40

POCKET REFERENCE

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For COMPUTER COMMUNICATIONS using the 40/2 DATA TERMINAL with a FULL-DUPLEX DATA LINK on the SWITCHED NETWORK

Technical Reference
Part 2, Article 6
Issue 5, June 1978

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1. GENERAL INFORMATION

This pocket reference contains some information a computer programmer may need to implement a communication system using a full-featured TELETYPE® 40/2 KD or KDP which is connected to a full-duplex data communication link, including those using 103-type data sets on the switched network.

Neither the KD-ROP configuration, the ROP as an independent terminal, nor the 4210 are specifically covered in this pocket reference.

Please read the appropriate product Catalog on the 40/2 data terminals before using this pocket reference. It contains information on 40/2 features, operation, options, and technical facts. For additional information, please contact your nearest sales representative.

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System Testing Support Teletype Corporation offers two services specifically designed to help a 40/2 user help himself when encountering communication system problems:

PHONE-A-40* Service This service allows a user to communicate with a 40 test center, located at Teletype Corporation in Skokie, Illinois. Under the user's direction, PHONE-A-40 service personnel will activate specified options on a 40/2 and then exchange messages with the user. They will also report whether:

- Carrier or reverse channel is being sent by the user's device.
- Characters are being received properly.
- Received messages are compatible with the options specified and proper use of ASCII controls and escape sequences.

PHONE-A-40 service is available by calling (312) 982-2000 and asking for PHONE-A-40 service. Charges for this service are based on test center personnel time and outgoing telephone line charges.

Testing Service or Loan Service A 40 user can gain access to the TSM-7810S through either the Testing Service or the Loan Service offered by Teletype Corporation Product Service Centers located across the U.S. and in Canada. This portable unit allows the user to see exactly what is happening at an EIA Standard RS-232 interface. The monitor is connected between the 40/2 and its data set, or the computer and its data set, and displays:

- The first or the most recent 1000 characters sent, received or both.
- The on or off status of each interface lead.

Loan Service provides use of the TSM-7810S while Testing Service provides a Product Service representative equipped with the unit. There is a charge for each service. Either service can be scheduled by calling the nearest Product Service Center or Product Service Headquarters, (312) 982-3920.

* service mark of Teletype Corporation

Ideas for Simplifying the Testing of a New Communication System

1. When the overall system is designed, sharply delineate communication and data processing functions, and write the software so that data processing problems will not affect the testing of the communication routines.
2. When the original communications software is written, incorporate test routines to log the contents of computer memory before and after each send or receive operation.
3. Personally check that the 40/2 options specified perform the desired functions, at the time of the initial installation.
4. Be sure that all messages have an adequate number of fill characters after certain control functions so that the functions can be completely performed.
5. Test to be sure that the 40/2 can communicate with another 40/2 before attempting to exchange messages directly with the computer. PHONE-A-40 service can be used for this purpose.

Key and Glossary

Symbols

•••••	A string of ASCII characters
[ ]	The items enclosed may be used but are not necessary
{ }	One and only one of the items enclosed must be used

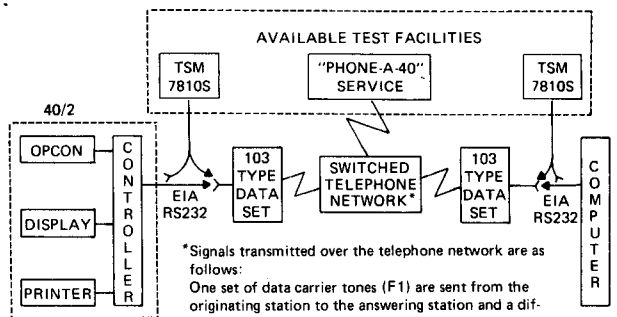
Equipment

ASCII	American National Standard Code for Information Interchange
EIA RS-232	Electronic Industries Association serial interface used with Bell System 103 and 202 type data sets
INTRPT	Interrupt key
KD	Keyboard-Display. Used to refer to either the KD station configuration or the keyboard-display portion of a KDP or KD-ROP.
KDP	Keyboard-Display-Printer configuration
OPCON	Operator Console. Keyboard plus editing and terminal controls
REC	Receive key or mode
ROP	Receive Only Printer configuration
S/R	Send/Receive key or mode, i.e., conversational mode
TSM-7810S	TELETYPE® TSM-7810S Line Monitor Data Display
40/2 or 40	For the purposes of this pocket reference, a 40/2 KD or KDP (i.e., full-duplex terminal) optioned to operate on a full-duplex data link.
103-type data set	Bell System 103 data set or equivalent modem
202-type data set	Bell System 202 data set or equivalent modem
4210	TELETYPE® 4210 Magnetic Tape Data Terminal

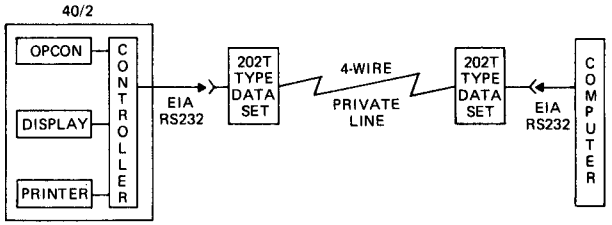
System Concepts

Data Link	What the terminal connects to, via terminal interface connector, in order to send data to and/or receive data from another device.
Full-duplex data link	Permits data to be sent in both directions at the same time
Half-duplex data link	Permits data to be sent in only one direction at a time
Full-duplex terminal	Terminal can send and receive at the same time. Can be used on full or half-duplex data link
Half-duplex terminal	Terminal can send or receive but not both at the same time.
Prompt Sequence	Application-dependent sequence of characters sent by computer to invite 40 operator to send a message or to automatically initiate sending by the 40.

