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PRELIMINARY

Bell System Data Communications
TECHNICAL REFERENCE

SYNCHRONOUS DATASPEED® 40/4

STATIONS

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Director - Data and Special Services

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NOTICE

This Technical Reference is specifically intended for the developers and designers of business machine data terminal equipments and devices which interface with Bell System data communications equipment, and for technical consultants for use in designing data communications systems and arrangements employing Bell System data communications services and equipments. The right to revise this Technical Reference for any reason, such as conformity with USAI, EIA, CCITT or other standards, to utilize new advances in the state of the technical arts, or to reflect changes in the design of the equipment and/or service described herein is expressly reserved. Liability for difficulties arising from technical limitations is disclaimed.

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1. ABBREVIATIONS

AA_1 = Attribute Address Plus 1, 1st Character
AA_2 = Attribute Address Plus 1, 2nd Character
AC = Attribute Character
ACK = Acknowledge
AID = Attention Identification
BA_1 = Buffer Address, 1st Character
BA_2 = Buffer Address, 2nd Character
BCC = Block Check Character
BEL = Bell
BS = Back Space
C = Specifiable Character
CA_1 = Cursor Address, 1st Character
CA_2 = Cursor Address, 2nd Character
CAN = Cancel
CCC = Copy Control Character
CR = Carriage Return
DA = Device Address
DC_1 = Device Control 1
DC_2 = Device Control 2
DC_3 = Device Control 3
DC_4 = Device Control 4
DEL = Delete
DLE = Data Link Escape
DUP = Duplicate
EM = End of Media
ENQ = Enquiry
EOT = End of Transmission
ESC = Escape
ETB = End of Transmission Block
ETX = End of Text
EUA = Erase Unprotected to Address
FF = Form Feed
FM = Field Mark
FS = File Separator
GS = Group Separator
HT = Horizontal Tab
IC = Insert Cursor
ITB = End of Intermediate Trans. Block
NAK = Negative Acknowledge
MDT = Modified Data Tag
NL = New Line
NUL = Null
PAD = Pad Character
PT = Program Tab
RA = Repeat to Address
RS = Record Separator
RVI = Delete Followed by Less Than
SBA = Set Buffer Address
SF = Start Field
SI = Shift-In
SO = Shift-Out
SOH = Start of Heading
SP = Space
SPA = Station Polling Address
SS_1 = Status and Sense, 1st Character
SS_2 = Status and Sense, 2nd Character
SSA = Station Selection Address
STX = Start of Text
SUB = Substitute
SYN = Synchronous
US = Unit Separator
VT = Vertical Tab
WACK = Delete Followed by Semicolon
WCC = Write Control Character
40/4 = DATASPEED 40 Synchronous Data Terminals for Computer Input-Output Multi-Point Private Line Facilities

2. INTRODUCTION

This technical reference introduces and describes a new version of the DATASPEED 40 data terminal family that is field oriented rather than character oriented and designed to be compatible with many in-use software supported systems for display devices. This version will enable users to take advantage of the economies obtained by clustering several terminal devices on a common controller. Also, its efficient interactive mode of operation makes it attractive for a variety of computer on-line input-output applications, such as inquiry-response, data entry and data retrieval.

The main features of the new DATASPEED 40/4 are binary synchronous line protocol, clustering capability for up to 24 keyboard display and 12 printer devices, ASCII code (shown in Figure 37), 2400 or 4800 bps operation, computer controlled display formatting and data entry, whole character impact printing, built-in internal diagnostics, modular construction and modern styling. (See Note.)

Advantages to the user of a system having DATASPEED 40/4 stations are as follows:

The binary synchronous line protocol used is a standard, software supported, communications procedure which conforms to ANSI (American National Standards Institute) standard X3.28-1971 sub 2.4 and sub B2 plus RVI and WACK.

The line protocol regulates message traffic by polling and selecting in a manner similar to that used in selective calling systems. This eliminates station contention for the communications facility and permits the computer to control the flow of messages.

The line protocol includes a strong error checking and correcting scheme, which employs automatic re-transmission of message blocks containing invalid block check characters and/or bad character parity. Each block check character includes not only a vertical parity check but also a longitudinal redundancy check for a more powerful error checking scheme than vertical parity alone could provide.

The 40/4 uses the synchronous method of character transmission. This method provides inherently more thruput than the traditional asynchronous method, since start and stop bits are not sent with each communicated character. Instead, synchronizing characters are sent at the beginning of each message block to establish synchronization between the sender and receiver for the entire block. This results in fewer bits sent for the same number of characters, compared to asynchronous communications.

The 40/4 employs both clustering and multi-point private-line facilities; to the economic advantage of the user. With clustering capability, several communications devices can be grouped around a common controller at each station. With multi-point private-line facilities, several stations can be grouped onto a common circuit. Thus, in effect, each device can share the cost of its controller with other devices at the same station, and each station can share the cost of its communications channel with other stations on the same circuit.

> *Note:* Reference Publication 41210 for Data Set 201C Interface Specification and Publication 41209 for Data Set 208 Interface Specification.

40/4 stations employ CRT (Cathode Ray Tube) type keyboard display terminals for data entry. This makes message communication both fast and accurate. It is accurate because each message is prepared prior to transmission on a display screen, where it can be seen in its entirety and edited before it is sent; and it is fast because all messages are sent at maximum station speed, rather than at the slower keyboarding speed at which they were prepared. Also, the entire operation has the advantage of not consuming paper for either preparation or communication.

With computer controlled Keyboard Displays, data entry is typically only a matter of filling out computer provided forms. This makes data entry both easy and accurate because the form guides the operator to the data to be entered, restricts data entry to the type and amount of data called for, and saves the operator the effort of entering redundant data.

A 40/4 Keyboard Display operator is never concerned with message transmission formats. All data necessary for observance of line protocol, station and device identification, and proper interpretation of the message by the computer is automatically generated.

The Keyboard Display has 14 special function keys available to aid the operator during data entry, by causing the computer to perform software assigned functions, such as, calculations, next and previous form display and local printout. This speeds data entry and reduces operator effort.

40/4 station mechanics are minimal and are not activated until needed to move data. This provides longer station life and reduces unnecessary noise.

Stations include built-in internal diagnostics. They permit troubles to be rapidly isolated by repair personnel. Two local test functions are provided to assist in isolating troubles. These test functions are covered later in this document.

3. SYSTEM DESCRIPTION

DATASPEED 40/4 stations are computer controlled via binary synchronous line protocol over 4-wire, half-duplex, communications facilities. A typical system configuration is shown in Figure 1.

In the system, the computer can receive a message from a station after polling it or it can send a message to a station after selecting it, however, both functions cannot be carried out simultaneously on the same communications channel. A message cannot be delivered to more than one station on the same channel at the same time.

Each station in the system can consist of several keyboard display (KD) and/or printer (P) devices which share one or two common controllers and an associated data set.

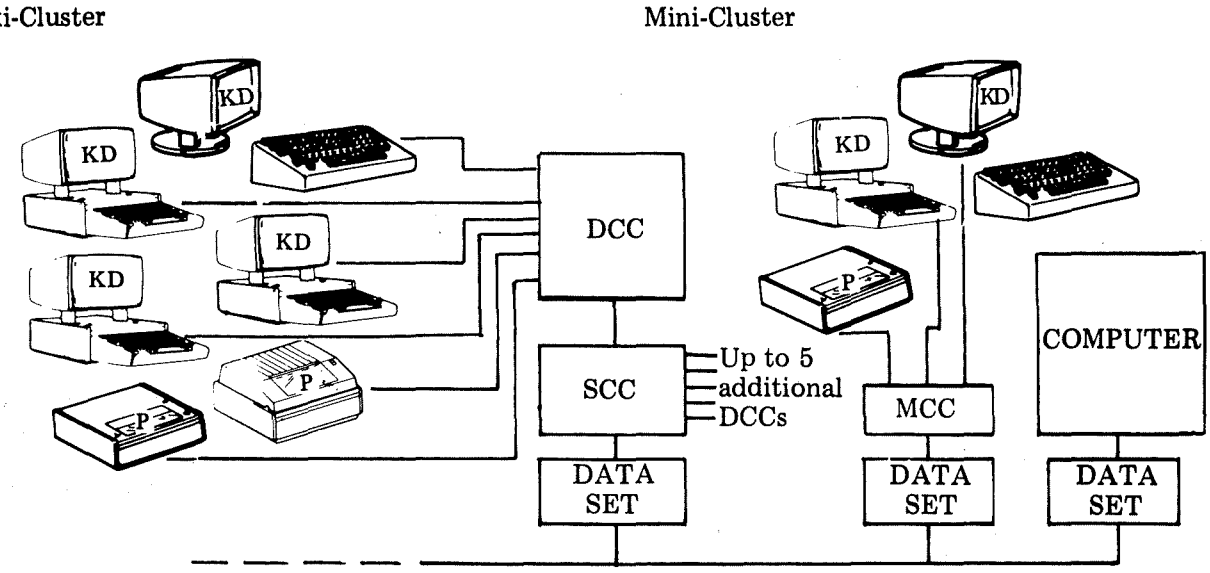


Figure 1

4. SYSTEM OPERATION

Operation of the system is best understood by means of an illustrative example, which follows on the next several pages. This example serves to bring out most of the system's operating capabilities, and has the advantage of doing so in the context of an on-going communications activity.

Following the illustrative example are tables and text which summarize all system capabilities, both those covered in the example and those not covered.

The illustrative example demonstrates the operation of a Maxi-Cluster, the operation of the Mini-Cluster may differ in some respects.

4.1 Illustrative Examples

System activity typically begins with the computer. It activates the rest of the system by selecting each device at each station and sending each in turn a "system ready" message. This is done for two reasons: To be sure that each system device is ready to function, and to inform the operator of each device that the system is ready to function.

A typical selection sequence sent from the computer consists of the following:

Selection (from computer)

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

SYN — SCC Requires two SYN characters before any line information is accepted. Received SYN characters are ignored, ie, not included in BCC and not passed on to DCC from SCC.
EOT — End of Transmission
SSA — Station Selection Address (sent twice)
DA — Device Address (sent twice)
ENQ — Enquiry
PAD — A specific character with all 8 bits marking (ASCII "DEL" with even parity or hex "FF"). Used to ensure that the carrier in the modem is not turned off while the last non-PAD character is being sent or received.

The required synchronization characters will not be shown in succeeding sequence diagrams for simplicity, however, they are always required in practice.

Each sent selection sequence selects a specific device at a specific station. For this purpose, each station has its own unique SSA character and each device at each station has its own DA character. Devices at different stations have the same DAs. (The Device Address is not a customer option since it is determined by station configuration.)

Assuming that both the station and the device being selected are able to receive, the station will reply with the ASCII control DLE (Data Link Escape) followed by the character Ø (zero), often called the ACK (Acknowledge) Ø response.

Reply to Selection (from station)

```
D
L Ø (ACK 0, able to receive)
E
```

Immediately after each DLE 0 reply comes the "system ready" message from the computer.

Sign-on Message (from computer)

```
S E   W                       S
T S 5 C  T E R M I N A L      P
X C   C                       E B
          S T A R T E D       T C
                              X C
```

At the start of the message is the ASCII control STX (Start of Text). As will be seen, STX begins all messages regardless of whether they are from or to the computer, with minor differences to be shown later.

Following STX is the sequence ESC (Escape) 5, which is an erase-write command. It erases any data that might be in the receiving device's buffer and tells it to write (into the buffer) the data following the WCC (Write Control Character).

The WCC character that follows the erase-write commands things to happen relative to the write portion of the erase-write command. These will be brought out as the illustration proceeds.

Following the WCC is that portion of the received message which will be displayed or printed by the device. But before this can take place, the received message must be determined to be valid according to the BCC (Block Check Character) that follows ETX (End of Text) at the end of the message.

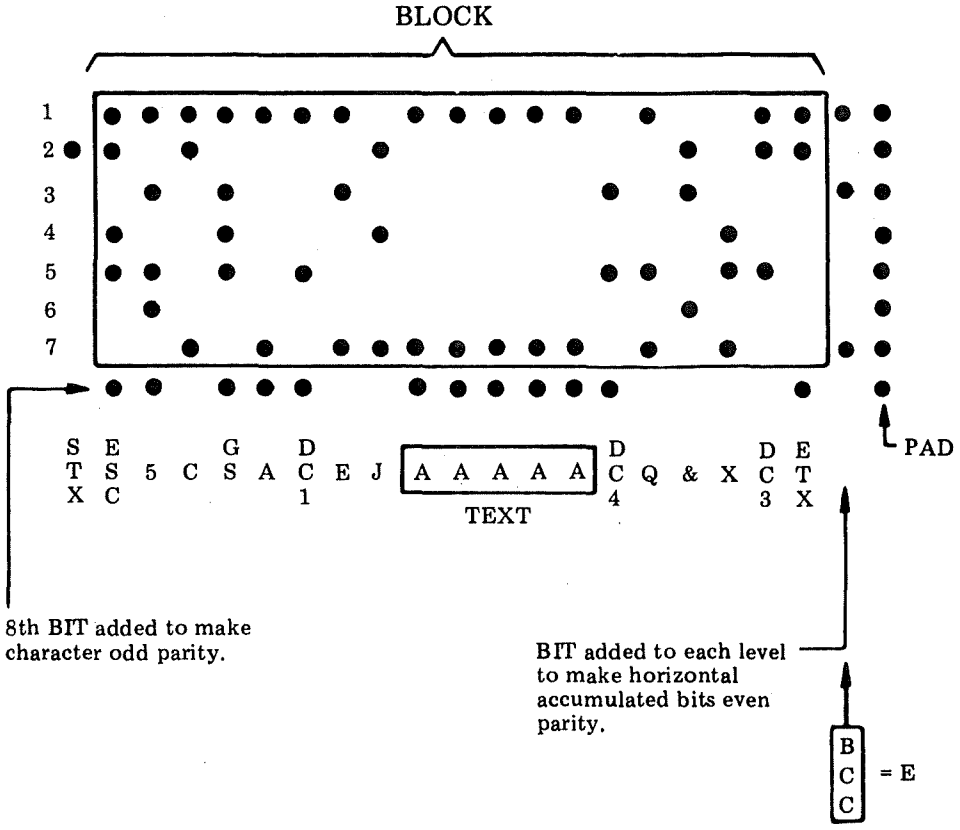
When ETX is received, it tells the station to compare the BCC it was constructing as the message was being received to the BCC it receives following ETX. If they are identical and character parity was valid, the message is declared valid, as far as its transmission is concerned (operator entry errors can still be present), and the station replies with the sequence DLE 1, often referred to as the ACK 1 response. (Other possible replies will be covered later.)

This reply in turn causes the computer to terminate the communication by sending the control EOT (End of Transmission); which then permits the text portion of the message to be displayed or printed.

Reply to BCC (from station)	Termination (from computer)
D	E
L 1 (ACK1, received OK)	O
E	T

BLOCK CHECK CHARACTER CONSTRUCTION
(Example)

A block check is performed on messages sent to the LCU and on command sequences addressed to the station.



The derived BCC is sent after each block and compared at the receiving station or LCU.

Figure 2

For the purposes of the illustration, assume from this point on that the device being discussed is a keyboard display (KD). In that case, the device operator sees the system ready message displayed on the screen and knows that the system is ready for data entry.

But before data entry from the KD begins, the operator normally requests a form from the computer for the type of data that will be entered. This request can be accomplished in one of two ways. The operator might depress one of the 14 special function keys, or the operator might enter form request data on the display and depress the send (S/R) key. In either case, a message would be sent to the computer next time the KD is polled, telling the computer that a form is desired and identifying the form that is desired.

But before the computer can receive this, or any other message from the KD, it must poll the station the KD is part of. To do this it can conduct either a general poll or a specific poll.

With a general poll, any device at the polled station having a message to send would do so. With a specific poll only the specific device polled would send a message if it had one.

General Poll (from computer)

E	S	S	"	"	E
O	P	P			N
T	A	A			Q

A general poll consists of the control EOT (End of Transmission), followed by the SPA (Station Polling Address) character sent twice, followed by the " (quote) character sent twice, followed by the control ENQ (Enquiry). Obviously, in addition to its SSA (Station Selection Address) character, each station must have its own unique SPA character.

A specific poll consists of the same items as the general poll except that the DA (Device Address) character is sent in place of the quote character.

Specific Poll (from computer)

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

Were there no message waiting to be sent, the station would reply with the control EOT.

Reply to Poll (from station)

E
O or message
T

In this case, however, there is a message waiting to be sent, the form request message, which appears below.

Message Requesting Format (from station)

S	S	D	A		C	C										E	B	
T	P	A	I				F	O	R	M	1	6	9	A	T	C		
X	A		A_D		A_1	A_2										X	C	

Notice that more data is sent than was entered by the operator (if any). The station automatically generates STX to denote the beginning of the message to the computer, SPA to identify the station sending so that the computer is assured that the station that is sending is the station that it polled, and the DA character to identify the device that is sending. Also, the station sends an AID (Attention Identification) character that identifies which key the operator depressed to cause the message to be sent. (Had the operator not entered data on the screen, this character alone would serve as the request for the form.

Following the AID character are CA (Cursor Address) characters. They identify, by row and column respectively, where the cursor is on the screen.

Following the CA characters is the data entered by the operator on the display screen (if any) and the message ending sequence ETX BCC. Since the message is going to the computer, the ETX tells the computer to compare the BCC it was constructing as the message was being received to the BCC it receives after ETX. If they agree, the computer will reply with the sequence DLE 1 and the station will terminate with EOT. See Figure 2 for construction of block check character.

Reply to BCC (from computer)

D
L 1 (ACK 1, received OK)
E

Termination (from station)

E
O
T

Now that the computer has a request for a form, it searches through its memory for the form. Once the computer has located the form, it then selects the station and device. . .

Selection (from computer)

```
E S S       E
O S S D D   N
T A A A A   Q
```

Reply to Selection (from station)

```
D
L 0 (ACK Ø, able to receive)
E
```

and delivers the form to it by means of the following message:

Format Message (from computer)

```
S E   W                    E B
T S 5 C  (details on next  T C
X C   C   several          X C
           diagrams)
```

Once again the message from the computer begins with an erase-write command (ESC 5). In this case, it will erase the form request data from the display, if the operator has entered one.

Following this is the WCC (Write Control Character). In this case, it may sound an audible tone on the KD to alert the operator to the reception of the form, and/or unlock the keyboard so that data entry can begin.

