TELETYPEWRITER STATION WITH 9140 STATION CONTROLLER

USING 8A1-TYPE (STATION-TO-STATION) OPERATION

DESCRIPTION AND PRINCIPLES OF OPERATION

CONTENTS PAGE

1. GENERAL

1.01 This section contains the description and principles of operation for versions of the 9140 station controller (data terminal accessory – Figure 1) using 8A1-type station-to-station operation (Table A). Refer to Section 581-124-100 for a complete description of system operation using the versions of the 9140 station controller discussed in this section, Section 581-124-200 for installation, Section 581-124-300 for checkout and troubleshooting, and Section 581-123-801 for parts. This equipment is intended to be operated in a room environment within the temperature range of 40°F to 110°F. Serious damage to it could result if this range is exceeded. In this connection, particular caution should be exercised in using acoustical or other enclosures.

1.02 The 9140 station controller may be applied to special 33 type Automatic Send-Receive (ASR) terminals and special 35 or 37 type ASR, Keyboard Send-Receive (KSR), or Receive-Only (RO) terminals; an auxiliary RO set is available for one 35 type ASR terminal. It enables them to serve as stations, on multistation private lines, in standard 8A1-type data selective calling systems. In standard 8A1-type systems, outlying terminals send messages directly to each other (intraline operation). Many variations and modifications of 8A1-type operation can be used.

1.03 The 9140 station controller differs greatly from the electromechanical 8A1 station controller (TP198400). It uses DTL-type integrated circuits and discrete solid state devices to perform all controlling and responding functions. In 33 and 35 type terminals, the controller is installed in a mounting frame (part of a selective calling 35 type terminal but ordered separately for a selective calling 33 type terminal) which has a power supply, control relays, and some strap options. In 37 type terminals, the station controller mounts in the electrical service unit. There are no adjustments or controls on either the controller or mounting frame.

1.04 Several features and options not available with the 8A1 station controller are provided by the 9140 station controller and the selective calling terminals for it. They are:

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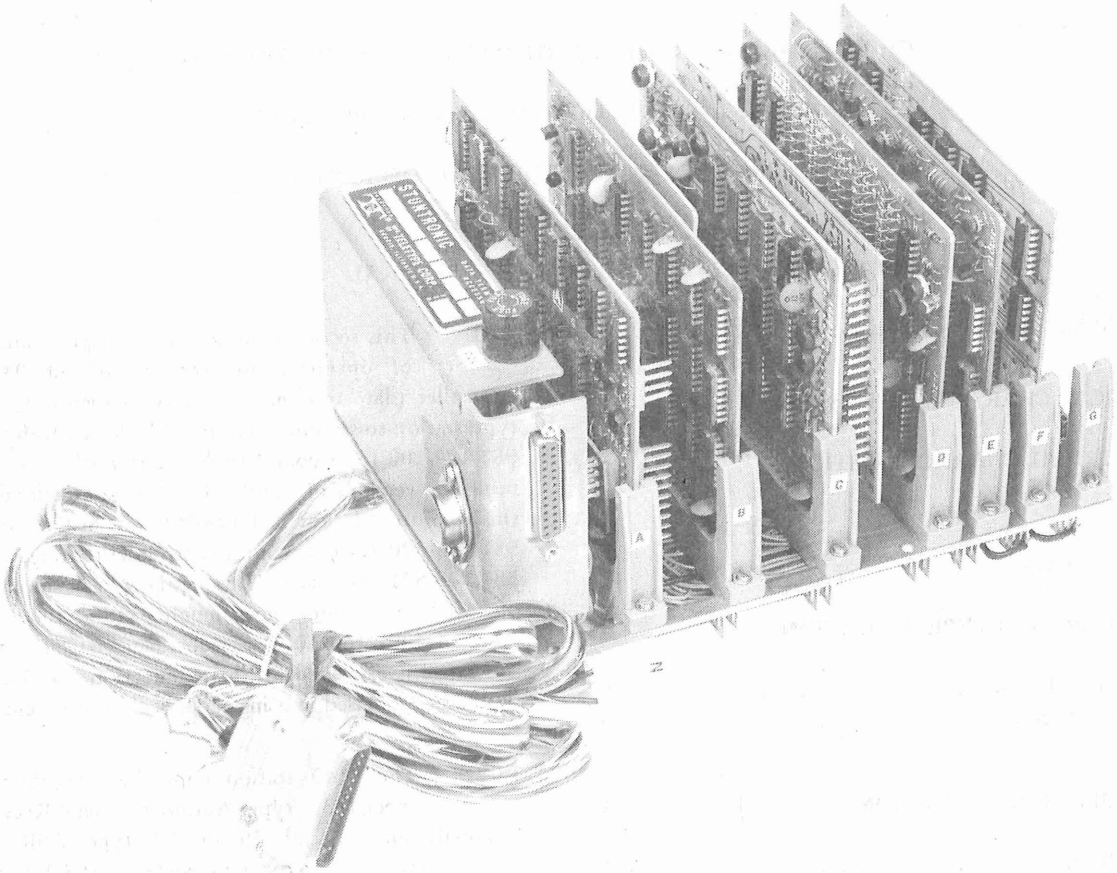


