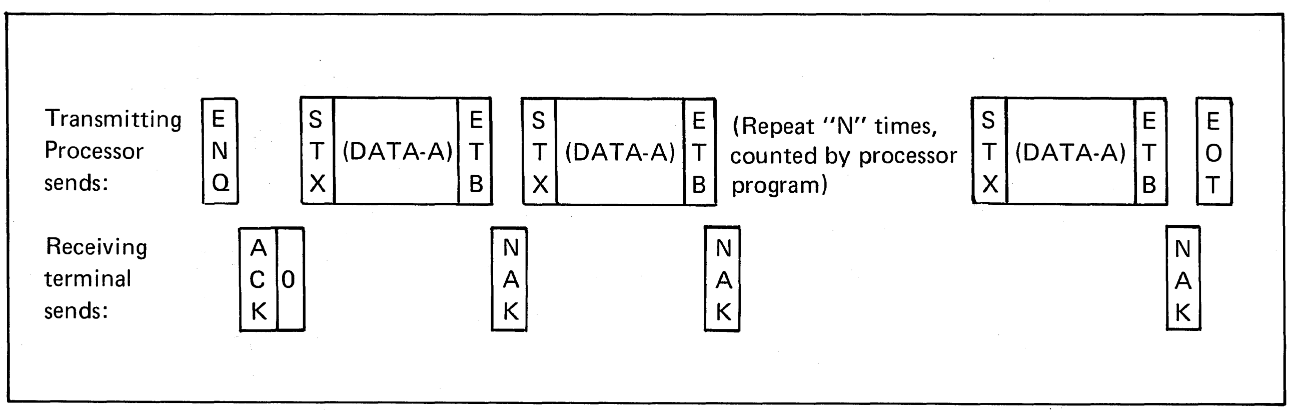


Figure 7-9 Processor-to-Terminal Retransmission Rejected

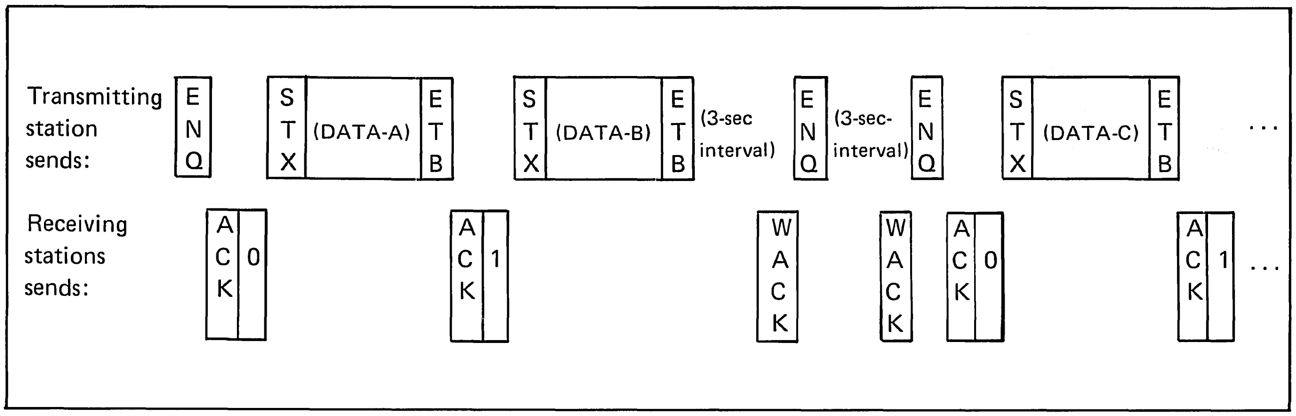


Figure 7-10 Receiver-Initiated Transmission Delay

clear), it responds with a wait-for-acknowledgement (WACK). The transmitting station continues to enquire (ENQ) until the receiver sends an acknowledgement (ACK). WACK-ENQ sequences are not counted by a Series 4310 unit. A Series 4310 unit responds to a WACK but has no capability for generating it. Figure 7-10 illustrates this type of transmission delay.

(I) Transmitter-Initiated Transmission Delay.

If the sending station is not ready to continue transmitting data, it sends continuous text-delay signals (TTD) until it is ready to resume transmission (a Series 4310 unit responds to a TTD but is not capable of generating it). This type of transmission delay is shown in Figure 7-11.

(J) STX Format Error, Data Ignored by Remote Tributary Station.

If the receiving station is not synchronized by the transmitting station, the data will not be received or acknowledged. This may occur if the transmitting station fails to send the STX sequence or if noise interference prevents reception of the synchronizing sequence. Whenever the receiving station fails to respond, the transmitting station continues to enquire until acknowledgement is made; see Figure 7-12.

(K) Response Not Matched to ODD/EVEN Block Count.

The first data block transmitted is considered an ODD block and is acknowledged by an ACK1; the second data block is considered an EVEN block and is acknowledged by an ACK0. This designation says nothing about the data block itself, but merely identifies the order in which it was transmitted.

If the receiving station acknowledges reception with the wrong signal (e.g., an ACK1 signal following an EVEN block), the transmitting station enquires (ENQ) until the correct acknowledgement is made or until the prescribed number of retransmissions have been completed.

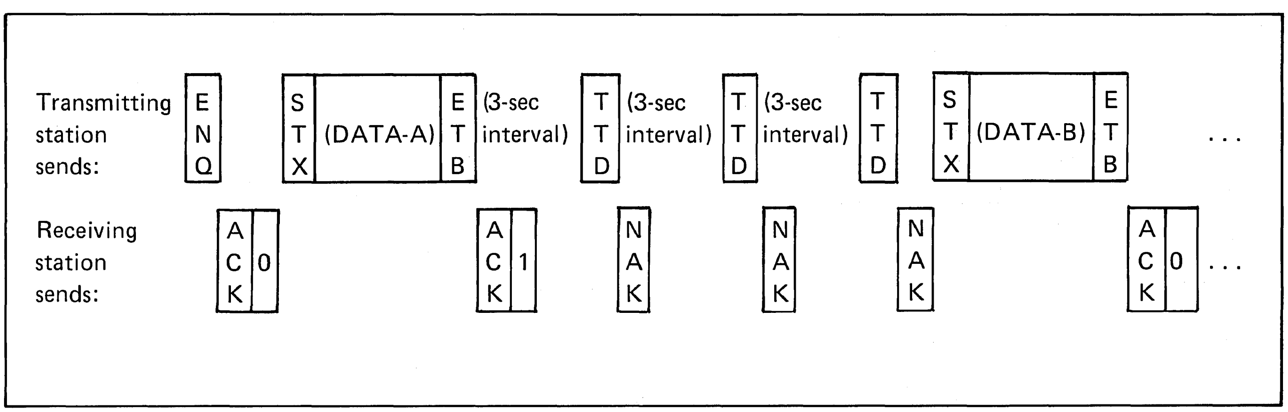


Figure 7-11 Transmitter-Initiated Transmission Delay

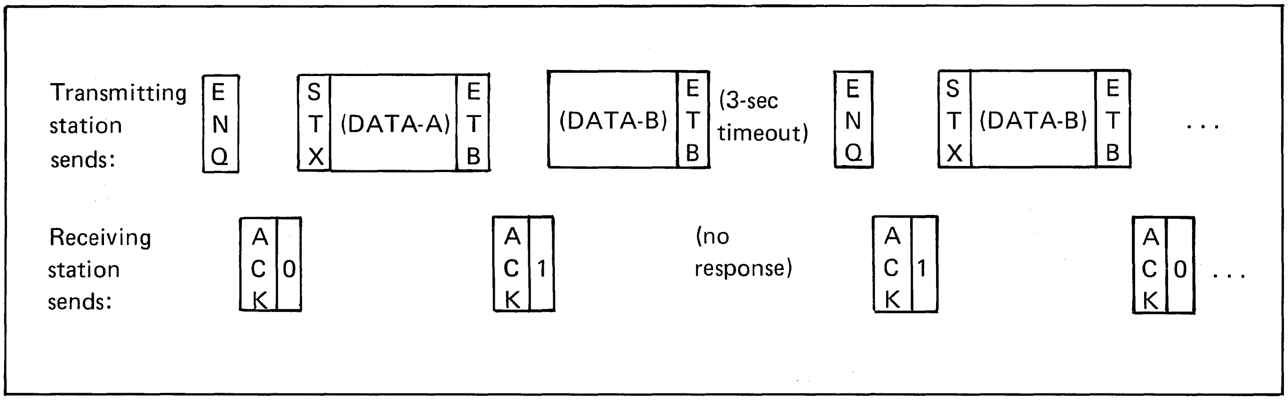


Figure 7-12. STX Format Error (Data Ignored by Remote Tributary Station)

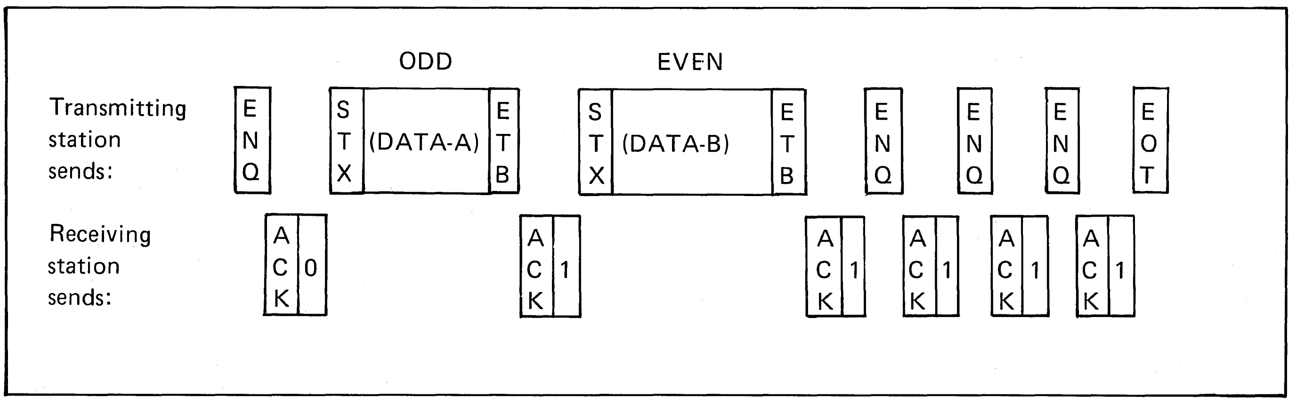


Figure 7-13. Response Not Matched To Odd/Even Block Count

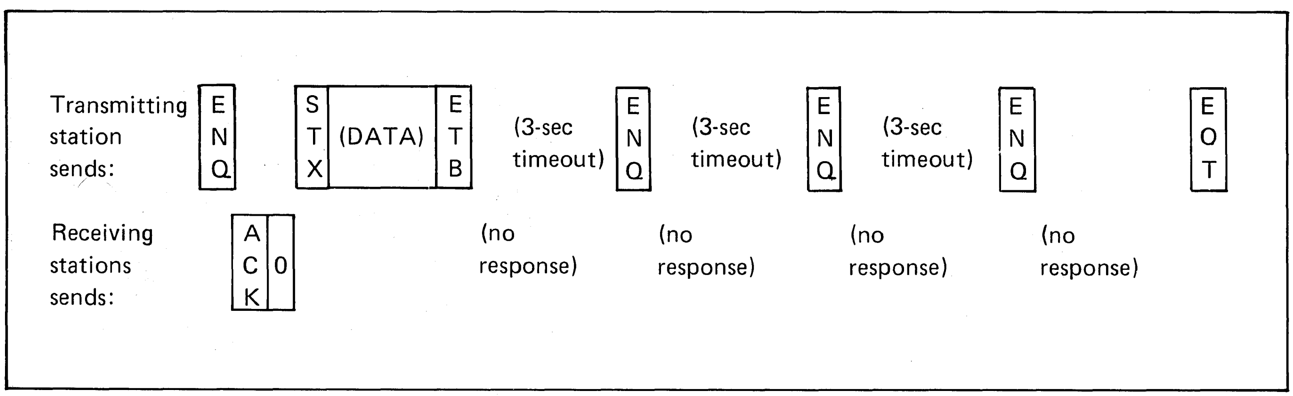


Figure 7-14. Data Link Aborted on No Response From Receiver

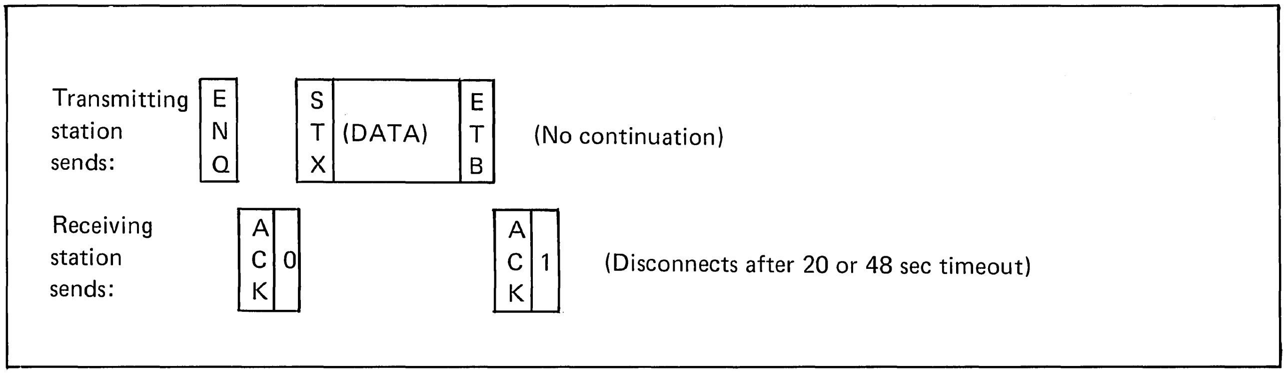


Figure 7-15. Data Link Stalemated By Transmitter Service

In Figure 7-13, the transmitting station enquires three times before disconnecting.

(L) Data Link Aborted on No Response from Receiver.

Whenever the receiving station fails to respond, the transmitting station begins a series of 3-second timeouts followed by ENQ's. This continues until the receiver responds or the prescribed number of retransmissions (3 or 15) is completed. This is illustrated in Figure 7-14.

(M) Data Link Stalemated by Transmitter Silence.

If the sending station fails to continue transmission (e.g., telephone line is down), the receiving station waits 20 or 48 seconds (depending on the retransmission feature) and then attempts to automatically disconnect. This is illustrated in Figure 7-15).

(N) Error Condition at a Series 4310 Unit serving as the Transmitting Terminal.

If an error condition develops at the sending terminal, the next transmission will not be successful and the receiving station will respond with a negative acknowledgement (NAK). The transmitting station uses the data still stored in its buffer and retransmits the block the prescribed number of times (3 or 15).

If the retries are not successful, the transmitting station sends an end of transmission signal (EOT) and disconnects. The sending station backspaces one record on tape, so that if the telephone call is reinitiated, no data is lost. The operator is alerted by an error indicator lamp. The EOT causes the receiving 4310 terminal to write an end-of-file mark (EOF) on its tape.

The transmission sequence (with three re-tries) is shown in Figure 7-16.

(O) Error Condition at a Series 4310 Unit serving as the Receiving Terminal.

If an error condition develops at the receiving station, it sends an end-of-transmission signal (EOT) and begins the time out to disconnect. The operator is alerted by an error indicator lamp. This is illustrated in Figure 7-17.

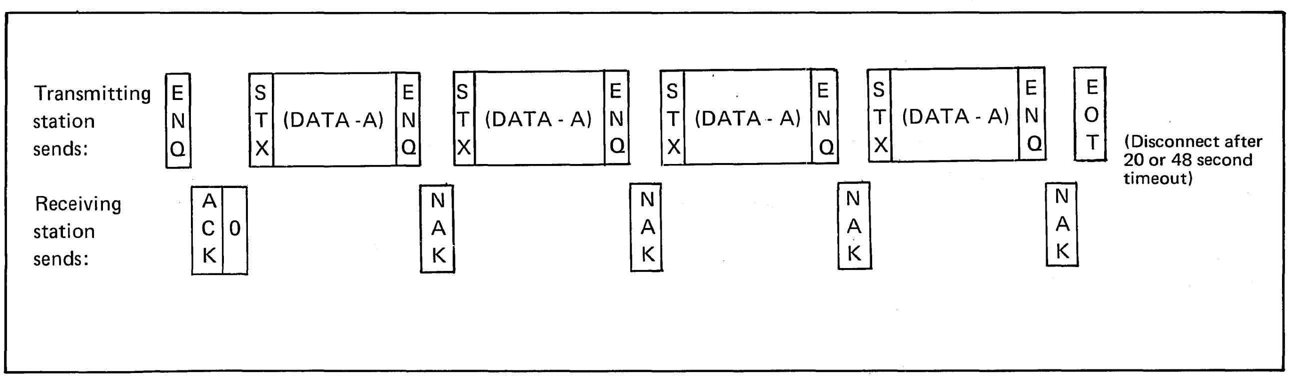


Figure 7-16. Error Condition At Transmitting Station

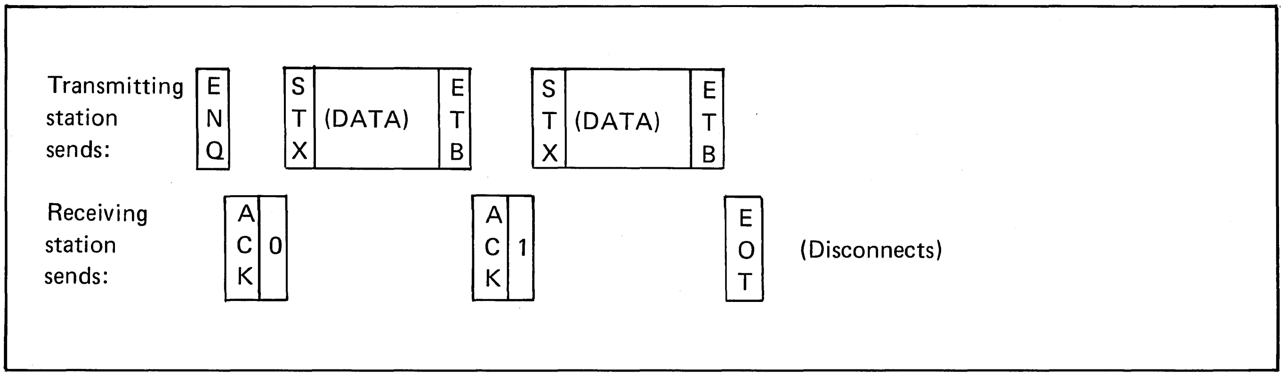


Figure 7-17. Error Condition At Receiving Station

7.5.4 Multipoint Operations

A Series 4310 unit is capable of engaging in multipoint communications (if properly equipped; see feature 7, Section 7.8). A multipoint operation involves a computer and two or more tributary terminals. The computer initiates all communications by "polling" or "selecting" a terminal. The terminals can only communicate with the computer; communication between terminals is not possible.

"Selecting" consists of:

1) Alerting a terminal that the computer wishes to transmit data.
2) Specifying which device (e.g., magnetic tape or line printer) the data will be received on.
3) Asking if the terminal is prepared to receive data.

Figure 7-18 shows the transmission sequence for selecting. ADR is the address code assigned to the tributary terminal (lower case as normally used to indicate selecting; however, with a Series 4310 terminal, upper or lower case may be used for either selecting or polling), and "DSC" is the device selection code (see Section 7.9.1). If the Series 4310 station is ready to receive data, it sends an acknowledgement sequence and the computer begins transmitting data (as shown in Figure 7-18). If the Series 4310 terminal is not prepared to receive (e.g., line printer not ONLINE), it sends a negative-acknowledgement sequence (LPAD LPAD SYN SYN NAK TPAD).

When the computer is prepared to receive data, it polls the terminals to see if any wish to transmit. Polling consists of:

1) Alerting a terminal that the computer is prepared to receive data.
2) Specifying which device the data will be sent from.
3) Asking if the terminal is prepared to send data.

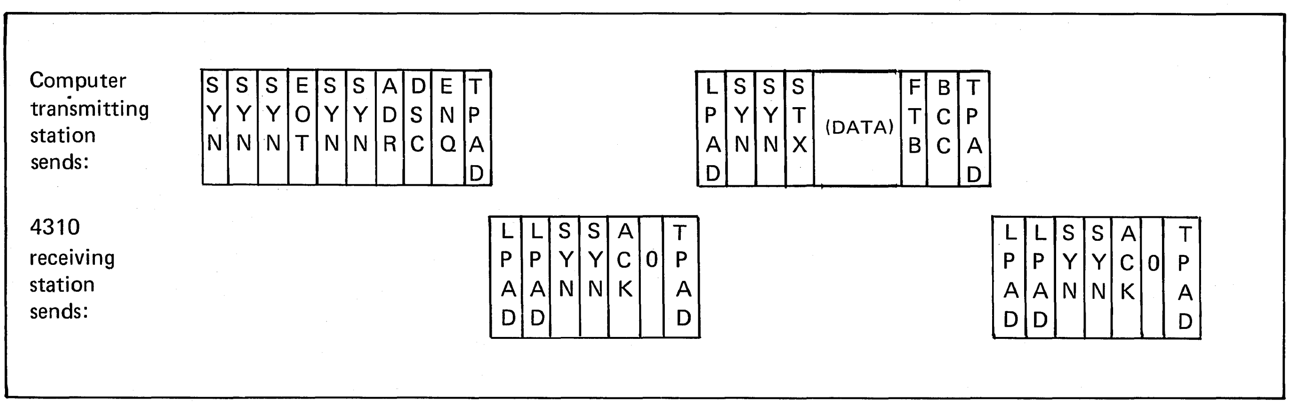


Figure 7-18. Selecting a Multipoint Operation

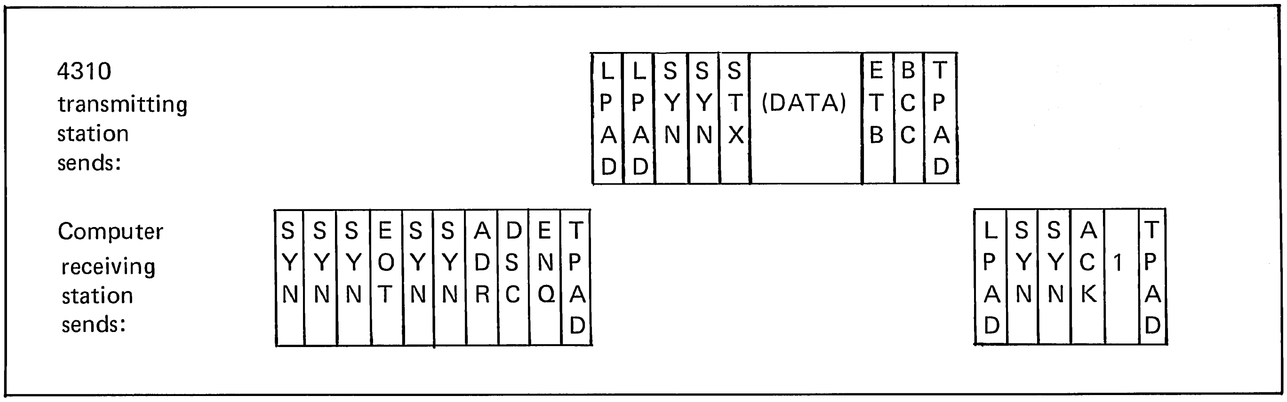


Figure 7-19. Polling in a Multipoint Operation

The transmission sequence for polling is shown in Figure 7-19. Again ADR is the address code assigned to the tributary terminal (see Section 7.8, features 2 and 3); the address code is normally upper case to indicate polling. DSC is the device selection code (see Section 7.9.1). The number of LPAD's sent by the computer may vary with the computer used. A Series 4310 terminal sends two LPAD's and at least two SYN's (two additional LPAD's are sent if the internal clock feature is present).
The Series 4310 terminal begins transmitting data after the computer's initial polling sequence. If the Series 4310 is not ready to transmit, it responds with an end-of-transmission sequence (LPAD LPAD SYN SYN EOT TPAD).