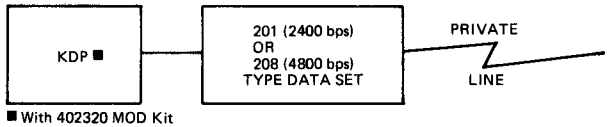
System Configuration



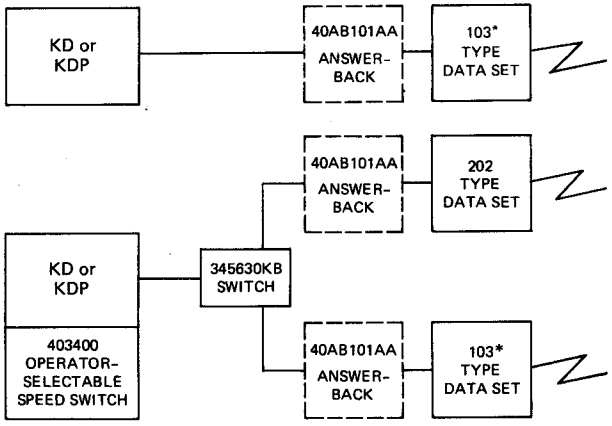
*Signals transmitted over the telephone network are as follows:
One set of data carrier tones (F1) are sent from the originating station to the answering station and a different set of tones (F2) are simultaneously sent from the answering station to the originating station. This allows data to be transmitted in both directions simultaneously.



Station Configurations

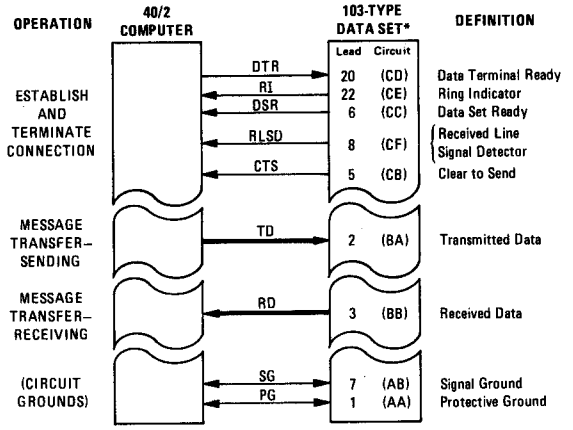


■ With 402320 MOD Kit



*OR ANY FULL-DUPLEX MODEM

Communications Interface



Speed Options

SPEED (bps)	OPTION
110	3j
150	3i
300	3h
600	3g
1200	3b
2400†	3c
4800†	3d

Stop Bit Options

NUMBER OF STOP BITS	UNIT CODE	OPTION
1	10	43a
2	11	43b

†With MOD Kit #402320, transmission is **Isochronous**, i.e. synchronous by bit, asynchronous by character using 10-unit code, and timing for the data set (201, 208 type or equivalent) is provided by the terminal.

General Functional Capabilities of Computer When Communicating with a 40/2

1. FOR CIRCUIT CONNECT, ESTABLISHMENT, AND INITIAL MESSAGE TRANSFER (IN SWITCHED NETWORK APPLICATIONS)

COMPUTER { DIALS / ANSWERS } [, RECOGNIZES ANSWERBACK]

[, { SENDS / RECEIVES } SIGN-ON MESSAGE]

2. FOR MESSAGE TRANSFER (IN BOTH SWITCHED AND NONSWITCHED NETWORK APPLICATIONS)

COMPUTER . [SENDS [REPLY] MESSAGE,]

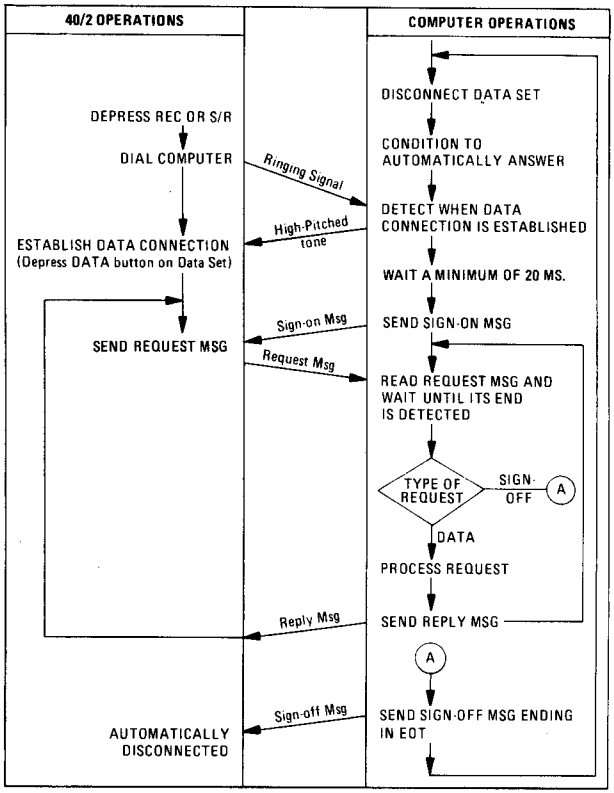
[RECEIVES [{ REQUEST / SIGN-OFF }] MESSAGE]