Following the WCC are the many details concerned with the characteristics of the form. In order to understand these details, it is best to first view the form as it will appear when displayed, and again as it will appear after it has been filled out by the operator, and finally, with boxes and line numbers added which are not actually displayed with the form but which will aid in the understanding of the details of its construction. (View next four illustrations.) See Figures 3, 4, 5, and 6.

Format (from computer) as Displayed

```
NAME                                    COMPANY

ADDRESS                                 ADDRESS

TEL . NO .                              TEL . NO .

PART NO .        QTY      DESCRIPTION          PRICE




APPROVAL
```

Figure 3

Format as it will appear when filled out by operator

```
NAME      JOHN A. GRANT                 COMPANY BINKES INC.

ADDRESS   2655 JANSON BLVD.             ADDRESS 4321 N. SOUTH ST.
          CHICAGO, ILL. 60634                   CHICAGO, ILL. 60621

TEL.NO.   321-543-7666                  TEL.NO. 321-746-5434

PART NO.        QTY          DESCRIPTION          PRICE

344567            6          CIRCUIT CARD        $15.00
576342            2          CABLE                 3.70
272895           12          CONNECTOR             2.40


APPROVAL  JONATHAN BINKES
```

Figure 4

Filled out format with boxes added to show extent of blanks open to operator entry

```
NAME      JOHN A. GRANT                 COMPANY BINKES INC.

ADDRESS   2655 JANSON BLVD.             ADDRESS 4321 N. SOUTH ST.
          CHICAGO, ILL. 60634                   CHICAGO, ILL. 60621

TEL.NO.   321-543-7666                  TEL.NO. 321-746-5434

PART NO.        QTY          DESCRIPTION          PRICE

344567            6          CIRCUIT CARD        $15.00
576342            2          CABLE                 3.70
272895           12          CONNECTOR             2.40


APPROVAL  JONATHAN BINKES
```

Figure 5

Operator entered data removed, line reference numbers added

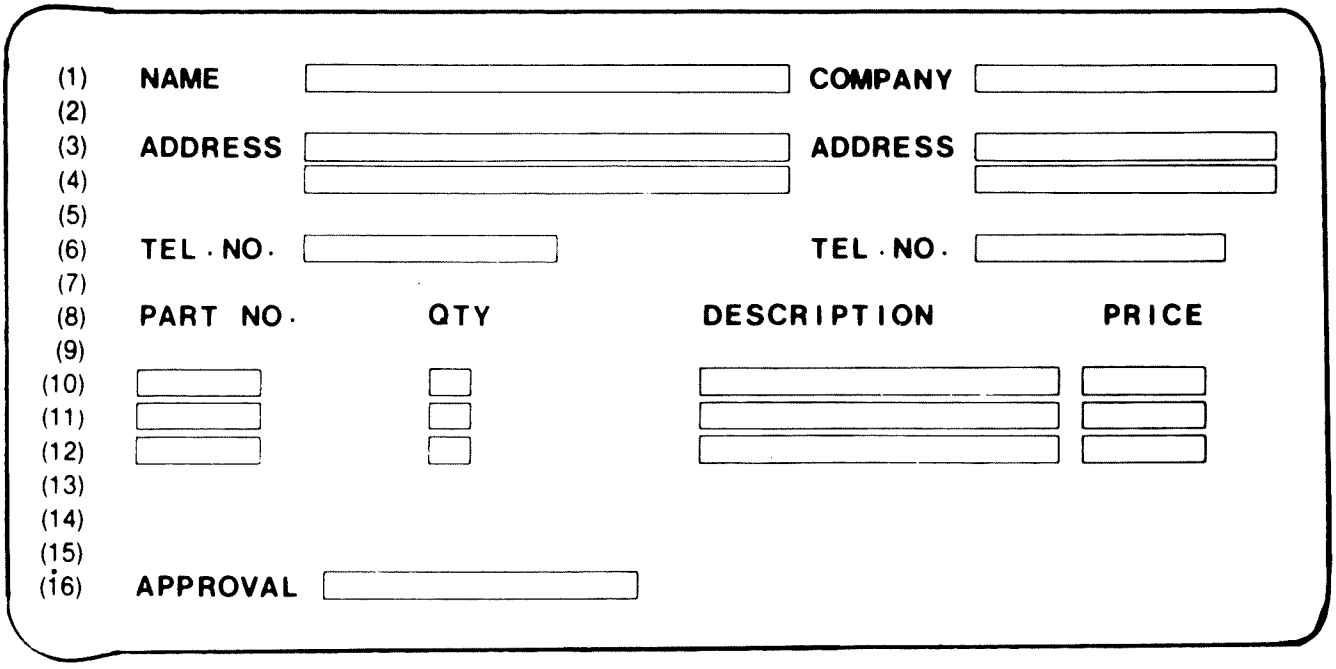


Figure 6

Figure 7 shows the sequence of characters (data stream) that gives line (1) the characteristics called for by the form.

This data stream follows immediately after the WCC in the received message, and each succeeding data stream for each succeeding line of the form then follows after it. But, as said before, nothing is actually displayed until the block check at the end of the message has been performed. All received data is stored in the device buffer until that time. In the sequence of illustrations below, however, each line of the form will be described as if it were being displayed a line at a time.

Receipt of GS (Group Separator) at the beginning of the data stream for line (1) tells the display device that the character following it is an AC (Attribute Character).

Attribute characters occupy a position on the display screen but are not displayed, and can neither be covered with another character nor changed by the operator. They will be indicated on the following diagrams by means of small character size rectangles.

Attribute characters determine the attributes for the characters that follow them on the screen, up to but not including the next AC. Thus, ACs

Received from computer for line (1)

GS GA NAME DC1 BA1 BA2 GS GA DC1 BA1 BA2 GS GA COMPANY GS GA

Displayed on line (1) of screen

Figure 7

permit a display screen to be divided into fields, each of which has the attributes of the AC that proceeds it. Possible attributes are protected, numeric, displayed, highlighted and modified, or the opposite of any of these, in any combination.

In the illustration in Figure 7, the first field is the one in which NAME resides. Obviously, the AC for that field can specify it as protected (from operator entry), alphanumeric, displayed, unmodified (by operator entry), and perhaps highlighted (so as to contrast with data to be entered later by the operator).

This first AC appears at the upper left-hand corner of the screen. This is because another job that the erase-write command did was to position the buffer address to the home position. It also positions the cursor to the home position, but it is the buffer address which determines where the next character will be displayed. The cursor merely follows the buffer address during operator data entry.

Following NAME in the data stream is the control DC1 (Device Control 1) followed by two BA (Buffer Address) characters. This is an SBA (Set Buffer Address) order. It moves the buffer address to the location specified by the BA characters. (BA_1 and BA_2 specific row and column, respectively.) In this case, it moves the buffer address to the position just ahead of the blank following NAME.

This movement of the buffer address could have also been accomplished by receipt of 3 SPs (Spaces) following NAME. This is one of many examples of the decisions made by the person(s) who design the forms and write the data streams. Generally speaking, they are concerned with keeping all data streams as short as possible for maximum efficiency of on-line time, but are also concerned with writing data streams that can be easily changed if the form is changed.

Following this first SBA order is the second GS AC, for the blank field following NAME. The desired attributes for this field are: unprotected, alphanumeric, displayed, unmodified, and unhighlighted.

The next SBA order moves the buffer address to the location just to the left of COMPANY, and the GS AC following it locates an AC there. This AC specifies that field as protected, alphanumeric, unmodified, displayed, and highlighted. Then, since only one space is called for following the word COMPANY, the next GS AC can follow immediately after it in the data stream without an intervening SBA order. This is the advantage of having the AC occupy, in effect, a protected space. It automatically provides the desired spacing between fields.

Continuing on to line (2), see Figures 8 and 9, the form calls for that entire line to be skipped. Consequently, the buffer address is set to the beginning of the line and a protected, nondisplayed, alpha or numeric, unhighlighted, unmodified AC put there.

For line (3), the buffer address is moved to the start of the line and an AC put there for the ADDRESS field, with the attributes of protected, highlighted, etc. The AC following ADDRESS then specifies the field after it as unprotected, unhighlighted, etc. Likewise for second ADDRESS.

Line (4) calls for 4 fields, to be alternately protected and unprotected, and alternately highlighted and unhighlighted, etc. Each SBA order moves the buffer address to the position just ahead of each field so that the GS AC following it will create the desired field.

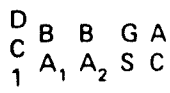
Line (5) is entirely protected, as was line (2); and as are lines (7) and (9).

Line (6) is somewhat different in that the ACs are deliberately located so as to limit the length of the field to 12 digits. Also, they specify the blank fields as numeric (assuming that telephone numbers will not have letters in them). Numeric fields permit the operator to enter numbers, hyphens, periods, and DUP.

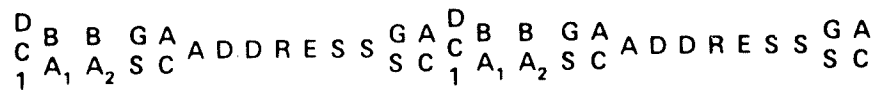
Line (6) is also different in the method used to move the buffer address from the position following the end of the first blank field. A RA (Repeat to Address) order is used, consisting of DC4 (Device Control 4) followed by two BA (Buffer Address) characters, in turn followed by the character to be repeated. This order tells the display to repeat the character following BA2, which is SP (Space) in this case, until it comes to the address specified by the BA characters, which in this case is the address for the T in the second TEL. NO.

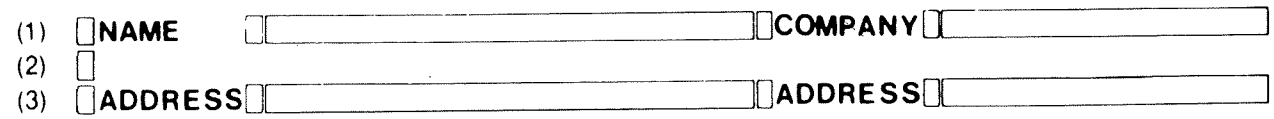
This is another example of the choices made by the data stream writer. In this case, sufficient spaces could have been sent to move the buffer address, or an SBA order could have been used. As a further illustration of this, line (8) repeats SP in one place and uses a repeat SP order in another place. It is all up to the data stream writer.

For line (2)

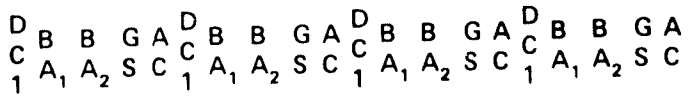


For line (3)

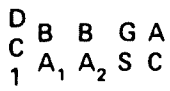




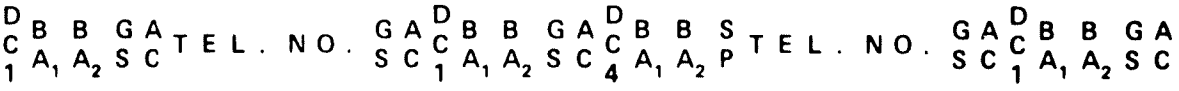
For line (4)



and line (5)



and line (6)



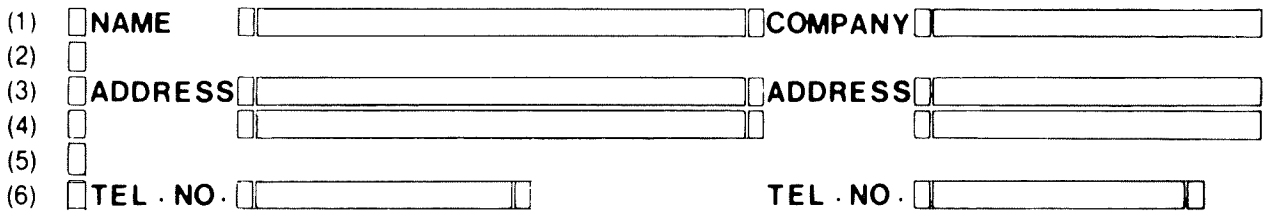
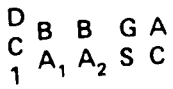
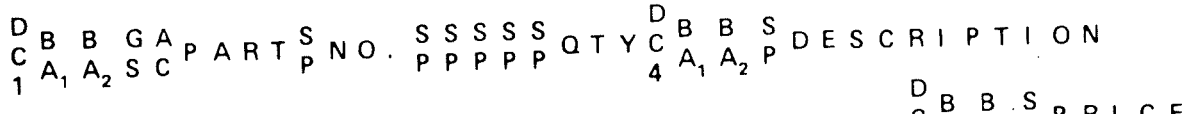


Figure 8

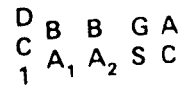
For line (7)



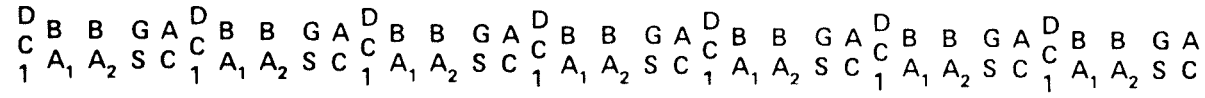
For line (8)



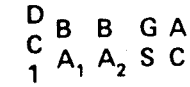
For line (9)



For line (10). Same for lines (11) and (12).



For line (13). Same for lines (14) and (15).



For line (16)

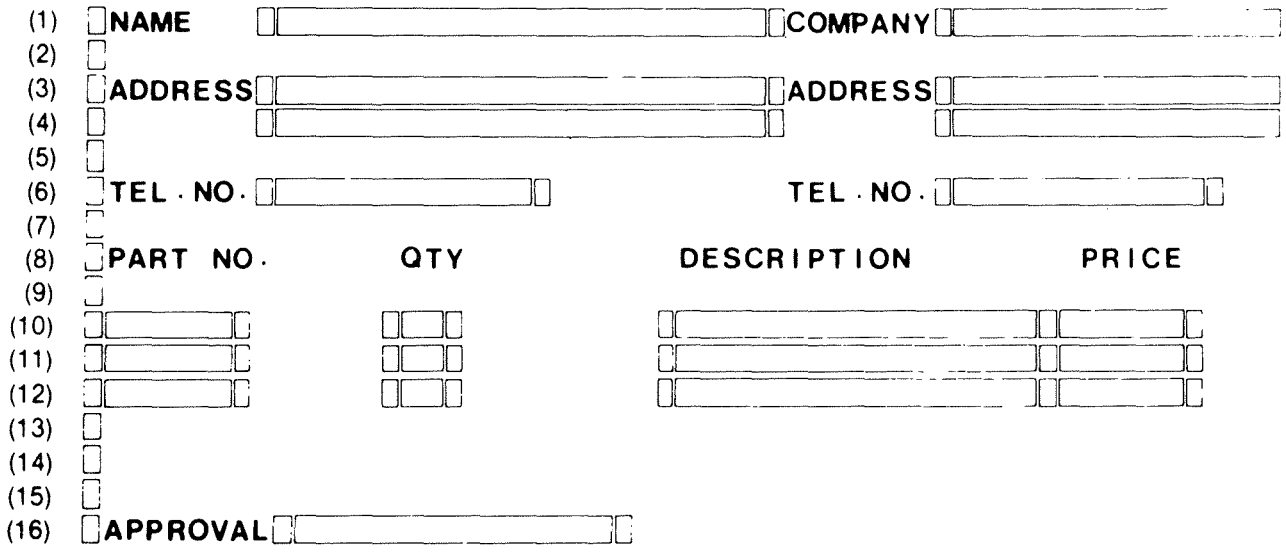


Figure 9

Line (8) is somewhat different in that the entire line is protected, hence only one AC is needed for the entire line even though the buffer address is reset several times to achieve the desired spacing between the words on that line. Thus, it shows that a GS AC does not always follow each SBA order.

On lines (10), (11), and (12), ACs are placed so as to limit the length of each blank field. The PART NO. blanks are limited to 6 digits, the QTY is limited to 2 digits, the DESCRIPTION is limited to standardized wording, and the PRICE field is limited. The ACs for these fields specify each as numeric except for the DESCRIPTION field.

An attribute of every AC that has not been used yet is the nondisplayed attribute. An illustration of its use might be for the fields under PRICE. It might be desired to prevent someone looking over the operator's shoulder from seeing this information. If these ACs were specified as nondisplay, the operator could enter the prices and they would be sent to the computer along with the other data but they could not be seen on the screen.

Lines (13), (14), and (15) are skipped over in the same manner as discussed for lines (2), (5), (7), and (9).

Line (16) is obvious except for the last 4 characters in its data stream. The SBA order represented by the first 3 characters moves the buffer address to the beginning of the first blank field on the display screen. The DC3 (Device Control 3) then moves the cursor to that location, ready for operator data entry.

At the end of the message from the computer is the normal ETX BCC message ending sequence, to which the station will reply and to which in turn the computer will terminate.

Reply to BCC (from station)

D
L 1 (ACK 1, received OK)
E

Termination (from computer)

E
O
T

On receipt of the requested form from the computer, the operator will fill it out. After it has been filled out and visually checked for errors, the operator will depress the send (S/R) key.

After the station has been polled and has replied. . .

General Poll (from computer)

E S S " " E
O P P N
T A A Q

Reply to Poll (from station)

E
O or message
T

the following message will be sent:

Formatted Message (from station)

S S D A C C D A A
T P A I C A A J O H N S A . S G R A N T
X A A D A1 A2 1 A1 A2 P P

D A A
C A1 A2 B I N K E S S I N C .
1 P

D A A E B
C A1 A2 2 6 5 5 S J A N S O N S B L V D . (etc) T C
1 P P X C

Notice that the form data is not sent. This is because a polled station only sends operator entered (ie, modified) fields to the computer. (Unmodified fields automatically become modified whenever the operator enters data into them.) Notice also that unfilled display positions are not sent. This is because each display position is a NUL (Null), until replaced with another character by the operator, and NULs are automatically not sent.

Also each field of operator entered data is preceded by its address, given by the sequence DC1 (Device Control 1) AA (Attribute Address plus one). This is done so that the computer can verify the location of the data on the form even though it did not receive the form.

The remainder of the sent message has been described before for other messages sent from the station and will not be redescribed except to say that, if it had exceeded 256 characters in length, the station would have halted and sent the sequence ETB (End of Transmission Block) BCC (Block Check Character) at the end of each 256 character block.

This would cause the same type of error check as discussed for the message ending sequence ETX BCC, except that the replies to each BCC would alternate between DLE 1 and DLE 0, so that the computer can be assured that the station will send the next block and not a previously sent one.