7.5.5 Multiple File Transmissions

Data transmission ordinarily halts when the sending station reaches an EOF (end-of-file) mark on tape. However, operator intervention at the sending station before telephone disconnect (within 20 or 48 seconds) can permit additional files to be sent without requiring a new

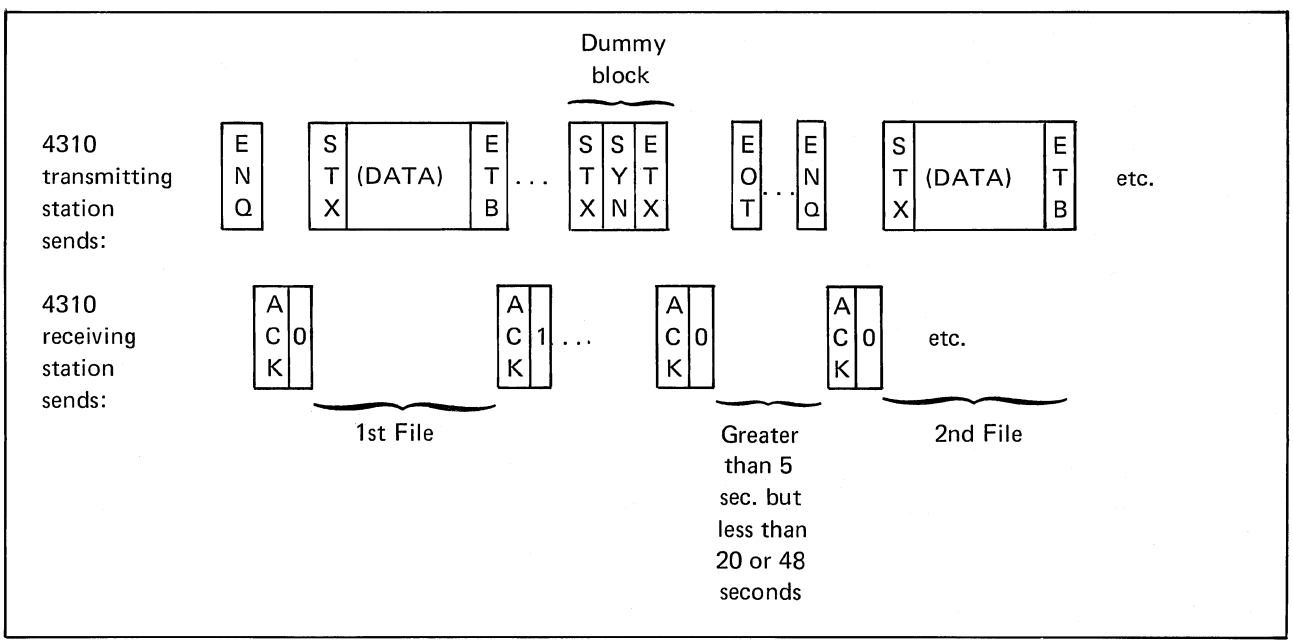


Figure 7-20. Multiple File Transmission

telephone call. The modem at the sending station must be capable of VOICE as well as DATA mode. No intervention is required at the receiving terminal. The transmission sequence is illustrated in Figure 7-20.

If the sending terminal is unattended, multiple files can be sent but the receiving terminal must allow telephone disconnect after each file transfer and re-initiate a call for each additional file.

7.5.6 Multiple-reel Communications

Two types of multiple-reel operations are possible:

1) The sending terminal operator can transmit data that occupies several reels of tape to the receiving terminal, where it is recorded on one large reel.
2) The sending unit operator can transmit data from one large reel of tape to the receiving unit, where it is recorded on several smaller reels. Multiple files on the sending unit's large reel of tape can be recorded at the receiving unit, a separate reel for each file.

These operations allow the operator to stop data transfer to change reels before the end-of-tape mark is encountered. In both cases, operator intervention is required before telephone disconnect (20 or 48 seconds after data transfer is halted).

7.6 Throughput Rates

This section is concerned with the factors that affect throughput in Series 4310 configurations in general rather than with throughput rates for specific configurations. This general approach is dictated by the great variety of configurations possible for the 4310 data communications series. With a sound understanding of the variables that influence throughput, the user can easily compute the throughput rate that applies to his particular configuration and ignore irrelevant considerations.

The first question to answer when considering throughput rate is "What is the best unit of measurement?"

For data communications, the answer could be: bits per second, characters per second, records per second, or for stations that include the line printer output, lines per minute. This last measurement, lines per minute, depends on the number of lines there are in each record.

For convenience, the following examples will deal in records per second and characters per second.

In the typical 4310 data communications environment, there are five categories of throughput variables:

1) Modem Speed — this is determined by the modem's data transfer speed.
2) Record Lenth — in 4310 data communications, record length can vary up to 200 characters.
3) Turnaround Time — this is the time it takes for half-duplex sending equipment (modem) to become receiving equipment. The time is significant when transmission is over two-wire communications facilities, but can be ignored when transmission is conducted over reverse channel or four-wire communications facilities.
4. Read Time — this is the time it takes the sending terminal to read the record about to be sent. When transmission is over two-wire facilities, the read time is usually less than the turnaround time, in which case it can be ignored when computing throughput rates.
5) Receiver's Data Handling Time — this is the time required by the receiving station to process the data it receives (write on its tape, output at line printer).

7.6.1 Typical Two-wire

Figure 7-21 illustrates the application of these throughput factors in a typical two-wire dial-up network.

In Figure 7-21, a complete transmission cycle begins when the local (sending) modem receives an acknowledgement signal from the remote (receiving) modem.

NOTE: Although the local modem receives signals from the remote modem at times, it is called a sending unit because it sends the data. The remote modem changes roles too, but is called a receiving unit in this example because it receives the data.

Since the acknowledgment signal indicates that the remote station will accept another transfer, the sending modem prepares to send more data; this preparation time is called the turnaround time (T_{TA}).

Before additional data can be transmitted, two operations must be completed:

1) The local modem must change from a receiving device (which it was in order to receive the acknowledgment) to a sending device.
2) The local terminal must read (RD) the data from the tape into its memory.

In two-wire transmissions, the turnaround time is usually greater than the read time; as a result, read time is not significant and does not appear in the throughput equation.

As soon as the sending modem is ready (after T_{TA}), it transmits the data that has been read into memory. The time it takes the modem to transfer the data from the memory to the telephone lines is the data transfer time (T_{DT}). The time it takes each data character to be transmitted between modems is the telephone propagation time (T_P).

When the data reaches the receiving modem, the modem prepares to send back another acknowledgement signal; the turnaround time for the receiving modem is also T_{TA}. Before the modem can transmit the acknowledgement signal, two operations must be completed:

1) The modem must turnaround.
2) The receiving terminal must complete the writing (WRT) and backspacing (BKSP) phases of the write tape operation.

NOTE: The write tape operation actually includes three phases: write (WRT), backspace (BKSP) and read-after-write (RD-AFTER-WRT).

The read-after-write phase is not shown, since it is not a factor in throughput. The WRT and BKSP phases of the write tape operation are referred to as the write operation.

In two-wire transmissions, the write time is usually less than the turnaround time; therefore, the write time is not significant and does not appear in the throughput equation.

The time required for the receiving modem to transmit an acknowledgement signal is T_{ACK} and, again, the telephone propagation time is T_P. When the sending modem receives the ACK signal, the transmission cycle is complete and a new one can begin.

The throughput rate equation that corresponds to the diagram shown in Figure 7-21 is:

$$T_{RECORD} = T_{DT} + 2T_{TA} + T_{ACK} + 2T_P$$

where: T_{DT} is the modem's data transfer rate

T_{TA} is the turnaround time

T_{ACK} is the receiver's acknowledgement response time

T_P is the telephone propagation time

Table 7-8 lists various throughput rates for 2-wire, half-duplex transmissions.

Figure 7-22 provides, in graph form, the effective transmission rates for dial-up or leased, two-wire communication between two terminals. The graph covers all possible record lengths.

NOTE: The 4800 BPS calculations in Table 7-8 and Figure 7-22 are based on the Paradyne Bi-Sync 48 Modem, which does not operate according to classic modem formulas.

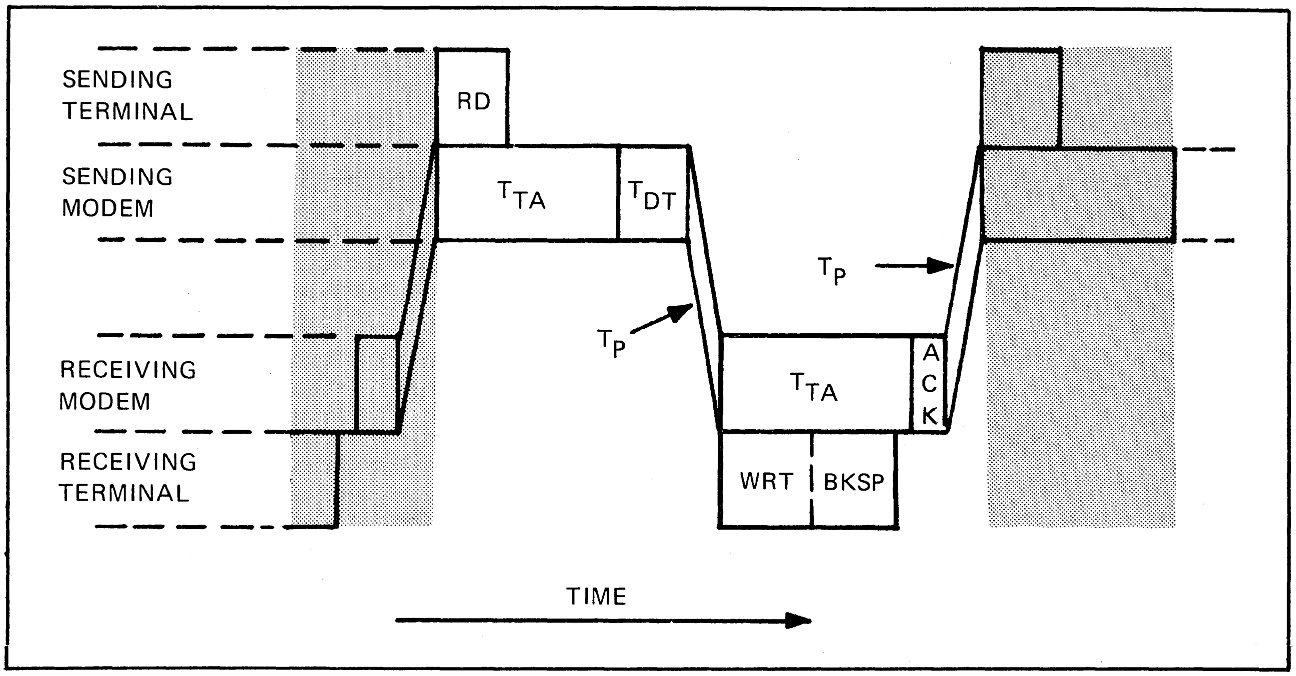


Figure 7-21. Sequential Diagram of Typical Data Communication on a Two-Wire Dial-Up Network

This graph illustrates the fact that, for transmission over two-wire facilities, the modem speed is the major factor in throughput. The effective transmission rate does not depend on which Series 4310 unit is used when communication is over a two-wire line.

7.6.2 Two-Wire with Printer

In the previous example, turnaround time was significant while the processing times (read and write) were not. If at the receiving terminal, however, each record is output to a line printer and printed as multiple lines this may not be the case. Acknowledgement from the receiving terminal must wait until processing is nearly completed, so that there will be no interference in attempts to receive new data before completion of processing for current data. If processing time at the receiving terminal is greater than 2 T_{TA}, it will be significant in the throughput equation. Figure 7-23 illustrates such a case.

The throughput rate equation that applies to Figure 7-23 is:

$$T_{RECORD} = T_{DT} + 2T_P = T_{ACK} + T_{TA} + T_{WRITE}$$

$$T_{PRINT}$$

where T_{DT} is the modem's transfer rate

T_P is the telephone propagation time

T_{ACK} is the receiver's acknowledgement response time

T_{WRITE} is the time to write the data on tape and back-space

T_{PRINT} is the time required to process the data to the line printer (see Section 6.3.1).

Table 7-8. 2-Wire Half-Duplex Transmission Throughput Rates

BPS (bits per second) Rate	Record Length	T_{DT} (MS)	$2T_P$ (MS)	$2T_{TA}$ (MS)	T_{ack} (MS)	T_{record} (MS)	Char/Sec	Rec/Min
600	20	400	40	400	120	960	20.8	62.4
	40	667	40	400	120	1227	32.6	48.9
	80	1200	40	400	120	1760	45.5	34.1
	120	1730	40	400	120	2290	52.4	26.2
	160	2260	40	400	120	2820	56.7	21.2
	200	2800	40	400	120	3360	59.5	17.8
1200	20	200	40	400	60	700	28.6	85.8
	40	333	40	400	60	833	48.0	72.0
	80	600	40	400	60	1100	72.7	54.5
	120	865	40	400	60	1365	87.9	43.9
	160	1130	40	400	60	1630	98.2	25.5
	200	1400	40	400	60	1900	105.3	31.6
2000	20	116	40	300	28	484	41.3	123.9
	40	196	40	300	28	564	70.9	106.7
	80	365	40	300	28	724	110.4	81.5
	120	516	40	300	28	884	135.6	67.8
	160	676	40	300	28	1044	153.2	57.4
	200	836	40	300	28	1204	166.1	49.8
2400	20	97	40	300	23	460	43.5	130.5
	40	163	40	300	23	526	76.0	114.0
	80	296	40	300	23	659	121.4	91.0
	120	430	40	300	23	793	151.3	75.6
	160	562	40	300	23	925	172.9	64.8
	200	696	40	300	23	1059	188.9	56.6
4800 (4311 to 4311)	20					295	67	204
	40					358	111	167.8
	80	N/A	N/A	N/A	N/A	438	183	137
	132					610	225	98
	200					770	260	78
4800 (4314 to 4314)	20					133	150	450
	40					192	210	312
	80	N/A	N/A	N/A	N/A	265	303	227
	132					424	311	141
	200					570	352	105

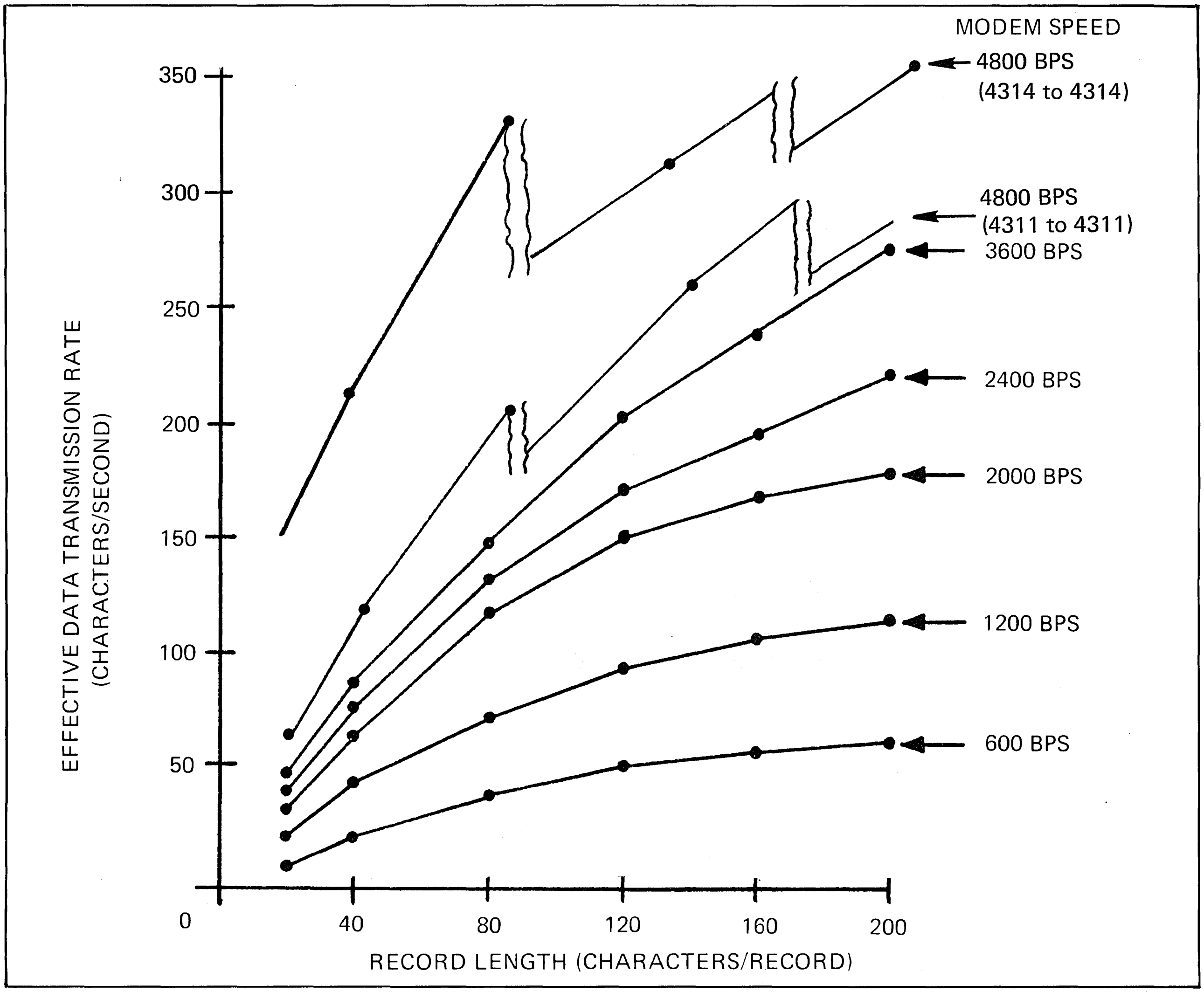


Figure 7-22. Graph of Effective Data Transmission Rates for 2-Wire Communications Over Dial-Up or Leased Lines 4310/CPU-to-4310/CPU (Tape-to-Tape) Operation

7.6.3 Typical Four-Wire

Figure 7-24 illustrates the application of the basic throughput factors in a tape-to-tape data communication over a four-wire, leased line network.

The throughput rate equation that applies to Figure 7-24 is:

$$T_{RECORD} = T_{DT} + T_{READ} + T_{WRITE} + T_{ACK} + 2T_P$$

where T_{READ} is the time it takes the sending terminal to read the record about to be transmitted

T_{WRITE} is the time it takes the receiving terminal to write the record and backspace

The line turnaround time in 4-wire, half-duplex operation is usually under 8 milliseconds. Consequently, the read and write times, which always exceed 16 milliseconds, are significant in the throughput calculations while T_{TA} is not.

Table 7-9 lists the various throughput rates for 4-wire half-duplex transmissions.

Table 7-10 lists the T_{READ} and T_{WRITE} speeds for the various models in the 4310 series. These speeds are further categorized by numer of tracks, character density and record size. Since this table does not include all possible record sizes, the tape-read and tape-write values for those record lengths not listed must be extrapolated.

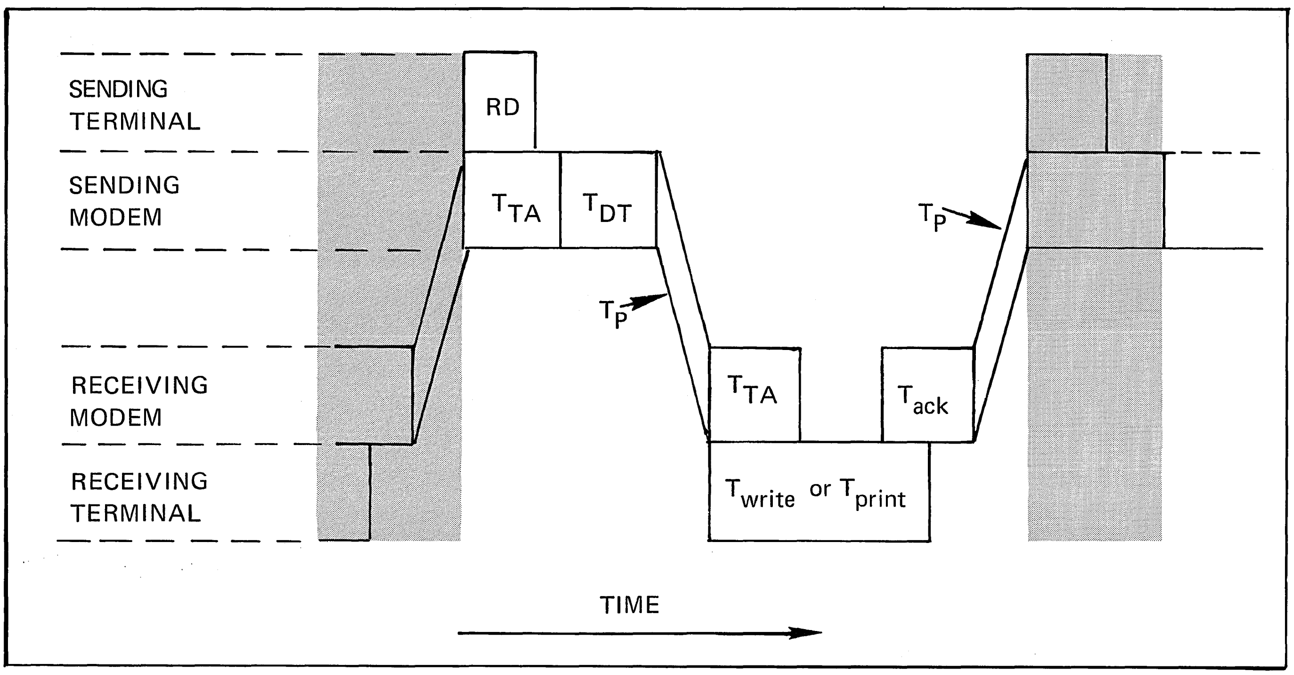


Figure 7-23. Sequences for 2-Wire Half-Duplex Operation When Process Time Exceeds 2 T_{TA}

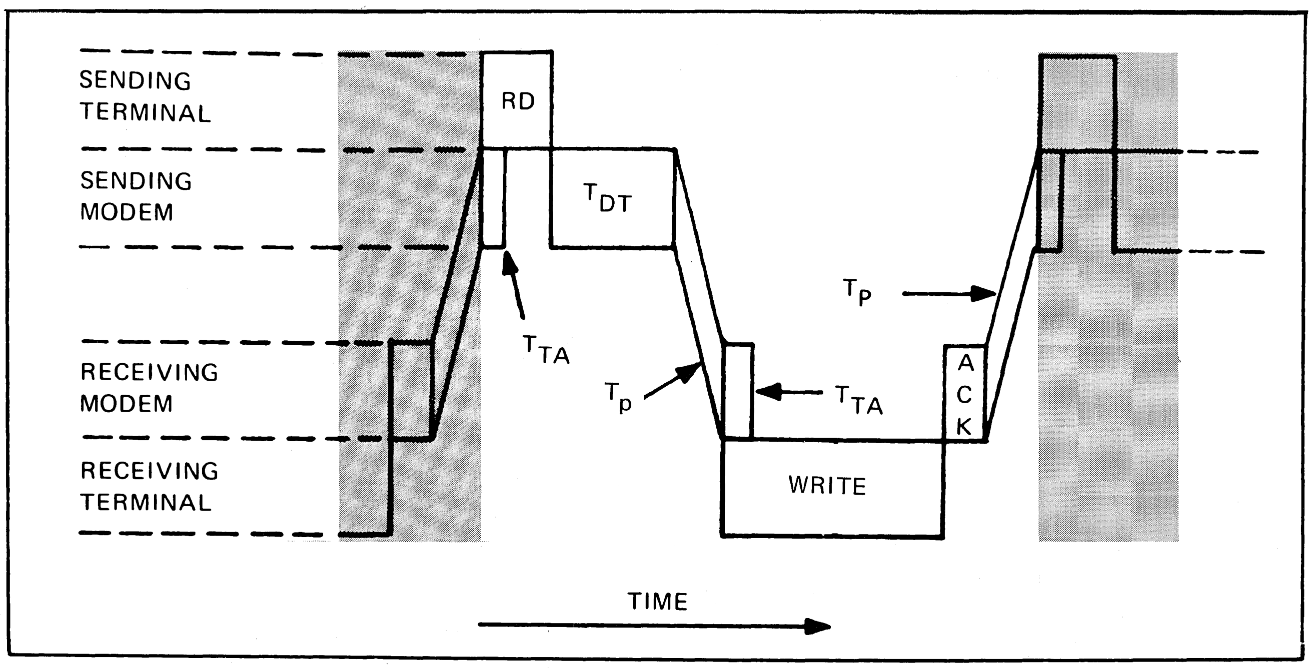


Figure 7-24. Sequential Diagram of Typical Tape-to-Tape Data Communication with 4-Wire Leased Line Network

Table 7-9. 4-Wire Half-Duplex Transmission Throughput Rates

Record Length	4314-4314 (Poolers)				4311-4311 (Recorders)			
	2400 BPS		4800 BPS		2400 BPS		4800BPS	
	C/S*	R/M*	C/S	R/M	C/S	R/M	C/S	R/M
40	134	201	185	277.5	85	127.5	106	159
80	184	138	288	216	129	96.7	175	131.2
120	209	104.5	333	166.5	157	78.5	233	116.5
160	224	84	381	155.3	178	66.7	262	98.2
200	234	70.2	407	122	192	57.6	289	86.7

* C/S is characters per second; R/M is records per minute.