3. FOR TERMINATION AND CIRCUIT DISCONNECT (IN SWITCHED NETWORK APPLICATIONS)

COMPUTER [SENDS SIGN-OFF MESSAGE,] DISCONNECTS

2. TYPICAL INTERACTIVE PROCEDURE

Sequence of Operations

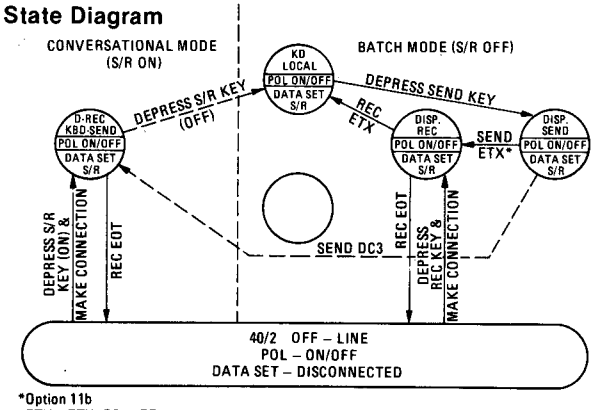


Message Formats

TYPE OF MESSAGE	CONVERSATIONAL	BATCH
SIGN-ON & REPLY (from computer)	[NL]..... [NL]	..... [ESC*] ETX
REQUEST (from 40)	..... {SYSTEM SPECIFIED CHAR}	..... {ETX / DC3}
SIGN-OFF (from computer)	[[NL].....] EOT	[[NL].....] EOT

*When ESC precedes ETX, neither is displayed.

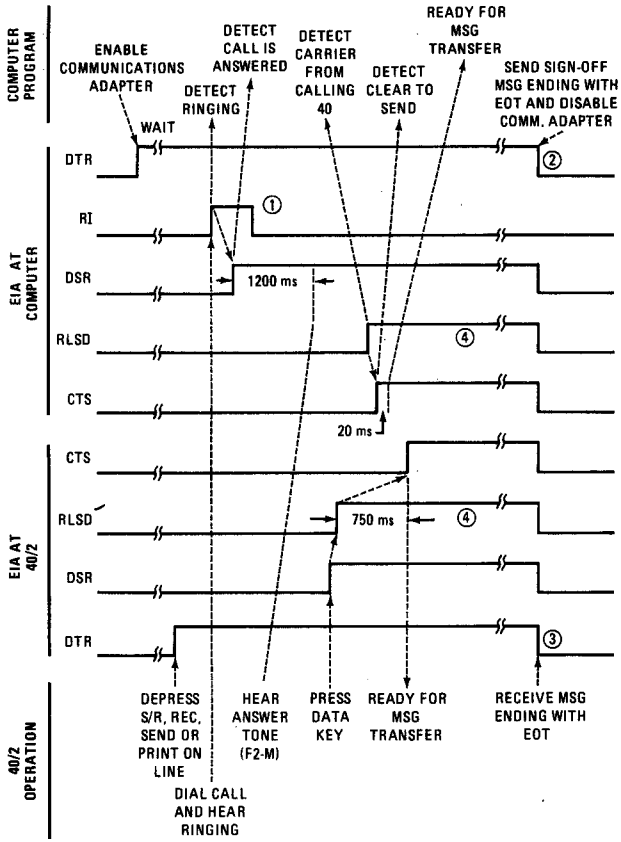
State Diagram



*Option 11b
ETX = ETX, GS or FF

Timing Diagrams (for adjacent sequence of operations)

Establish and Terminate Connection



① Data set option "CE OFF" must be elected for proper operation.

② Disconnect initiated when computer disables communications adapter.

③ Disconnect initiated when 40/2 detects EOT.

④ 103-type data sets can also be optioned to initiate disconnect upon loss of carrier and/or receipt of timed continuous space/state 0. Refer to appropriate Bell System documents for details of data set operation and options.

3. SUGGESTED COMPUTER PROCEDURES FOR LINE CONTROL

Basic Computer Routines

HOW TO USE THESE TABLES TO DEVELOP A COMPUTER PROCEDURE

1. Define what functions the computer should perform
2. After finding the applicable row(s) in Table I read across to find the applicable computer routines
3. Follow the applicable columns down into Table II, read across to the left to find the required computer operations
4. Table III contains explanations of individual computer operations

BASIC COMPUTER ROUTINES WHICH MAY BE PROGRAMMED AS MACROS

SPECIFIC COMPUTER FUNCTIONS	1 Answer incoming call, receive sign-on message	2 Answer incoming call, send sign-on msg, receive request msg.	3 Answer incoming call, send sign-on msg, receive calling sta to send answerback, receive answerback msg	4 Dial station, send sign-on message	5 Dial station, condition called sta to send answerback message, receive answerback message	6 Dial station, receive request msg	7 Receive (request) message	8 Send (reply) message	9 Send (reply) message, receive next (request) message	10 Disconnect remote station and computer	11 Disconnect computer
A. Dial, Receive msg, Disconnect						X →				→ X	X
B. Dial, Send msg, Disconnect				X →						→ X	
C. Dial, Recognize answerback, Receive msg, Send msg, Disconnect					X →		X →	X →		→ X	
D. Answer, Receive msg, Send msg, Disconnect	X →							X →		→ X	
E. Answer, Send sign-on msg, Receive request msg		X									
F. Answer, Send sign-on msg, Recognize answerback, Send msg, Receive request msg			X →						→ X		
G. Send reply msg, Receive request msg									X		
H. Send msg, Disconnect								X →		→ X	

TABLE I

INDIVIDUAL COMPUTER OPERATIONS	1	2	3	4	5	6	7	8	9	10	11
1. Write [sign-off message] EOT or DC4□										●	
2. Disconnect data set from line (turn off DTR)	●	●	●	●	●	●				●	●
3. Answer incoming call (turn on DTR, DSR comes on)	●	●	●								
4. Dial remote station (via automatic calling unit)				●	●	●					
5. WRITE [sign-on message] ENQ*			●		●						
6. READ answerback*			●		●						
7. Write sign on or reply msg ending with [ESC] ETX+		●		●				●	●		
8. Read sign-on or request msg ending with EOT, DC3, ETX or application-dependent character	●	●				●	●		●		

TABLE II

ETX = ETX, GS or FF
*Requires 40AB/101/AA Answer-Back
+ESC ETX and/or application-dependent ending sequence
□See footnote about DC4 on page 10.