On receipt of formatted data from a station, the computer will normally examine each field for valid operator entries. In this illustrative example, the operator has entered an invalid part number. To indicate this to the operator, the computer selects the display and then sends it an error message.

Selection (from computer)

E S S D D E
O S S A A N
T A A Q

Reply to Selection (from station)

D
L 0 (ACK 0, able to receive)
E

Message (from computer)

S E W D
T S 1 C C B B G A N O S P S U C H S P N O .
X C C 1 A_1 A_2 S C P

S P A S S P 5 7 6 3 4 2 S P R E – E N T E R

D B B D B B D B B D E B
C A_1 A_2 C A_1 A_2 C A_1 A_2 C T C
1 2 1 3 X C

In contrast to previous messages from the computer, this message begins with a write command (ESC 1) instead of an erase-write (ESC 5), since the computer does not want to erase the data displayed on the screen but only to indicate that there is an error.

The SBA order that follows moves the buffer address to an unused display line at the bottom of the screen, and the GS AC specifies a protected, highlighted, alphanumeric, displayed unmodified field at that location.

At the end of the message is another SBA which moves the buffer to the beginning of the erroneous number. This is followed by the control DC2 (Device Control 2) and 2 BA (Buffer Address) characters. This is an EVA order which tells the display to erase all unprotected data from the present buffer address up to but not including the address specified by the BA characters, which in this case is an address just beyond the erroneous number. This erasure is not necessary in that the operator could simply replace the wrong number with the correct one, but erasure by the computer provides more visual impact to the operator.

Following the erasure order is an order to move the buffer address to the beginning of the field, and following that is an order (DC3) to move the cursor to that location. This puts the cursor where the operator must enter the correction.

Note: Cursor does not move when data input to buffer from line.

The final result of the error message was quite effective in that it told the operator that there was an error, told the operator what the error was, erased the error, and put the cursor where the correction should go.

Not shown this time for this message is the usual block check, reply and termination sequence of events. See Figure 10.

Since the computer has sent an error message to the display requesting a correction, it might wish to specifically poll that device to obtain the correction.

A specific poll appears as follows:

Specific Poll (from computer)

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

The only difference between it and a general poll is that the DA character is sent in place of the quote character.

Assuming that the operator has made the correction, the reply will be the following message.

Message (from station)

S S D A C C D A A E B
T P A I C C C A A 5 3 3 2 9 6 T C
X A A D A_1 A_2 1 A_1 A_2 X C

Notice that the only data sent from the display screen is the corrected number. Previously entered data is not sent.

There are three reasons for this result: (1) Whenever an operator enters data into a field, its AC automatically changes from unmodified to modified, as stated earlier, assuming that the computer specified it as unmodified to begin with; (2) whenever a station is polled, it sends only modified fields to the computer; and, (3) the computer can reset all modified fields to unmodified by means of the WCC (Write Control Character).

In this illustration, when the form was originally received from the computer all ACs were specified as unmodified. Then, as the operator entered each field to fill in the form, each field changed from unmodified to modified. Thus, each operator entered field was sent to the computer when the station was polled. Then, on receipt of the error message from the computer, the WCC at the beginning of the message reset all modified fields back to unmodified, such that only the field entered by the operator to make the correction would be changed to modified and therefore sent to the computer when the station was next polled.

Since the error correction message to the computer is short and normal operation is well understood by now, this is a good opportunity to examine abnormal replies to a transmission block.

Possible replies to a data transmission block are NAK (Negative Acknowledge) — block invalid, DLE 1 — block valid, or none. A NAK reply would cause the station to re-send the message, up to 7 times, after which an error recovery would take place. DLE 1 causes normal termination from the station — EOT. No reply causes the station to send ENQ, typically every 3 seconds, to jog the computer into replying.

The only variation on this routine would be if the message were longer than 256 characters, in which case the valid reply alternates between DLE 1 and DLE 0 as described earlier.

Since we are examining possible replies, let us also examine possible replies to selection.

Selection (from computer)

E	S	S			E
O	S	S	D	D	N
T	A	A	A	A	Q

Reply to Selection (from station)

D
L Ø (ACK Ø, ready to receive)
E

D
L ; (WACK, not ready to rec; no s & s)
E

D
L < (RVI, not ready to rec; has s & s)
E

The DLE 0 reply means able to receive. DLE ; means unable to receive because the selected device at the station is busy. (Were the device a printer, it could be busy printing a message.) DLE < means that the station or device cannot receive because it has a trouble; and that if the computer will poll it (a specific poll is used), it has a status message to send which will identify the trouble to the computer. In fact, whenever there is a trouble, there will automatically be a status message waiting to be sent when the station is next polled, which will take priority over normal messages waiting to be sent.

NAME JOHN A. GRANT

ADDRESS 2655 JANSON BLVD.
CHICAGO, ILL. 60634

TEL.NO. 321-543-7666

COMPANY BINKES INC.

ADDRESS 4321 N. SOUTH ST.
CHICAGO, ILL. 60621

TEL.NO. 321-746-5434

PART NO.	QTY	DESCRIPTION	PRICE
344567	6	CIRCUIT CARD	$15.00
■	2	CABLE	3.70
272895	12	CONNECTOR	2.40

APPROVAL JONATHAN BINKES

☐ NO SUCH NO. AS 576342 RE-ENTER

Figure 10

A status message appears as follows:

Status Message (from station)

```
S     S S          E B
O % R T P  D S  S  T C
H     X A  A S1 S2 X C
```

Status messages begin with SOH (Start of Heading) instead of STX (Start of Text), followed by the characters %, R, STX, SPA (Station Polling Address), DA (Device Address), two SS (Status and Sense) characters, ETX and BCC. Reply to BCC would be the same as described for all messages. The SS characters tell the computer such things as: Invalid command, command invalid for device address, paper supply needs refilling; which the computer uses as a basis for an error recovery routine.

To continue the illustration, the computer will indicate its acceptance of the corrected form by selecting the display and erasing all operator entered data, assuming that the operator wishes to use the same form for the next data entry.

Message (from computer)

```
S E   E
T S ? T
X C   X
```

The message begins with an erase unprotected data command (ESC ?) which erases all operator entered (unprotected) data from the display screen (modified or not), resets all ACs to unmodified, positions the buffer address and the cursor to the beginning of the first unprotected field, and unlocks the keyboard. The operator could then re-use the form in the same manner as just described.

The next usage of the illustrative form after that, however, is different from the previous in that the computer enters data on the forms and asks the operator to verify it for accuracy. To do this, it sends the message shown in Figure 11 to the display, after the normal selection and reply routine has taken place.

The data to be entered in the field following NAME follows the write command and the order setting the buffer address to the beginning of that field. At the end of the data for this first field, and after the data for each succeeding field, is the program tab (HT) order. It does two things. It moves the buffer address to the beginning of the next unprotected field, and it erases any unprotected data between the present and new buffer address. The data stream writer could have chosen to send the erase unprotected data command (ESC ?) at the beginning of the message, but the HT order performs this function as it moves the buffer address to the beginning of each field. The result is that each previously displayed unprotected field is either replaced with received data or erased by the HT order.

This concludes the illustrative example. It has served to bring out the main characteristics of the system. The following is a summarization of all system capabilities in table form with accompanying explanations.

Message (from computer) following Selection & Reply

```
S E   W D                S       S          H                S           H           S       S              S
T S 1 C C B  B  F R E D  E .   A M E S    A M I T Y        C O .       6 1 2       S .       W A T E R
X C   C 1 A1 A2          P       P          T                P           T           P       P              P
```

As Displayed on Screen (to that point)

```
NAME      FRED E. AMES                 COMPANY  AMITY CO.

ADDRESS   612 S. WATER LVD.            ADDRESS  4321 N. SOUTH ST.
          CHICAGO, ILL. 60634                   CHICAGO, ILL. 60621

TEL.NO.   321-543-7666                 TEL.NO.  321-746-5434

PART NO.        QTY         DESCRIPTION          PRICE

344567           6          CIRCUIT CARD        $15.00
576342           2          CABLE                 3.70
272895          12          CONNECTOR             2.40
```

Figure 11

4.2 Summary of System Operation

The computer polls stations to obtain messages from them and selects stations in order to deliver messages to them. For this purpose, each station has its own unique station polling address (SPA) and its own unique station selection address (SSA). In addition to this, each device at each station must have its own unique device address (DA), which must be different from all other devices at its station but which can, and typically is, the same as another device at another station.

Stations are numbered, from 00 to 35, and each device at each station is numbered, from 00 to 35. Once each station and device in the system is assigned a number, it is automatically assigned SPA, SSA, and DA characters, in accordance with the table in Figure 12.

Note: DA is determined by hardware configuration, not by customer option except in MCC.

Stn or Dvce No.	SPA	SSA	DA	Stn or Dvce No.	SPA	SSA	DA
0	SP	–	SP	18	K	2	K
1	A	/	A	19	L	3	L
2	B	S	B	20	M	4	M
3	C	T	C	21	N	5	N
4	D	U	D	22	O	6	O
5	E	V	E	23	P	7	P
6	F	W	F	24	Q	8	Q
7	G	X	G	25	R	9	R
8	H	Y	H	26	]	:	]
9	I	Z	I	27	$	#	$
10	[	`	[	28	.	@	.
11	.	,	.	29	)	'	)
12	<	%	<	30	;	=	;
13	(	_	(	31	^	"	^
14	+	>	+	32			–
15	!	?	!	33			/
16	&	0	&	34			S
17	J	1	J	35			T

Figure 12

Messages from Computer:

All messages from the computer begin with the ASCII control STX (Start of Text), followed by a Command, text and/or orders, ETX (End of Text), and BCC (Block Check Character).

Note: Synchronization characters also required but not shown.

STX	command	text &/or orders	ETX BCC

Possible Commands are listed in Figure 13. The first is the write command. It tells the receiving device to write the data that follows after it into its buffer. This data may consist of text which will be displayed or printed, depending on the device, and/or orders which will be obeyed; but neither is performed until the block check at the end of the message has been performed.

Commands	
Write	ESC 1
Erase-Write	ESC 5
Erase All Unprotected	ESC ?
Copy	ESC 7
Read Modified	ESC 6
Read All	ESC 2

Figure 13

The ETX control at the end of all messages tells the receiver to compare the BCC it constructs during reception to the BCC it receives following ETX. If they are identical and character parity is valid, the DLE 1 reply is sent from the message receiver to the sender, which then terminates the communications by sending EOT (End of Transmission).

The erase-write command is the same as the write except that it tells the receiving device to erase its buffer of all data that might be in it before writing into the buffer the data that follows. It also sets the buffer address and the cursor to the home position.

The erase all unprotected command tells the device to erase all unprotected data in its buffer. Protected data, if any, would remain.

The copy command tells the device to copy all or part of the data that is in the buffer of the device whose address is specified by the DA character in the message. This buffer to buffer transfer can only occur if the two devices are on the same device controller.

The read modified command causes the same result as when the device is polled, hence it is seldom used. It just makes it possible to select a device (normally done for the purpose of delivering data to a device) and have it send modified data in its buffer to the computer.

The read all command is normally issued for diagnostic purposes and causes the device to send all data in its buffer as it actually appears in the buffer. Blank spaces on the display screen where the operator did not enter the character SP would be sent as NULs, and each field would be preceded by its AC (Attribute Character) in turn preceded by SF (Start Field), otherwise, the message is the same as for read modified.

The WCC (Write Control Character shown in Figure 14) at the end of the write and erase-write commands, and the CCC (Copy Control Character shown in Figure 15) at the end of the copy command are somewhat the same. Both can cause print-out (start printer) of the data following the character, if it is desired and if the device is a printer, and both can specify the print line length to be used. Also, both can sound an audible tone if the device has one, as a means of making the operator aware of the data reception. The alarm which is controlled by options 402A and B allow the alarm to respond with a single stroke or continuous. With continuous alarm, the local key must be depressed to terminate alarm located in opcon and reset keyboard.

The remaining characteristics about the WCC and CCC differ. The WCC can reset the keyboard, that is unlock it so that the operator can enter data, if the device is a keyboard display. It can also reset attribute characters from modified to unmodified. The remaining characteristics of the CCC are concerned with what data is copied. Attribute characters are always copied. If the copying device is a display, it needs them to accurately reproduce the fields stored in the copied device's buffer. If it is a printer, it needs them because it will print a space in place of each AC, which it needs to do to preserve the format of the copied data.

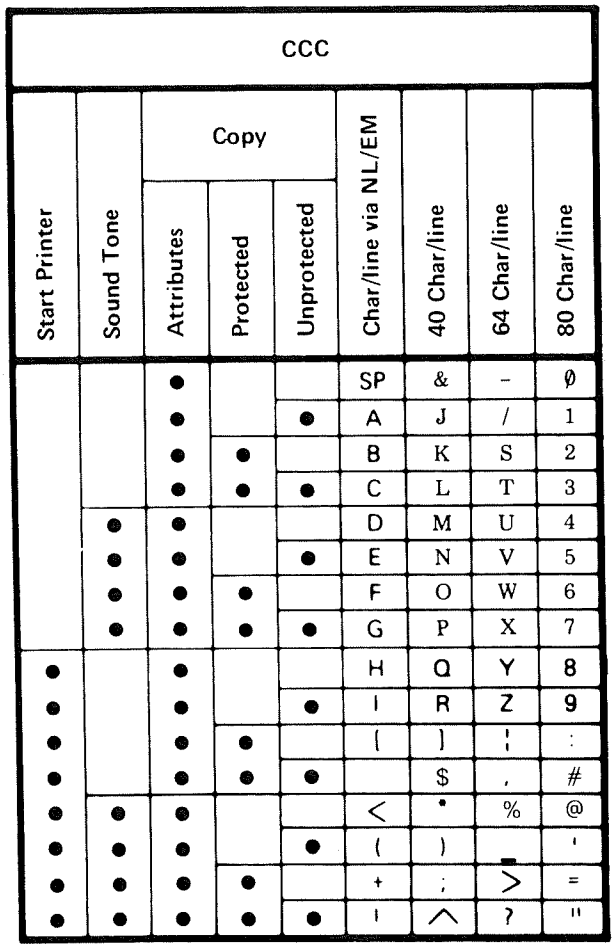
WCC							
Start Printer	Sound Tone	Reset Keyboard	Reset Attributes	Char/line via NL/EM	40 Char/line	64 Char/line	80 Char/line
				SP	&	-	ø
			●	A	J	/	1
		●		B	K	S	2
		●	●	C	L	T	3
	●			D	M	U	4
	●		●	E	N	V	5
	●	●		F	O	W	6
	●	●	●	G	P	X	7
●				H	Q	Y	8
●			●	I	R	Z	9
●		●		[	]	¦	:
●		●	●	.	$	,	#
●	●			<	*	%	@
●	●		●	(	)	_	'
●	●	●		+	;	>	=
●	●	●	●	¦	^	?	"

Figure 14

The CCC can also specify whether protected and/or unprotected data is copied or not. If the copying device is a printer loaded with forms having the protected data preprinted on them, it will not need the protected data. On the other hand, if it is printing on plain paper it will need both protected and unprotected. Analogous considerations can be applied if the device is a display.

After commands come text and/or orders. Possible orders are listed in Figure 16. The set buffer address order moves the buffer address to the location specified by the BA (Buffer Address) characters. This applies whether the device is a display or a printer. The location of the buffer address is important because it determines where the next character will be placed in the buffer.

The insert cursor order moves the cursor to the current buffer address. The cursor does not determine where the next character will appear, only the buffer address does that. The cursor only follows the buffer address during data entry by the operator as a visual indication of the buffer address.



CCC								
Start Printer	Sound Tone	Copy: Attributes	Copy: Protected	Copy: Unprotected	Char/line via NL/EM	40 Char/line	64 Char/line	80 Char/line
		●			SP	&	-	∅
		●		●	A	J	/	1
		●	●		B	K	S	2
		●	●	●	C	L	T	3
	●	●			D	M	U	4
	●	●		●	E	N	V	5
	●	●	●		F	O	W	6
	●	●	●	●	G	P	X	7
●		●			H	Q	Y	8
●		●		●	I	R	Z	9
●		●	●		[	]	¦	:
●		●	●	●		$	.	#
●	●	●			<	*	%	@
●	●	●		●	(	)	_	'
●	●	●	●		+	;	>	=
●	●	●	●	●	¦	^	?	"

Figure 15

The program tab order moves the buffer address to the beginning of the next unprotected field. It also erases any unprotected data between the present and new buffer address, if data was being entered into the buffer when the PT order was received.

The repeat to address order causes the character following BA2 to be automatically repeated into the device buffer up to but not including the buffer address specified by the characters BA1 BA2.

The erase unprotected to address order erases unprotected data from the current buffer address up to but not including the buffer address specified by the characters BA1 BA2.

The start field order starts a field by placing the AC (Attribute Character) following GS (Group Separator) at the current buffer location. This AC can specify the attributes of all characters following it up to but not including the next AC.

Orders	
Set Buffer Address	DC1 BA_1 BA_2
Start Field	GS AC
Insert Cursor	DC3
Program Tab	HT
Repeat to Address	DC4 BA_1 BA_2 C
Erase Unprotected to Address	DC2 BA_1 BA_2

Figure 16

Attributes that can be specified are protected, numeric, modified, displayed, and highlighted, or the opposite of any of these in any combination. Protected fields are protected from operator entry. Numeric fields permit entry of numbers, hyphens, periods, and DUP only. Nondisplayed fields can be entered and the entered data will be put into the buffer but will not be displayed. Fields are normally specified as unmodified by the computer and change from unmodified to modified whenever data is entered into them by the operator. In this manner, the computer can receive only operator entered data from the device buffer by polling the device station since only modified data is sent when the station is polled.

Highlighted fields can be either intensified, that is displayed at higher than normal brightness, or blinked, that is flashed from half intensity to intensified brightness.

The table in Figure 17 shows all possible attribute combinations plus the actual character that would follow GS to cause those attributes to be in effect. For example, if it is desired to start a field whose attributes are protected, numeric, displayed, blinked and field modified the character 9 if received after GS would have that effect in systems where option 403B is required.