Figure 7-25 identifies the effective data transmission rates between two terminals over leased, four-wire communication networks. All possible record lengths are represented.

This graph illustrates the fact that when communication is over a four-wire line, the read/write speeds, which are different for each Series 4310 unit (see Table 7-10) are major factors in throughput considerations.

7.7 Editing

Various editing features of the Series 4310 magnetic data recorders can be useful during data communications operations:

- File Edit — data can be automatically changed in every record of a file.
- End Stripping — causes all records sent or received to be terminated at a point prior to the original end of a record.
- Internal Stripping — strips out selected characters from every record of a file.
- Internal Insert — inserts selected characters into every record of a file.

7.7.1 File Edit

File edit permits data to be automatically changed in every record of a file during a data communications transmission operation. This is accomplished by entering special control field characters into data memory positions corresponding to dup fields in the program memory. When a file is transmitted, the special control field characters are automatically inserted in place of existing data in every record. This feature is useful, for example, in correcting an error duplicated in every record on the source tape. File edit is illustrated in Figure 7-26.

Table 7-10. Times (in Milliseconds) to Read and Write One Record

Model	Record Length	7-Track 200 CPI Read	7-Track 200 CPI Write	7-Track 556 CPI Read	7-Track 556 CPI Write	7-Track 800 CPI Read	7-Track 800 CPI Write	9-Track 800 CPI Read	9-Track 800 CPI Write	9-Track 1600 CPI Read	9-Track 1600 CPI Write
4311	20	120.8	293.2	115.02	274.75	115.6	272.8	90.8	237.6		
	40	128.8	327.2	117.90	283.39	117.6	278.8	92.8	243.6		
	80	114.8	365.2	123.65	300.65	121.6	290.8	96.8	255.6		
	120	160.8	413.2	129.41	317.92	125.6	302.8	100.8	267.6		
	160	176.8	461.2	135.16	335.18	129.6	314.8	104.8	279.6		
	200	192.8	509.2	140.92	352.45	133.6	326.8	108.8	291.6		
4314	20	37.75	91.62	35.94	85.86	36.12	85.25	28.38	74.25	29.5	78.2
	40	40.25	99.23	36.84	88.56	36.75	87.12	29.00	76.12	29.8	79.2
	80	45.25	114.12	38.64	93.95	38.00	90.88	30.25	79.88	30.5	81.2
	120	50.25	129.12	40.44	99.35	39.25	94.62	31.50	83.62	31.2	83.2
	160	55.25	144.12	42.24	104.74	40.50	98.38	32.75	87.38	31.8	85.2
	200	60.25	159.12	44.04	110.14	41.75	102.12	34.00	91.12	32.5	87.2

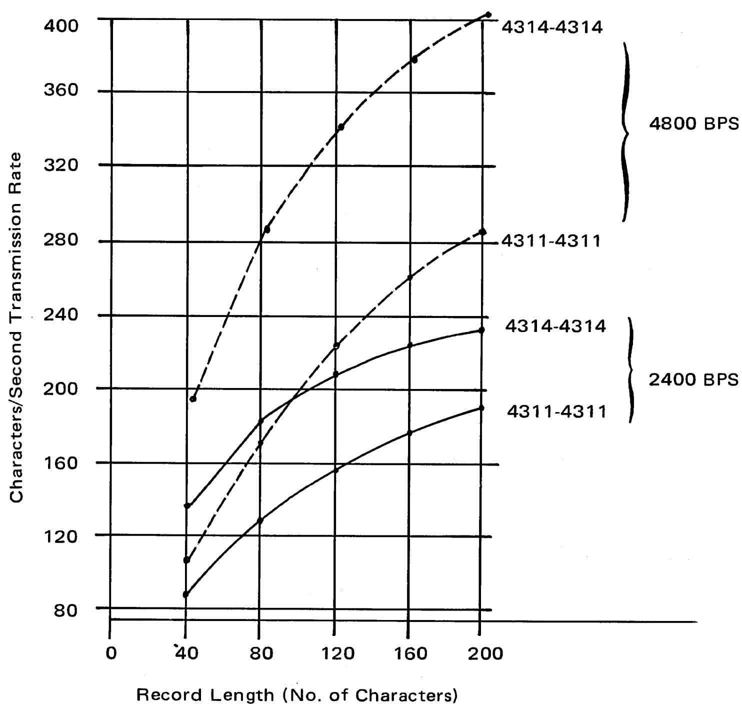


Figure 7-25 Graph of Effective Data Transmission Rates for 4-Wire Half-Duplex over Leased Lines, Tape-To-Tape Operation, for various models recording at 800 BPI, 9-Track, and Transmitting at 2400 and 4800 BPS

7.7.2 End Stripping

End stripping causes all records sent or received to be terminated at a point prior to the original end of a record. Before transmission, a release program command code must be entered in the program memory at the sending or receiving unit.

If, for instance a series of records are 80 characters long but the information desired is in the first 20 characters, the operator can use end stripping to send (or receive) only the first 20 characters. This is illustrated in Figure 7-27.

7.7.3 Internal Stripping and Internal Insert

These are actually two separate data editing features, but they are generally used in conjunction with each other; that is, a sending unit strips out data to be transmitted and a receiving unit inserts data during reception of the records. However, it is possible to use internal stripping at the sending unit without using internal insert to add anything at the receiving unit or vice versa. These features are illustrated in Figure 7-28 and 7-29. In the sending or receiving unit, a program field must correspond to the characters to be stripped out or inserted in the data records. Character positions stripped at the sending unit could be filled with new data at the receiving unit.

The internal stripping and insert features are used either with a programmed dup or skip field in the sending and receiving units. The basic difference is that using a dup field at the sending unit causes transmission of the first record in its entirety and all subsequent records are stripped of the specified data. Using a skip field causes all transmitted records to be stripped of the specified data as they are sent.

The operator must remember that dup and skip fields have special significance for these features; therefore, dup or skip fields for other purposes must not be used simultaneously with these two editing features.

7.8 Selectable Features for Data Communications

There are a number of features that are selectable at the time of acquisition of Series 4310 equipment. Some may also be selected later, through assistance of a customer service representative.

Selectable features are as follows:

1) Internal Clock – allows a Series 4310 unit to provide timing signals for 600, 1200, or 2400 baud transmissions (allows operation on Bell 202C/D modems) when an asynchronous modem is used.
2) Terminal Address Identification – used for identification (address) of a specific terminal in a communica-

Data records on source tape of sending unit:

```
Character
position      1        8  11          20       60

Record #1     17853215JCA575321652 ... 3
Record #2     48937148JCA876215413 ... 2
Record #3     87526315JCA521735271 ... 1
```

Contents entered into sending unit's program memory:

```
              1        8  11          20       60
              NNNNNNNNDNDNNNNNNNNN ... NR
              UUUUUUUUUUUUUUUUUUUU ... UE
              MMMMMMMMPMPMMMMMMMMM ... ML
              S         S
              T         T
                     Dup
                     Field
```

Contents entered into sending unit's data memory: (Sp=Space code)

```
              1                 8  11                       20      60
              SpSpSpSpSpSpSpSpAHCSpSpSpSpSpSpSpSpSp ... Sp
                               Special
                               Control
                               Field
```

Transmitted records:

```
              1        8  11          20       60
Record #1     17853215AHC575321652 ... 3
Record #2     48937148AHC876215413 ... 2
Record #3     87526315AHC521735271 ... 1
```

The data in character positions 9 through 11 has been changed in every record.

Figure 7-26. File Edit

tions network. In a point-to-point system, an address may be used by a sending Series 4310 terminal. If the receiving terminal is another Series 4310 unit, then the address/identification will be ignored. If the receiver is a computer, the address/identification may or may not be ignored depending on the needs of the computer. In a multipoint network the address is not needed by the sending/receiving Series 4310 terminal. However, identification must be defined in the ID module of a Series 4310 unit to allow it to respond to polling and selecting sequences from a computer. The address identification is a two-character sequence (the same character repeated); the character specified may be any alphabetic character, A through Z, or any numeric character, 0 through 9.

3) Terminal Security Identification – provides additional identification for a Series 4310 terminal. In a point-to-point configuration, use of the security code by a sending Series 4310 is ignored by a receiving Series 4310 terminal and may or may not be required by a receiving computer. In a multipoint configuration, the security identification code is not needed at all,

```
Data records on source tape of sending unit:

Character
position
            1                     20         30   71         80
Record #1   ABCDEFGHIJKLMNOPQRSTUVWXYZ1234...5051525354
Record #2   ALLGOODBOYSDOFINEYESTHEYA12345...5152535455

Contents entered into sending or receiving unit's program memory:
              1                    21
PROGRAM       LLLLLLLLLLLLLLLLLLLLR
              TTTTTTTTTTTTTTTTTTTTE
              RRRRRRRRRRRRRRRRRRRRL
              S
              T               Release Code
Data records as they are recorded on tape at the receiving unit:
              1                  20
Record #1     ABCDEFGHIJKLMNOPQRST
Record #2     ALLGOODBOYSDOFINEYES
```

Figure 7-27. End Stripping

but terminal address ID must be enabled. Three characters are used for security identification: they may be any three distinct and valid data characters except 0-8-2, space, and " (quotation marks).

4) Normal Retransmission – this feature is selectable for sending terminals and provides three retransmission attempts (re-tries) in the event that a remote receiving terminal gives no response to a sending terminal or three consecutive NAK responses to a sending terminal. After three re-tries, the sending unit sends end-of-transmission (EOT) signal and then begins a 20-second listening period, at the end of which it automatically disconnects from the telephone line.

5) Extended Retransmission – exactly the same feature, and used in the same way as the normal re-try feature explained above, with the exception that the number of retransmission attempts is 15 and the timeout period before automatic disconnect is 48 seconds.

6) Indefinite Retransmission – this feature is best suited for communication systems involving a computer which controls the number of re-tries from a remote sending unit. With this feature installed, a sending Series 4310 terminal makes continuous retransmission attempts until terminated when the computer sends an EOT signal or disconnects the data line after a 20 or 48 second timeout period.

7) Multi-Point – allows a Series 4310 unit to function as a tributary terminal in a multi-point communications network.

8) Optimum Throughput Feature – the optimum throughput feature allows the receiving terminal to delay acknowledgement (ACK or WACK) of a received record until processing (recording on tape and/or printing on a line printer) has sufficiently progressed so as not to cause interference with the next record block sent.

This feature should be selected when a line printer attached to a receiving Series 4310 terminal is expected to print multiple line records, i.e., records which, through use of format control codes, extend over three or more lines when printed.

This feature must be selected for four-wire service or else there will be throughput degradation.

The feature should also be used when extensive use of the DUAL position of the PRINT/DUAL/WRITE TAPE switch is anticipated.

Data record on source tape of sending unit (internal stripping/dup):

Character position

```
              1          11     17        26
Record #1     0123456789ACC NO 987654321
Record #2     9876543210ACC NO 123456789
Record #3     5432109876ACC NO 678901234
```

Contents entered into sending unit's program memory:

```
              1          11     17        26
              NNNNNNNNNNDNNNNNDNNNNNNNNR
              UUUUUUUUUUUUUUUUUUUUUUUUUE
Program       MMMMMMMMMMMPMMMMMPMMMMMMMML
              S                S
              T       DUP      T
                     FIELD
```

It is not necessary to enter any data into the data memory.

Transmitted records:

```
Record #1     0123456789ACC NO 987654321
Record #2     9876543210123456789
Record #3     5432109876678901234
```

If internal insert is also used at receiving unit (internal insert/dup), contents of receiving unit's program memory:

```
              1          11     17        27
              NNNNNNNNNNDNNNNNDNNNNNNNNNR
              UUUUUUUUUUUUUUUUUUUUUUUUUUE
Program       MMMMMMMMMMMPMMMMMPMMMMMMMML
              S                S
              T       DUP      T
                     FIELD
```

Data records as they are recorded on tape at the receiving unit:

```
              1          11     17        26
Record #1     0123456789ACC NO 987654321
Record #2     9876543210ACC NO 123456789
Record #3     5432109876ACC NO 678901234
```

Figure 7-28. Internal Stripping and Insert with First Record Excepted

Data records on source tape of sending unit (internal stripping/skip):

```
Character position   1      8          20          30    36
        Record #1    DUMABC CORP., 1076 MAIN ST., ANYTOWN
        Record #2    DUMEDF CORP., 1781 EAST ST., ANYTOWN
        Record #3    DUMXYZ CORP., 1232 WEST ST., ANYTOWN
```

Contents entered into sending unit's program memory:

```
                 1                                     36
                 SNSLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLR
                 KUKTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTE
Program          IMIRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRL
                 P P S
                 SKIP T
                 FIELD
```

```
                         1                 17             33
Transmitted Records:     ABC CORP., 1076 MAIN ST., ANYTOWN
                         EDF CORP., 1781 EAST ST., ANYTOWN
                         XYZ CORP., 1232 WEST ST., ANYTOWN
```

If internal insert is also used at receiving unit (internal insert/skip), contents entered into receiving unit's data memory:

```
Character position   1  3                              30      40

                     0                                 0
                     8¬ RSpSpSpSpSpSp....SpSpSpSpSpSp8NSpSp..Sp
                     2                                 2
                          Characters to be inserted
```

Contents entered into receiving unit's program memory:

```
                 1 3                          30       40
                 SNSLLLLLLLLLLLLLLLLLLLLLLLLLLSNSLLLLLLLR
                 KUKUTTTTTTTTTTTTTTTTTTTTTTTTTKUKTTTTTTTE
                 IMIRRRRRRRRRRRRRRRRRRRRRRRRRRIMIRRRRRRRL
                 P PS                         P PS
                    T                            T
                 SKIP                         SKIP
                 FIELD                        FIELD
```

Data records as they are recorded on tape at the receiving unit:

```
               1 3                          30      40
               0                            0
  Record #1    8¬RABC CORP., 1076 MAIN ST., 8N ANYTOWN
               2                            2
               0                            0
  Record #2    8¬REDF CORP., 1781 EAST ST., 8N ANYTOWN
               2                            2
               0                            0
  Record #3    8¬RXYZ CORP., 1232 WEST ST., 8N ANYTOWN
               2                            2
          INSERTED                     INSERTED
          CHARACTERS                   CHARACTERS*
```

*Notice that it is possible to insert characters (using internal insert) in positions where characters were not previously stripped.

Figure 7-29. Internal Stripping and Insert of all Records.

9) Format Control Code Transmitting Capability (Extended Character Feature) – The 8-bit EBCDIC and 7-bit USASCII languages contain format control codes that allow automatic line printer formatting. These format control codes are not capable of being written on a 4310 tape unit since they are not part of the normal 64-character data set. To allow temporary storage on tape of the codes, the data communication adapter, will convert each format control code into a two-character sequence in the memory as it is released (see Table 7-11). For example, a message being received from a CPU containing the format control sequence [ESC A] (skip to top of form) is stored in memory as [0-8-2 ¬ A].

If the extended character feature is enabled, a Series 4310 data communication terminal is also capable of

Table 7-11. Format Command Code Sequences (Phone to Tape)

PHONE LINE CHARACTER	TAPE SEQUENCE CHARACTER
FF	0-8-2 K
CR	0-8-2 M
NL	0-8-2 N
LF	0-8-2 N
RS	0-8-2 O
IRS	0-8-2 P
HT	0-8-2 Q
VT	0-8-2 R
ESC	0-8-2 ¬

Table 7-12. Format Command Code Sequences (Tape to EBCDIC or USASCII)

Series 4310 Unit – Two Character Tape Sequence	EBCDIC or USASCII Code Sequence
0-8-2 &	(SYN) (SYN)
0-8-2 J	(SYN) (SYN)
0-8-2 K	(SYN) FF
0-8-2 L	(SYN) (SYN)
0-8-2 M	(SYN) CR
0-8-2 N	(SYN) NL/LF
0-8-2 O	(SYN) RS
0-8-2 P	(SYN) IRS/RS
0-8-2 Q	(SYN) HT
0-8-2 R	(SYN) VT
0-8-2 !	(SYN) (SYN)
0-8-2 $	(SYN) (SYN)
0-8-2 *	(SYN) BEL
0-8-2)	(SYN) (SYN)
0-8-2 ;	(SYN) (SYN)
0-8-2 ¬	(SYN) ESC

generating these format control codes whenever it is transmitting to a CPU or IBM 2770 terminal. The extended character feature converts the two-character tape sequence shown in Table 7-12 into the industry standard format control characters. If the 0-8-2 character on tape is followed by a character not shown in Table 7-12, it is considered an "illegal 0-8-2 follower" and will result in a key error at the sending 4310 data communication terminal. The tape character sequence representing a format command code must be recognized as such and translated into a unique EBCDIC or USASCII code.

Thus, while any Series 4310 unit can receive format command codes, only those units with this feature enabled are capable of transmitting them.

7.9 Data Communications With Line Printer

7.9.1 Device Selection Codes (DSC)

Data being received by a Series 4310 terminal may be routed to the magnetic tape and/or the line printer. There are two ways to designate the destination of data:

1) The PRINT/DUAL/WRITE TAPE (P/D/W) switch on the Series 4310 unit routes data to the line printer if the switch is in the PRINT position, to the magnetic tape if the switch is in the WRITE TAPE position, or to both printer and tape if the switch is in DUAL position.
2) A device selection code, generated by a computer, can direct data to the line printer or to the magnetic tape, but not to both.

If the P/D/W switch is in the DUAL position, data goes to both the printer and tape, regardless of any DSC's received. The DUAL position overrides any DSC's. A DSC, however, overrides the other two positions of the switch. If, for example, the P/D/W switch is in the PRINT position and a DSC designating the magnetic tape is received, the data goes only to the tape, not to the printer.

During point-to-point operations device selection codes are transmitted in a data block sequence ("in text") as shown below:

COMPUTER
SENDS . . . LPAD SYN SYN STX DSC (DATA)
ETB BCC TPAD . . .

The DSC character may be the first block by itself, or else the first character in a data block, as shown above. No more than one DSC character must be sent in the same text (i.e., between a STX and an EXT).

During multipoint operations DSC's are transmitted in the initial polling or selecting sequence (see Section 7.5.4).

The device selection codes are:

DC1 – Selects the line printer
DC2 – Selects the magnetic tape
DC3 – Selects the line printer

DSC's sent by the computer in a multipoint polling sequence can also be the characters 0, 6 or 7; these DSC characters are all interpreted as a request to send data from the magnetic tape unit.

There is no single DSC to select both the magnetic tape and line printer. The P/D/W switch must be in the DUAL position to designate both devices.

When data is directed to both devices, it is output to the printer first, then recorded on tape. The total processing time is equal to the printer processing time (see Section 6.3.1) plus the time required to write on tape (see Section 2.5.3).

Naturally, the line printer must be ONLINE and prepared to receive data whenever it is selected.

If the line printer is not ONLINE when data is routed to it, the Series 4310 terminal will send an end-of-transmission sequence (SYN SYN SYN SYN EOT TPAD) to the transmitting terminal (see Figure 7-30).

7.9.2 Forcing A Remote Sending Terminal To Receive Data On Printer

An unattended remote sending terminal can be forced to receive data by operator intervention at the local terminal. The purpose of reversing the sender/receiver roles is to have data printed out at a remote line printer. It is impossible to force a sending terminal to write on its tape because the remote terminal's mode select switch is in the DATA SEND position.

This change in roles is possible if the local station modem is capable of VOICE as well as DATA mode. The local operator must intervene during one of the periods that the remote terminal is not sending the data file.

Intervention may occur:

1) Before the remote unit starts sending its file.
2) During the time out period (before telephone disconnect—20 or 48 seconds) following an end-of-transmission sequence or development of an error condition.

The transmission sequence for this operation is shown in Figure 7-4 of Section. 7.5.3.

7.9.3 Format Command Codes

Format command codes (described in Section 6.4) can be transmitted over a data communications network if the sending station is a Series 4310 unit equipped with the format control code transmitting feature (see Section 7.8, feature 9); any Series 4310 unit, however, can receive format command codes even without this feature.

NOTE: Incoming format command codes are translated into two-character sequences, thus requiring two memory locations in the buffer memory. Care must be taken not to overflow the buffer of the Series 4310 receiving terminal.

7.10 Compatibility With Other Options

Since the data communications option and the pooling option utilize some of the same internal logic, both operations cannot proceed simultaneously. It is often advantageous, however, to prepare tapes for data communications through a merging operation. If all data is merged onto one reel of tape, data communications throughout is enhanced.

Since the check digit and printing totalizer options are only available on Series 4320 units, they are not compatible with the data communications option, which is only available on Series 4310 units.