Explanation of Individual Computer Operations

TABLE III

OPERATION	EVENTS AT 40/2 END	EVENTS AT COMPUTER END: DETECTABLE BY COMPUTER	EVENTS AT COMPUTER END: CONSEQUENT ACTION
ESTABLISH CONNECTION	If 40/2 OPERATOR MANUALLY INITIATES OR RECEIVES A CALL – Operator depresses DATA on modem with 40/2 KD not in LOCAL and/or PRINT ON LINE not on If 40/2 AUTOMATICALLY ANSWERS A CALL – 40/2 in S/R REC, REC, SEND or LOCAL with INTRPT off and modem automatically answers incoming call. PRINT ON LINE will turn on.	Modem has turned on DSR, RLSD and CTS caused by computer having DTR on and: Operator depressing DATA on modem OR Modem automatically answering incoming call OR Automatic Calling Unit successfully establishing connection	Wait a minimum of 20ms after CTS turns on, then start message transfer
MESSAGE TRANSFER – 40/2 SENDS (Computer READ)	40/2 sends character-at-a-time from keyboard (S/R mode) or page-at-a-time from display (Batch mode)	Receipt of characters with stop bit missing or incorrect parity	Analyze the received message and/or events detected and send appropriate reply message ending with system specified prompt sequence
	40/2 sends message-ending control – Application-dependent character in S/R or DC3 in Batch mode	Receipt of application-dependent character or DC3	
	40/2 sends message-ending control – ETX, GS or FF – in Batch mode and switches to: REC mode (option 11b) – – – – OR – – – – – –	Receipt of ETX, GS or FF	
	LOCAL mode (option 11a)		Wait to receive more data. After a specified time interval, terminate connection
	Operator stops sending characters from keyboard in S/R mode	No characters being received	
	Operator depresses REC while in Batch mode		
	Operator depresses LOCAL while in: Batch mode OR S/R mode with PRINT ON LINE on – – – – OR – – – – – –		
	S/R mode with PRINT ON LINE off (causes 40/2 to disconnect modem)	Modem has turned off RLSD (modem may also turn off CTS and DSR and disconnect depending on modem options	Terminate connection
MESSAGE TRANSFER – 40/2 RECEIVES (Computer WRITE)	40/2 receives message followed by application-dependent ending sequence and/or message-ending control ESC ETX (mode change depends on current mode)	Computer sends application – dependent ending sequence and/or ESC ETX	Prepare to receive from 40/2
	Operator depresses INTRPT* (indicator turns on) See event below	RD from modem has gone to steady spacing/state 0*	Stop sending. Wait a specified time interval, then terminate connection
	Operator depresses INTRPT a second time (indicator turns off)	RD from modem returns to marking/state 1	Prepare to receive from 40/2
	Operator depresses LOCAL with PRINT ON LINE: On – – – – OR – – – – – –		Continue sending
	Off	Modem has turned off RLSD (modem may also turn off CTS and DSR and disconnect depending on modem options)	Terminate connection
	No carrier received for 45 seconds (causes 40/2 to disconnect modem – option 28a)	Modem has turned off CTS or RLSD	
TERMINATE CONNECTION	40/2 sends EOT	Receipt of EOT	Terminate connection and prepare to establish next connection
	40/2 receives EOT or DC4+	Computer sends EOT or DC4+	

*Modems should not be optioned for "space disconnect".

+ If 40/2 automatically answered the call and turned on PRINT ON LINE, or operator, while in REC mode, depressed LOCAL with PRINT ON LINE on, DC4 is required from the computer in order for the 40/2 to cause its modem to disconnect immediately.

4. MESSAGE TRANSFER—40/2 SENDS

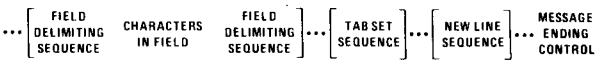
S/R (Conversational) Mode

In the S/R mode, data is sent on line, character by character, directly from the keyboard. The editing and cursor controls do not operate except Cursor← (Cursor Left sends BS control).

1. Option 41a (half-duplex terminal operation) causes the sent data to be displayed (and printed). The display will react to such data as if were being received from the line. Refer to Section 5, Message Transfer – 40/2 Receives.
2. Option 41b (full-duplex terminal operation) allows the 40/2 to send data from the keyboard and simultaneously receive data from the line on the display (and printer).

Batch Mode

General Message Format



Field Delimiting Sequences Generated and Sent

WHEN CURSOR DETECTS	IF FORM SEND KEY ON
Start of Protected Field	ESC W
End of Protected Field	ESC X
Start of Highlighted Field	ESC 3*
End of Highlighted Field	ESC 4*
Tab Set	ESC 0 (zero)

*Always sent if Option 9b is elected.

New Line Sequences Generated and Sent

ASCII CONTROLS SENT WHEN CURSOR DETECTS NL OR THE END OF THE LINE	OPTION
NL	10c
CR NL	10a
CR CR NL	10b

Characters in Protected (P) and Unprotected (U) Fields Actually Sent - With Form Send Off

OPTION	SENT AS UNPROTECTED	SENT AS UNPROTECTED SP	SENT AS UNPROTECTED DEL	SENT AS IS EXCEPT HT CONVERTED TO SP	NOT SENT EXCEPT NL SENT AS UNPROTECTED
13a	P & U				
13b	P			U	
13c	U	P			
13d		P		U	
13e	U		P		
13f	U				P
13g	U*				
13h				U	P

* HT generated and sent in lieu of each protected field if there is no preceding unprotected field containing a HT control. That guarantees that each unprotected field will be ended by a HT control and, if the initial cursor position lies in a protected field, the first character will be a HT control.