Specify Field as †					A C † option 403a or b			
Protected	Numeric	Hidden	Highlighted †	Modified				
					SP	D	B	F
				●	A	E	C	G
			●		H	[		
			●	●	I	.		
		●			<	+		
		●		●	(	!		
	●				&	M	K	O
	●			●	J	N	L	P
	●		●		Q	]		
	●		●	●	R	$		
	●	●			*	;		
	●	●		●	)	^		
●					-	U	S	W
●				●	/	V	T	X
●			●		Y	¦		
●			●	●	Z	,		
●		●			%	>		
●		●		●	_	?		
●	●				0	4	2	6
●	●			●	1	5	3	7
●	●		●		8	:		
●	●		●	●	9	#		
●	●	●			@	=		
●	●	●		●	'	"		

Specify Field as †						A C † option 403c			
Protected	Numeric	Hidden	Blinked †	Intensified †	Modified				
						SP	D	B	F
					●	A	E	C	G
				●		H			
				●	●	I			
			●			[			
			●		●	.			
		●				<	+		
		●			●	(	!		
	●					&	M	K	O
	●				●	J	N	L	P
	●			●		Q			
	●			●	●	R			
	●		●			]			
	●		●		●	$			
	●	●				*	;		
	●	●			●	)	^		
●						-	U	S	W
●					●	/	V	T	X
●				●		Y			
●				●	●	Z			
●			●			¦			
●			●		●	,			
●		●				%	>		
●		●			●	_	?		
●	●					0	4	2	6
●	●				●	1	5	3	7
●	●			●		8			
●	●			●	●	9			
●	●		●			:			
●	●		●		●	#			
●	●	●				@	=		
●	●	●			●	'	"		

†Fields specified as not displayed are also not printed.

Fields are intensified or blinked according to whether option 403A or 403B is elected, respectively. (See figure 19.)

Blinked fields cause intensified fields to be blinked. If displayed at the same time on the same display.

Note: Options may be different on devices not on same controller.

†In systems where some displays employ option 403C and others employ option 403A or 403B, elect characters in the 1st column in preference to those in the 2nd, 3rd, or 4th column. Otherwise, the same character will have a different effect depending on the option elected for the display receiving it. Options 403A, B or C effect all KDs coupled to the same SCC or MCC.

Figure 17

Messages from Station:

The following are the various types of message transmission formats sent from a station as a result of being polled. Synchronization characters not shown.

Read Modified Message (in reply to poll or rd-mod'd cmd if S/R or PF depressed)				
STX SPA DA	AID CA1 CA2	DC1 AA1 AA2	data in field (less NULs)	EBTC XC
		for ea mod'd field*		

*if no fields, data in buffer (less NULs) sent

Read All Message (in reply to rd all cmd)				
STX SPA DA	AID CA1 CA2	GSC AC	data in field (+ NULs)	EBTC XC
		for ea field*		

*if no fields, data in buffer (+NULs) sent

Read Modified Message (in reply to poll or rd mod'd cmd if PA or CLEAR depressed)		
STX SPA DA	AID	EBTC XC

Remote Test Request Message (in reply to poll or rd mod'd cmd if R/TST depressed)				
SOH %/	STX	DC1 AA1 AA2	data in field (less NULs)	EBTC XC
		for ea mod'd field*		

*if no fields (normally the case), data in buffer (less NULs) sent

Status Message (in reply to poll if s & s. Takes priority over other msges)		
SOH %R	STX SPA DA SS1 SS2	EBTC XC

The table in Figure 18 shows the character that will be sent as the AID (Attention Identification) character according to which key (if any) was depressed in order to cause the transmission of a message from the device. (No key was depressed if the transmission is the result of a selection followed by a read command.)

Key Depressed	AID
S/R	'
PA1	%
PA2	>
PF1	1
PF2	2
PF3	3
PF4	4
PF5	5
PF6	6
PF7	7
PF8	8
PF9	9
PF10	:
PF11	#
PF12	@
CLEAR	_
none †	–
none ‡	Y

† on KD
‡ on P

Figure 18

LEVELS OF DISPLAY INTENSITY				
DISPLAY MODE	DISPLAY LEVEL			
	OFF	HALF NORMAL	NORMAL	INTENSIFIED
NORMAL COPY			X	
HIGHLIGHT				X
BLINK		X ←	Toggles	→ X
OFF	X			

Note: Intensified and blinked firlds cannot appear at the same time on the same display device.

Figure 19

The SS (Status and Sense) characters sent in status messages are assigned according to Figure 20. For example, if a selected device is unavailable, the station will reply DLE < to the selection sequence and will cause the status message listed in Figure 20 to be sent if the station receives a specific poll from the computer.

Trouble	S S_1	S S_2	
Invalid Command	SP	A	
Device Available	SP	&	
Command not Valid for Device	SP	—	
Device Busy	H	SP	
From Device Busy	H	A	
From Device Unavailable	SP	J	
Device no Longer Busy	B	SP	*
Printer Paper Out	B	C	*
Internal Timing Error	SP	B	*
Buffer Locked From Copy	D	A	
Block Forward Aborted	SP	D	*

*Also sent to a general poll.

Figure 20

The table in Figure 21 shows the characters that are used to control the station and device from the computer in the order in which they are typically used. The pattern can be easily seen in the WCC, CCC, and AC tables, for an example.

Character Set for Control Sequences			
SP	&	–	0
A	J	/	1
B	K	S	2
C	L	T	3
D	M	U	4
E	N	V	5
F	O	W	6
G	P	X	7
H	Q	Y	8
I	R	Z	9
[	]	¦	:
.	$	,	#
<	*	%	@
(	)	_	'
+	;	>	=
!	^	?	"

Figure 21

These same characters are also used to specify buffer addresses (see Figure 22). Each character is combined with every other character, in the order they are listed on the table, in order to assign buffer addresses. As an illustration, the "home" (location Ø) position in the buffer has the address SP SP, the first position to the right of that location has the address, SP A, to the right of that SP B. After SP has been used in combination with all other characters in the list, the first character in subsequent buffer addresses becomes "A" and is combined with all other characters in the list, at which point it becomes B, etc. See example in Figure 22 below.

EXAMPLES FOR DETERMINING
BUFFER ADDRESS (BA) CODES

BA — BUFFER ADDRESS
COORDINATES EXAMPLES

SEQUENTIAL ADDRESS	DISPLAY ROW	DISPLAY COLUMN	ODD PARITY GRAPHICS	
0	1	1	SP	SP
1	1	2	SP	A
2	1	3	SP	B
3	1	4	SP	C
63	1	64	SP	"
64	1	65	A	SP
65	1	66	A	A
66	1	67	A	B
127	2	48	A	"
128	2	49	B	SP
129	2	50	B	A
130	2	51	B	B
etc	etc	etc	etc	etc

Figure 22

Blocking:

Up to this point, we stated that all messages, whether from the computer or from the station, end with ETX, BCC.

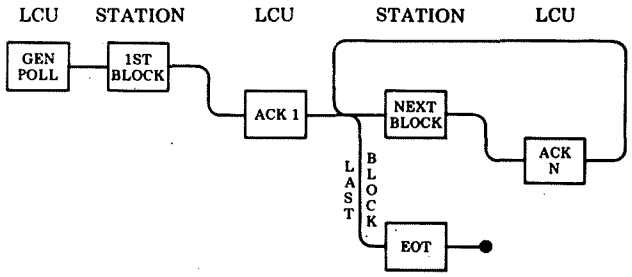
Exception to this occurs when the message is longer than 256 character. In that case, the station or computer halts at the end of each 256 character block and sends the sequence ETB (End of Transmission Block) BBC. Character Blocks are always created when transmitting from a station to the computer. The converse does not hold true at all times. This is dependent on the software package that is associated with the computer.

The ETB or ETX control at the end of all messages tells the receiver to compare the BCC it constructs during reception to the BCC it receives following ETB or ETX. If they are identical and character parity for all characters in the block is valid, the DLE 1 reply is sent from the message

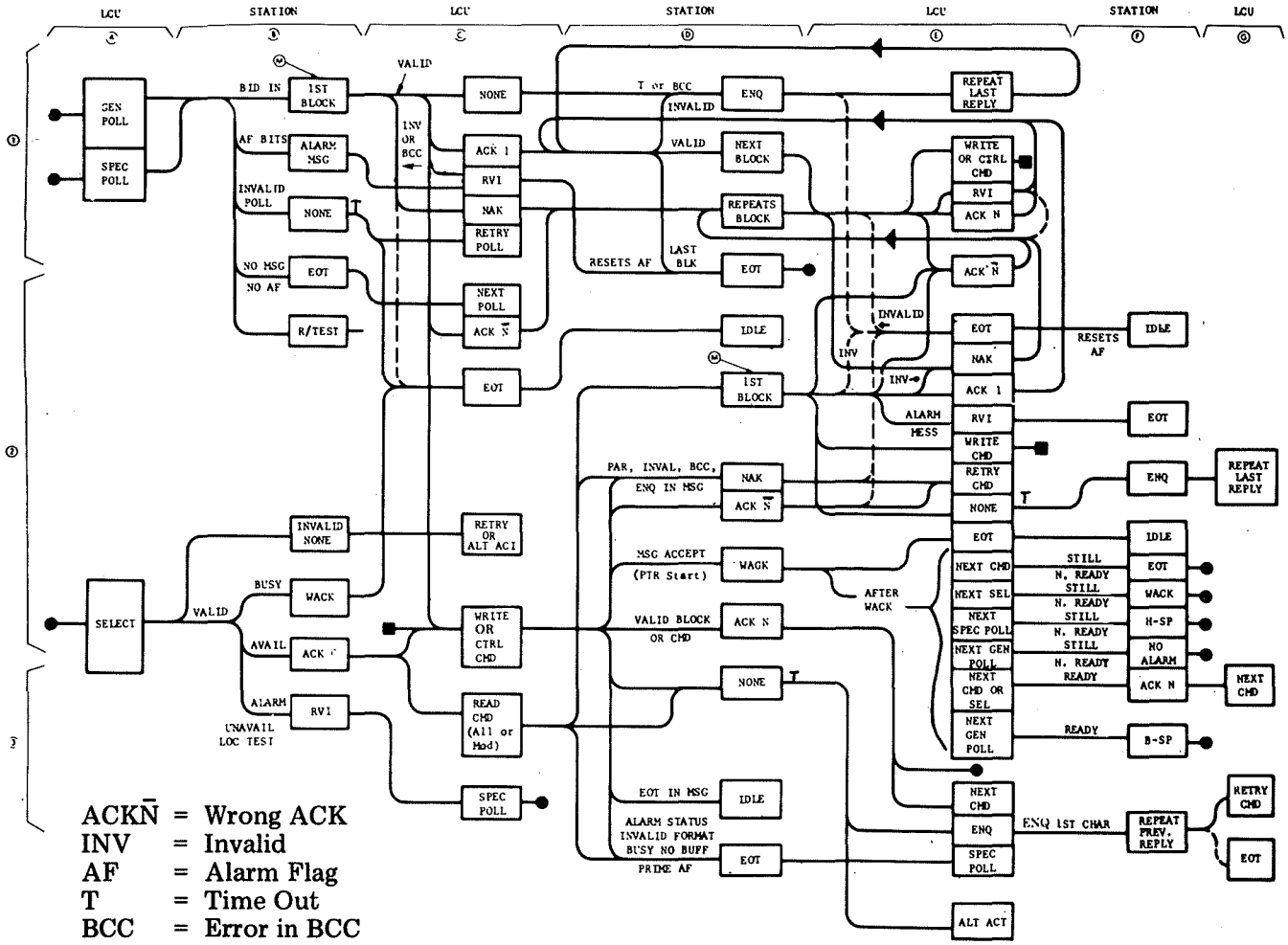
receiver to the sender to the first such block, DLE 0 to the next, DLE 1 to the next, etc. The last block, equal to or less than 256 characters, would end in ETX BCC which causes the receiver to send the DLE N reply, which then terminates the communications by sending EOT (End of Transmission).

If the constructed and received BCCs are not identical or a character parity error is detected, the receiver sends NAK to the sender (Negative Acknowledge), causing it to re-send the message or block, typically up to 7 times before some type of error recovery takes over. If no reply is received, the receiver sends ENQ (Enquiry) to the sender, typically every 3 seconds, to indicate that it has not received a reply.

For additional Data Link Controls refer to Figure 23 below. The Flowchart starts at the computer (LCU) with a polled (1A) or a select (2A) condition. Example: You want Gen. Poll; Station has traffic; No invalid commands or BCC; More than one block of data.



SYSTEM FLOW DIAGRAM



ACK$\bar{N}$ = Wrong ACK
INV = Invalid
AF = Alarm Flag
T = Time Out
BCC = Error in BCC
CMD = Command
MSG = Message
— — — — — — Repeated Condition
Ⓜ Station becomes master on SOH or STX
● Next Poll, Sel or ALT Action or Idle
■ Retry

Note: "A" through "G" and "1" through "3" are indicated for coordinate purposes.

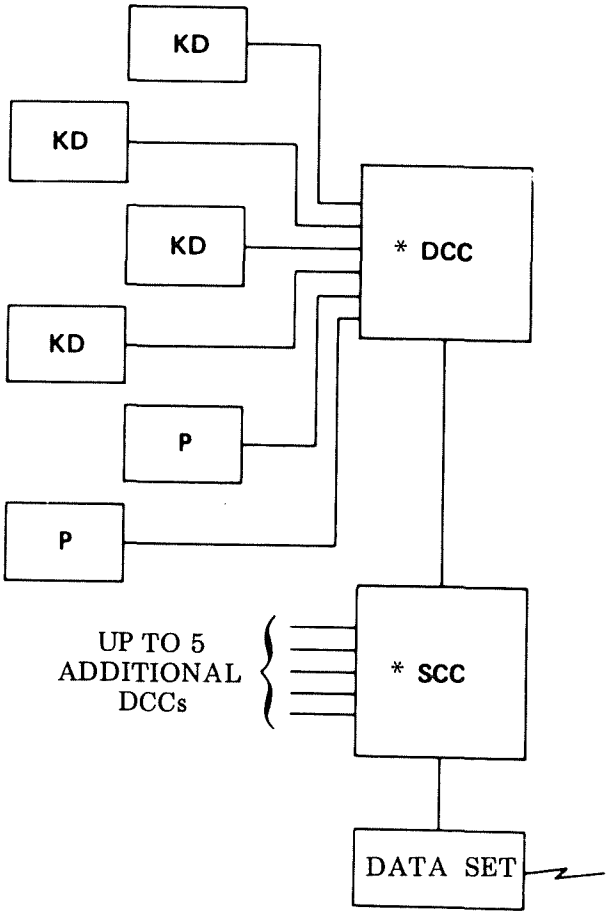
Figure 23

5. STATION DESCRIPTION

Each station in the system can consist of several devices clustered around 1 or up to 7 controllers. Clustering is available in a range from maxi to mini.

The maximum configuration shown in Figure 24 consists of 24 keyboard displays (KDs) and 12 printers (Ps) coupled to 6 device cluster controllers (DDCs) plus 1 station cluster controller (SCC) and its associated data set. More Ps can be accommodated if fewer KDs are used, but the total number of devices per DCC cannot exceed 6, and the total number of DCCs per SCC cannot exceed 6. See Note.

Maxi-Cluster Station Configuration

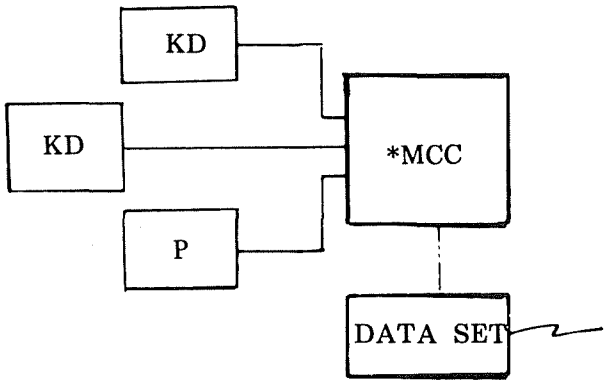


*All controllers must be mounted in pedestals.

Figure 24

The mini-clustered configuration shown in Figure 25 consists of 1 or 2 KDs and 1 P coupled to a mini-cluster controller (MCC) and its associated data set. More Ps can be accommodated if fewer KDs are elected, but the total number of devices cannot exceed 3. See Note.

Mini-Cluster Station Configuration



*All controllers must be mounted in pedestals.

Figure 25

Without going into unnecessary detail, the DCC portion of a maxi station configuration essentially contains the logic and data storage buffers for the devices coupled to it, and the SCC portion contains the line protocol logic required for the station to operate in the system, including such things as polling and selection address recognition and replies.

In a mini-cluster configuration the MCC performs both the SCC and DCC functions for that configuration.

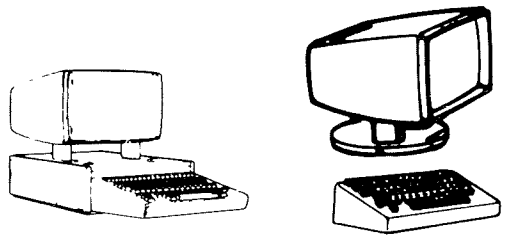
With this method of station configuration construction physical flexibility is built in as well as economy of electronics. KDs can be located up to 100 cable feet and Ps can be located up to 2000 cable feet from their DCC or MCC, DCCs can be located up to 2000 cable feet from their SCCs, and SCCs or MCCs can be located up to 50 cable feet from their associated data set.

Note: For maintenance reasons, at least 1 KD required with each device cluster controller and each mini-cluster controller.

6. DEVICE DESCRIPTION

Each device at each station can be either a keyboard display (KD) or printer (P), provided that the total number of each does not exceed the restriction stated under Station Description.

KDs can be either cabinet or base mounted. The cabinet mounted type is designed for locating on top of pedestals, which can also mount a SCC, DCC or MCC. See Figure 26.



Cabinet Mounted Base Mounted

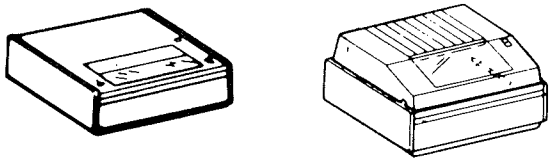
Figure 26

The base mounted type of KD is designed for desk top use. The keyboard and display portions are separately mounted on bases which permit them to be easily slid around on a desk top surface to suit operator convenience and varying requirements of a desk location.

Printers can be friction or tractor feed as shown in Figure 27, for printing on continuous rolled or fan-folded form paper, respectively. Both types are cabinet mounted for locating on top of station pedestals which can also mount a SCC, DCC or MCC. These devices can also be mounted on customer provided furniture. See Note.

Note: Refer to section on Technical Facts for dimensions of equipment.

Both KDs and Ps are available with optional 96-character full ASCII character set instead of the 64-character monocase character set. Additional standard features for each device are as follows.