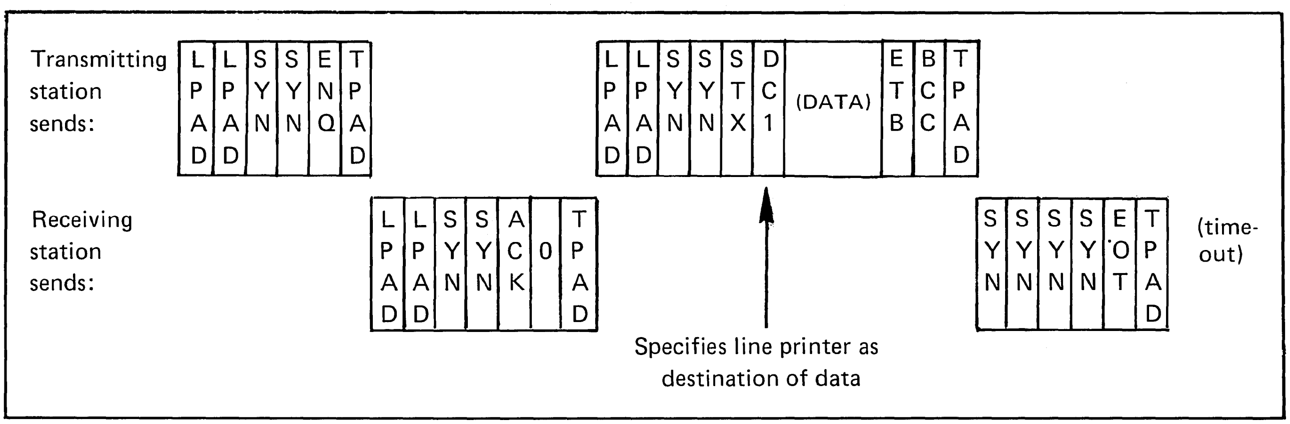


Figure 7-30. Attempt To Send Data To OFFLINE Printer—Error Condition

APPENDIX A. KEYBOARDS

APPENDIX A. KEYBOARDS

To assure computer compatibility throughout the international market, thirteen different keyboards are available. Seven of these permit tape recording in the IBM compatible languages (EBCDIC 9-track and BCDIC 7-track). Two keyboards record data in the Honeywell-EL language and two others allow compatibility with ICL equipment. There is also a special accounting keyboard with the numeric digit keys arranged in "ten key" fashion. A special Kana keyboard is available for use in Japan; in addition to the 64 standard alphanumeric characters, 47 Kana characters can be generated (see Section 2.2.5).

Figure A-1 pictures the IBM compatible keyboard for use in the USA, Holland, Italy, Germany, Switzerland and Austria. The USA accounting keyboard that has a slightly different layout but which generates the same tape language codes is pictured in Figure A-2. Table 2-8 of Section 2.5.2 lists the internal machine language (MDRS) and corresponding tape languages, EBCDIC and BCDIC, for these keyboards.

Photographs and coding charts for the other IBM-compatible keyboards are included in the following figures and tables.

Figure A-9 shows the keyboard used to record data in the Honeywell-EL language; the coding chart for this keyboard is listed in Table 2-9 of Section 2.5.2.

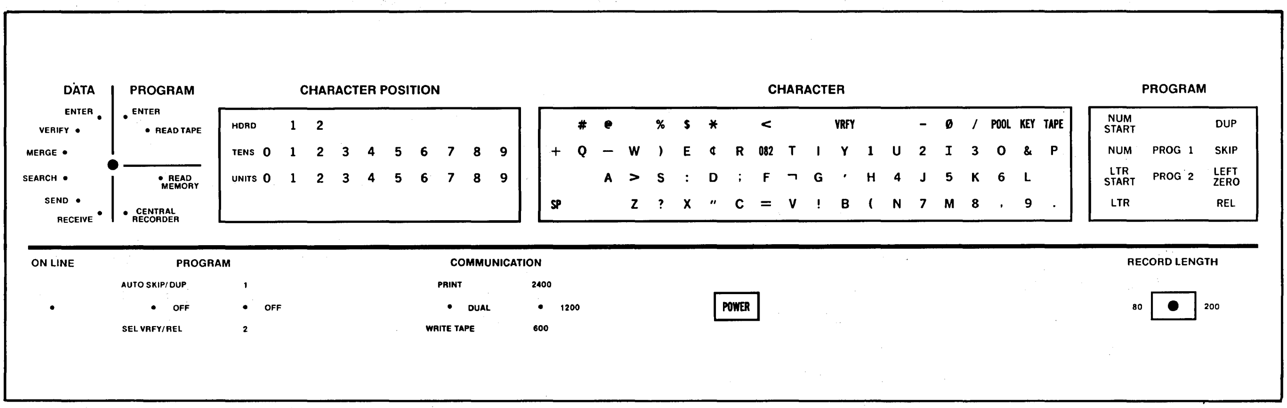
Figure A-10 pictures the Honeywell compatible keyboard designed for use in France; the coding chart for this keyboard is listed in Table A-7.

The keyboard used to record data in the ICL language is shown in Figure A-11; its coding chart is given in Table 2-10 of Section 2.5.2.

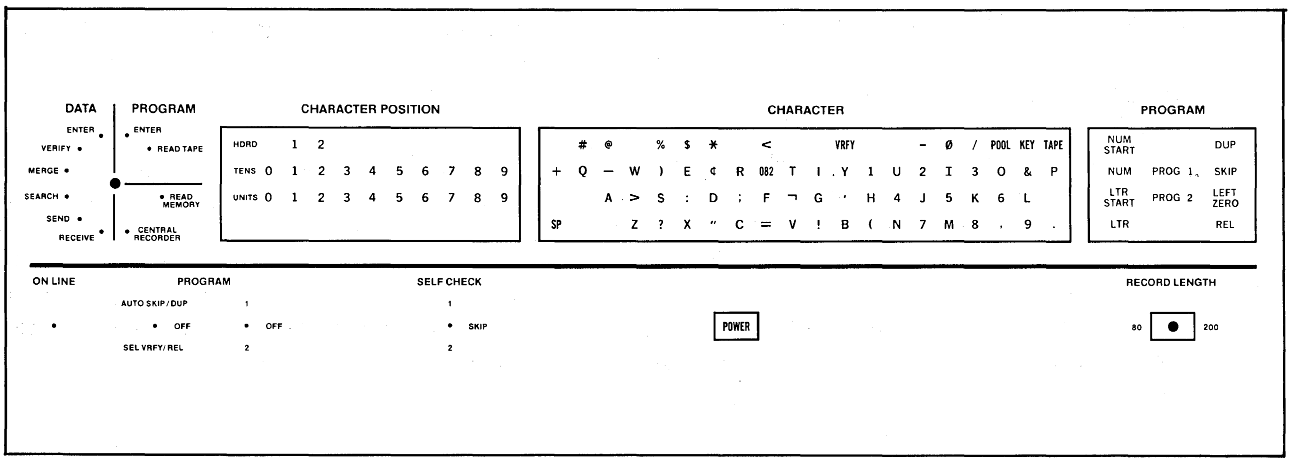
A special ICL-compatible keyboard designed for use in Sweden is shown in Figure A-12; its coding chart is listed in Table A-8.

The Kana keyboard, designed especially for the Jananese market, is pictured in Figure A-13. The Kana keyboard is capable of generating the codes for 47 Kana characters, as well as the 64 standard alphanumeric characters. The internal machine language codes and corresponding tape language codes for the 47 Kana characters are listed in Table A-9.

NATION(s) WHERE KEYBOARD IS USED	PHOTOGRAPH	CODING CHART
England	Figure A-3	Table A-1
France/Belgium	Figure A-4	Table A-2
Norway	Figure A-5	Table A-3
Sweden/Finland	Figure A-6	Table A-4
Denmark	Figure A-7	Table A-5
Yugoslavia	Figure A-8	Table A-6



4310 Series



4320 Series

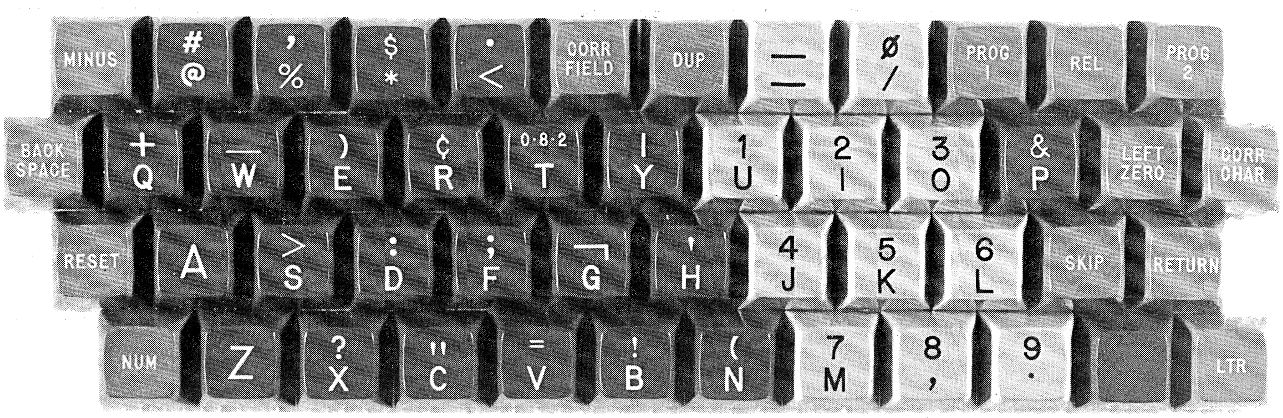
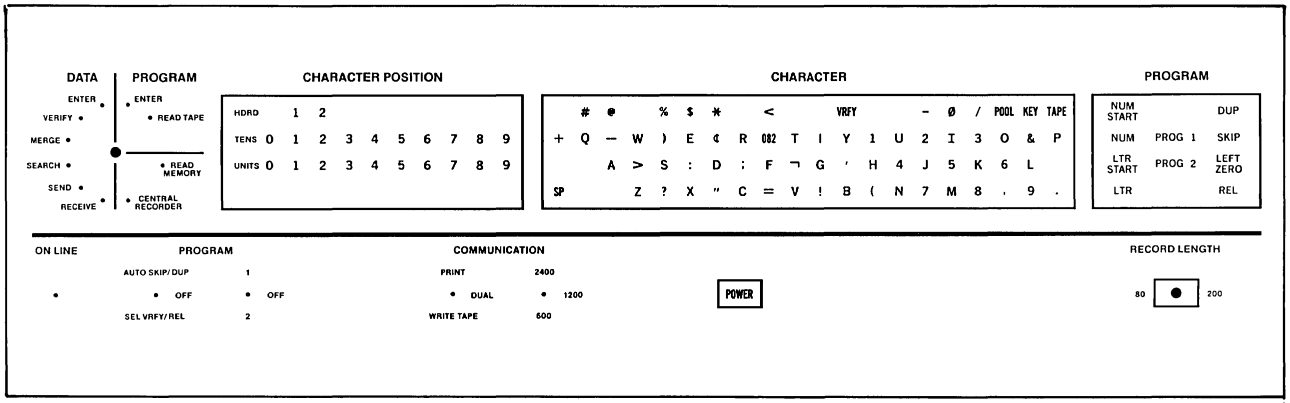
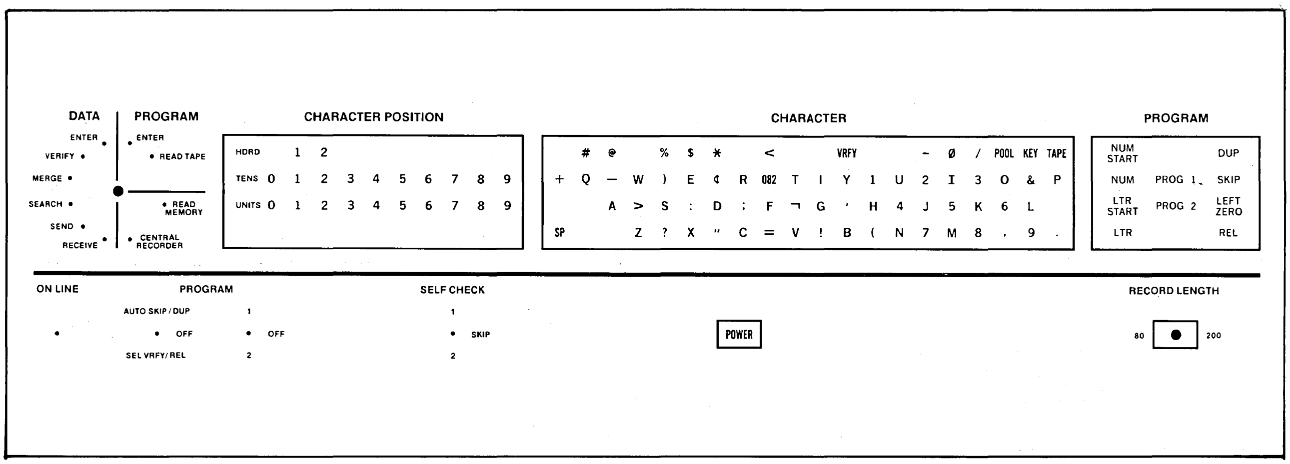


Figure A-1. USA/Holland/Italy/Germany/Switzerland/Austria

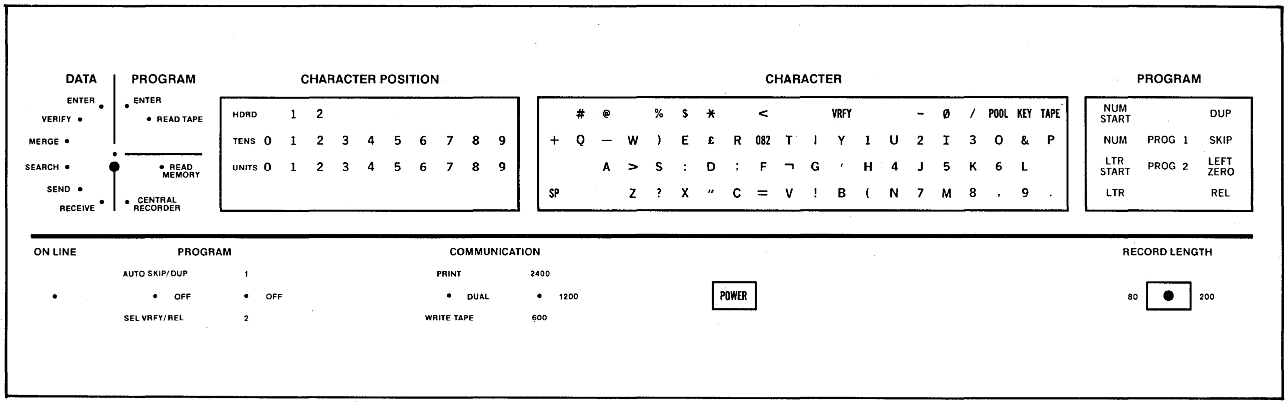


4310 Series

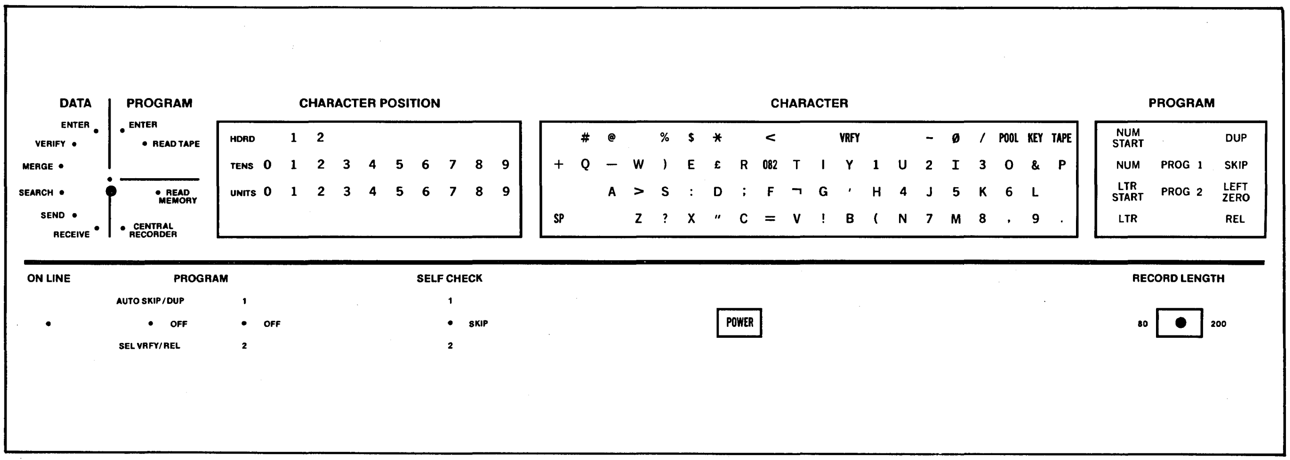


4320 Series

Figure A-2. USA Accounting



4310 Series



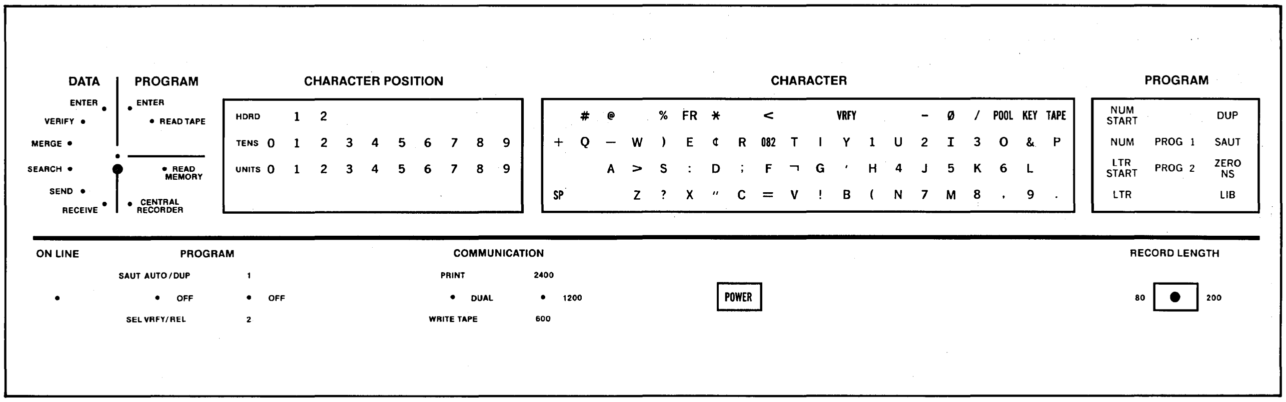
4320 Series

Figure A-3. England

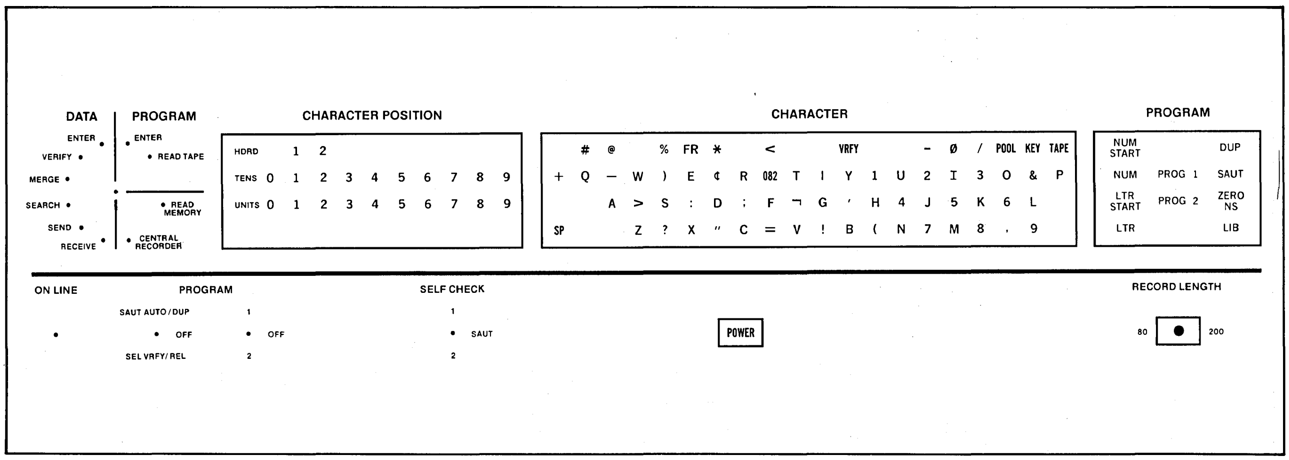
Table A-1. Keyboard Coding Chart: England

Graphic/Control Symbol	MDRS Internal Machine code						IBM 7-Track EBCDIC code						IBM 9-Track EBCDIC code							
	0	1	2	3	4	5	B	A	8	4	2	1	0	1	2	3	4	5	6	7
0	1	1	0	0	0	0			8		2		1	1	1	1	0	0	0	0
1	1	1	0	0	0	1						1	1	1	1	1	0	0	0	1
2	1	1	0	0	1	0					2		1	1	1	1	0	0	1	0
3	1	1	0	0	1	1					2	1	1	1	1	1	0	0	1	1
4	1	1	0	1	0	0				4			1	1	1	1	0	1	0	0
5	1	1	0	1	0	1				4		1	1	1	1	1	0	1	0	1
6	1	1	0	1	1	0				4	2		1	1	1	1	0	1	1	0
7	1	1	0	1	1	1				4	2	1	1	1	1	1	0	1	1	1
8	1	1	1	0	0	0			8				1	1	1	1	1	0	0	0
9	1	1	1	0	0	1			8			1	1	1	1	1	1	0	0	1
–	1	0	1	0	1	0	B						0	1	1	0	0	0	0	0
&	0	1	0	0	0	0	B	A					0	1	0	1	0	0	0	0
A	0	0	0	0	0	1	B	A				1	1	1	0	0	0	0	0	1
B	0	0	0	0	1	0	B	A			2		1	1	0	0	0	0	1	0
C	0	0	0	0	1	1	B	A			2	1	1	1	0	0	0	0	1	1
D	0	0	0	1	0	0	B	A		4			1	1	0	0	0	1	0	0
E	0	0	0	1	0	1	B	A		4		1	1	1	0	0	0	1	0	1
F	0	0	0	1	1	0	B	A		4	2		1	1	0	0	0	1	1	0
G	0	0	0	1	1	1	B	A		4	2	1	1	1	0	0	0	1	1	1
H	0	0	1	0	0	0	B	A	8				1	1	0	0	1	0	0	0
I	0	0	1	0	0	1	B	A	8			1	1	1	0	0	1	0	0	1
J	0	1	0	0	0	1	B					1	1	1	0	1	0	0	0	1
K	0	1	0	0	1	0	B				2		1	1	0	1	0	0	1	0
L	0	1	0	0	1	1	B				2	1	1	1	0	1	0	0	1	1
M	0	1	0	1	0	0	B			4			1	1	0	1	0	1	0	0
N	0	1	0	1	0	1	B			4		1	1	1	0	1	0	1	0	1
O	0	1	0	1	1	0	B			4	2		1	1	0	1	0	1	1	0
P	0	1	0	1	1	1	B			4	2	1	1	1	0	1	0	1	1	1
Q	0	1	1	0	0	0	B		8				1	1	0	1	1	0	0	0
R	0	1	1	0	0	1	B		8			1	1	1	0	1	1	0	0	1
/	1	0	0	0	0	1		A				1	0	1	1	0	0	0	0	1
S	1	0	0	0	1	0		A			2		1	1	1	0	0	0	1	0
T	1	0	0	0	1	1		A			2	1	1	1	1	0	0	0	1	1
U	1	0	0	1	0	0		A		4			1	1	1	0	0	1	0	0
V	1	0	0	1	0	1		A		4		1	1	1	1	0	0	1	0	1
W	1	0	0	1	1	0		A		4	2		1	1	1	0	0	1	1	0
X	1	0	0	1	1	1		A		4	2	1	1	1	1	0	0	1	1	1
Y	1	0	1	0	0	0		A	8				1	1	1	0	1	0	0	0
Z	1	0	1	0	0	1		A	8			1	1	1	1	0	1	0	0	1
Space	0	0	0	0	0	0		A					0	1	0	0	0	0	0	0
£	0	0	1	0	1	0	B	A	8		2		0	1	0	0	1	0	1	0
•	0	0	1	0	1	1	B	A	8		2	1	0	1	0	0	1	0	1	1
<	0	0	1	1	0	0	B	A	8	4			0	1	0	0	1	1	0	0
(	0	0	1	1	0	1	B	A	8	4		1	0	1	0	0	1	1	0	1
+	0	0	1	1	1	0	B	A	8	4	2		0	1	0	0	1	1	1	0
|	0	0	1	1	1	1	B	A	8	4	2	1	0	1	0	0	1	1	1	1
!	0	1	1	0	1	0	B		8		2		1	1	0	1	0	0	0	0*
$	0	1	1	0	1	1	B		8		2	1	0	1	0	1	1	0	1	1
*	0	1	1	1	0	0	B		8	4			0	1	0	1	1	1	0	0
)	0	1	1	1	0	1	B		8	4		1	0	1	0	1	1	1	0	1
;	0	1	1	1	1	0	B		8	4	2		0	1	0	1	1	1	1	0
¬	0	1	1	1	1	1	B		8	4	2	1	0	1	0	1	1	1	1	1
0-8-2	1	0	0	0	0	0		A	8		2		1	1	1	0	0	0	0	0
,	1	0	1	0	1	1		A	8		2	1	0	1	1	0	1	0	1	1
%	1	0	1	1	0	0		A	8	4			0	1	1	0	1	1	0	0
_	1	0	1	1	0	1		A	8	4		1	0	1	1	0	1	1	0	1
>	1	0	1	1	1	0		A	8	4	2		0	1	1	0	1	1	1	0
?	1	0	1	1	1	1		A	8	4	2	1	0	1	1	0	1	1	1	1
:	1	1	1	0	1	0	No equivalent						0	1	1	1	1	0	1	0
#	1	1	1	0	1	1			8		2	1	0	1	1	1	1	0	1	1
@	1	1	1	1	0	0			8	4			0	1	1	1	1	1	0	0
'	1	1	1	1	0	1			8	4		1	0	1	1	1	1	1	0	1
=	1	1	1	1	1	0			8	4	2		0	1	1	1	1	1	1	0
"	1	1	1	1	1	1			8	4	2	1	0	1	1	1	1	1	1	1

* This is not the standard EBCDIC code for a "!" graphic; it is assigned for use in the "Negative Decimal Digit" mode of operation (see Section 2.2.3).