Note: (1) Options 13a – e are generally used when final message destination is a printer and options 13f – h when destination is a computer. Refer to Options Guide.
(2) Message-ending characters EOT, ETX, GS, and FF which are protected are sent, and have the same effect on the terminal's mode as they would have if they were unprotected.

Message-Ending ASCII Controls Which Switch 40/2 from Send Mode

ASCII CONTROL SENT	RECOGNIZED AS MSG - END CONTROL IF IN	
	S/R	BATCH
ETX		Opt. 8c
GS		Opt. 8g
FF		Opt. 8a
DC3		X
EOT	DISCONNECT	

8th Bit Generated by Terminal

8th BIT	OPTION
EVEN PARITY	42a
ODD PARITY	42b
ALL MARK	42c & 43a
ALL SPACE	42c & 43b

Notes on control of the display during message transfer*

40/2 Sends

1. In Batch mode, receipt of ESC f or depressing SEND key puts 40 in Send mode; cursor homes (Opt. 27a) or stays at same position (27b); RTS turns on. Sending occurs when modem is ready (i.e. DSR and CTS on). If no ending character (i.e. DC3, EOT, ETX, GS, FF, CR) is stored in display memory, either ETX (8c) or ETX EOT (8d) is sent to line and 40 switches to Receive (11b) or Local (11a) mode.
2. If the character sent from the 80th position of a line in the **display memory** is not NL, the new line sequence specified by option 10 is generated and sent immediately after that character, and the sending operation continues from the beginning of the next line. Thus, the full 80 positions on the line can hold data.
3. If the last character sent from the last line on the **display screen** is not an ending control,
   (a) The 1st line on the display screen disappears,
   (b) the 2nd – 24th lines are shifted up one line,
   (c) the next line in the display memory appears as the 24th line on the display screen,
   (d) the cursor returns to the beginning of the 24th line,
   (e) and sending continues.
   Thus, the screen scrolls continuously from one line to the next, once the cursor reaches the bottom.
4. If the last character sent from the last line in the **display memory** is not an ending control, the sending continues from the beginning of the first line in the display memory. Thus, the display memory is a continuous scroll, and sending of a partially filled or full display memory can start at any point.

40/2 Receives

1. Received data is displayed starting in the present cursor location.
2. When the cursor is in the 79th position of a line and a character is received, the character is displayed and the cursor moves to the 80th position. If another character is then received other than NL, it is displayed but the cursor remains in the 80th position. If a third character is now received other than NL, it is displayed in the first position of the next line and the cursor moves to the second position. If that third character is a NL, the cursor moves to the first position of the next line.

   Thus, this "line wraparound" feature precludes the requirement that a received multi-line message contains the NL control. Also the full 80 positions on the line can hold data.
3. If the cursor has been on the 24th line of the **display screen** and subsequent received data are to be displayed on a new line,
   (a) The 1st line on the display screen disappears,
   (b) the 2nd – 24th lines are shifted up one line,
   (c) the last line is cleared to spaces,
   (d) the cursor returns to the beginning of the last line,
   (e) the new data are displayed on the line.
   Thus, once it is full, the screen scrolls from one line to the next.
4. If data have been stored in the last line of the **display memory** and new data to be displayed on the next line are subsequently received, the newly received data are stored in the first line of the display memory. Thus, the display memory stores the most recently received characters of a message which can be infinitely long.

*Assumes the terminal includes the TP410018 circuit card.

5. MESSAGE TRANSFER—40/2 RECEIVES

General Message Format

... [ASCII CONTROL] [FILL CHARACTERS] ... [ESCAPE SEQUENCE] [FILL CHARACTERS] ... [CHARACTERS WHICH CAN BE IGNORED] ... MESSAGE-ENDING CONTROL

ASCII Controls Which Display Can Ignore

ASCII CONTROL IGNORED	OPTION
NUL	5a
CR	5c
DEL	5e
DC1	5g
DC3	5i

Message-Ending ASCII Controls Which Switch 40/2 from Receive Mode

ASCII CONTROL RECEIVED	RECOGNIZED AS MSG-END CONTROL IF IN	
	S/R	BATCH
ETX		Opt. 8c
GS		Opt. 8g
FF		Opt. 8a
ESC f		X
DC1		X†
EOT	DISCONNECT	