Friction Feed Tractor Feed

Figure 27

DEVICE FEATURE SUMMARY

Station

- Binary Synchronous Line Protocol
- EIA (RS-232-C) Interface, matches 201 or 208 data set or equivalent
- Non-Simultaneous Send-Receive Operation on 4-wire HDX multi-point private line
- 2400 or 4800 bit/sec
- Modular Design with Built-In Diagnostics
- 115 V AC @ 60 Hz
- ASCII Code
- Odd Vertical Parity & Block Check Gen'd. Error in either causes block re-send.
- Operates with OS, DOS, CICS, IMS, BTAM and TCAM Software.

Keyboard Display

- 97 Characters and Controls
- Shift, Caps Lock & Control keys
- Cursor Up, Down, Left & Right keys
- Cursor Return, New Line & Home keys
- Tab, Cursor Tab & Back Tab keys
- Erases to End of Field on Tab
- Character & Line Delete & Insert keys
- Erase Input (Unprotected Data) key
- Clear (All Data) key
- Repeatable keys: Cursor Up, Dn, L, R, ., -, , Space, >, Char Del & Insert
- Cursor Wraps Around
- Automatic Skip: Field fill automatically moves cursor to start of next field
- Character-Size Cursor, Doesn't Hide Chars
- Tube-Tilt & Brightness Controls
- Keyboard Entry Error Tone
- Displays 64 (or optionally 96) Symbols via 7 x 9 dot matrix refreshed 60X/sec on 24-line @ 80 char/line
- Display can be formatted into fields by receipt of attribute characters
- Attribute characters can define fields as Protected (from keyboard entry), Highlighted (intensified or opt'l blink), Numeric (only numeric entries allowed), unmodified (by keyboard entry) and/or Non-Displayed (there but not seen)
- Screen address accompanies each sent field
- Spaces are sent, blanks (NULs) are not
- Performs following commands & orders: Read Buffer, Read Modified, Write, Erase-Write, Copy, Erase All Unprotected, Start Field, Set Buffer Address, Insert Cursor, Program Tab, Repeat to Address and Erase Unprotected to Address; many of which translate into features listed above & below
- 1920 Character Buffer
- Send all data or only modified and unprotected fields, under computer control

- Erase all data or only unprotected fields, under computer control
- Erase unprotected fields from one specifiable screen address to another, under computer control
- Display data starting at a specifiable screen address, under computer control
- Move cursor to specifiable screen address, under computer control
- Repeat specifiable character from one specifiable screen address to another, under computer control
- Erase unprotected data from a specifiable screen address to end of field & tab to start of next field, under computer control

Printer

- Print Protected and Unprotected Fields Under computer control
- Print Protected and Unprotected Fields via PRINT LOCAL key
- Print 64 chars @ up to 5.2 lines/sec. or optionally 96 chars @ 3.7 lines/sec.
- Prints 10 char/in, 80 char/line, 6 line/in adjustable for double line feed printing
- Friction Feed: Prints on standard 8-1/2 in single-ply rolled paper
- Tractor Feed: Prints on standard fan-folded forms, up to 6-ply. Adjustable for forms 4 to 9-1/2 in wide, 3-2/3, 5-1/2 or 11 in long
- Automatic Form/Paper Feedout
- Full Character Impact Printing
- 1920 Character Buffer

Controller

- Keyboard Displays can be up to 100 cable ft from Device Cluster Controller, Printers can be up to 2000 cable ft from Device Cluster Controller, Device Cluster Controller can be up to 2000 cable ft from Station Cluster Controller, Station Cluster Controller can be up to 50 cable ft from modem
- Responds to General Station & Specific Device Polling with message, status-message or no-message reply
- Message and status message include station and device identification
- Responds to Selection with ready, ready-but-wait or not-ready reply.

7. STATION OPERATION

The majority of station operation is under the control of the computer, as brought out under System Operation. The operator is primarily concerned only with obeying instructions from the computer which are displayed on his KD, and with entering the data called for. Printer operation is also minimal and typically amounts to loading paper and removing printed messages.

Operation of a KD device is done by means of the keyboard, shown in Figure 28.

Typical data entry amounts to filling in a computer provided form such as the one shown earlier under System Operation.

During data entry the keyboard is operated like that of a typewriter. The SHIFT key permits entry of upper case letters and shift position characters. The CAPS LOCK key permits upper case letters to be entered without having to operate the SHIFT key and without having to unlock the CAPS LOCK key in order to generate numbers and other unshifted characters.

During operator data entry, the operator may be informed of an improper entry by a tone signal located in the opcon. This signal can be a continuous tone or single stroke tone. Termination of the continuous tone is accomplished by depressing the LOCAL key.

The CONTROL key is used to enter the controls FM (Field Mark) and DUP (Duplicate) and also to generate L/TST (Local Test) and R/TST (Remote Test) requests.

In certain systems, entry of FM is used to denote sub-fields within displayed fields; and DUP is used to cause the computer to assume that the data in the field where DUP is entered is the same as the data entered in the corresponding field on a previously sent form, or is the same as the data in the previous field on the same form.

Entry of L/TST causes a test message to be generated by the station controller and displayed on the KD. Depression of the send (S/R) key causes this message to be sent from the display to the data set interface, where it is looped back and displayed on the next line. A visual comparison between the line sent and the line received back is used to determine if the overall station is working properly or not. See Note.

Entry of R/TST causes a test request message to be sent to the computer when the station is next polled. The nature of the test will depend on the system.

As each field on a form is filled in by the operator the cursor follows along. If mistakes are made they can be easily corrected by moving the cursor to the location of the mistake. The cursor controls are located at the left-hand end of the keyboard. The 4 arrow keys move the cursor

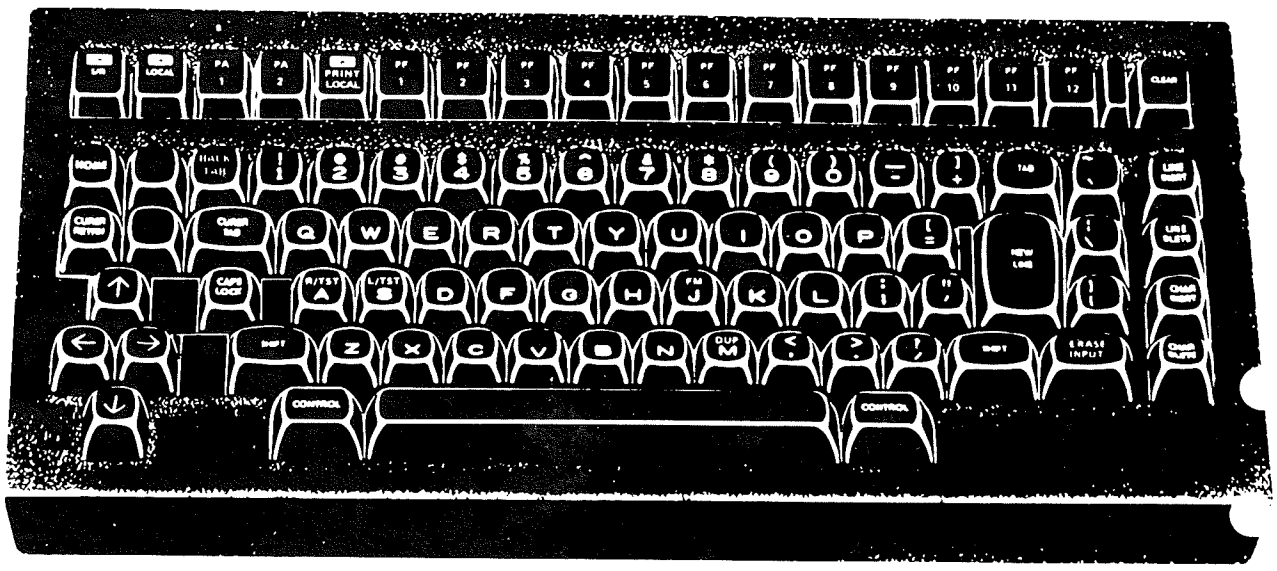


Figure 28

character or line at a time with normal depression and several characters and lines at a time with extra pressure. CRSR RET moves the cursor to the start of whatever line the cursor is on. CRSR TAB moves the cursor to the beginning of the next unprotected field and BACK TAB moves the cursor to the beginning of the present or previous unprotected field, depending on whether the cursor is in the middle or at the beginning of a field, respectively.

All of the above mentioned cursor controls can cause cursor wraparound. That is, if the cursor is moved off the screen to the right it will re-appear on the left, one line below. If moved off the screen to the left it will appear on the right, one line above. If moved off the screen below, it will appear above in the same column; and if moved off above it will appear below, in the same column.

Remaining cursor controls are HOME and NEW LINE, the latter of which is integrated into the keyboard on the right hand end. HOME moves the cursor to the upper left-hand corner of the screen and NEW LINE moves the cursor to the first unprotected character position on the next line.

Once the cursor is moved to the location of an error, be it a wrong, missing or unwanted character, the error can be corrected by replacing erroneous data with correct data and/or by operating the editing controls located at the right-hand end of the keyboard.

In the case of a wrong character, entry of the correct one on top of the wrong one will correct the error. If a character is missing, the CHAR INSRT key is depressed, once for each missing character, and if there are blank spaces at the end of the field or line whichever comes first, the character covered by the cursor and all characters to the right will move to the right each time the CHAR INSRT key is depressed, to make room for the missing characters.

If there is an unwanted character the CHAR DEL key will remove the character the cursor is covering and move all characters on the right in the same field to the left each time the key is depressed. Both this key and the CHAR INSRT key can be repeated by applying extra pressure.

> *Note:* When performing local test, all stations behind controller disconnect from the line for approximately 200 MS (duration of data loop back) without adverse effect on the system. A bid may be placed during test mode but will not be reacted upon until test is completed.

The LINE INSRT and LINE DEL keys do on a line basis the same things that the CHAR INSRT and CHAR DEL keys do except that they do not perform their function if there are any fields present on the display. That is, they have application only during unformatted data entry.

The TAB, ERASE, and CLEAR keys come into use during repetitive usage of the same displayed form; either because the computer does not erase data for the operator between usages or because the operator has made so many mistakes during entry that he desires to start over again.

In this context then, the TAB key moves the cursor to the beginning of the next unprotected field and erases any unprotected data between the present and new cursor locations. The ERASE INPUT key erases all unprotected data from the screen. Protected form data and all fields remain. The CLEAR key erases all data and fields and homes cursor.

To send entered data to the computer the operator depresses the S/R (Send/receive) key or one of the PF (Program Function) keys. Which is depressed depends on the system and on the interpretation (if any) that the computer attaches to the AID character automatically sent along with the data. A different AID character is sent for each key.

As a illustration of usage, depression of a certain one of the PF keys might cause the computer to calculate the sales tax for all prices displayed on the screen and accordingly revise the displayed prices.

Typically the operator is not expected to remember which PF key causes what function — the computer tells him via a displayed instruction.

Regardless of which send key was depressed, transmission begins when the station is next polled, and typically includes only data entered by the operator since the station was previously polled, plus automatically generated message format data, unless the computer desires otherwise.

Exception to this is the PA (Program Access) keys. They cause a short message containing the AID character to be sent to the computer.

An illustration of their use is in a multi-form data transaction with the computer where PA2 might be used to cause the next form to be displayed and PA1 might be used to cause the previous form to be displayed.

Depression of the CLEAR key also causes a short message containing the AID character to be sent to the computer, to inform it that the display screen no longer contains fields on it.

Depression of the PRINT LOCAL key causes the displayed data to be printed on a printer coupled to the same DCC or MCC as the KD. In most systems, an alternate way of accomplishing the same thing is to depress one of the PF keys. PRINT LOCAL function is possible only on cluster controller positions designated for printers (P). If printers are used in KD positions, PRINT LOCAL function is not available. These "NO LOCAL" printers are however capable of responding to copy command.

Depression of the LOCAL key permits the operator to enter data on the display. Typically, however, the computer unlocks the keyboard for the operator after sending it a data entry format. But sometimes the computer leaves the keyboard locked, as an attention getting device to cause the operator to think about the data that he will enter.

OPERATOR CONTROLS

The Display On-Off control turns display screen on and off. It does not effect data in display buffer.

The tube tilt control permits the operator to compensate for nearby room light glare by tilting the tube forwards and backwards.

The brightness control varies the intensity of the brightness. See Figure 29.

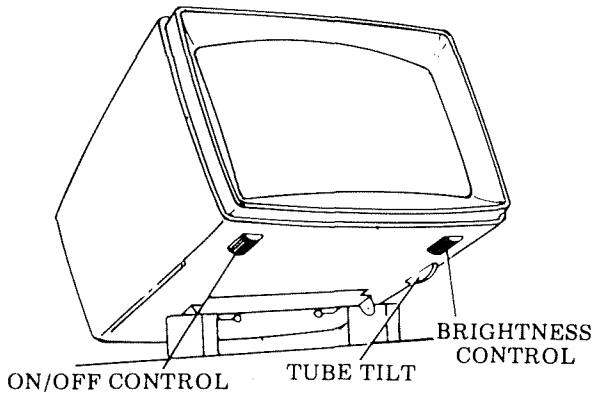


Figure 29

The audible tone on the opcon sounds on any of the following conditions to assist the operator during data entry: Attempting to enter data in a protected field, attempting to enter alphabetical data in a numeric field, attempting to insert data where space does not permit, attempting to delete or insert lines on a screen having fields on it. Loudness is adjustable. See Figure 31. The audible tone can also sound as result of computer command. Depression of LOCAL key terminates alarm.

The ON/OFF switch is a master AC switch controlling all devices plugged into the AC strip in the cabinet. The individual device power ON/OFF controls are secondary to this AC switch. See Figure 30.

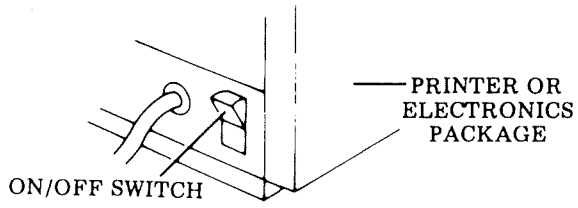


Figure 30

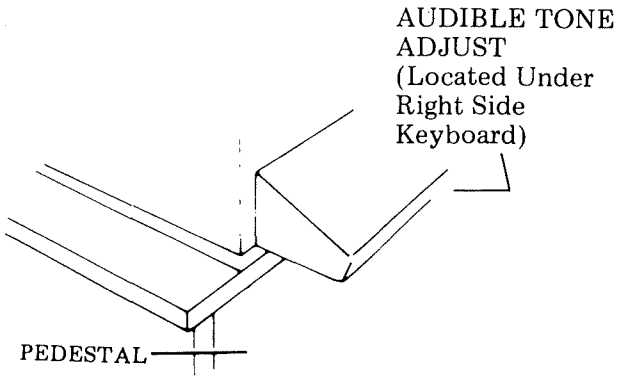


Figure 31

The PAPER pushbutton feeds out blank paper for as long as it is depressed; and illuminates when paper supply needs refilling. The needs refilling condition permits the present print-out to continue but prevents the next one from beginning until the paper supply is refilled. See Figures 32 and 33.

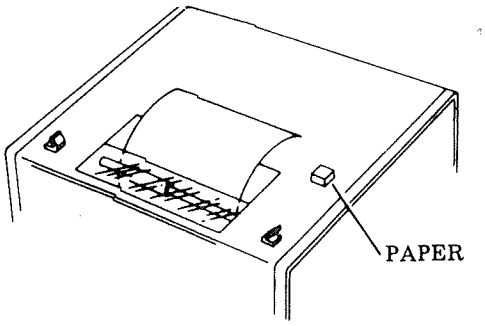


Figure 32

The FORM ADVANCE pushbutton feeds out forms on a tractor feed printer to the beginning of the next form. See Figure 33.

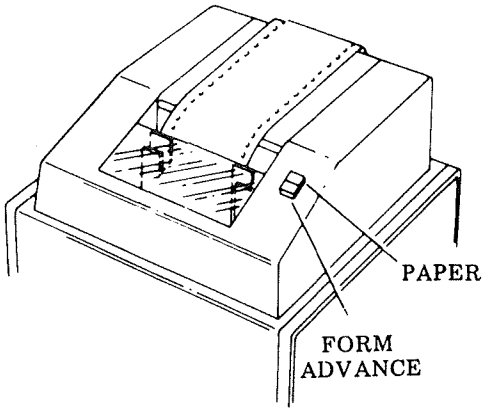


Figure 33

8. LOCAL TEST FEATURE

The Local Test feature of the Model 40 Synchronous Inter-Active Terminal allows the terminal operator to test the Device Cluster Controller (DCC) to Station Cluster Controller (SCC) communications link and the SCC up to the modem interface. The testing disconnects the SCC (MCC) from the Line Control Unit (LCU) for approximately 200 ms. while performing the loop-back portion of the test. This interruption is only allowed when the SCC is not processing text to the link so it means that the SCC (MCC) may fail to respond to a poll or selection sequence.

The test is in the form of a dialogue between the operator and the SCC (MCC) with a minimum amount of typing required by the operator. The sequence of events are as follows:

The operator requests a local test by striking the LCL TST key (Control S). This action locks her keyboard and requests the test procedure from the SCC.

When the SCC (MCC) completes a message transaction to the LCU (if one was in progress), it places the requesting K/D into the receive mode and sends the following message to the display preceded by an Erase/Write Command to clear the display:

YOU HAVE REQUESTED A LOCAL TEST WHICH WILL MOMENTARILY DISCONNECT THE M-40 CLUSTER FROM THE SYSTEM.

IF YOU WISH TO CONTINUE —

(1) Type Y
(2) Press S/R

IF YOU WISH TO STOP —

(1) TYPE C
(2) PRESS S/R

(α β γ)

The keyboard is then unlocked to allow the operator to respond. The α β γ in the parentheses are the station poll address, the station select address and the device address. If during installation, the α or β character is programmed on the PIT/SID circuit card with incorrect parity a delete character is displayed in its place. (A delete will display as underline on sets that are upper case only.)

The operator has to make a decision and respond. If the operator wishes to cancel the test, typing C and depressing S/R will cause the SCC (MCC) to clear the operator's display and cancel the test. If Y is typed instead, the SCC (MCC) will clear the display and send the following:

THE QUICK BROWN FOX JUMPED OVER THE LAZY DOG'S BACK 1234567890 TIMES

TO INITIATE TEST — PRESS S/R KEY

If any character other than Y or C is sent by the operator, the SCC (MCC) will cancel the test and flash the S/R lamp on the keyboard. The operator can recover by depressing the LOCAL key and clearing her display.