4310 Series



4320 Series

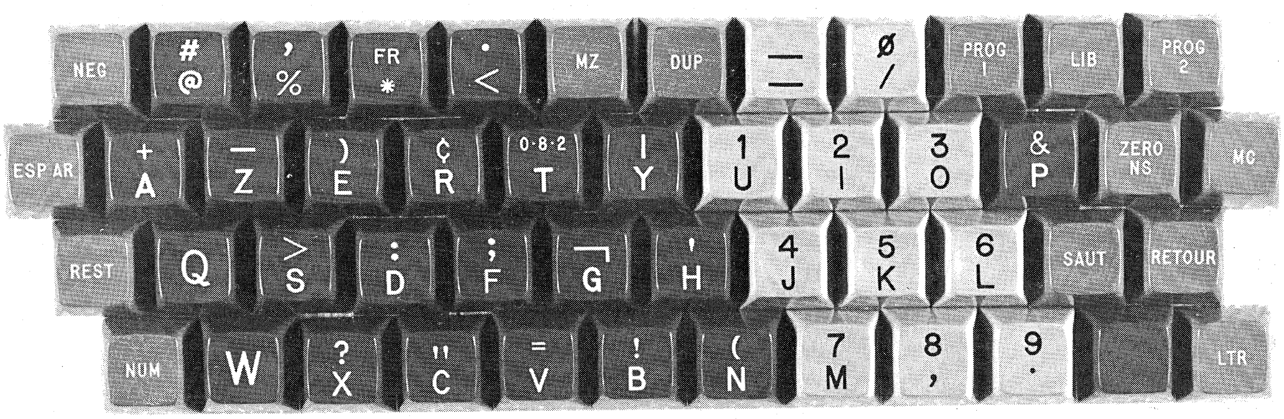
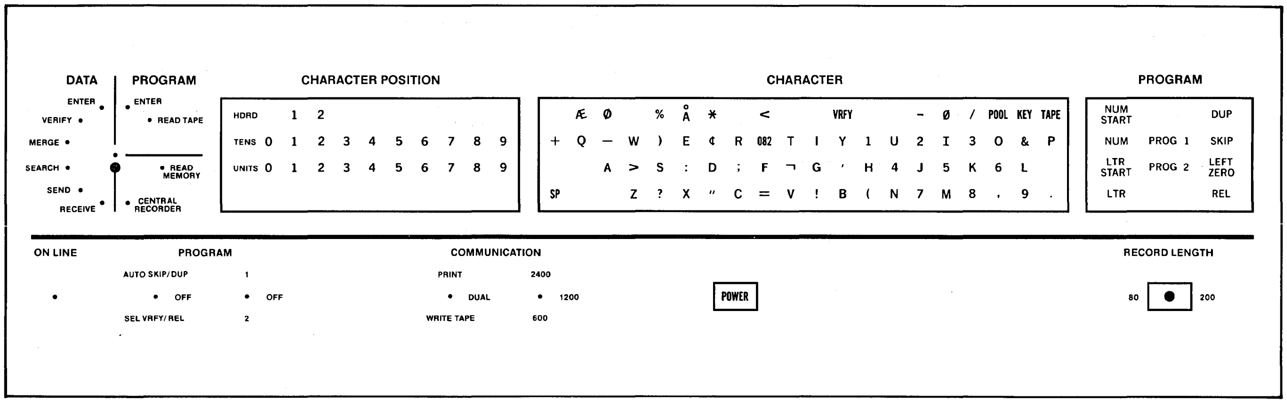


Figure A-4 France/Belgium

Table A-2. Keyboard Coding Chart: France/Belgium

Graphic/Control Symbol	MDRS Internal Machine Code						IBM 7-Track BCDIC Code						IBM 9-Track EBCDIC Code							
	0	1	2	3	4	5	B	A	8	4	2	1	0	1	2	3	4	5	6	7
0	1	1	0	0	0	0			8		2		1	1	1	1	0	0	0	0
1	1	1	0	0	0	1						1	1	1	1	1	0	0	0	1
2	1	1	0	0	1	0					2		1	1	1	1	0	0	1	0
3	1	1	0	0	1	1					2	1	1	1	1	1	0	0	1	1
4	1	1	0	1	0	0				4			1	1	1	1	0	1	0	0
5	1	1	0	1	0	1				4		1	1	1	1	1	0	1	0	1
6	1	1	0	1	1	0				4	2		1	1	1	1	0	1	1	0
7	1	1	0	1	1	1				4	2	1	1	1	1	1	0	1	1	1
8	1	1	1	0	0	0			8				1	1	1	1	1	0	0	0
9	1	1	1	0	0	1			8			1	1	1	1	1	1	0	0	1
—	1	0	1	0	1	0	B						0	1	1	0	0	0	0	0
&	0	1	0	0	0	0	B	A					0	1	0	1	0	0	0	0
A	0	0	0	0	0	1	B	A				1	1	1	0	0	0	0	0	1
B	0	0	0	0	1	0	B	A			2		1	1	0	0	0	0	1	0
C	0	0	0	0	1	1	B	A			2	1	1	1	0	0	0	0	1	1
D	0	0	0	1	0	0	B	A		4			1	1	0	0	0	1	0	0
E	0	0	0	1	0	1	B	A		4		1	1	1	0	0	0	1	0	1
F	0	0	0	1	1	0	B	A		4	2		1	1	0	0	0	1	1	0
G	0	0	0	1	1	1	B	A		4	2	1	1	1	0	0	0	1	1	1
H	0	0	1	0	0	0	B	A	8				1	1	0	0	1	0	0	0
I	0	0	1	0	0	1	B	A	8			1	1	1	0	0	1	0	0	1
J	0	1	0	0	0	1	B					1	1	1	0	1	0	0	0	1
K	0	1	0	0	1	0	B				2		1	1	0	1	0	0	1	0
L	0	1	0	0	1	1	B				2	1	1	1	0	1	0	0	1	1
M	0	1	0	1	0	0	B			4			1	1	0	1	0	1	0	0
N	0	1	0	1	0	1	B			4		1	1	1	0	1	0	1	0	1
O	0	1	0	1	1	0	B			4	2		1	1	0	1	0	1	1	0
P	0	1	0	1	1	1	B			4	2	1	1	1	0	1	0	1	1	1
Q	0	1	1	0	0	0	B		8				1	1	0	1	1	0	0	0
R	0	1	1	0	0	1	B		8			1	1	1	0	1	1	0	0	1
/	1	0	0	0	0	1		A				1	0	1	1	0	0	0	0	1
S	1	0	0	0	1	0		A			2		1	1	1	0	0	0	1	0
T	1	0	0	0	1	1		A			2	1	1	1	1	0	0	0	1	1
U	1	0	0	1	0	0		A		4			1	1	1	0	0	1	0	0
V	1	0	0	1	0	1		A		4		1	1	1	1	0	0	1	0	1
W	1	0	0	1	1	0		A		4	2		1	1	1	0	0	1	1	0
X	1	0	0	1	1	1		A		4	2	1	1	1	1	0	0	1	1	1
Y	1	0	1	0	0	0		A	8				1	1	1	0	1	0	0	0
Z	1	0	1	0	0	1		A	8			1	1	1	1	0	1	0	0	1
Space	0	0	0	0	0	0		A					0	1	0	0	0	0	0	0
¢	0	0	1	0	1	0	B	A	8		2		0	1	0	0	1	0	1	0
.	0	0	1	0	1	1	B	A	8		2	1	0	1	0	0	1	0	1	1
<	0	0	1	1	0	0	B	A	8	4			0	1	0	0	1	1	0	0
(	0	0	1	1	0	1	B	A	8	4		1	0	1	0	0	1	1	0	1
+	0	0	1	1	1	0	B	A	8	4	2		0	1	0	0	1	1	1	0
|	0	0	1	1	1	1	B	A	8	4	2	1	0	1	0	0	1	1	1	1
!	0	1	1	0	1	0	B		8		2		1	1	0	1	0	0	0	0*
FR	0	1	1	0	1	1	B		8		2	1	0	1	0	1	1	0	1	1
*	0	1	1	1	0	0	B		8	4			0	1	0	1	1	1	0	0
)	0	1	1	1	0	1	B		8	4		1	0	1	0	1	1	1	0	1
;	0	1	1	1	1	0	B		8	4	2		0	1	0	1	1	1	1	0
¬	0	1	1	1	1	1	B		8	4	2	1	0	1	0	1	1	1	1	1
0-8-2	1	0	0	0	0	0		A	8		2		1	1	1	0	0	0	0	0
,	1	0	1	0	1	1		A	8		2	1	0	1	1	0	1	0	1	1
%	1	0	1	1	0	0		A	8	4			0	1	1	0	1	1	0	0
_	1	0	1	1	0	1		A	8	4		1	0	1	1	0	1	1	0	1
>	1	0	1	1	1	0		A	8	4	2		0	1	1	0	1	1	1	0
?	1	0	1	1	1	1		A	8	4	2	1	0	1	1	0	1	1	1	1
:	1	1	1	0	1	0	No equivalent						0	1	1	1	1	0	1	0
#	1	1	1	0	1	1			8		2	1	0	1	1	1	1	0	1	1
@	1	1	1	1	0	0			8	4			0	1	1	1	1	1	0	0
'	1	1	1	1	0	1			8	4		1	0	1	1	1	1	1	0	1
=	1	1	1	1	1	0			8	4	2		0	1	1	1	1	1	1	0
"	1	1	1	1	1	1			8	4	2	1	0	1	1	1	1	1	1	1

* This is not the standard EBCDIC code for "!" graphic; it is assigned for use in the "Negative Decimal Digit" mode of operation (see Section 2.2.3).



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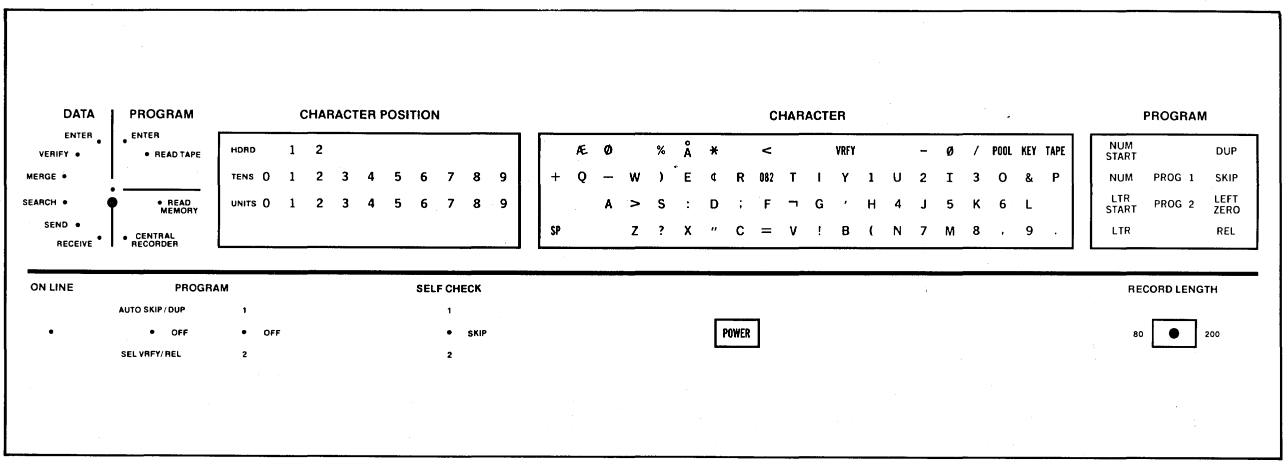

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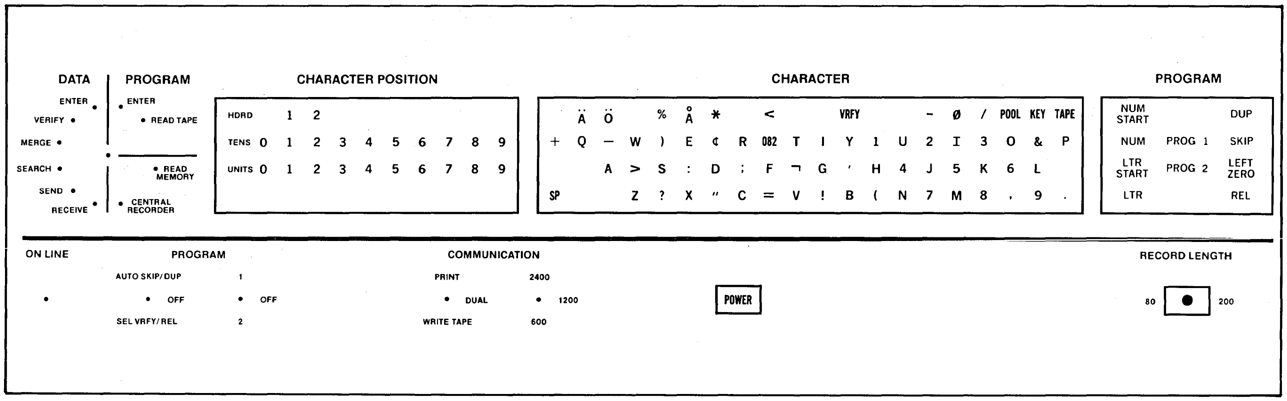
Figure A-5. Norway

Table A-3. Keyboard Coding Chart: Norway

Graphic/Control Symbol	MDRS Internal Machine code	IBM 7-Track EBCDIC code	IBM 9-Track EBCDIC code
	0 1 2 3 4 5	B A 8 4 2 1	0 1 2 3 4 5 6 7
0	1 1 0 0 0 0	8 2	1 1 1 1 0 0 0 0
1	1 1 0 0 0 1	1	1 1 1 1 0 0 0 1
2	1 1 0 0 1 0	2	1 1 1 1 0 0 1 0
3	1 1 0 0 1 1	2 1	1 1 1 1 0 0 1 1
4	1 1 0 1 0 0	4	1 1 1 1 0 1 0 0
5	1 1 0 1 0 1	4 1	1 1 1 1 0 1 0 1
6	1 1 0 1 1 0	4 2	1 1 1 1 0 1 1 0
7	1 1 0 1 1 1	4 2 1	1 1 1 1 0 1 1 1
8	1 1 1 0 0 0	8	1 1 1 1 1 0 0 0
9	1 1 1 0 0 1	8 1	1 1 1 1 1 0 0 1
–	1 0 1 0 1 0	B	0 1 1 0 0 0 0 0
&	0 1 0 0 0 0	B A	0 1 0 1 0 0 0 0
A	0 0 0 0 0 1	B A 1	1 1 0 0 0 0 0 1
B	0 0 0 0 1 0	B A 2	1 1 0 0 0 0 1 0
C	0 0 0 0 1 1	B A 2 1	1 1 0 0 0 0 1 1
D	0 0 0 1 0 0	B A 4	1 1 0 0 0 1 0 0
E	0 0 0 1 0 1	B A 4 1	1 1 0 0 0 1 0 1
F	0 0 0 1 1 0	B A 4 2	1 1 0 0 0 1 1 0
G	0 0 0 1 1 1	B A 4 2 1	1 1 0 0 0 1 1 1
H	0 0 1 0 0 0	B A 8	1 1 0 0 1 0 0 0
I	0 0 1 0 0 1	B A 8 1	1 1 0 0 1 0 0 1
J	0 1 0 0 0 1	B 1	1 1 0 1 0 0 0 1
K	0 1 0 0 1 0	B 2	1 1 0 1 0 0 1 0
L	0 1 0 0 1 1	B 2 1	1 1 0 1 0 0 1 1
M	0 1 0 1 0 0	B 4	1 1 0 1 0 1 0 0
N	0 1 0 1 0 1	B 4 1	1 1 0 1 0 1 0 1
O	0 1 0 1 1 0	B 4 2	1 1 0 1 0 1 1 0
P	0 1 0 1 1 1	B 4 2 1	1 1 0 1 0 1 1 1
Q	0 1 1 0 0 0	B 8	1 1 0 1 1 0 0 0
R	0 1 1 0 0 1	B 8 1	1 1 0 1 1 0 0 1
/	1 0 0 0 0 1	A 1	0 1 1 0 0 0 0 1
S	1 0 0 0 1 0	A 2	1 1 1 0 0 0 1 0
T	1 0 0 0 1 1	A 2 1	1 1 1 0 0 0 1 1
U	1 0 0 1 0 0	A 4	1 1 1 0 0 1 0 0
V	1 0 0 1 0 1	A 4 1	1 1 1 0 0 1 0 1
W	1 0 0 1 1 0	A 4 2	1 1 1 0 0 1 1 0
X	1 0 0 1 1 1	A 4 2 1	1 1 1 0 0 1 1 1
Y	1 0 1 0 0 0	A 8	1 1 1 0 1 0 0 0
Z	1 0 1 0 0 1	A 8 1	1 1 1 0 1 0 0 1
Space	0 0 0 0 0 0	A	0 1 0 0 0 0 0 0
¢	0 0 1 0 1 0	B A 8 2	0 1 0 0 1 0 1 0
.	0 0 1 0 1 1	B A 8 2 1	0 1 0 0 1 0 1 1
<	0 0 1 1 0 0	B A 8 4	0 1 0 0 1 1 0 0
(	0 0 1 1 0 1	B A 8 4 1	0 1 0 0 1 1 0 1
+	0 0 1 1 1 0	B A 8 4 2	0 1 0 0 1 1 1 0
|	0 0 1 1 1 1	B A 8 4 2 1	0 1 0 0 1 1 1 1
!	0 1 1 0 1 0	B 8 2	1 1 0 1 0 0 0 0*
Å	0 1 1 0 1 1	B 8 2 1	0 1 0 1 1 0 1 1
*	0 1 1 1 0 0	B 8 4	0 1 0 1 1 1 0 0
)	0 1 1 1 0 1	B 8 4 1	0 1 0 1 1 1 0 1
;	0 1 1 1 1 0	B 8 4 2	0 1 0 1 1 1 1 0
¬	0 1 1 1 1 1	B 8 4 2 1	0 1 0 1 1 1 1 1
0-8-2	1 0 0 0 0 0	A 8 2	1 1 1 0 0 0 0 0
,	1 0 1 0 1 1	A 8 2 1	0 1 1 0 1 0 1 1
%	1 0 1 1 0 0	A 8 4	0 1 1 0 1 1 0 0
_	1 0 1 1 0 1	A 8 4 1	0 1 1 0 1 1 0 1
>	1 0 1 1 1 0	A 8 4 2	0 1 1 0 1 1 1 0
?	1 0 1 1 1 1	A 8 4 2 1	0 1 1 0 1 1 1 1
:	1 1 1 0 1 0	No equivalent	0 1 1 1 1 0 1 0
AE	1 1 1 0 1 1	8 2 1	0 1 1 1 1 0 1 1
Ø	1 1 1 1 0 0	8 4	0 1 1 1 1 1 0 0
'	1 1 1 1 0 1	8 4 1	0 1 1 1 1 1 0 1
=	1 1 1 1 1 0	8 4 2	0 1 1 1 1 1 1 0
"	1 1 1 1 1 1	8 4 2 1	0 1 1 1 1 1 1 1

* This is not the standard EBCDIC code for "!" graphic; it is assigned for use in the "Negative Decimal Digit" mode of operation (see Section 2.2.3).