†with 407414 Mod Kit, Opt. A

Effect of ASCII Controls and Escape Sequences on Display

RECEIPT OF	DISPLAYS	AND CAUSES
BEL	B_L	100 ms beep
BS		Cursor ← –moves cursor 1 position left
CR	⟨	Cursor to move 1 position right
EOT	E_T	40/2 to switch to LOCAL mode and disconnect
ETX	E_X	40/2 to switch from REC mode if option 8c is elected
FF	F_F	40/2 to switch from REC mode if option 8a is elected
GS	G_S	40/2 to switch from REC mode if option 8g is elected
HT	▶	Cursor to move to first tab stop on right; if none, to start of new line. If protected data on the way, stops at first unprotected space. Unprotected data in the path of the cursor is replaced by spaces during tabbing
NL	≡	Cursor to move to start of next line–all unprotected data on the line to the right of the NL is replaced with spaces
VT	V_T	Cursor to move 1 position right
ESC @		CURSOR TAB–cursor moves to first tab stop on right; if none, to start of new line. If protected data on the way, stops at first unprotected space
ESC 0	.	Tab set (single)–sets single tab in the cursor position
ESC 1	⋮	TAB SET (column)–sets a column of tabs in and below the cursor position to the bottom of the display memory
ESC 2		TAB CLEAR–clears all tabs below and to the right of the cursor position
ESC 3		HIGHLIGHT ON–causes data that follow to be highlighted
ESC 4		HIGHLIGHT Off
ESC 7		Cursor ↑ –cursor moves 1 line up
ESC B		Cursor ↓ –cursor moves 1 line down
ESC C		Cursor → –cursor moves 1 position right
ESC G		CURSOR RETURN–cursor moves to start of same line
ESC H		Cursor HOME–cursor moves to 1st position on 1st segment
ESC J		CLEAR*–sets all unprotected positions to spaces from present cursor position to end of display memory
ESC L		LINE INSERT*–moves unprotected data down one line to create a line of spaces on the line the cursor is on and returns the cursor to the start of the line
ESC M		LINE DELETE*–clears unprotected data form the line the cursor is on, moves all unprotected data displayed below up one line, and returns the cursor to the start of the line
ESC ^		CHARACTER INSERT*–moves unprotected data one position to the right to create a character of space at the cursor position
ESC P		CHARACTER DELETE*–clears unprotected character at the cursor position and moves all unprotected data displayed on the right one position to the left
ESC R		Device Reset–homes cursor, sets all positions in display memory to unprotected, non-highlighted spaces, and clears all tabs
ESC S		SCROLL UP–moves all displayed data up one line
ESC T		SCROLL DOWN–moves all displayed data down one line
ESC U		SEGMENT ADVANCE–causes next whole segment to be displayed
ESC W		FORM ENTER On–puts terminal in FORM ENTER mode, during which all subsequently received data will be protected
ESC X		FORM ENTER Off
ESC f, DC1		40/2 to switch to SEND mode

*Affects protected as well as unprotected data when terminal is in FORM ENTER mode.
Note: Assumes Option 6b and TP410018 circuit card.

Effect of ASCII Controls and Escape Sequences on Printer

RECEIPT OF	CAUSES
ETX	16 lines to be fed out and next character to be printed in same position on the line if option 418c is elected
NL, VT	Next character to be printed at start of next line
FF	(Friction Feed) NL function (Tractor Feed) next character to be printed at the start of the first line of the next form with FORMS switch On. With FORMS switch Off, FF is treated as a NL
CR	Next character to be printed at start of same line
DC2	PRINT ON LINE On
DC4	PRINT ON LINE Off
Other Controls	No action – position where next character is to be printed does not change
Any ESC sequence	No action – position where next character is to be printed does not change. The character following ESC is printed on ROP's.

Timing Considerations

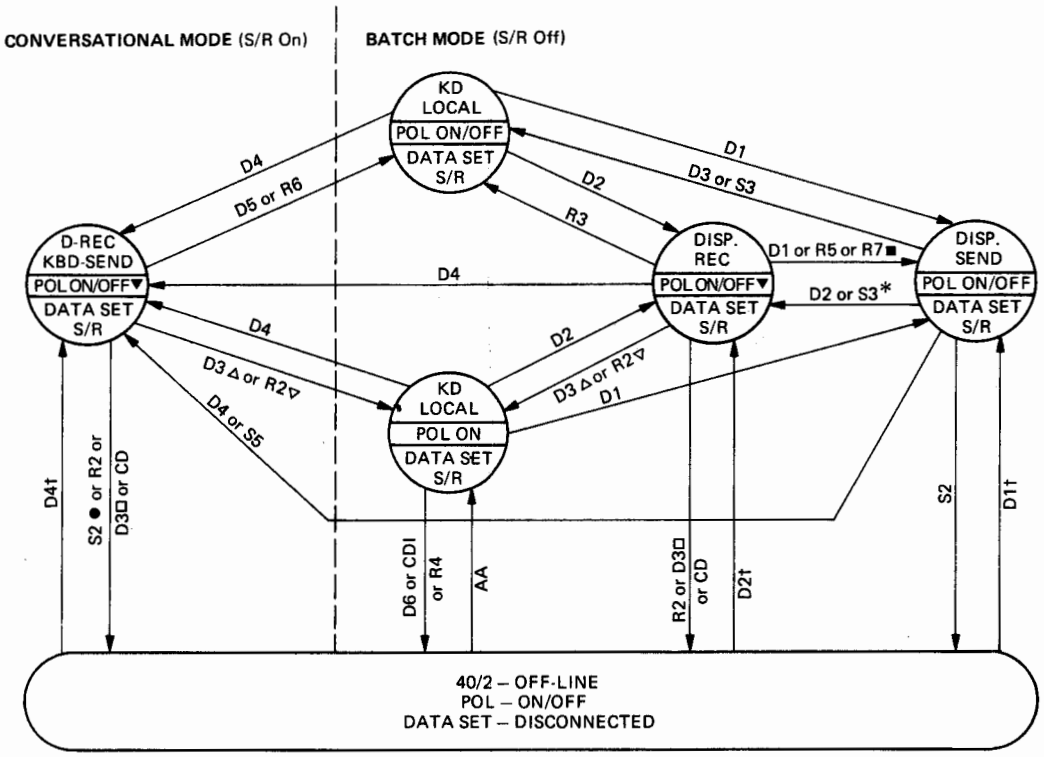
ASCII CONTROL OR ESCAPE SEQUENCE	DEVICE AFFECTED	EXECUTION TIME*
HT, ESC @	Display	0.540 ms to tab one character position plus 0.195 ms for each additional character position.
ESC 2	Display	50 ms per memory segment.
ESC J	Display	70 ms per memory segment. This refers to the time during which additional control functions are prohibited. After 12 ms, NL's may be received and repeated if they are at least 12 ms apart during the execution time. Other graphics may be sent immediately.
ESC L, ESC M	Display	50 ms for one memory segment, 115 ms for two, or 170 ms for three.
ESC R	Display	10 ms when the next characters received are graphics. At least 55 ms per memory segment must elapse before additional control functions are received.
DC2	Printer	2.0 sec motor start-up
ETX	Printer	480 ms if option 18c is elected.
FF	Tractor Feed Printer	20 ms per line of feed out to top of next form.†
NL	Printer	32 ms before next NL is received. If the NL was preceded by printing graphics (including SP), the time required before the next NL is: 196 ms – 80 column printer, monocase 278 ms – 80 column printer, full ASCII 278 ms – 132 column printer, monocase or full ASCII Add 32 ms to the above execution times if the printer is set for double line feed (LF switch set on 2). **No timing considerations are required if the printer is an ROP with an input buffer operating within its constraints.**