When the operator depresses the S/R key the SCC (MCC) determines if it is in the process of sending to the LCU. If it is, it waits until the last character is sent, before it proceeds to loop back the Communication Interface Unit (CIU) or the integral modem (if present) and sends the "QUICK BROWN FOX------" message to the CIU which loops it back to the receive data routines in the SCC (MCC). When the loop back is complete the CIU or modem is returned to normal operation.

If the message was looped back without error, the display is first cleared, the message is sent to the display, the keyboard is restored, and the test mode is canceled. If the message was received with an error, the following message is displayed on the screen with the original test message:

* * * TEST FAILED * * *

IF YOU WISH TO RETRY — PRESS S/R

TO CANCEL TEST —

(1) TYPE C
(2) PRESS S/R

Sending the "C" causes the SCC (MCC) to cancel the test and clear the operator's display. Just pressing S/R causes the SCC to repeat the loop-back portion of the test.

Affects on System Operation

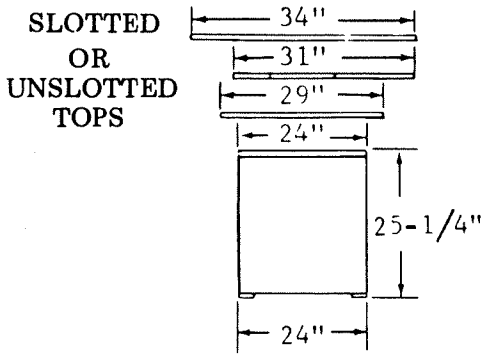
From the time an operator initiates a Local Test Request until the test is canceled or completed, no other device is allowed to send data to the LCU or request a Local Test. Bids to send will be stored in the SCC (MCC) and acted upon as soon as the test has ended.

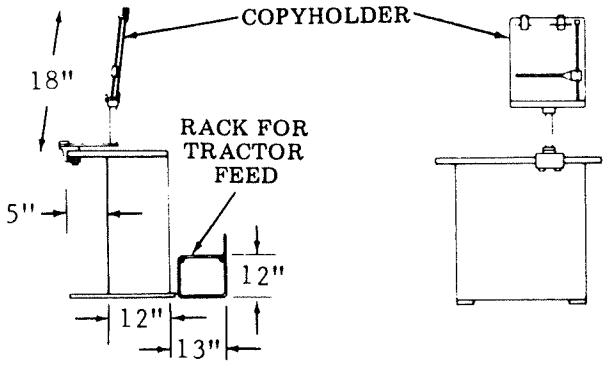
If another device is selected while a local test is in operation, the SCC will accept the message and pass it to the device if the SCC (MCC) is not in the process of passing a stored message to the device under test. If it is, the select will be ignored and no answer-back sent.

If the device that has requested a Local Test is selected by the LCU the SCC (MCC) will cancel the test, acknowledge the select and prepare the device to accept data.

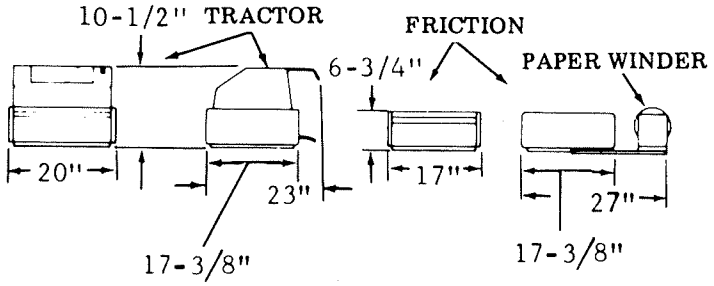
9. TECHNICAL FACTS

Outline Dimensions, Space Requirements, and Weight

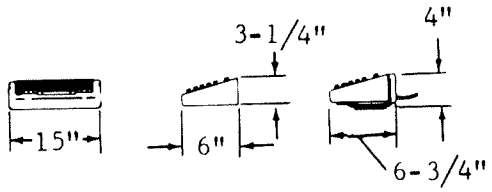




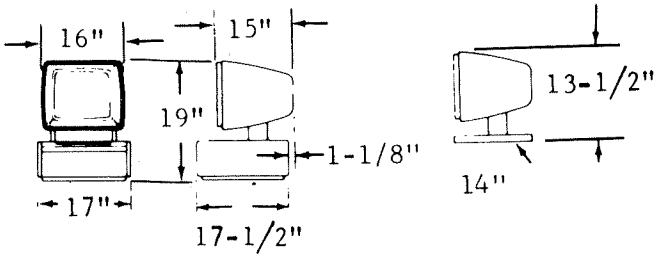
PEDESTALS



PRINTERS



OPERATOR CONSOLES



MONITOR

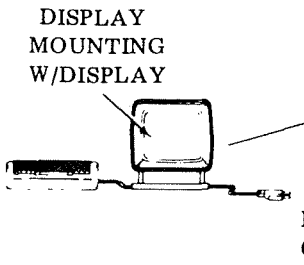
COMPONENTS	WEIGHT
Opcon	7-1/2 lbs
Cabinet (Without Controller)	25 lbs
Pedestal (No Controller)	55 lbs
Pedestal With Controller	110 lbs
Printer in Cabinet (Tractor)	60 lbs
Printer in Cabinet (Friction	55 lbs
Monitor	38 lbs
Controller	52 lbs
Paper Winder	9-1/2 lbs
Rack	6-1/2 lbs
Copy Holder	2-3/4 lbs

Figure 34

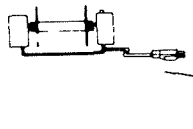
AC Power and Environmental Requirements

Currents and power shown are maximum values based on power company supplied voltages within the limits:
115 ±10% volts ac 60 Hz ±0.1%.

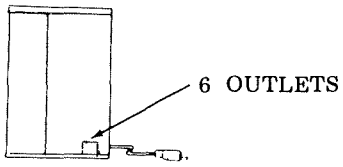
	WATTS*	RUNNING CURRENT
SCC	200	2.2
DCC	350	3.5
MCC	300	3A



EACH KD FREE STANDING OR INTERCONNECTED	100	1A.
EACH PRINTER (F)	105	1.6A
EACH PRINTER (T)	105	1.6A



EACH PAPER WINDER	45	0.3A



EACH PEDESTAL (Does not consume power but can handle values shown in 6 receptacles total.)		13

*BTU = WATTS x 3.41

Environmental conditions should be maintained within the following limits to avoid damage and provide proper operation.

ENVIRONMENTAL CONDITIONS	STORAGE OR TRANSPORTATION		OPERATION	
	MIN	MAX	MIN	MAX
Temperature	-40°F	+150°F	+40°F	+110°F
Humidity	2%	95%	2%	95%
Altitude	SEA LEVEL	50,000 ft.	SEA LEVEL	50,000 ft.

Note: As with any device that can be damaged by water, sudden temperature changes that can cause condensation should be avoided.
Example: A device stored in subzero temperatures will collect frost when unpacked in a warm humid room.

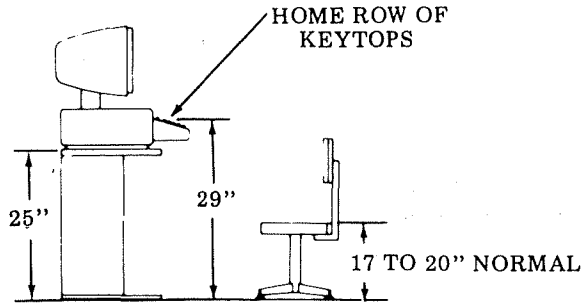
Figure 35

Terminal Layouts

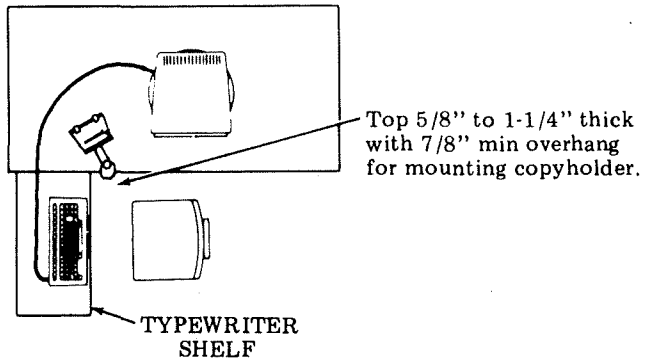
The Synchronous 40 Devices should be located for convenient operation of the keyboard, viewing of display and reading and handling of printed copy. Standard pedestals of various top widths or customer supplied tables may be used. Space for source data papers and/or copyholders should also be considered along with access to paper winders and/or accumulating racks.

A standard 30" table will place the free standing display at approximately the same height as the interconnected display on the 25" pedestal.

Note: Printers may be located at any height except for tractor feed which must allow for height of form boxes and form accumulation. Distances from the operator are limited only by the cable length. See Figure 36.



The interconnected KD provides a fixed relationship between the keyboard and display and the use of a standard pedestal provides proper height for normal seated operation of the keyboard.



On free standing KDs the keyboard can be mounted at different levels and up to 4 feet away from the display. Table height can be chosen for seated or standing operation, however, the 29" home row keytop height is suggested for seated keyboard operation.

Figure 36

TERMINAL VOCABULARY

KEYBOARD VOCABULARY (See Figure 37)

All 96 characters shown in the last 6 columns of the ASCII code chart can be entered on the keyboard. Also, the controls RS and FS can be entered, by entering FM and DUP, respectively.

DISPLAY VOCABULARY

The display can display the 64 characters shown in the middle 4 columns, or optionally the 96 characters shown in the last 6 columns, of the ASCII code chart. If only 64 characters can be displayed, the corresponding character 2 columns to the left is displayed for characters shown in the last 2 columns of the code chart. Also, the symbols F_S and D_L are displayed, for the controls RS and FS, respectively. The absence of any other symbol indicates the display of the character SP or the control NUL.

PRINTER VOCABULARY

Monocase printers can print the 64 characters shown in the middle 4 columns of the ASCII code chart. Full ASCII printers can print all 96 characters shown in the last 6 columns except DEL. Monocase printers print the corresponding character 2 columns to the left for characters shown in the last 2 columns of the code chart, except DEL which is not printed.

ASCII (American Standard Code for Information Interchange)

ASCII							
Controls		Characters					
NUL	DLE	SP	0	@	P	`	p
SOH	DC1 (SBA)	!	1	A	Q	a	q
STX	DC2 (EUA)	"	2	B	R	b	r
ETX	DC3 (IC)	#	3	C	S	c	s
EOT	DC4 (RA)	$	4	D	T	d	t
ENQ	NAK	%	5	E	U	e	u
ACK	SYN	&	6	F	V	f	v
BEL	ETB	'	7	G	W	g	w
BS	CAN	(	8	H	X	h	x
HT (PT)	EM	)	9	I	Y	i	y
NL	SUB	*	:	J	Z	j	z
VT	ESC	+	;	K	[	k	{
FF	FS (DUP)	,	<	L	\	l	|
CR	GS (SF)	-	=	M	]	m	}
SO	RS (FM)	.	>	N	^	n	~
SI	US (ITB)	/	?	O		o	DEL

0	1	0	1	0	1	0	1	5
0		1		0		1		6
0				1				7

0	0	0	0	0
1				
0			1	
1				
0		1	0	
1				
0			1	
1				
0	1	0	0	
1				
0			1	
1				
0		1	0	
1				
0			1	
1				
1	2	3	4	BITS

NUL - Null
SOH - Start of Heading
STX - Start of Text
ETX - End of Text
EOT - End of Transmis'n
ENQ - Enquiry
ACK - Acknowledge
BEL - Bell
BS - Back Space
HT - Horizontal Tab
NL - New Line
VT - Vertical Tab
FF - Form Feed
CR - Carriage Ret.
SO - Shift-Out
SI - Shift-In
DLE - Data Link Escape
DC1 - Device Control 1
DC2 - Device Control 2
DC3 - Device Control 3
DC4 - Device Control 4
NAK - Negative Acknowledge
SYN - Synchronous
ETB - End of Trans'n Block
CAN - Cancel
EM - End of Media
SUB - Substitute
ESC - Escape
FS - Field Separator
GS - Group Separator
RS - Record Separator
US - Unit Separator

SP - Space
DEL - Delete

Bit sequence is 1 through 7 with an 8th bit added for parity.

Figure 37

MINI- AND MAXI-CLUSTER ARRANGEMENTS

Figures 38 and 39 illustrate the planning of station arrangements.

Station numbers must be different for each station. Determines SPA and SSA. See Figure 38.

Stn or Dvce No.	SPA	SSA	DA	Stn or Dvce No.	SPA	SSA	DA
0	SP	–	SP	18	K	2	K
1	A	/	A	19	L	3	L
2	B	S	B	20	M	4	M
3	C	T	C	21	N	5	N
4	D	U	D	22	O	6	O
5	E	V	E	23	P	7	P
6	F	W	F	24	Q	8	Q
7	G	X	G	25	R	9	R
8	H	Y	H	26	]	:	]
9	I	Z	I	27	$	#	$
10	[	¦	[	28	*	@	*
11	.	,	.	29	)	'	)
12	<	%	<	30	;	=	;
13	(	_	(	31	^	"	^
14	+	>	+	32			–
15	!	?	!	33			/
16	&	0	&	34			S
17	J	1	J	35			T

Device Number Assignments (DA) follow in sequence starting at 0 through 35. Device numbers must be different for each device.

Examples:

1st Device 0 = SP
2nd Device 35 = T

ABBREVIATIONS

DCC – Device Cluster Controller
SCC – Station Cluster Controller
MCC – Mini-Cluster Controller
SPA – Station Polling Address
SSA – Station Selection Address
DA – Device Address
KD – Keyboard Display
P – Printer

Note: Local copy can be obtained on printers located in (printer only) positions. Printers may be used in KD positions also, but cannot be used for local copy.

MAXIMUM CABLE FEET

DCC to SCC = 2000 Ft
KD to DCC or MCC = 100 Ft
PTR to DCC or MCC = 2000 Ft
SCC or MCC to Data Set = 50 Ft

MINI-STATION CONFIGURATION WORKSHEET

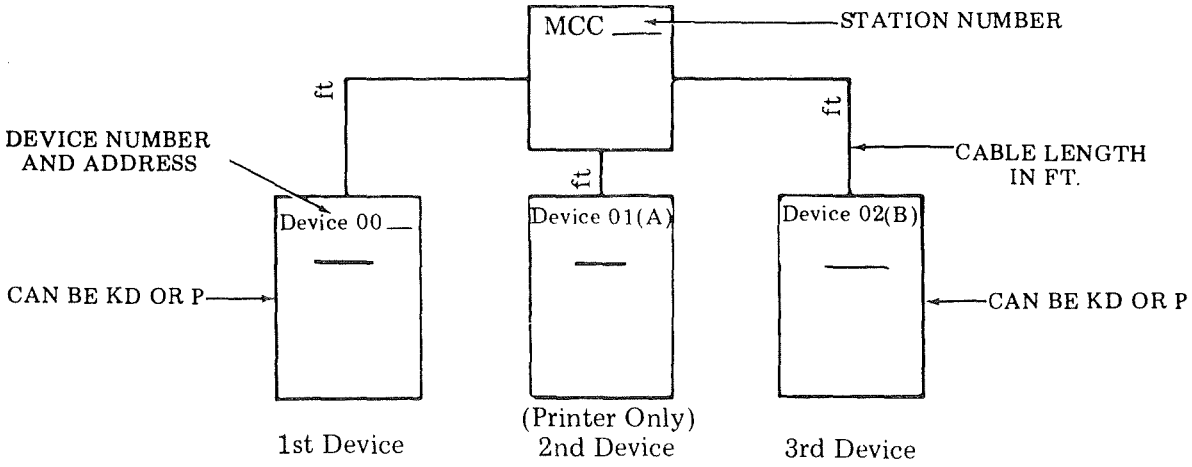


Figure 38

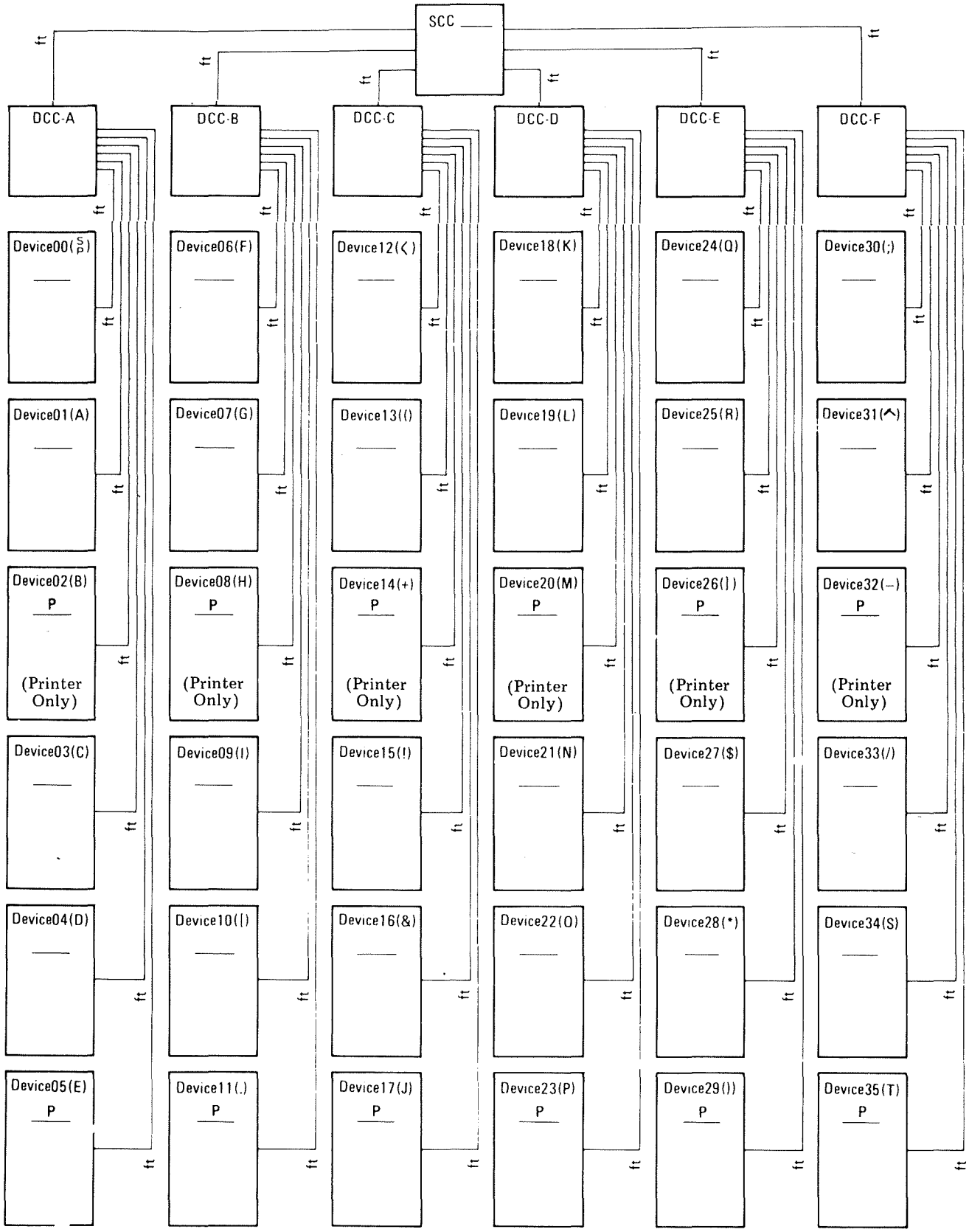

SCC
ft
DCC-A
DCC-B
DCC-C
DCC-D
DCC-E
DCC-F
Device00(Sp)
Device06(F)
Device12(<)
Device18(K)
Device24(Q)
Device30(;)
Device01(A)
Device07(G)
Device13(()
Device19(L)
Device25(R)
Device31(^)
Device02(B)
P
(Printer Only)
Device08(H)
Device14(+)
Device20(M)
Device26(])
Device32(–)
Device03(C)
Device09(I)
Device15(!)
Device21(N)
Device27($)
Device33(/)
Device04(D)
Device10([)
Device16(&)
Device22(O)
Device28(*)
Device34(S)
Device05(E)
Device11(.)
Device17(J)
Device23(P)
Device29())
Device35(T)

Figure 39

10. GLOSSARY OF TERMS

Acknowledge — A positive response to a message. The sequences ACK 0 and ACK 1 are used in this system.