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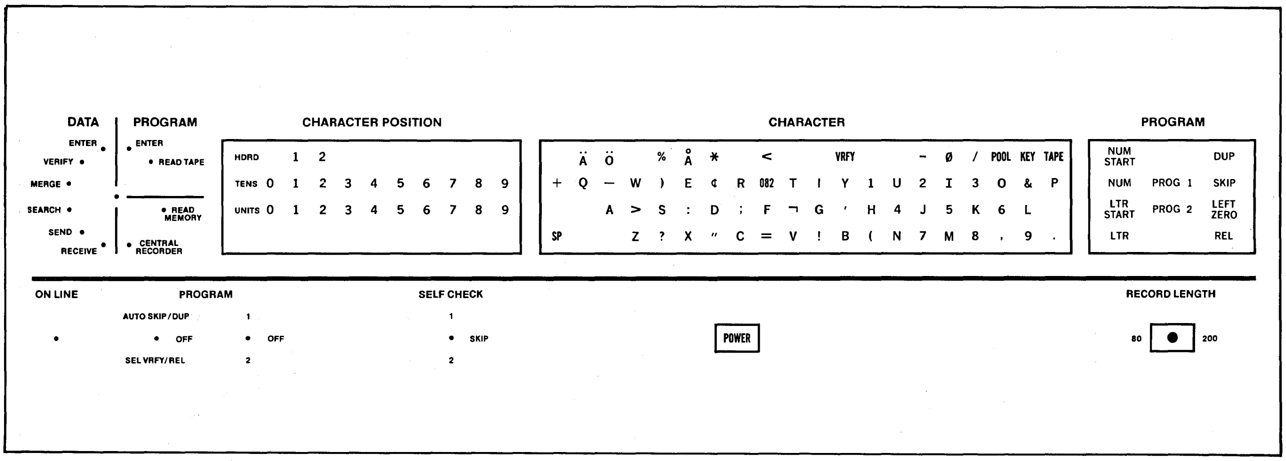

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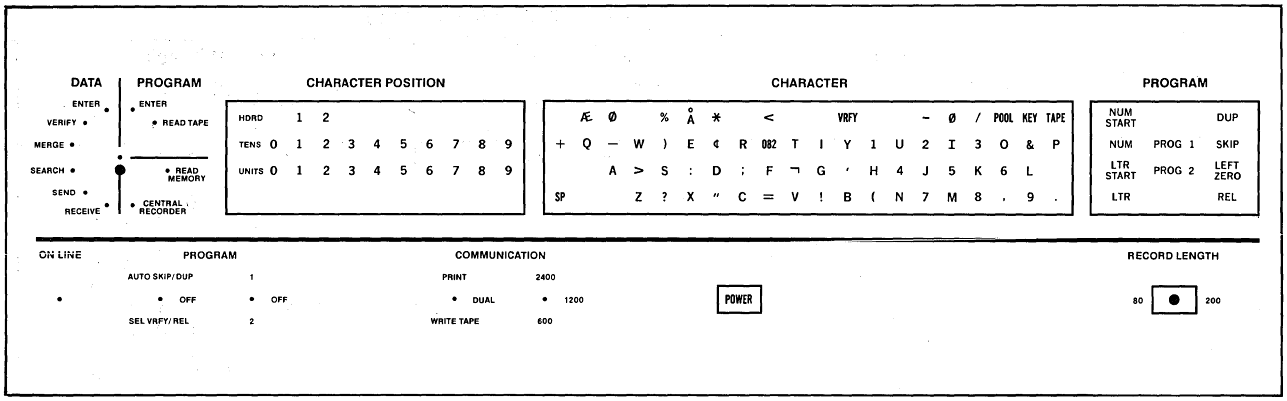
Figure A-6. Sweden/Finland

Table A-4. Keyboard Coding Chart: Sweden/Finland

Graphic/Control Symbol	MDRS Internal Machine code	IBM 7-Track EBCDIC code	IBM 9-Track EBCDIC code
	0 1 2 3 4 5	B A 8 4 2 1	0 1 2 3 4 5 6 7
0	1 1 0 0 0 0	8 2	1 1 1 1 0 0 0 0
1	1 1 0 0 0 1	1	1 1 1 1 0 0 0 1
2	1 1 0 0 1 0	2	1 1 1 1 0 0 1 0
3	1 1 0 0 1 1	2 1	1 1 1 1 0 0 1 1
4	1 1 0 1 0 0	4	1 1 1 1 0 1 0 0
5	1 1 0 1 0 1	4 1	1 1 1 1 0 1 0 1
6	1 1 0 1 1 0	4 2	1 1 1 1 0 1 1 0
7	1 1 0 1 1 1	4 2 1	1 1 1 1 0 1 1 1
8	1 1 1 0 0 0	8	1 1 1 1 1 0 0 0
9	1 1 1 0 0 1	8 1	1 1 1 1 1 0 0 1
—	1 0 1 0 1 0	B	0 1 1 0 0 0 0 0
&	0 1 0 0 0 0	B A	0 1 0 1 0 0 0 0
A	0 0 0 0 0 1	B A 1	1 1 0 0 0 0 0 1
B	0 0 0 0 1 0	B A 2	1 1 0 0 0 0 1 0
C	0 0 0 0 1 1	B A 2 1	1 1 0 0 0 0 1 1
D	0 0 0 1 0 0	B A 4	1 1 0 0 0 1 0 0
E	0 0 0 1 0 1	B A 4 1	1 1 0 0 0 1 0 1
F	0 0 0 1 1 0	B A 4 2	1 1 0 0 0 1 1 0
G	0 0 0 1 1 1	B A 4 2 1	1 1 0 0 0 1 1 1
H	0 0 1 0 0 0	B A 8	1 1 0 0 1 0 0 0
I	0 0 1 0 0 1	B A 8 1	1 1 0 0 1 0 0 1
J	0 1 0 0 0 1	B 1	1 1 0 1 0 0 0 1
K	0 1 0 0 1 0	B 2	1 1 0 1 0 0 1 0
L	0 1 0 0 1 1	B 2 1	1 1 0 1 0 0 1 1
M	0 1 0 1 0 0	B 4	1 1 0 1 0 1 0 0
N	0 1 0 1 0 1	B 4 1	1 1 0 1 0 1 0 1
O	0 1 0 1 1 0	B 4 2	1 1 0 1 0 1 1 0
P	0 1 0 1 1 1	B 4 2 1	1 1 0 1 0 1 1 1
Q	0 1 1 0 0 0	B 8	1 1 0 1 1 0 0 0
R	0 1 1 0 0 1	B 8 1	1 1 0 1 1 0 0 1
/	1 0 0 0 0 1	A 1	0 1 1 0 0 0 0 1
S	1 0 0 0 1 0	A 2	1 1 1 0 0 0 1 0
T	1 0 0 0 1 1	A 2 1	1 1 1 0 0 0 1 1
U	1 0 0 1 0 0	A 4	1 1 1 0 0 1 0 0
V	1 0 0 1 0 1	A 4 1	1 1 1 0 0 1 0 1
W	1 0 0 1 1 0	A 4 2	1 1 1 0 0 1 1 0
X	1 0 0 1 1 1	A 4 2 1	1 1 1 0 0 1 1 1
Y	1 0 1 0 0 0	A 8	1 1 1 0 1 0 0 0
Z	1 0 1 0 0 1	A 8 1	1 1 1 0 1 0 0 1
Space	0 0 0 0 0 0	A	0 1 0 0 0 0 0 0
¢	0 0 1 0 1 0	B A 8 2	0 1 0 0 1 0 1 0
.	0 0 1 0 1 1	B A 8 2 1	0 1 0 0 1 0 1 1
<	0 0 1 1 0 0	B A 8 4	0 1 0 0 1 1 0 0
(	0 0 1 1 0 1	B A 8 4 1	0 1 0 0 1 1 0 1
+	0 0 1 1 1 0	B A 8 4 2	0 1 0 0 1 1 1 0
|	0 0 1 1 1 1	B A 8 4 2 1	0 1 0 0 1 1 1 1
!	0 1 1 0 1 0	B 8 2	1 1 0 1 0 0 0 0*
Å	0 1 1 0 1 1	B 8 2 1	0 1 0 1 1 0 1 1
*	0 1 1 1 0 0	B 8 4	0 1 0 1 1 1 0 0
)	0 1 1 1 0 1	B 8 4 1	0 1 0 1 1 1 0 1
;	0 1 1 1 1 0	B 8 4 2	0 1 0 1 1 1 1 0
¬	0 1 1 1 1 1	B 8 4 2 1	0 1 0 1 1 1 1 1
0-8-2	1 0 0 0 0 0	A 8 2	1 1 1 0 0 0 0 0
,	1 0 1 0 1 1	A 8 2 1	0 1 1 0 1 0 1 1
%	1 0 1 1 0 0	A 8 4	0 1 1 0 1 1 0 0
_	1 0 1 1 0 1	A 8 4 1	0 1 1 0 1 1 0 1
>	1 0 1 1 1 0	A 8 4 2	0 1 1 0 1 1 1 0
?	1 0 1 1 1 1	A 8 4 2 1	0 1 1 0 1 1 1 1
:	1 1 1 0 1 0	No equivalent	0 1 1 1 1 0 1 0
Ä	1 1 1 0 1 1	8 2 1	0 1 1 1 1 0 1 1
ö	1 1 1 1 0 0	8 4	0 1 1 1 1 1 0 0
'	1 1 1 1 0 1	8 4 1	0 1 1 1 1 1 0 1
=	1 1 1 1 1 0	8 4 2	0 1 1 1 1 1 1 0
"	1 1 1 1 1 1	8 4 2 1	0 1 1 1 1 1 1 1

* This is not the standard EBCDIC code for a "!" graphic: it is assigned for use in the "Negative Decimal Digit" mode of operation (see Section 2.2.3).



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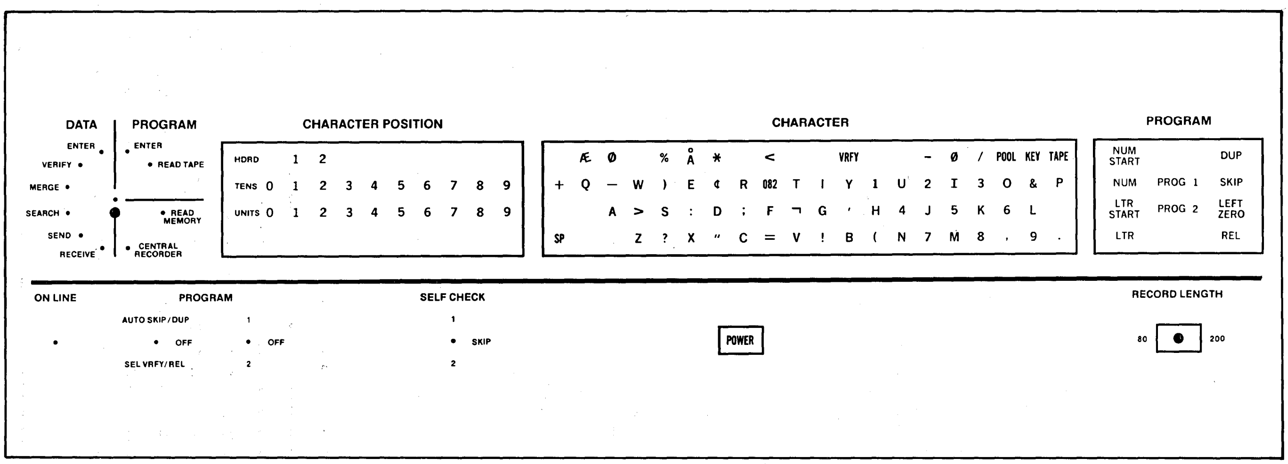

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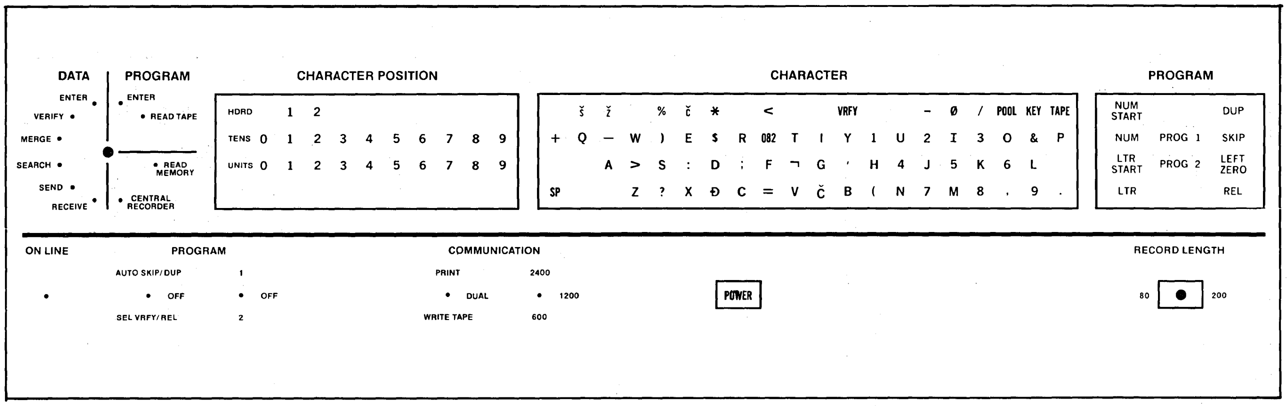
Figure A-7. Denmark

Table A-5. Keyboard Coding Chart: Denmark

Graphic/Control Symbol	MDRS Internal Machine Code						IBM 7-Track BCDIC Code						IBM 9-Track EBCDIC Code							
	0	1	2	3	4	5	B	A	8	4	2	1	0	1	2	3	4	5	6	7
Ø	1	1	0	0	0	0			8		2		1	1	1	1	0	0	0	0
1	1	1	0	0	0	1						1	1	1	1	1	0	0	0	1
2	1	1	0	0	1	0					2		1	1	1	1	0	0	1	0
3	1	1	0	0	1	1					2	1	1	1	1	1	0	0	1	1
4	1	1	0	1	0	0				4			1	1	1	1	0	1	0	0
5	1	1	0	1	0	1				4		1	1	1	1	1	0	1	0	1
6	1	1	0	1	1	0				4	2		1	1	1	1	0	1	1	0
7	1	1	0	1	1	1				4	2	1	1	1	1	1	0	1	1	1
8	1	1	1	0	0	0			8				1	1	1	1	1	0	0	0
9	1	1	1	0	0	1			8			1	1	1	1	1	1	0	0	1
–	1	0	1	0	1	0	B						0	1	1	0	0	0	0	0
&	0	1	0	0	0	0	B	A					0	1	0	1	0	0	0	0
A	0	0	0	0	0	1	B	A				1	1	1	0	0	0	0	0	1
B	0	0	0	0	1	0	B	A			2		1	1	0	0	0	0	1	0
C	0	0	0	0	1	1	B	A			2	1	1	1	0	0	0	0	1	1
D	0	0	0	1	0	0	B	A		4			1	1	0	0	0	1	0	0
E	0	0	0	1	0	1	B	A		4		1	1	1	0	0	0	1	0	1
F	0	0	0	1	1	0	B	A		4	2		1	1	0	0	0	1	1	0
G	0	0	0	1	1	1	B	A		4	2	1	1	1	0	0	0	1	1	1
H	0	0	1	0	0	0	B	A	8				1	1	0	0	1	0	0	0
I	0	0	1	0	0	1	B	A	8			1	1	1	0	0	1	0	0	1
J	0	1	0	0	0	1	B					1	1	1	0	1	0	0	0	1
K	0	1	0	0	1	0	B				2		1	1	0	1	0	0	1	0
L	0	1	0	0	1	1	B				2	1	1	1	0	1	0	0	1	1
M	0	1	0	1	0	0	B			4			1	1	0	1	0	1	0	0
N	0	1	0	1	0	1	B			4		1	1	1	0	1	0	1	0	1
O	0	1	0	1	1	0	B			4	2		1	1	0	1	0	1	1	0
P	0	1	0	1	1	1	B			4	2	1	1	1	0	1	0	1	1	1
Q	0	1	1	0	0	0	B		8				1	1	0	1	1	0	0	0
R	0	1	1	0	0	1	B		8			1	1	1	0	1	1	0	0	1
/	1	0	0	0	0	1		A				1	0	1	1	0	0	0	0	1
S	1	0	0	0	1	0		A			2		1	1	1	0	0	0	1	0
T	1	0	0	0	1	1		A			2	1	1	1	1	0	0	0	1	1
U	1	0	0	1	0	0		A		4			1	1	1	0	0	1	0	0
V	1	0	0	1	0	1		A		4		1	1	1	1	0	0	1	0	1
W	1	0	0	1	1	0		A		4	2		1	1	1	0	0	1	1	0
X	1	0	0	1	1	1		A		4	2	1	1	1	1	0	0	1	1	1
Y	1	0	1	0	0	0		A	8				1	1	1	0	1	0	0	0
Z	1	0	1	0	0	1		A	8			1	1	1	1	0	1	0	0	1
Space	0	0	0	0	0	0		A					0	1	0	0	0	0	0	0
¢	0	0	1	0	1	0	B	A	8		2		0	1	0	0	1	0	1	0
.	0	0	1	0	1	1	B	A	8		2	1	0	1	0	0	1	0	1	1
<	0	0	1	1	0	0	B	A	8	4			0	1	0	0	1	1	0	0
(	0	0	1	1	0	1	B	A	8	4		1	0	1	0	0	1	1	0	1
+	0	0	1	1	1	0	B	A	8	4	2		0	1	0	0	1	1	1	0
|	0	0	1	1	1	1	B	A	8	4	2	1	0	1	0	0	1	1	1	1
!	0	1	1	0	1	0	B		8		2		1	1	0	1	0	0	0	0*
Å	0	1	1	0	1	1	B		8		2	1	0	1	0	1	1	0	1	1
*	0	1	1	1	0	0	B		8	4			0	1	0	1	1	1	0	0
)	0	1	1	1	0	1	B		8	4		1	0	1	0	1	1	1	0	1
;	0	1	1	1	1	0	B		8	4	2		0	1	0	1	1	1	1	0
¬	0	1	1	1	1	1	B		8	4	2	1	0	1	0	1	1	1	1	1
0-8-2	1	0	0	0	0	0		A	8		2		1	1	1	0	0	0	0	0
,	1	0	1	0	1	1		A	8		2	1	0	1	1	0	1	0	1	1
%	1	0	1	1	0	0		A	8	4			0	1	1	0	1	1	0	0
_	1	0	1	1	0	1		A	8	4		1	0	1	1	0	1	1	0	1
>	1	0	1	1	1	0		A	8	4	2		0	1	1	0	1	1	1	0
?	1	0	1	1	1	1		A	8	4	2	1	0	1	1	0	1	1	1	1
:	1	1	1	0	1	0	No equivalent						0	1	1	1	1	0	1	0
Æ	1	1	1	0	1	1			8		2	1	0	1	1	1	1	0	1	1
ø	1	1	1	1	0	0			8	4			0	1	1	1	1	1	0	0
'	1	1	1	1	0	1			8	4		1	0	1	1	1	1	1	0	1
=	1	1	1	1	1	0			8	4	2		0	1	1	1	1	1	1	0
	1	1	1	1	1	1			8	4	2	1	0	1	1	1	1	1	1	1

* This is not the standard EBCDIC code for "!" graphic; it is assigned for use in the "Negative Decimal Digit" mode of operation (see Section 2.2.3).



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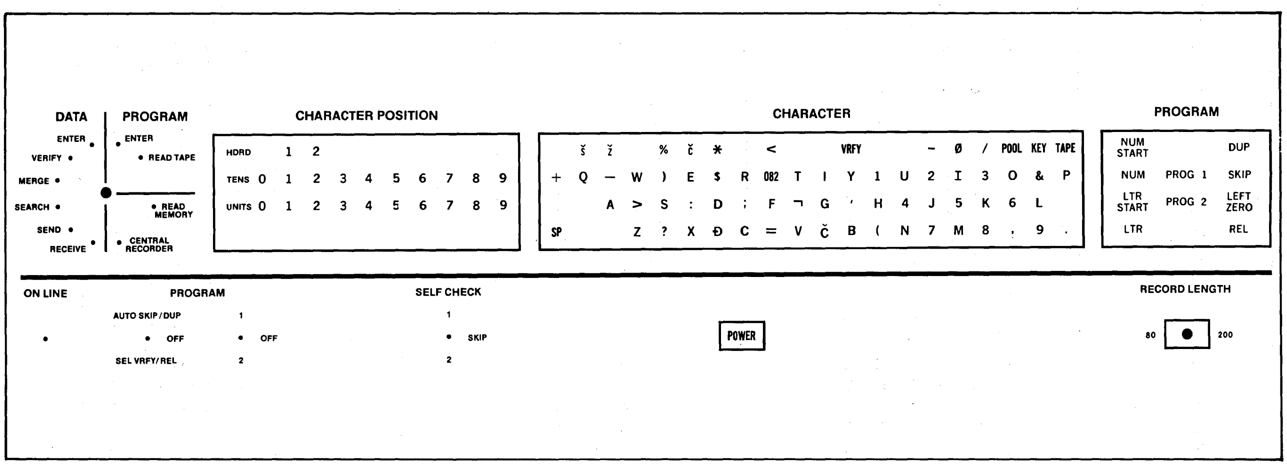

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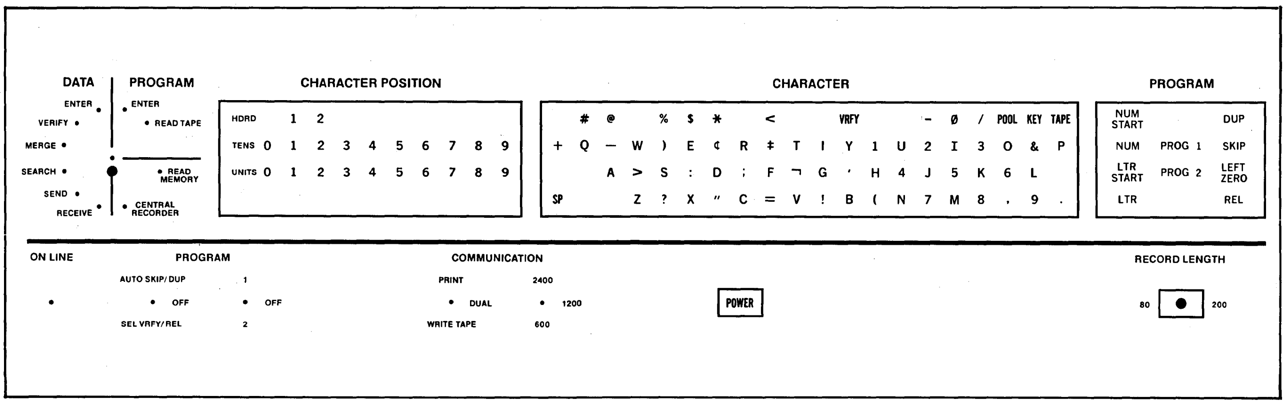
(keyboard not available at time of printing)