* The times shown are required for the terminal to execute the control function, or to have progressed to the point where reception of another character will no longer interfere with the completion of the function. An appropriate number of fill characters, or a delay in transmission, must be provided whenever the execution time *exceeds* the time required to receive one character from the line. It takes 8.3 ms at 120 cps, 33.3 ms at 30 cps, or 100.0 ms at 10 cps to receive one character. The formula to calculate the number of fill characters required is:

$$\text{Number of fill characters (rounded up)} \quad \left(\frac{\text{Time required to execute function (in ms)}}{\text{Time to receive one character (in ms)}}\right) - 1$$

†See Special Note on page 17.

6. STATE DIAGRAM– (Full-Duplex Data Link)



Legend

DEPRESS		SEND		RECEIVE	
D1	SEND key	S1	DLE EOT	R1	DLE EOT
D2	REC key	S2	EOT	R2	EOT
D3	LOCAL key	S3	ETX or GS or FF	R3	ETX or GS or FF
D4	S/R key (on)	S4	CR	R4	DC4
D5	S/R key (off)	S5	DC3	R5	ESC f
D6	INTRPT key (on) or PRINT ON LINE key (off)			R6	DLE ETX or DLE GS or DLE FF
				R7	DC1

AA = Detection of Ring Indicator from the data set with PRINT LOCAL off, INTRPT off and KD in LOCAL.

CD = No Carrier Detected for 45 seconds.

CDI = No Carrier Detected

↗ = Change in mode.

† = then make connection or auto-answer (RI)

Δ = if PRINT ON LINE is on.

□ = if PRINT ON LINE is off.

▽ = if display in RECEIVE and PRINT ON LINE on prior to auto-answer (RI) and remain so until receipt of EOT.

* = option 11b, otherwise option 11a

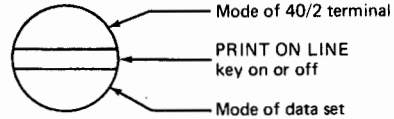
▼ = See p17, Station Modes, PRINT ON LINE

● = if option 41a (HDX) elected

■ = with 407414 Mod Kit

Note: To provide the operation described, the following options are assumed: 8a, c, e, g; 11a; 28a; 29a; and 46a.

Station Status Symbol



Purpose of STATE DIAGRAM: The STATE DIAGRAM precisely describes (a) the terminal & data set mode + Print On Line Key status, (b) indicates the alternate states which are available, (c) shows the effect of sending and receiving various characters or control codes, and/or manually operating key switches on the terminal.

To use the STATE DIAGRAM: (a) Locate the **Station Status Symbol** which exactly corresponds to the present state of your terminal, data set, & POL Key, (b) follow the arrow(s) pointing away from this symbol to possible alternate states. The control codes and/or manual actions which would shift the station to a new state are immediately adjacent to the arrow which points to the desired change.

Station Modes

40/2 Modes

LOCAL
Allows message preparation and editing on the display and operation of PRINT LOCAL.

S/R SEND – RECEIVE (Conversational mode)
Conditions display portion of terminal for receiving a message from the computer and

conditions the keyboard for simultaneously sending a message, character at a time, to the computer. (Option 41a allows half-duplex terminal operation where data sent from the keyboard is received on the display.)

RECEIVE (Batch mode)
Conditions display portion of terminal for receiving a message from the computer. No transmission is possible.

SEND (Batch mode)
Conditions display portion of terminal for sending a prepared message to the computer. No reception is possible.

PRINT ON LINE
Conditions the printer portion of terminal for receiving messages from the computer or to copy messages from the terminal to the computer (refer to option 29). PRINT ON LINE goes on when:

1. POL key is depressed (on) or
2. DC2 is received or
3. Station automatically answers an incoming call (RI turns on)

PRINT ON LINE goes off when:

1. POL key is depressed (off) or
2. DC4 is received

PRINT LOCAL
Causes the message currently in the display memory, both protected and unprotected, to be printed on the printer starting from the present cursor location (option 27b) or Home position (option 27a). PRINT LOCAL goes on when the PRINT LOCAL key is depressed while in the LOCAL mode.

PRINT LOCAL goes off when:

1. An option-specified message-ending control is encountered in the message or
2. LOCAL key is depressed

Note: Operation of INTRPT key (on) causes terminal to send continuous space/state 0 until key is depressed again (off).

Special Note: If form is in "home" position, FF commands must be preceded by a NL command with NL execution time observed.

If controller involved is buffered, FF commands must be preceded by two NL commands.

If characters are received immediately after a form feed, one or more of the characters in the first 8 columns of the first line may be printed slightly above the line. This may be prevented by following each FF with 8 non-print (pad) characters or one LF character. If this procedure is chosen, the first printed line will be one line below the "home" position.

7. ASCII CODE

Bit Transmission Sequence: Start bit (spacing/state 0), bits 1 through 8, then one or two stop bits (marking/state 1).