Address — Column and row in the buffer represented by two characters.

Attention Identification (AID) — A group of ASCII characters used for program attention generated by special keys on opcon.

Alarm Flag — ASCII character pairs (AF 0, AF 1) indicating alarm.

Attribute Character — Character following start field character that designates the characteristics of displayed characters in a formatted field displayed and printed as a SPACE.

Blink — An optional feature that allows intensified fields to be varied between intensified and half intensity display.

Binary Synchronous — Transmission of data consisting of bi-state (mark or space) bit characters using identical clocks to maintain synchronism between sender and receiver.

Block — A group of up to 256 characters starting with STX or SOH and ending with ETB or ETX and followed by a block check character (BCC).

Block Check Character (BCC) — A character derived from the binary accumulation of bits during a block.

Buffer Address — Any of 1920 locations in the buffer.

Command Codes — Character sequences ESC-1, 2, 5, 6, 7, ? initiated by LCU to effect message transfer (write or read) or control operations.

Controller — A DATASPEED 40 control unit used to interface with data sets and other control units or devices.

Communications Interface Unit (CIU) — A circuit card used in station controllers to interface to the data set (EIA and parallel interfaces).

Control Characters — Characters generated by combined use of the CONTROL and control type keys on the keyboard.

Copy — The Transfer of data from one device to another device on the same device cluster or single controller station.

Copy Control Character — Character following ESC 7 command that determines the type of data to be copied, sounding of alarm, printing, and line length.

Central Processing Unit — Provides system host program and control via the LCU to the remote stations.

Cursor — A white rectangular indicator on the display. In local operation the cursor is located at the address where the next operation will take place. Characters already in memory at the cursor location will be displayed within the cursor form.

Cursor Address (CA) — ASCII character pairs indicating address of cursor.

Device — A keyboard-display or printer.

Device Cluster Controller (DCC) — A controller that provides control and interface ports for devices and interfaces with a station Cluster Controller.

Display — Unit with a CRT tube face capable of displaying up to 1920 characters.

Erase — A function that replaces stored characters with Nulls.

Erase-Write — A command causing a buffer to be erased to nulls, positions the cursor to Home and resets the buffer address to 0. The command may be followed by a message to be printed or displayed under control of a write control character.

Erase All Unprotected — A command causing all unprotected locations in a buffer to be erased. Resets MDT and AID. Cursor sent to 1st field. KD returns to local mode.

Erase Unprotected to Address — An order causing all unprotected characters in the buffer up to a specified address to be replaced by Nulls.

Enquiry (ENQ) — Character sent when receiver does not receive a response.

End of Transmission (EOT) — Character sent to terminate transmission.

End of Text (ETX) — Character sent from station as last character of last block.

End Transmitted Block (ETB) — Character sent from station as last character of a block when additional blocks follow.

End Medium — The ASCII EM character, if present, defines the last buffer location which will be printed when fixed field line lengths are not specified in the WCC or CCC message control characters.

Field — An area on a formatted display defined by one attribute character to have certain display characteristics starting at the sequential address following the attribute character and ending one character before the next attribute character.

Field Address (FA 0, FA 1) — ASCII character pair that indicates address of character following an attribute character.

Formatted Display — Display with any fields designated by an attribute character.

Free Standing KD — Keyboard display in which the keyboard and display are each mounted on a separate free-standing base.

General Poll — A communication initiated by the LCU requesting a message from any device on a station. A 2-character Station Identification Code (SID) is required.

Home Position — The 1st sequential address of a display — Row 1 Column 1, upper left corner of display.

Insert Cursor — An order to place cursor at the current buffer address.

Invalid Reply — Reply to a poll, selection, or command that has a parity error or wrong block check character.

Invalid Command — Incorrect characters in or following command sequences.

Intermediate Transmission Block (ITB) — Character sent from LCU as last character of block when additional blocks are to follow.

Keyboard — Unit containing alphanumeric, control, and editing keys. Also referred to as an Operator Console.

Keyboard Display (KD) — Device containing both a keyboard and display monitor. May be attached to the controller cabinet or mounted separately, ie either attached or free standing.

Line Control Unit (LCU) — A unit that provides binary synchronous line control procedures for all stations on a communications line and interfaces with a Central Processing Unit.

Modified Data Tag (MDT) — A set of attribute characters used to indicate that data in a field has either been modified or is to be treated as modified. Character is set by CPU or by the operator when any data in a field is changed. Character can be reset by a write control character.

Message Control Character — Characters within a data stream that control message transfer.

Master Station — Station that is sending a data block.

MINI Cluster Controller — A combined station and device controller that interfaces with the data set and up to three devices.

New Line (NL) — ASCII control character, if present, defines the end of a line on a printer when fixed field lengths are not specified in the WCC or CCC message control characters.

Null — ASCII character used to replace data in buffer. Not printed or displayed.

Not Acknowledged (NAK) — A negative response to a message.

Orders — Characters in data stream following write commands.

Opcon — Acronym for operator console — also referred to as a keyboard.

PAD — ASCII even parity DEL character (8 marks) used after all transmissions.

Poll — General or Specific. Used to initiate communication and request a message.

Program Attention — Characters used to alert the program at the Host CPU for special action.

Program Access — PA 1 and 2 — Special keys on opcon.

Program Function — PF 1-12 — Special keys on opcon.

Program Tab — Order causing buffer address to be moved to the next unprotected field. The remainder of the current field is cleared to nulls if being written into at the time of the TAB order.

Protected Character — All characters in field with "protect" attribute. Attempts to enter data in these fields will result in an audible alarm. Data will not be changed or overwritten.

Random Access Memory — Temporary read/write memory. Data stored can be changed and is lost when power is turned off.

Read — Buffer function in which data in storage is transmitted.

Read All — Command that causes entire buffer contents to be transmitted.

Read Modified — Command that causes only modified fields on formatted displays to be transmitted depending on AID.

Read Command — Either read all or read modified.

Repeat to Address — Order (following write command) causes all characters in a buffer up to a specified address to be replaced by a specified character.

Reset MDT — See modified data tag.

Read Only Memory — Permanent memory. Data is stored permanently and can be read out repeatedly.

Reverse Interrupt (RVI) — A communications control sequence.

Selection — A communication initiated by the LCU that prepares device on a station to accept a command.

Set Buffer Address — An order (following a write command) causing a change in the buffer address to an address specified as part of the order.

Start Field — An order followed by an attribute character and address that indicates the type of a field.

Station Cluster Controller — A controller that interfaces with a data set and at least one device cluster controller.

Station — A remote data communications facility that has a unique address or identity. Includes data set and data terminal; i.e. controller(s) and devices.

Synchronous DATASPEED 40 — A family of DATASPEED 40 Stations using binary synchronous line control procedures.

Temporary Text Delay — A communications control character sequence.

Wait Acknowledge (WACK) — Communication Control Character sequence.

Write Control Character (WCC) — Character following ESC 1 or 5 write commands that determines if message is to be printed, alarm sounded, keyboard and AID reset, MDT reset, and length of print line.

11. TECHNICAL PUBLICATIONS ORDERING INFORMATION

ANSI (USAS) X3.4-1968	(ASCII) American National Standard Code for Information Interchange
Order from:	American National Standards Institute, 1430 Broadway, New York, New York 10018
ANSI X3.28-1971	Procedures for the Use of Communication Control Characters
Order from:	(Same as ANSI)
EIA RS-232-C	Interface Between Data Terminal and Communication Equipment (Serial Binary)
Order from:	Electronics Industry Association 2001 Eye St. NW Washington DC 20006
EIA RS-334	Signal Quality at Interface
Order from:	(Same as EIA above)

POCKET REFERENCE

For COMMUNICATIONS using the 40/4 DATA TERMINAL on a MULTI-POINT PRIVATE LINE

PUB41716
Section 12
Bell System
Data Communications
Technical Reference

AT&T

CONTENTS

GENERAL

Foreword This pocket reference contains information that a computer programmer may need in order to implement a communications system using Dataspeed® 40/4 data terminals on multipoint private-line communications facilities.

Only message transfer and communications establishment and termination are covered in this reference. When to poll, select, process and recover are beyond its scope.

This pocket reference is specifically intended for the developers and designers of business machine data terminal equipments and devices which interface with Bell System data communications equipment, and for technical consultants for use in designing data communications systems and arrangements employing Bell System data communications services and equipments. The right to revise this reference for any reason, such as conformity with USAI, EIA, CCITT or other standards, to utilize new advances in the state of the technical arts, or to reflect changes in the design of the equipment and/or service described herein is expressly reserved. Liability for difficulties arising from technical limitations is disclaimed.

Ideas for Simplifying the Testing of a New Communications System

When the overall system is designed, sharply distinguish between the data communication and the data processing functions, and write the software so that data processing problems will not affect the testing of communications routines.

When the original communications software is written, incorporate test routines to log the contents of the computer memory before and after each send or receive operation.

Be sure that the options specified for the 40/4 stations perform the desired functions at the time of installation.

Symbols

/ = or
[ ] = optional possibility

Abbreviations

(ASCII Code abbreviations on page 13)

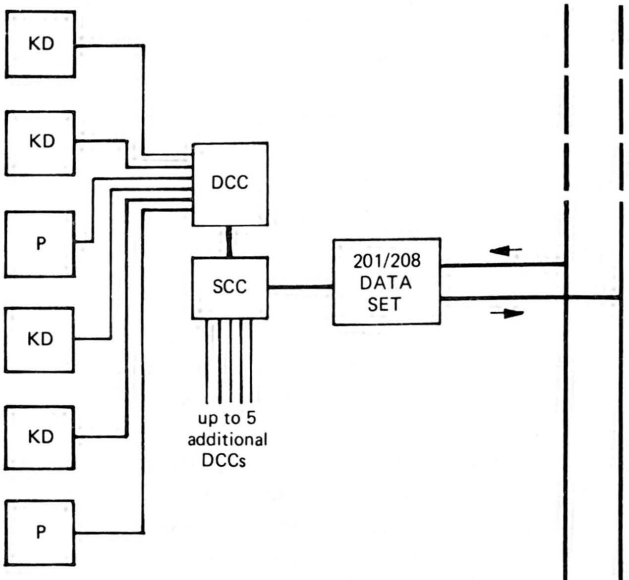
AA1 – Attribute Address +1, 1st char
AA2 – Attribute Address +1, 2nd char
AC – Attribute Character
ACK – Acknowledge = DLE 1/0
AID – Attention Identification
ANSI – American Nat'l Standards Inst
ASCII – American Standard Code for Information Interchange
BA1 – Buffer Address, 1st character
BA2 – Buffer Address, 2nd character
BCC – Block Check Character
Bsy – Busy
C – Specifiable Character
CA1 – Cursor Address, 1st character
CA2 – Cursor Address, 2nd character
CCC – Copy Control Character
Cmd – Command
DA – Device Address
DCC – Device Cluster Controller
DUP – Duplicate
EIA – Electronic Industries Association
EUA – Erase Unprotected to Address
IACK – Incorrect ACK 1/0
IC – Insert Cursor
ITB – End of Intermediate Trans'n Block
KD – Keyboard Display
MCC – Mini-Cluster Controller
Msg – Message
Mod'd – Modified
P – Printer
PAD – Pad
PT – Program Tab
Ptg – Printing
RA – Repeat to Address
Rec – Receive
Rd – Read
Rdy – Ready
RVI – Reverse Interrupt = DLE<
SBA – Set Buffer Address
SCC – Station Cluster Controller
SF – Start Field
SPA – Station Polling Address
Spec – Specific
SS1 – Status & Sense, 1st character
SS2 – Status & Sense, 2nd character
S&S – Status & Sense
SSA – Station Selection Address
Stn – Station
WACK – Wait Acknowledge = DLE ;
WCC – Write Control Character

Glossary

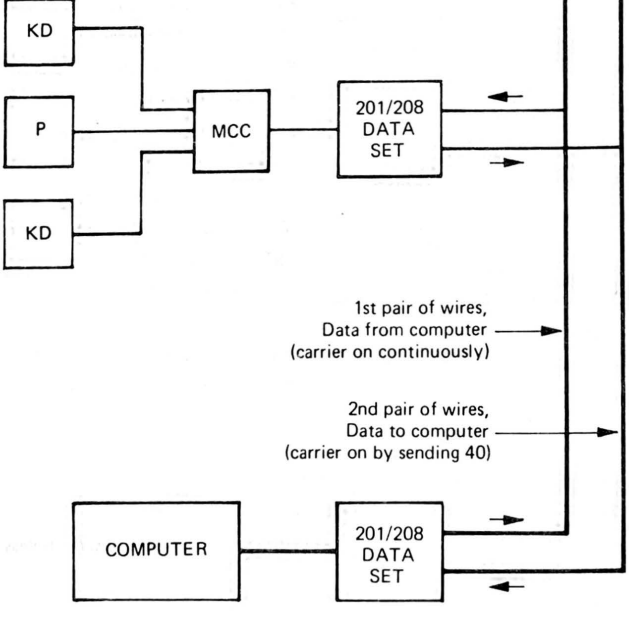
Blink – Flash between normal & intensified
Field – AC and characters following it
General Poll – Causes lowest numbered device with message to send, unless a higher numbered has not had its turn
Hidden – Not displayed/printed
Highlight – Intensify/blink
Intensify – Display above normal brightness
Modify – by operator entry
Numeric – Numbers, –, DUP, . and ,
Protect – from operator entry
Specific Poll – Causes only device polled to send if it has a message

SYSTEM AND STATION CONFIGURATION

Maxi-Cluster 40/4 Configuration



Mini-Cluster 40/4 Configuration



Station Identification

Stn or Dvce No.	SPA	SSA	DA	Stn or Dvce No.	SPA	SSA	DA
0	SP	-	SP	18	K	2	K
1	A	/	A	19	L	3	L
2	B	S	B	20	M	4	M
3	C	T	C	21	N	5	N
4	D	U	D	22	O	6	O
5	E	V	E	23	P	7	P
6	F	W	F	24	Q	8	Q
7	G	X	G	25	R	9	R
8	H	Y	H	26	]	:	]
9	I	Z	I	27	$	#	$
10	[	¦	[	28	*	@	*
11	.	,	.	29	)	'	)
12	<	%	<	30	;	=	;
13	(	_	(	31	^	"	^
14	+	>	+	32			-
15	!	?	!	33			/
16	&	0	&	34			S
17	J	1	J	35			T

COMPUTER...

...Communications Capabilities

Computer can:

Poll & receive a message from a 40
[then send a message to the 40 [and
then receive a message from the 40]]

Select & send a message to a 40
[then receive a message from the 40]

Select & receive a message from a 40

Cause re-transmission of any message [block]
received with invalid BCC or invalid 8th bit on
any character in message [block]

Messages to computer are blocked; messages
from computer may be blocked

...Procedures for Line Control

Computer Operations \ Computer Functions	Poll 40, receive reply	Receive next block	Cause 40 to re-send block	Reply not recognized by 40	Cause 40 to abort trans'n	Select 40, rec reply, send msg	Select 40, rec reply, send msg rec msg	Send last block	Send msg, rec reply, rec msg	Cause 40 to re-send reply	Cause 40 to delay sending	Terminate
Write EOT Write ACK 0/1 (DLE 1/0) Write NAK	•	•	•			•	•					
Write RVI (DLE<) Write Select Seq. (pg 8) Write Poll Seq. (pg 8)	•				•	•	•					
Read ENQ Read reply Write WACK						•	•				•	
Write ENQ Read EOT/msg [block] Write message	•	•	•			•	•	•	•	•		
Read reply Read message Write EOT						•	• • •	• • •	• • •	• • •	•	•
Read ENQ Read EOT				•	•							

...Replies & Responses

Computer			
① Sends	② Rec's	③ Sends	④ Rec's
Gen'l or Spec Poll Sequence	Msg/Msg block end'g in ETX/ETB BCC	ACK 0/1* BCC good	next block ② / EOT ①
		NAK/IACK BCC bad ‡	msg/msg block again ②
		EOT BCC bad again ①	
		RVI can't rec more	EOT ①
		Write/Ctrl Cmd Msg ⑤ if BCC good	
		reply not rec'd by 40	ENQ ③
	EOT	next poll ①	
	no/bad reply	Poll again ①	
	no/bad reply again	EOT ①	
Select Sequence	ACK 0 40 rdy to rec	Write/Ctrl Cmd Msg ⑤	
		Read Cmd Msg ⑤	
	WACK 40 bsy	EOT ①	
	RVI 40 has s & s	Spec Poll ①	
	no/bad reply	Select again ①	
	no/bad reply again	EOT ①	

Computer		
⑤ Sends	⑥ Rec's	⑦ Sends
Write/Ctrl Cmd Msg/Msg block end'g in ETX/ETB BCC	ACK 0/1* BCC good	EOT ① / next block ⑤ / Read Cmd Msg ⑤
	WACK BCC good but can't rec more, bsy ptg msg/block	EOT ①
	NAK/IACK BCC bad ‡	msg/msg block again ⑤
	NAK/IACK again	EOT ①
	EOT has s & s	Spec Poll ①
	no/bad reply	ENQ ⑥
	no/bad reply again	EOT ①
Read Cmd Msg end'g in ETX BCC	Msg/Msg block ②	③ but not to ⑤†
	NAK/IACK BCC bad ‡	Read Cmd Msg again ⑤
	EOT has s & s	Spec Poll ①
	no/bad reply	ENQ ⑥
	no/bad reply again	EOT ①

Tables adjacent show automatic responses generated by 40 and typically generated by computer. Situations not included require manual intervention and/or error recovery routine.