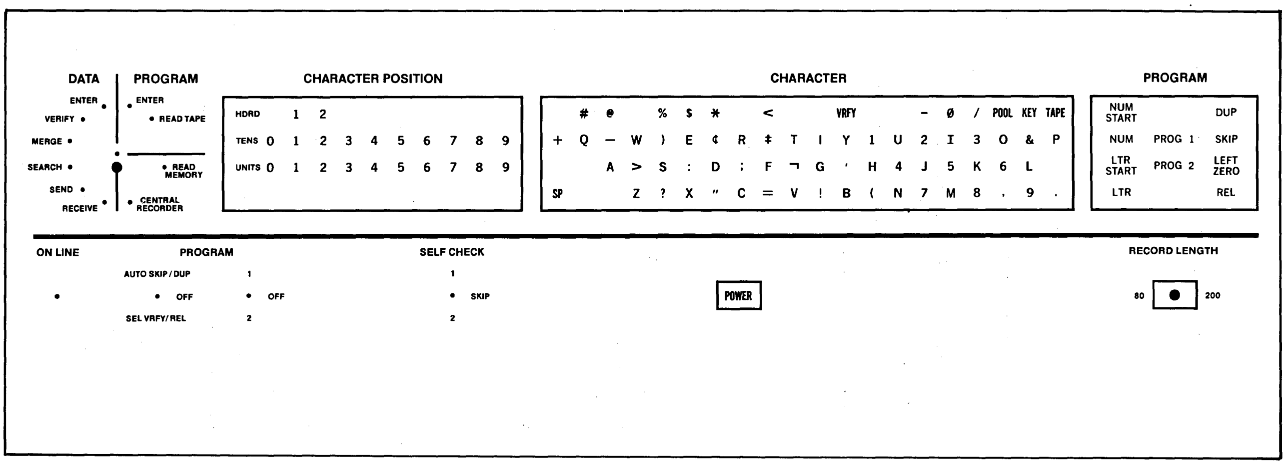
Figure A-8. Yugoslavia

Table A-6. Keyboard Coding Chart: Yugoslavia

Graphic/Control Symbol	MDRS Internal Machine Code	IBM 7-Track BCDIC Code	IBM 9-Track EBCDIC Code
	0 1 2 3 4 5	B A 8 4 2 1	0 1 2 3 4 5 6 7
Ø	1 1 0 0 0 0	8 2	1 1 1 1 0 0 0 0
1	1 1 0 0 0 1	1	1 1 1 1 0 0 0 1
2	1 1 0 0 1 0	2	1 1 1 1 0 0 1 0
3	1 1 0 0 1 1	2 1	1 1 1 1 0 0 1 1
4	1 1 0 1 0 0	4	1 1 1 1 0 1 0 0
5	1 1 0 1 0 1	4 1	1 1 1 1 0 1 0 1
6	1 1 0 1 1 0	4 2	1 1 1 1 0 1 1 0
7	1 1 0 1 1 1	4 2 1	1 1 1 1 0 1 1 1
8	1 1 1 0 0 0	8	1 1 1 1 1 0 0 0
9	1 1 1 0 0 1	8 1	1 1 1 1 1 0 0 1
–	1 0 1 0 1 0	B	0 1 1 0 0 0 0 0
&	0 1 0 0 0 0	B A	0 1 0 1 0 0 0 0
A	0 0 0 0 0 1	B A 1	1 1 0 0 0 0 0 1
B	0 0 0 0 1 0	B A 2	1 1 0 0 0 0 1 0
C	0 0 0 0 1 1	B A 2 1	1 1 0 0 0 0 1 1
D	0 0 0 1 0 0	B A 4	1 1 0 0 0 1 0 0
E	0 0 0 1 0 1	B A 4 1	1 1 0 0 0 1 0 1
F	0 0 0 1 1 0	B A 4 2	1 1 0 0 0 1 1 0
G	0 0 0 1 1 1	B A 4 2 1	1 1 0 0 0 1 1 1
H	0 0 1 0 0 0	B A 8	1 1 0 0 1 0 0 0
I	0 0 1 0 0 1	B A 8 1	1 1 0 0 1 0 0 1
J	0 1 0 0 0 1	B 1	1 1 0 1 0 0 0 1
K	0 1 0 0 1 0	B 2	1 1 0 1 0 0 1 0
L	0 1 0 0 1 1	B 2 1	1 1 0 1 0 0 1 1
M	0 1 0 1 0 0	B 4	1 1 0 1 0 1 0 0
N	0 1 0 1 0 1	B 4 1	1 1 0 1 0 1 0 1
O	0 1 0 1 1 0	B 4 2	1 1 0 1 0 1 1 0
P	0 1 0 1 1 1	B 4 2 1	1 1 0 1 0 1 1 1
Q	0 1 1 0 0 0	B 8	1 1 0 1 1 0 0 0
R	0 1 1 0 0 1	B 8 1	1 1 0 1 1 0 0 1
/	1 0 0 0 0 1	A 1	0 1 1 0 0 0 0 1
S	1 0 0 0 1 0	A 2	1 1 1 0 0 0 1 0
T	1 0 0 0 1 1	A 2 1	1 1 1 0 0 0 1 1
U	1 0 0 1 0 0	A 4	1 1 1 0 0 1 0 0
V	1 0 0 1 0 1	A 4 1	1 1 1 0 0 1 0 1
W	1 0 0 1 1 0	A 4 2	1 1 1 0 0 1 1 0
X	1 0 0 1 1 1	A 4 2 1	1 1 1 0 0 1 1 1
Y	1 0 1 0 0 0	A 8	1 1 1 0 1 0 0 0
Z	1 0 1 0 0 1	A 8 1	1 1 1 0 1 0 0 1
Space	0 0 0 0 0 0	A	0 1 0 0 0 0 0 0
$	0 0 1 0 1 0	B A 8 2	0 1 0 0 1 0 1 0
.	0 0 1 0 1 1	B A 8 2 1	0 1 0 0 1 0 1 1
<	0 0 1 1 0 0	B A 8 4	0 1 0 0 1 1 0 0
(	0 0 1 1 0 1	B A 8 4 1	0 1 0 0 1 1 0 1
+	0 0 1 1 1 0	B A 8 4 2	0 1 0 0 1 1 1 0
|	0 0 1 1 1 1	B A 8 4 2 1	0 1 0 0 1 1 1 1
Č	0 1 1 0 1 0	B 8 2	0 1 0 1 1 0 1 0
č	0 1 1 0 1 1	B 8 2 1	0 1 0 1 1 0 1 1
*	0 1 1 1 0 0	B 8 4	0 1 0 1 1 1 0 0
)	0 1 1 1 0 1	B 8 4 1	0 1 0 1 1 1 0 1
;	0 1 1 1 1 0	B 8 4 2	0 1 0 1 1 1 1 0
¬	0 1 1 1 1 1	B 8 4 2 1	0 1 0 1 1 1 1 1
0-8-2	1 0 0 0 0 0	A 8 2	1 1 1 0 0 0 0 0
,	1 0 1 0 1 1	A 8 2 1	0 1 1 0 1 0 1 1
%	1 0 1 1 0 0	A 8 4	0 1 1 0 1 1 0 0
_	1 0 1 1 0 1	A 8 4 1	0 1 1 0 1 1 0 1
>	1 0 1 1 1 0	A 8 4 2	0 1 1 0 1 1 1 0
?	1 0 1 1 1 1	A 8 4 2 1	0 1 1 0 1 1 1 1
:	1 1 1 0 1 0	No equivalent	0 1 1 1 1 0 1 0
š	1 1 1 0 1 1	8 2 1	0 1 1 1 1 0 1 1
ž	1 1 1 1 0 0	8 4	0 1 1 1 1 1 0 0
'	1 1 1 1 0 1	8 4 1	0 1 1 1 1 1 0 1
=	1 1 1 1 1 0	8 4 2	0 1 1 1 1 1 1 0
Đ	1 1 1 1 1 1	8 4 2 1	0 1 1 1 1 1 1 1

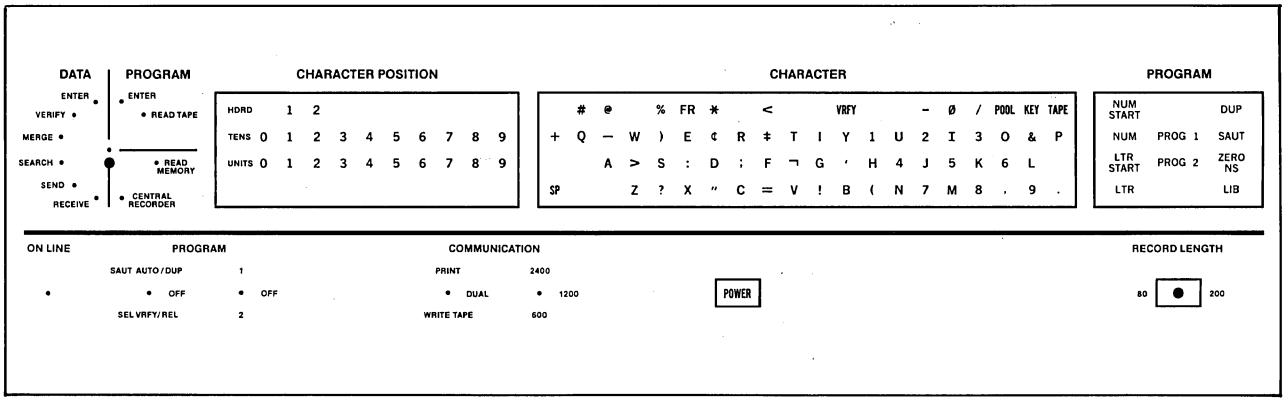


4310 Series



4320 Series

Figure A-9. Honeywell



4310 Series

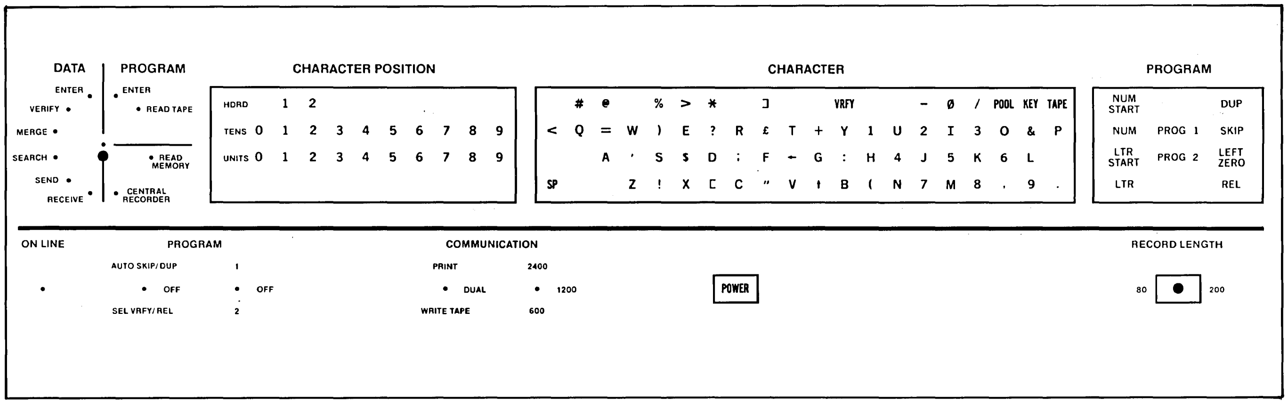
(4320 Series Display not available at time of publication)

4320 Series

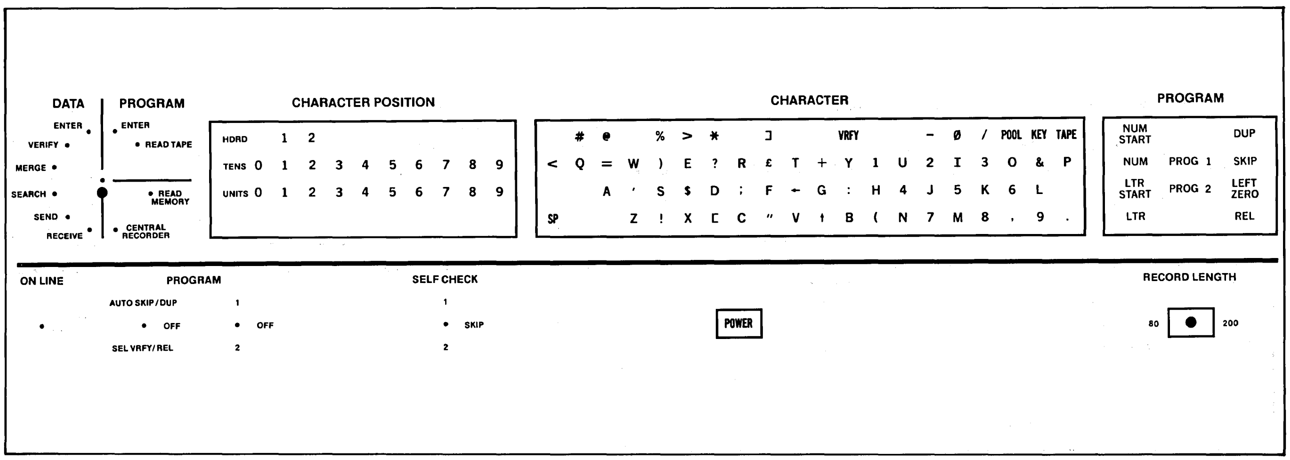
Figure A-10. Honeywell — France

Table A-7. Keyboard Coding Chart: Honeywell - France

Graphic/Control Symbol	MDRS Internal Machine code						Honeywell 7-Track Tape Code					
	0	1	2	3	4	5	B	A	8	4	2	1
0	1	1	0	0	0	0						
1	1	1	0	0	0	1						1
2	1	1	0	0	1	0					2	
3	1	1	0	0	1	1					2	1
4	1	1	0	1	0	0				4		
5	1	1	0	1	0	1				4		1
6	1	1	0	1	1	0				4	2	
7	1	1	0	1	1	1				4	2	1
8	1	1	1	0	0	0			8			
9	1	1	1	0	0	1			8			1
—	1	0	1	0	1	0	B					
&	0	1	0	0	0	0		A				
A	0	0	0	0	0	1		A				1
B	0	0	0	0	1	0		A			2	
C	0	0	0	0	1	1		A			2	1
D	0	0	0	1	0	0		A		4		
E	0	0	0	1	0	1		A		4		1
F	0	0	0	1	1	0		A		4	2	
G	0	0	0	1	1	1		A		4	2	1
H	0	0	1	0	0	0		A	8			
I	0	0	1	0	0	1		A	8			1
J	0	1	0	0	0	1	B					1
K	0	1	0	0	1	0	B				2	
L	0	1	0	0	1	1	B				2	1
M	0	1	0	1	0	0	B			4		
N	0	1	0	1	0	1	B			4		1
O	0	1	0	1	1	0	B			4	2	
P	0	1	0	1	1	1	B			4	2	1
Q	0	1	1	0	0	0	B		8			
R	0	1	1	0	0	1	B		8			1
/	1	0	0	0	0	1	B	A				1
S	1	0	0	0	1	0	B	A			2	
T	1	0	0	0	1	1	B	A			2	1
U	1	0	0	1	0	0	B	A		4		
V	1	0	0	1	0	1	B	A		4		1
W	1	0	0	1	1	0	B	A		4	2	
X	1	0	0	1	1	1	B	A		4	2	1
Y	1	0	1	0	0	0	B	A	8			
Z	1	0	1	0	0	1	B	A	8			1
Space	0	0	0	0	0	0			8	4		1
¢	0	0	1	0	1	0		A	8		2	
.	0	0	1	0	1	1		A	8		2	1
<	0	0	1	1	0	0		A	8	4		
(	0	0	1	1	0	1		A	8	4		1
+	0	0	1	1	1	0		A	8	4	2	
|	0	0	1	1	1	1		A	8	4	2	1
!	0	1	1	0	1	0	B		8		2	
FR	0	1	1	0	1	1	B		8		2	1
*	0	1	1	1	0	0	B		8	4		
)	0	1	1	1	0	1	B		8	4		1
;	0	1	1	1	1	0	B		8	4	2	
¬	0	1	1	1	1	1	B		8	4	2	1
ǂ	1	0	0	0	0	0	B	A	8		2	
,	1	0	1	0	1	1	B	A	8		2	1
%	1	0	1	1	0	0	B	A	8	4		
¯	1	0	1	1	0	1	B	A	8	4		1
>	1	0	1	1	1	0	B	A	8	4	2	
?	1	0	1	1	1	1	B	A	8	4	2	1
:	1	1	1	0	1	0			8		2	
#	1	1	1	0	1	1			8		2	1
@	1	1	1	1	0	0			8	4		
'	1	1	1	1	0	1	B	A				
=	1	1	1	1	1	0			8	4	2	
"	1	1	1	1	1	1			8	4	2	1

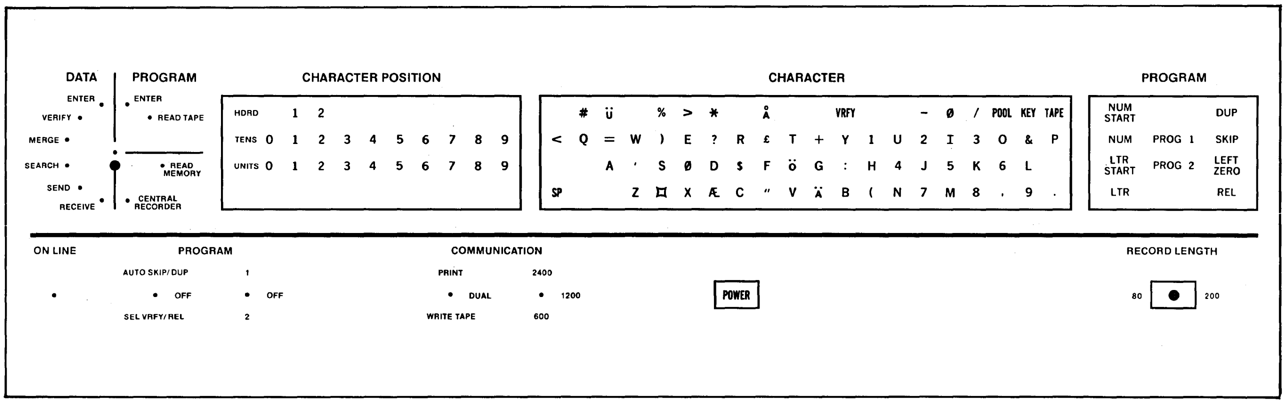


4310 Series

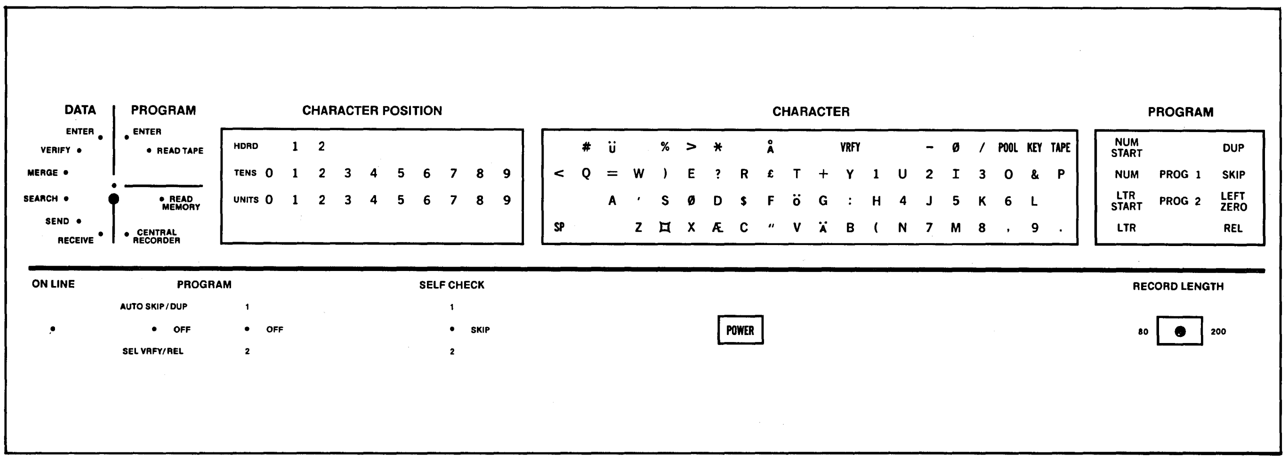


4320 Series

Figure A-II. ICL



4310 Series



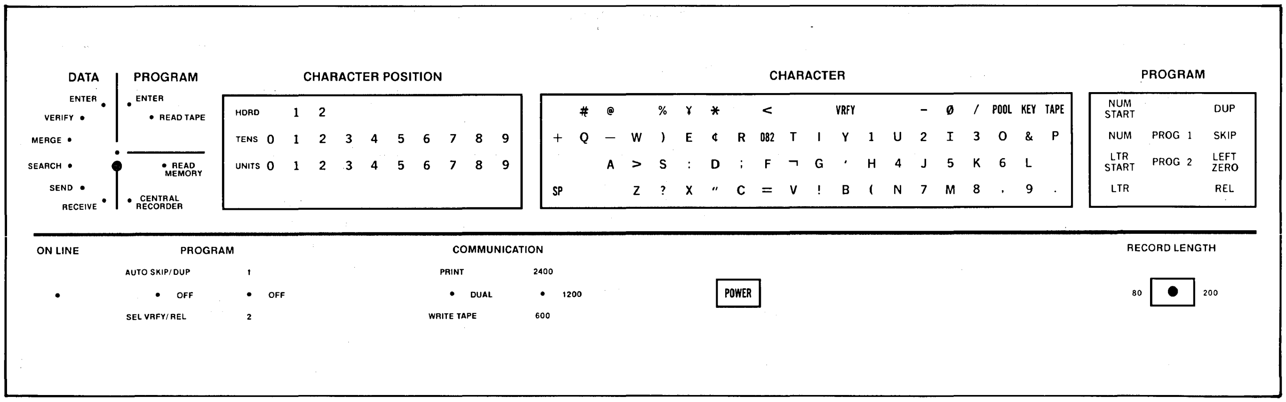
4320 Series

Figure A-12. ICL - Sweden

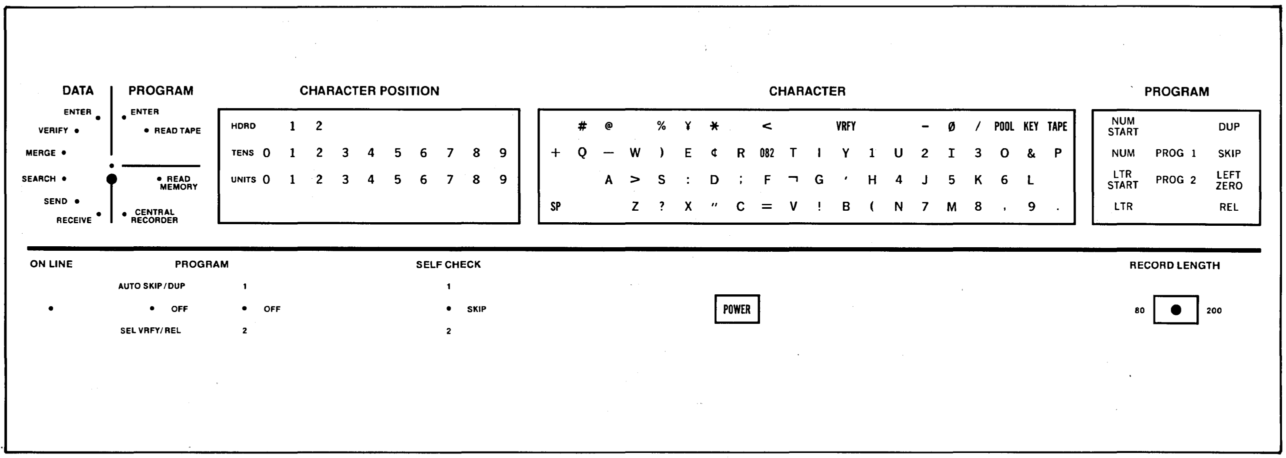
Table A-8. Keyboard Coding Chart; ICL - Sweden

ICL Graphic/ Control Symbol	MDRS internal Machine Code						ICL 7-Track Tape Code (Shown w/o parity)					
	0	1	2	3	4	5	B	A	8	4	2	1
0	1	1	0	0	0	0	B	A	8	4		
1	1	1	0	0	0	1	B	A	8	4		1
2	1	1	0	0	1	0	B	A	8	4	2	
3	1	1	0	0	1	1	B	A	8	4	2	1
4	1	1	0	1	0	0	B	A	8			
5	1	1	0	1	0	1	B	A	8			1
6	1	1	0	1	1	0	B	A	8		2	
7	1	1	0	1	1	1	B	A	8		2	1
8	1	1	1	0	0	0	B	A		4		
9	1	1	1	0	0	1	B	A		4		1
—	1	0	1	0	1	0	B					1
&	0	1	0	0	0	0	B		8		2	
A	0	0	0	0	0	1		A	8	4		1
B	0	0	0	0	1	0		A	8	4	2	
C	0	0	0	0	1	1		A	8	4	2	1
D	0	0	0	1	0	0		A	8			
E	0	0	0	1	0	1		A	8			1
F	0	0	0	1	1	0		A	8		2	
G	0	0	0	1	1	1		A	8		2	1
H	0	0	1	0	0	0		A		4		
I	0	0	1	0	0	1		A		4		1
J	0	1	0	0	0	1		A		4	2	
K	0	1	0	0	1	0		A		4	2	1
L	0	1	0	0	1	1		A				
M	0	1	0	1	0	0		A				1
N	0	1	0	1	0	1		A			2	
O	0	1	0	1	1	0		A			2	1
P	0	1	0	1	1	1			8	4		
Q	0	1	1	0	0	0			8	4		1
R	0	1	1	0	0	1			8	4	2	
/	1	0	0	0	0	1	B				2	1
S	1	0	0	0	1	0			8	4	2	1
T	1	0	0	0	1	1			8			
U	1	0	0	1	0	0			8			1
V	1	0	0	1	0	1			8		2	
W	1	0	0	1	1	0			8		2	1
X	1	0	0	1	1	1				4		
Y	1	0	1	0	0	0				4		1
Z	1	0	1	0	0	1				4	2	
Space	0	0	0	0	0	0	B		8	4		
?	0	0	1	0	1	0	B	A			2	1
.	0	0	1	0	1	1	B				2	
Å	0	0	1	1	0	0						1
(	0	0	1	1	0	1	B			4		
<	0	0	1	1	1	0	B	A				
+	0	0	1	1	1	1	B			4	2	1
Ä	0	1	1	0	1	0					2	
>	0	1	1	0	1	1	B	A			2	
*	0	1	1	1	0	0	B			4	2	
)	0	1	1	1	0	1	B			4		1
$	0	1	1	1	1	0	B	A		4	2	1
Ö	0	1	1	1	1	1					2	1
£	1	0	0	0	0	0	B		8			
,	1	0	1	0	1	1	B					
%	1	0	1	1	0	0	B		8			1
=	1	0	1	1	0	1	B	A				1
'	1	0	1	1	1	0	B		8		2	1
¤	1	0	1	1	1	1	B		8	4		1
¢	1	1	1	0	1	0			*			
#	1	1	1	0	1	1	B		8	4	2	1
Ü	1	1	1	1	0	0		A	8	4		
:	1	1	1	1	0	1	B	A		4	2	
"	1	1	1	1	1	0	B		8	4	2	
Æ	1	1	1	1	1	1				4	2	1

* Unallowable on even parity tape.