CHARACTER	Binary Bits 87654321 Even Parity	OCTAL 87 654 321 Even Parity	OCTAL 87 654 321 No Parity	HEX 765 4321 Even Parity	HEX 1234 5678 Even Parity
NUL	00000000	000	00	00	00
SOH	10000001	201	01	81	
STX	10000010	202	02	41	
ETX	00000011	003	03	C0	
EOT	10000100	204	04	21	
ENQ	00000101	005	05	A0	
ACK	00000110	006	06	60	
BEL	10000111	207	07	E1	
BS	10001000	210	08	11	
HT	00001001	011	09	90	
NL	00001010	012	0A	50	
VT	10001011	213	0B	D1	
FF	00001100	014	0C	30	
CR	10001101	215	0D	B1	
SO	10001110	216	0E	71	
SI	00001111	017	0F	F0	
DLE	10010000	220	10	09	
DC1	00010001	021	11	88	
DC2	00010010	022	12	48	
DC3	10010011	223	13	C9	
DC4	00010100	024	14	28	
NAK	10010101	225	15	A9	
SYN	10010110	226	16	69	
ETB	00010111	027	17	E8	
CAN	00011000	030	18	18	
EM	10011001	231	19	99	
SUB	10011010	232	1A	59	
ESC	00011011	033	1B	D8	
FS	10011100	234	1C	39	
GS	00011101	035	1D	B8	
RS	00011110	036	1E	78	
US	10011111	237	1F	F9	
SP	10100000	240	20	05	
!	00100001	041	21	84	
"	00100010	042	22	44	
#	10100011	243	23	C5	
$	00100100	044	24	24	
%	10100101	245	25	A5	
&	10100110	246	26	65	
'	00100111	047	27	E4	
(	00101000	050	28	14	
)	10101001	251	29	95	
*	10101010	252	2A	55	
+	00101011	053	2B	D4	
,	10101100	254	2C	35	
—	00101101	055	2D	B4	
.	00101110	056	2E	74	
/	10101111	257	2F	F5	
0	00110000	060	30	0C	
1	10110001	261	31	8D	
2	10110010	262	32	4D	
3	00110011	063	33	CC	
4	10110100	264	34	2D	
5	00110101	065	35	AC	
6	00110110	066	36	6C	
7	10110111	267	37	ED	
8	10111000	270	38	1D	
9	00111001	271	39	9C	
:	00111010	072	3A	5C	
;	10111011	273	3B	DD	
<	00111100	074	3C	3C	
=	10111101	275	3D	BD	
>	10111110	276	3E	7D	
?	00111111	077	3F	FC	

CHARACTER	Binary Bits 87654321 Even Parity	OCTAL 87 654 321 Even Parity	OCTAL 87 654 321 No Parity	HEX 765 4321 Even Parity	HEX 1234 5678 Even Parity
@	11000000	300	40	03	
A	01000001	101	41	82	
B	01000010	102	42	42	
C	11000011	303	43	C3	
D	01000100	104	44	22	
E	11000101	305	45	A3	
F	11000110	306	46	63	
G	01000111	107	47	E2	
H	01001000	110	48	12	
I	11001001	311	49	93	
J	11001010	312	4A	53	
K	01001011	113	4B	D2	
L	11001100	314	4C	33	
M	01001101	115	4D	B2	
N	01001110	116	4E	72	
O	11001111	317	4F	F3	
P	01010000	120	50	0A	
Q	11010001	321	51	8B	
R	11010010	322	52	4B	
S	01010011	123	53	CA	
T	11010100	324	54	2B	
U	01010101	125	55	AA	
V	01010110	126	56	6A	
W	11010111	327	57	EB	
X	11011000	330	58	1B	
Y	01011001	131	59	9A	
Z	01011010	132	5A	5A	
[	11011011	333	5B	DB	
\	01011100	134	5C	3A	
]	11011101	335	5D	BB	
^	11011110	336	5E	7B	
_	01011111	137	5F	FA	
`	01100000	140	60	06	
a	11100001	341	61	87	
b	11100010	342	62	47	
c	01100011	143	63	C6	
d	11100100	344	64	27	
e	01100101	145	65	A6	
f	01100110	146	66	66	
g	11100111	347	67	E7	
h	11101000	350	68	17	
i	01101001	151	69	96	
j	01101010	152	6A	56	
k	11101011	353	6B	D7	
l	01101100	154	6C	36	
m	11101101	355	6D	B7	
n	11101110	356	6E	77	
o	01101111	157	6F	F6	
p	11110000	360	70	0F	
q	01110001	161	71	8E	
r	01110010	162	72	4E	
s	11110011	363	73	CF	
t	01110100	164	74	2E	
u	11110101	365	75	AF	
v	11110110	366	76	6F	
w	01110111	167	77	EE	
x	01111000	170	78	1E	
y	11111001	371	79	9F	
z	11111010	372	7A	5F	
{	01111011	173	7B	DE	
|	11111100	374	7C	3F	
}	01111101	175	7D	BE	
~	01111110	176	7E	7E	
DEL	11111111	377	7F	FF	

NUL - Null
SOH - Start of Heading
STX - Start of Text
ETX - End of Text
EOT - End of Transmission
ENQ - Enquiry
ACK - Acknowledge
BEL - Bell
BS - Backspace
HT - Horizontal Tabulation
NL - New Line (Line Feed)
VT - Vertical Tabulation

FF - Form Feed
CR - Carriage Return
SO - Shift Out
SI - Shift In
SP - Space
DEL - Delete
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 Idle
ETB - End of Transmission Block
CAN - Cancel
EM - End of Medium
SUB - Substitute
ESC - Escape
FS - File Separator
GS - Group Separator
RS - Record Separator
US - Unit Separator

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