ACK 0/1 = DLE 0/1 IACK = wrong DLE 0/1
RVI = DLE< WACK = DLE ;

◯ = go to column whose number is inside ◯

* Reply alternates between ACK 0 & ACK 1 for successive blocks, beginning with ACK 1 for the 1st block.

† Only one two-way message transfer permitted between 40 and computer per poll/selection unless there is an intervening ACK 0/1.

‡ Or invalid 8th bit on a char in msg/msg block.

ESTABLISHMENT OF COMMUNICATIONS

	Control Sequences (from computer)		Reply Sequences (from 40)	
	type	character	type	char
40 to Send	General* Poll	EOT SPA " " ENQ	rdy to send†	msg
	Specific Poll	EOT SPA DAA ENQ	not rdy to send†	EOT
40 to Receive	Selection	EOT SSA DAA ENQ	ACK 0 rdy to rec	DLE 0
			WACK not rdy to rec, busy*	DLE
			RVI not rdy to rec. Poll for status msg	DLE <

*lowest numbered device sends 1st unless a higher numbered has not taken its turn. Only 1 device can send per poll.

†Applies equally to general and specific poll.

MESSAGE TRANSFER—40 SENDS

type	Message Format: character sequence
Rd Mod'd† if S/R or PF or no key depressed	STX SPA DAD ACK C1C2 DC1 AA1A2 data in field (less NULs) ETX BCC — for ea mod'd field*
Rd Mod'd† if PA or CLEAR key depressed	STX SPA DAD AIT EBC DXC
Rmte Test Rqst† (R/TST key depressed)	SOH %0 / STX DC1 AA1A2 data in field (less NULs) ETX BCC — for ea mod'd field*
Read All (in reply to read all cmd)	STX SPA DAD ACK C1C2 GSA CSC data in field (plus NULs) ETX BCC — for ea field**
Status (in reply to poll if S&S) Takes priority over other msgs	SOH %0 R STX SPA DAS S1S2 ETX BCC

Key Depressed	AID
S/R	
PA1	%
PA2	>
R/TST	0
PF1	1
PF2	2
PF3	3
PF4	4
PF5	5
PF6	6
PF7	7
PF8	8
PF9	9
PF10	:
PF11	#
PF12	@
CLEAR	_
none, KD	-
none, P	Y

†Sent in reply to poll or read modified command

*if no fields, data in buffer (less NULs) sent

**if no fields, data in buffer (plus NULs) sent

Status & Sense (S&S)					
Only on Specific Poll	S_1	S_2	On Gen'l/Spec Poll	S_1	S_2
Invalid Command	SP	A	Device No Longer Busy	B	SP
Device Unavailable	SP	&	Printer Paper Out	B	&
Command not Valid for Device	SP	-	Internal Timing Error	SP	B
Device Busy	H	SP	Block Forward Abort	SP	D
From Device Busy	H	A			
From Device Unavailable	SP	J			
Locked Buffer	D	A			

MESSAGE TRANSFER—40 RECEIVES

Write Command Message			
STX	write or erase-write command	data and/or orders	ETX BCC
Read/Control Command Message			
STX	erase all unprotected, copy, read modified or read all command		ETX BCC

Command	
Write	ESC 1 WCC
Erase-Write	ESC 5 WCC
Erase All Unprotected	ESC ?
Copy	ESC 7 CCC DA*
Read Modified	ESC 6
Read All	ESC 2

Orders	
Set Buffer Address	DC1 B_{A_1} B_{A_2}
Start Field	GS A
Insert Cursor	DC3
Program Tab	HT
Repeat to Address	DC4 B_{A_1} B_{A_2} C
Erase Unprotected to Address	DC2 B_{A_1} B_{A_2}

*Copying and copied device must share same DCC or MCC.
Copying and copied device can be the same device.

WCC†							
Start Printer	Sound KD Tone	Put KD in LOCAL	Reset ACs to Unmodified	Print: NL char/line	Print: 40 char/line	Print: 64 char/line	Print: 80 char/line
				SP	&	-	0
			•	A	J	/	1
		•		B	K	S	2
		•	•	C	L	T	3
	•			D	M	U	4
	•		•	E	N	V	5
	•	•		F	O	W	6
	•	•	•	G	P	X	7
•				H	Q	Y	8
•			•	I	R	Z	9
•		•		[	]	¦	:
•		•	•	.	$	,	#
•	•			<	*	%	@
•	•		•	(	)	_	'
•	•	•		+	;	>	=
•	•	•	•	!	^	?	"

CCC†								
Start Printer	Sound KD Tone	Copy: ACs	Copy: Protected Data	Copy: Unprotected Data	Print: NL char/line	Print: 40 char/line	Print: 64 char/line	Print: 80 char/line
		•			SP	&	-	0
		•		•	A	J	/	1
		•	•		B	K	S	2
		•	•	•	C	L	T	3
	•	•			D	M	U	4
	•	•		•	E	N	V	5
	•	•	•		F	O	W	6
	•	•	•	•	G	P	X	7
•		•			H	Q	Y	8
•		•		•	I	R	Z	9
•		•	•		[	]	¦	:
•		•	•	•	.	$	,	#
•	•	•			<	*	%	@
•	•	•		•	(	)	_	'
•	•	•	•		+	;	>	=
•	•	•	•	•	!	^	?	"

† device ignores [portions of] commands it cannot perform; without causing a status message to be generated

Specify Field as						A C option 403a or b*			
Protected†	Numeric	Hidden	Highlighted*	Modified					
					•	SP	D	B	F
				•		A	E	C	G
			•			H	[		
			•	•		I	.		
		•				<	+		
		•		•		(	!		
	•					&	M	K	O
	•			•		J	N	L	P
	•		•			Q	]		
	•		•	•		R	$		
	•	•				*	;		
	•	•		•		)	^		
•						-	U	S	W
•				•		/	V	T	X
•			•			Y	¦		
•			•	•		Z	,		
•		•				%	>		
•		•		•		_	?		
•	•					0	4	2	6
•	•			•		1	5	3	7
•	•		•			8	:		
•	•		•	•		9	#		
•	•	•				@	=		
•	•	•		•		'	"		

Specify Field as						A C option 403c†			
Protected†	Numeric	Hidden	Blinked†	Intensified†	Modified				
					•	SP	D	B	F
				•		A	E	C	G
			•			H			
			•	•		I			
		•				[			
		•			•	.			
		•				<	+		
		•			•	(	!		
	•					&	M	K	O
	•				•	J	N	L	P
	•			•		Q			
	•			•	•	R			
	•		•			]			
	•		•		•	$			
	•	•				*	;		
	•	•			•	)	^		
•						-	U	S	W
•					•	/	V	T	X
•				•		Y			
•				•	•	Z			
•			•			¦			
•			•		•	,			
•		•				%	>		
•		•			•	_	?		
•	•					0	4	2	6
•	•				•	1	5	3	7
•	•			•		8			
•	•			•	•	9			
•	•		•			:			
•	•		•		•	#			
•	•	•				@	=		
•	•	•			•	'	"		

Options 403a, b & c affect all KDs coupled to the same DCC or MCC.

*Highlighted fields are intensified or blinked, according to whether option 403a or 403b is elected, respectively.

†Fields specified as blinked cause fields specified as intensified to be blinked if displayed at the same time on the same display.

†A protected alphanumeric AC at BA_1 BA_2 = SP SP location prevents local print-out.

*†In systems where some displays employ option 403c & others 403a or b, elect characters in the 1st column in preference to those in other columns. Otherwise the same character will have different effects depending on the option elected for the display receiving it.

BUFFER ADDRESSES

Two-character buffer addresses for all 1920 possible display/print positions (24 rows, 80 columns) are determined left to right and top to bottom by combining each character in the adjacent table with itself and all other characters in the table. e.g. the buffer addresses for row 1, columns 1, 2 & 3 are SP SP, SP A & SP B, respectively.

However, since there are only 64 characters in the adjacent table but 80 columns in each row, the table below is needed to determine when the 1st character in the buffer address changes to the next one as you proceed from row 1 column 1 to row 24 column 80.

Also, the table below relates display/print columns, 16 at a time, to columns of 16 characters in the adjacent table, in order to determine the 2nd character in the buffer address. e.g. the buffer address for R1 C8 is SP G, for R6 C13 is F * and for R24 C80 is) "

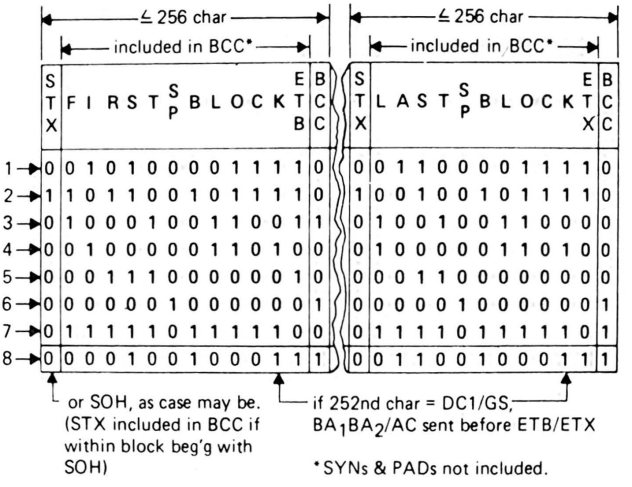
1st	2nd	3rd	4th
SP	&	-	0
A	J	/	1
B	K	S	2
C	L	T	3
D	M	U	4
E	N	V	5
F	O	W	6
G	P	X	7
H	Q	Y	8
I	R	Z	9
[	]	¦	:
.	$	,	#
<	*	%	@
(	)	_	'
+	;	>	=
!	^	?	"

Row	A A A_1A_2	B B A_1A_2		C C A_1A_2	
	Column				
	01 to 16	17 to 32	33 to 48	49 to 64	65 to 80
01	SP, 1st	SP, 2nd	SP, 3rd	SP, 4th	A, 1st
02	A, 2nd	A, 3rd	A, 4th	B, 1st	B, 2nd
03	B, 3rd	B, 4th	C, 1st	C, 2nd	C, 3rd
04	C, 4th	D, 1st	D, 2nd	D, 3rd	D, 4th
05	E, 1st	E, 2nd	E, 3rd	E, 4th	F, 1st
06	F, 2nd	F, 3rd	F, 4th	G, 1st	G, 2nd
07	G, 3rd	G, 4th	H, 1st	H, 2nd	H, 3rd
08	H, 4th	I, 1st	I, 2nd	I, 3rd	I, 4th
09	[, 1st	[, 2nd	[, 3rd	[, 4th	., 1st
10	., 2nd	., 3rd	., 4th	<, 1st	<, 2nd
11	<, 3rd	<, 4th	(, 1st	(, 2nd	(, 3rd
12	(, 4th	+, 1st	+, 2nd	+, 3rd	+, 4th
13	!, 1st	!, 2nd	!, 3rd	!, 4th	&, 1st
14	&, 2nd	&, 3rd	&, 4th	J, 1st	J, 2nd
15	J, 3rd	J, 4th	K, 1st	K, 2nd	K, 3rd
16	K, 4th	L, 1st	L, 2nd	L, 3rd	L, 4th
17	M, 1st	M, 2nd	M, 3rd	M, 4th	N, 1st
18	N, 2nd	N, 3rd	N, 4th	O, 1st	O, 2nd
19	O, 3rd	O, 4th	P, 1st	P, 2nd	P, 3rd
20	P, 4th	Q, 1st	Q, 2nd	Q, 3rd	Q, 4th
21	R, 1st	R, 2nd	R, 3rd	R, 4th	], 1st
22	], 2nd	], 3rd	], 4th	$, 1st	$, 2nd
23	$, 3rd	$, 4th	*, 1st	*, 2nd	*, 3rd
24	*, 4th	), 1st	), 2nd	), 3rd	), 4th

MESSAGE BLOCKING

Occurs if message is to computer and is greater than 252 chars.
May also occur on messages from computer.

Each block begins with STX (1st may begin with SOH) & ends with ETB BCC (last ends with ETX BCC). BCC halts transmission & requires reply per table on page 6.



Each BCC bit = 1/0 according to whether the number of 1 bits in the corresponding row for the characters included in the block is odd/even, respectively.

Each character's 8th (parity) bit = 1/0 according to whether the number of 1 bits in the char is even/odd, respectively.

SYNs & PADS

Transmissions to computer begin with 4 SYNs (01101000) & end with 1 PAD (11111111). Transmissions from computer must begin with at least 2 SYNs & end with 1 PAD (which can be 11111111 or 11111110). Also, 2 SYNs are sent once each second during transmission.

EOT is teated as a transmission in itself, even when followed by other chars. i.e. 2 SYNs & 1 PAD precede & follow EOT & precede & follow the chars following EOT.

ASCII CODE WITH ODD PARITY

(Bits are sent in sequence 1 through 8)
(ASCII bits 87654321 = EBCDIC bits 01234567)

	Binary Bits 87654321	ASCII Hex 7654321	EBCDIC Hex 01234567		Binary Bits 87654321	ASCII Hex 7654321	EBCDIC Hex 01234567
NUL	10000000	00	00	@	01000000	40	7C
SOH	00000001	01	01	A	11000001	41	C1
STX	00000010	02	02	B	11000010	42	C2
ETX	10000011	03	03	C	01000011	43	C3
EOT	00000100	04	37	D	11000100	44	C4
ENQ	10000101	05	2D	E	01000101	45	C5
ACK	10000110	06	2E	F	01000110	46	C6
BEL	00000111	07	2F	G	11000111	47	C7
BS	00001000	08	16	H	11001000	48	C8
HT	10001001	09	05	I	01001001	49	C9
NL	10001010	0A	15	J	01001010	4A	D1
VT	00001011	0B	0B	K	11001011	4B	D2
FF	10001100	0C	0C	L	01001100	4C	D3
CR	00001101	0D	0D	M	11001101	4D	D4
SO	00001110	0E	0E	N	11001110	4E	D5
SI	10001111	0F	0F	O	01001111	4F	D6
DLE	00010000	10	10	P	11010000	50	D7
DC1	10010001	11	11	Q	01010001	51	D8
DC2	10010010	12	12	R	01010010	52	D9
DC3	00010011	13	13	S	11010011	53	E2
DC4	10010100	14	3C	T	01010100	54	E3
NAK	00010101	15	3D	U	11010101	55	E4
SYN	00010110	16	32	V	11010110	56	E5
ETB	10010111	17	26	W	01010111	57	E6
CAN	10011000	18	18	X	01011000	58	E7
EM	00011001	19	19	Y	11011001	59	E8
SUB	00011010	1A	3F	Z	11011010	5A	E9
ESC	10011011	1B	27	[	01011011	5B	
FS	00011100	1C	1C	\	11011100	5C	
GS	10011101	1D	1D	]	01011101	5D	
RS	10011110	1E	1E	^	01011110	5E	
US	00011111	1F	1F	_	11011111	5F	6D
SP	00100000	20	40	`	11100000	60	
!	10100001	21	5A	a	01100001	61	81
"	10100010	22	7F	b	01100010	62	82
#	00100011	23	7B	c	11100011	63	83
$	10100100	24	5B	d	01100100	64	84
%	00100101	25	6C	e	11100101	65	85
&	00100110	26	50	f	11100110	66	86
'	10100111	27	7D	g	01100111	67	87
(	10101000	28	4D	h	01101000	68	88
)	00101001	28	5D	i	11101001	69	89
*	00101010	2A	5C	j	11101010	6A	91
+	10101011	2B	4E	k	01101011	6B	92
,	00101100	2C	6B	l	11101100	6C	93
-	10101101	2D	60	m	01101101	6D	94
.	10101110	2E	4B	n	01101110	6E	95
/	00101111	2F	61	o	11101111	6F	96
0	10110000	30	F0	p	01110000	70	97
1	00110001	31	F1	q	11110001	71	98
2	00110010	32	F2	r	11110010	72	99
3	10110011	33	F3	s	01110011	73	A2
4	00110100	34	F4	t	11110100	74	A3
5	10110101	35	F5	u	01110101	75	A4
6	10110110	36	F6	v	01110110	76	A5
7	00110111	37	F7	w	11110111	77	A6
8	00111000	38	F8	x	11111000	78	A7
9	10111001	39	F9	y	01111001	79	A8
:	10111010	3A	7A	z	01111010	7A	A9
;	00111011	3B	5E	{	11111011	7B	C0
<	10111100	3C	4C	¦	01111100	7C	6A
=	00111101	3D	7E	}	11111101	7D	D0
>	00111110	3E	6E	~	11111110	7E	A1
?	10111111	3F	6F	DEL	01111111	7F	07

NUL = Null
SOH = Start of Heading
STX = Start of Text
ETX = End of Text
EOT = End of Trans'n
ENQ = Enquiry
ACK = Acknowledge
BEL = Bell
BS = Back Space
HT = Horizontal Tab
NL = New Line
VT = Vertical Tab
FF = Form Feed
CR = Carriage Return
SO = Shift-Out
SI = Shift-In
DLE = Data Link Escape
DC1 = Device Control 1
DC2 = Device Control 2
DC3 = Device Control 3
DC4 = Device Control 4
NAK = Negative Acknowledge
SYN = Synchronous
ETB = End of Trans'n Block
CAN = Cancel
EM = End of Media
SUB = Substitute
ESC = Escape
FS = Field Separator
GS = Group Separator
RS = Record Separator
US = Unit Separator
SP = Space
DEL = Delete