4310 Series



4320 Series

Figure A-13. Katakana - Japan

Table A-9. Keyboard Coding Chart for Kana Characters

Kana Character	Hex Codes	Tape Binary Codes								Internal Bus Codes						
		0	1	2	3	4	5	6	7	K	0	1	2	3	4	5
ア	81	1	0	0	0	0	0	0	1	1	0	0	0	0	0	1
イ	82	1	0	0	0	0	0	1	0	1	0	0	0	0	1	0
ウ	83	1	0	0	0	0	0	1	1	1	0	0	0	0	1	1
エ	84	1	0	0	0	0	1	0	0	1	0	0	0	1	0	0
オ	85	1	0	0	0	0	1	0	1	1	0	0	0	1	0	1
カ	86	1	0	0	0	0	1	1	0	1	0	0	0	1	1	0
キ	87	1	0	0	0	0	1	1	1	1	0	0	0	1	1	1
ク	88	1	0	0	0	1	0	0	0	1	0	0	1	0	0	0
ケ	89	1	0	0	0	1	0	0	1	1	0	0	1	0	0	1
コ	8A	1	0	0	0	1	0	1	0	1	0	0	1	0	1	0
サ	8C	1	0	0	0	1	1	0	0	1	0	0	1	1	0	0
シ	8D	1	0	0	0	1	1	0	1	1	0	0	1	1	0	1
ス	8E	1	0	0	0	1	1	1	0	1	0	0	1	1	1	0
セ	8F	1	0	0	0	1	1	1	1	1	0	0	1	1	1	1
ソ	90	1	0	0	1	0	0	0	0	1	0	1	0	0	0	0
タ	91	1	0	0	1	0	0	0	1	1	0	1	0	0	0	1
チ	92	1	0	0	1	0	0	1	0	1	0	1	0	0	1	0
ツ	93	1	0	0	1	0	0	1	1	1	0	1	0	0	1	1
テ	94	1	0	0	1	0	1	0	0	1	0	1	0	1	0	0
ト	95	1	0	0	1	0	1	0	1	1	0	1	0	1	0	1
ナ	96	1	0	0	1	0	1	1	0	1	0	1	0	1	1	0
ニ	97	1	0	0	1	0	1	1	1	1	0	1	0	1	1	1
ヌ	98	1	0	0	1	1	0	0	0	1	0	1	1	0	0	0
ネ	99	1	0	0	1	1	0	0	1	1	0	1	1	0	0	1
ノ	9A	1	0	0	1	1	0	1	0	1	0	1	1	0	1	0
ハ	9D	1	0	0	1	1	1	0	1	1	0	1	1	1	0	1
ヒ	9E	1	0	0	1	1	1	1	0	1	0	1	1	1	1	0
フ	9F	1	0	0	1	1	1	1	1	1	0	1	1	1	1	1
ヘ	A2	1	0	1	0	0	0	1	0	1	1	0	0	0	1	0
ホ	A3	1	0	1	0	0	0	1	1	1	1	0	0	0	1	1
マ	A4	1	0	1	0	0	1	0	0	1	1	0	0	1	0	0
ミ	A5	1	0	1	0	0	1	0	1	1	1	0	0	1	0	1
ム	A6	1	0	1	0	0	1	1	0	1	1	0	0	1	1	0
メ	A7	1	0	1	0	0	1	1	1	1	1	0	0	1	1	1
モ	A8	1	0	1	0	1	0	0	0	1	1	0	1	0	0	0
ヤ	A9	1	0	1	0	1	0	0	1	1	1	0	1	0	0	1
ユ	AA	1	0	1	0	1	0	1	0	1	1	0	1	0	1	0
ヨ	AC	1	0	1	0	1	1	0	0	1	1	0	1	1	0	0
ラ	AD	1	0	1	0	1	1	0	1	1	1	0	1	1	0	1
リ	AE	1	0	1	0	1	1	1	0	1	1	0	1	1	1	0
ル	AF	1	0	1	0	1	1	1	1	1	1	0	1	1	1	1
レ	BA	1	0	1	1	1	0	1	0	1	1	1	1	0	1	0
ロ	BB	1	0	1	1	1	0	1	1	1	1	1	1	0	1	1
ワ	BC	1	0	1	1	1	1	0	0	1	1	1	1	1	0	0
ン	BD	1	0	1	1	1	1	0	1	1	1	1	1	1	0	1
ﾞ	BE	1	0	1	1	1	1	1	0	1	1	1	1	1	1	0
ﾟ	BF	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1

APPENDIX B. APPROVED MODEMS

The following is a list of modems that have been tested and approved for use with the Series 4310 data communications option:

BELL DATA SET 201*
BELL DATA SET 202*
PARADYNE BYSYNC -- 48
RIXON (UBC) DS-2400
MILGO (ICC) 3300/36
MILGO (ICC) 2200/24
MILGO (ICC) 2200/20
TELTECH TT 201
TELTECH TT 202
TELESIGNAL 888 R

* When using BELL 202C modems, make sure telephone company checks for latest revision level on those modems. In addition, the 202 is the only modem in this list which includes reverse channel operation.

APPENDIX C. USASCII AND EBCDIC CODE SETS

Table C-1. USASCII Code Set (With Odd Parity)

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

CHAR.	CARD CODE	USASCII CODE								HEX
		1	2	3	4	5	6	7	P	
@	8-4	0	0	0	0	0	0	1	0	40
A	12-1	1	0	0	0	0	0	1	1	41
B	12-2	0	1	0	0	0	0	1	1	42
C	12-3	1	1	0	0	0	0	1	0	43
D	12-4	0	0	1	0	0	0	1	1	44
E	12-5	1	0	1	0	0	0	1	0	45
F	12-6	0	1	1	0	0	0	1	0	46
G	12-7	1	1	1	0	0	0	1	1	47
H	12-8	0	0	0	1	0	0	1	1	48
I	12-9	1	0	0	1	0	0	1	0	49
J	11-1	0	1	0	1	0	0	1	0	4A
K	11-2	1	1	0	1	0	0	1	1	4B
L	11-3	0	0	1	1	0	0	1	0	4C
M	11-4	1	0	1	1	0	0	1	1	4D
N	11-5	0	1	1	1	0	0	1	1	4E
O	11-6	1	1	1	1	0	0	1	0	4F
P	11-7	0	0	0	0	1	0	1	1	50
Q	11-8	1	0	0	0	1	0	1	0	51
R	11-9	0	1	0	0	1	0	1	0	52
S	0-2	1	1	0	0	1	0	1	1	53
T	0-3	0	0	1	0	1	0	1	0	54
U	0-4	1	0	1	0	1	0	1	1	55
V	0-5	0	1	1	0	1	0	1	1	56
W	0-6	1	1	1	0	1	0	1	0	57
X	0-7	0	0	0	1	1	0	1	0	58
Y	0-8	1	0	0	1	1	0	1	1	59
Z	0-9	0	1	0	1	1	0	1	1	5A
[	12-8-2	1	1	0	1	1	0	1	0	5B
\	0-8-2	0	0	1	1	1	0	1	1	5C
]	11-8-2	1	0	1	1	1	0	1	0	5D
¬	11-8-7	0	1	1	1	1	0	1	0	5E
–	0-8-5	1	1	1	1	1	0	1	1	5F
'	8-1	0	0	0	0	0	1	1	1	60
a	12-0-1	1	0	0	0	0	1	1	0	61
b	12-0-2	0	1	0	0	0	1	1	0	62
c	12-0-3	1	1	0	0	0	1	1	1	63
d	12-0-4	0	0	1	0	0	1	1	0	64
e	12-0-5	1	0	1	0	0	1	1	1	65
f	12-0-6	0	1	1	0	0	1	1	1	66
g	12-0-7	1	1	1	0	0	1	1	0	67
h	12-0-8	0	0	0	1	0	1	1	0	68
i	12-0-9	1	0	0	1	0	1	1	1	69
j	12-11-1	0	1	0	1	0	1	1	1	6A
k	12-11-2	1	1	0	1	0	1	1	0	6B
l	12-11-3	0	0	1	1	0	1	1	1	6C
m	12-11-4	1	0	1	1	0	1	1	0	6D
n	12-11-5	0	1	1	1	0	1	1	0	6E
o	12-11-6	1	1	1	1	0	1	1	1	6F
p	12-11-7	0	0	0	0	1	1	1	0	70
q	12-11-8	1	0	0	0	1	1	1	1	71
r	12-11-9	0	1	0	0	1	1	1	1	72
s	11-0-2	1	1	0	0	1	1	1	0	73
t	11-0-3	0	0	1	0	1	1	1	1	74
u	11-0-4	1	0	1	0	1	1	1	0	75
v	11-0-5	0	1	1	0	1	1	1	0	76
w	11-0-6	1	1	1	0	1	1	1	1	77
x	11-0-7	0	0	0	1	1	1	1	1	78
y	11-0-8	1	0	0	1	1	1	1	0	79
z	11-0-9	0	1	0	1	1	1	1	0	7A
{	12-0	1	1	0	1	1	1	1	1	7B
¦	12-11	0	0	1	1	1	1	1	0	7C
}	11-0	1	0	1	1	1	1	1	1	7D
~	11-0-1	0	1	1	1	1	1	1	1	7E
DEL	12-9-7	1	1	1	1	1	1	1	0	7F

Parity bit not included in hexidecimel count (HEX)

Table C-2. EBCDIC Code Set

CHAR.	CARD CODE	EBCDIC CODE 7	6	5	4	3	2	1	0	HEX
NUL	12-0-1-8-9	0	0	0	0	0	0	0	0	00
SOH	12-1-9	0	0	0	0	0	0	0	1	01
STX	12-2-9	0	0	0	0	0	0	1	0	02
ETX	12-3-9	0	0	0	0	0	0	1	1	03
PF	12-4-9	0	0	0	0	0	1	0	0	04
HT	12-5-9	0	0	0	0	0	1	0	1	05
LC	12-6-9	0	0	0	0	0	1	1	0	06
DEL	12-7-9	0	0	0	0	0	1	1	1	07
	12-8-9	0	0	0	0	1	0	0	0	08
RLF	12-1-8-9	0	0	0	0	1	0	0	1	09
SMM	12-2-8-9	0	0	0	0	1	0	1	0	0A
VT	12-3-8-9	0	0	0	0	1	0	1	1	0B
FF	12-4-8-9	0	0	0	0	1	1	0	0	0C
CR	12-5-8-9	0	0	0	0	1	1	0	1	0D
SO	12-6-8-9	0	0	0	0	1	1	1	0	0E
SI	12-7-8-9	0	0	0	0	1	1	1	1	0F
DLE	12-11-1-8-9	0	0	0	1	0	0	0	0	10
DC1	11-1-9	0	0	0	1	0	0	0	1	11
DC2	11-2-9	0	0	0	1	0	0	1	0	12
DC3 (TM)	11-3-9	0	0	0	1	0	0	1	1	13
RES	11-4-9	0	0	0	1	0	1	0	0	14
NL	11-5-9	0	0	0	1	0	1	0	1	15
BS	11-6-9	0	0	0	1	0	1	1	0	16
IL	11-7-9	0	0	0	1	0	1	1	1	17
CAN	11-8-9	0	0	0	1	1	0	0	0	18
EM	11-1-8-9	0	0	0	1	1	0	0	1	19
CC	11-2-8-9	0	0	0	1	1	0	1	0	1A
CUI	11-3-8-9	0	0	0	1	1	0	1	1	1B
IFS	11-4-8-9	0	0	0	1	1	1	0	0	1C
IGS	11-5-8-9	0	0	0	1	1	1	0	1	1D
IRS	11-6-8-9	0	0	0	1	1	1	1	0	1E
IUS	11-7-8-9	0	0	0	1	1	1	1	1	1F
DS	11-0-1-8-9	0	0	1	0	0	0	0	0	20
SOS	0-1-9	0	0	1	0	0	0	0	1	21
FS	0-2-9	0	0	1	0	0	0	1	0	22
	0-3-9	0	0	1	0	0	0	1	1	23
BYP	0-4-9	0	0	1	0	0	1	0	0	24
LF	0-5-9	0	0	1	0	0	1	0	1	25
ETB (EOB)	0-6-9	0	0	1	0	0	1	1	0	26
ESC (PRE)	0-7-9	0	0	1	0	0	1	1	1	27
	0-8-9	0	0	1	0	1	0	0	0	28
	0-1-8-9	0	0	1	0	1	0	0	1	29
SM	0-2-8-9	0	0	1	0	1	0	1	0	2A
CU2	0-3-8-9	0	0	1	0	1	0	1	1	2B
	0-4-8-9	0	0	1	0	1	1	0	0	2C
ENQ	0-5-8-9	0	0	1	0	1	1	0	1	2D
ACK	0-6-8-9	0	0	1	0	1	1	1	0	2E
REL	0-7-8-9	0	0	1	0	1	1	1	1	2F
	12-11-0-1-8-9	0	0	1	1	0	0	0	0	30
	1-9	0	0	1	1	0	0	0	1	31
SYN	2-9	0	0	1	1	0	0	1	0	32
	3-9	0	0	1	1	0	0	1	1	33
FN	4-9	0	0	1	1	0	1	0	0	34
RS	5-9	0	0	1	1	0	1	0	1	35
UC	6-9	0	0	1	1	0	1	1	0	36
EOT	7-9	0	0	1	1	0	1	1	1	37
	8-9	0	0	1	1	1	0	0	0	38
	1-8-9	0	0	1	1	1	0	0	1	39
	2-8-9	0	0	1	1	1	0	1	0	3A
CU3	3-8-9	0	0	1	1	1	0	1	1	3B
DC4	4-8-9	0	0	1	1	1	1	0	0	3C
NAK	5-8-9	0	0	1	1	1	1	0	1	3D
	6-8-9	0	0	1	1	1	1	1	0	3E
SUB	7-8-9	0	0	1	1	1	1	1	1	3F

CHAR.	CARD CODE	EBCDIC CODE 7	6	5	4	3	2	1	0	HEX
SPACE	NO PUNCHING	0	1	0	0	0	0	0	0	40
	12-0-1-9	0	1	0	0	0	0	0	1	41
	12-0-2-9	0	1	0	0	0	0	1	0	42
	12-0-3-9	0	1	0	0	0	0	1	1	43
	12-0-4-9	0	1	0	0	0	1	0	0	44
	12-0-5-9	0	1	0	0	0	1	0	1	45
	12-0-6-9	0	1	0	0	0	1	1	0	46
	12-0-7-9	0	1	0	0	0	1	1	1	47
	12-0-8-9	0	1	0	0	1	0	0	0	48
	12-1-8	0	1	0	0	1	0	0	1	49
¢	12-2-8	0	1	0	0	1	0	1	0	4A
.	12-3-8	0	1	0	0	1	0	1	1	4B
<	12-4-8	0	1	0	0	1	1	0	0	4C
(	12-5-8	0	1	0	0	1	1	0	1	4D
+	12-6-8	0	1	0	0	1	1	1	0	4E
|	12-7-8	0	1	0	0	1	1	1	1	4F
&	12	0	1	0	1	0	0	0	0	50
	12-11-1-9	0	1	0	1	0	0	0	1	51
	12-11-2-9	0	1	0	1	0	0	1	0	52
	12-11-3-9	0	1	0	1	0	0	1	1	53
	12-11-4-9	0	1	0	1	0	1	0	0	54
	12-11-5-9	0	1	0	1	0	1	0	1	55
	12-11-6-9	0	1	0	1	0	1	1	0	56
	12-11-7-9	0	1	0	1	0	1	1	1	57
	12-11-8-9	0	1	0	1	1	0	0	0	58
	11-1-8	0	1	0	1	1	0	0	1	59
|	11-2-8	0	1	0	1	1	0	1	0	5A
$	11-3-8	0	1	0	1	1	0	1	1	5B
*	11-4-8	0	1	0	1	1	1	0	0	5C
)	11-5-8	0	1	0	1	1	1	0	1	5D
;	11-6-8	0	1	0	1	1	1	1	0	5E
¬	11-7-8	0	1	0	1	1	1	1	1	5F
-	11	0	1	1	0	0	0	0	0	60
/	0-1	0	1	1	0	0	0	0	1	61
	11-0-2-9	0	1	1	0	0	0	1	0	62
	11-0-3-9	0	1	1	0	0	0	1	1	63
	11-0-4-9	0	1	1	0	0	1	0	0	64
	11-0-5-9	0	1	1	0	0	1	0	1	65
	11-0-6-9	0	1	1	0	0	1	1	0	66
	11-0-7-9	0	1	1	0	0	1	1	1	67
	11-0-8-9	0	1	1	0	1	0	0	0	68
	0-1-8	0	1	1	0	1	0	0	1	69
	12-11	0	1	1	0	1	0	1	0	6A
,	0-3-8	0	1	1	0	1	0	1	1	6B
%	0-4-8	0	1	1	0	1	1	0	0	6C
_	0-5-8	0	1	1	0	1	1	0	1	6D
>	0-6-8	0	1	1	0	1	1	1	0	6E
?	0-7-8	0	1	1	0	1	1	1	1	6F
	12-11-0	0	1	1	1	0	0	0	0	70
F1	12-11-0-1-9	0	1	1	1	0	0	0	1	71
F2	12-11-0-2-9	0	1	1	1	0	0	1	0	72
F3	12-11-0-3-9	0	1	1	1	0	0	1	1	73
F4	12-11-0-4-9	0	1	1	1	0	1	0	0	74
F5	12-11-0-5-9	0	1	1	1	0	1	0	1	75
F6	12-11-0-6-9	0	1	1	1	0	1	1	0	76
F7	12-11-0-7-9	0	1	1	1	0	1	1	1	77
F8	12-11-0-8-9	0	1	1	1	1	0	0	0	78
	1-8	0	1	1	1	1	0	0	1	79
:	2-8	0	1	1	1	1	0	1	0	7A
#	3-8	0	1	1	1	1	0	1	1	7B
@	4-8	0	1	1	1	1	1	0	0	7C
'	5-8	0	1	1	1	1	1	0	1	7D
=	6-8	0	1	1	1	1	1	1	0	7E
"	7-8	0	1	1	1	1	1	1	1	7F

Table C-2. EBCDIC Code Set (Continued)

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

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

APPENDIX D. SPECIFICATIONS

The following standard specifications are common to all units:

A) *Keyboard:* 63 Alphanumeric and control characters with keys arranged in the IBM 029 keypunch form.

B) *Maximum Keyboard Rate:* 20 keystrokes per second.

C) *Program Control:* Two stored programs which can be loaded from either keyboard or tape.

D) *Display:* Shows actual alphanumeric characters and symbols, character position, and program commands.

E) *Record Length:* Variable from 20 to 200 characters.

F) *Environment:* 36° F to 105°F, 20% to 95% relative humidity, no condensation.

Models 4311 and 4321 Magnetic Data Recorder

A) *Record release time:* 260 milliseconds.

B) *Magnetic tape:* Choice of 7-track (200, 556, or 800 characters per inch) or 9-track (800 characters per inch) computer compatible.

C) *Tape capacity:* 7-inch diameter reels of 1/2-inch wide computer tape (600 feet of recording surface).

D) *Recording mode:* NRZI.

E) *Search speed:* 13-15 records per second (depends on record length and density).

F) *Tape Rewind Time:* 150 seconds for full 7-inch reel

G) *Power required:* 115-230 Volts, 50-60 Hz at 175 Watts.

H) *Tape Languages:* on 7 track tapes — Honeywell, ICL, BCDIC
on 9 track tapes — EBCDIC

I) *Dimensions/Weight:* Width: 24-1/2 inches
Depth: 19-1/2 inches
Height: 19-1/2 inches
Weight: 70 pounds

J) *Record Counter:* Automatic 4-digit released record counter and record position indicator. Readily accessible manual reset button.

Model 4314 Magnetic Data Central Pooler

A) *Recording mode:* NRZI Format.
Phase Encoding 1600 CPI Format (Option)

B) *Tape speed:* Model 4314 — 40 inches per second (NRZI)
(37-1/2 ips with Phase Encoding format)

C) *Magnetic tape:* Choice of 7 or 9 track (200, 556, or 800 characters per inch), computer compatible. (Phase Encoding format uses 9-track tape.)

D) *Tape capacity:* 10-1/2 inch diameter reels of 1/2 inch wide, 1-1/2 mils thick, computer grade magnetic tape.

E) *Rewind speed:* 150 inches per second, nominal.

F) *Power required:* 115-230 Volts, 50/60 Hertz, 300 to 400 Watts.

G) *Weight:* Keyboard Entry Unit — 50 pounds
Magnetic Tape Unit — 150 pounds

H) *Dimensions:* Keyboard Entry unit:
Height — 10 inches
Width — 21-1/4 inches
Depth — 19-1/2 inches

Magnetic Tape Units:
Height — 29 inches
Width — 30 inches
Depth — 24 inches

I) *Tape languages:* On 7-track tapes - Honeywell, ICL, BCDIC
On 9 track (NRZI) - EBCDIC
(With Phase Encoding Format - EBCDIC)

Model 4322 Magnetic Data Keyboard. The following standard specifications apply to the Model 4322 Magnetic Data Keyboard.

A) *Record release time:* 260 milliseconds

B) *Power:* 115-230 Volts, 50-60 Hertz at 175 Watts.

C) *Dimensions/Weight:* Width: 12-1/4 inches
Depth: 19-1/2 inches
Height: 19-1/2 inches
Weight: 70 pounds

4310, 4320 SERIES
SYSTEM REFERENCE MANUAL
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  - ☐ Programmer.
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