Figure 1 - 9140 Station Controller

(a) Terminal motors controlled by the 9140, permitting their operation only when selected. This provides silent operation, longer maintenance intervals, and use of 33 type terminals at standard duty stations.

(b) Silent electronic code detection and answer-backs.

(c) Error detection – insertion of special characters into copy as substitutes for characters received with incorrect parity.

(d) Ability to send from reader while preparing tape off-line with page copy at 35 or 37 tvpe terminals.

PHYSICAL CHARACTERISTICS

1.05 The controller is approximately 8-1/2 inches high, 6-1/2 inches wide, and 5-1/8 inches deep (Figure 2). It weighs approximately 2 pounds. The mounting frame is 19-1/4 inches high, 6-3/4 inches wide, and 6 inches deep (Figure 3).

ELECTRICAL CHARACTERISTICS

1.06 The dc power requirements for the station controller are:

Nominal Voltage	Voltage Range	Ripple Voltage (P to P Volts)	Current Range (Ampere)
+12 v dc	+11.0 v dc min +16.2 v dc max	0.60	0.3 min 1.5 max
-12 v dc	-11.0 v dc min -16.2 v dc max	0.60	0.06 min 0.15 max

The maximum power consumption is 25 watts, with maximum heat generation 7 BTU/hr. The controller is fused for 2

TABLE A

VERSIONS OF 9140 STATION CONTROLLER FOR 8A1 OPERATION

Code: 9140/--	110 Baud	150 Baud	Receive-Only	Send-Receive	Substitute Character On Parity Error	Printer and Punch (Both) CDCs Only (2)	Printer and Punch, Printer Only CDCs (3)
BA	X		X			X	
BB	X		X				X
BC	X		X		X	X	
BD	X		X		X		X
BE	X			X		X	
BF	X			X			X
BG	X			X	X	X	
BH	X			X	X		X
CA		X	X			X	
CB		X	X				X
CC		X	X		X	X	
CD		X	X		X		X
CE		X		X		X	
CF		X		X			X
CG		X		X	X	X	
CH				X	X		X

Note 1: Codes shown are those stamped on unit. Different codes are required for ordering.

Note 2: Codes listed do not include channel control. Channel control is available upon request.

amperes on a +12 v dc supply. Power is supplied by the mounting frame in 33 and 35 type terminals, while the 37 type terminal supplies power directly to the 9140.

1.07 The 9140 station controller is installed between the communications channel (data set or signal line converter) and the terminal (mounting frame). It provides an EIA RS-232-B interface to the channel (Table B) and an extended EIA RS-232-B interface to the terminal (Table C).

1.08 Data is transmitted at 100 words per minute (110 baud) with 33, 35, and some 37 type equipment using a code consisting of 11 units; a 1-unit start pulse, seven 1-unit information bits as shown in Figure 4, one 1-unit parity bit, and a 2-unit stop pulse (Figure 5). Data is transmitted at 150 words per minute (150 baud) with other 37 type equipment. In this case, the code consists of 10 units (same as described above for an 11-unit code, except that the stop pulse is only one unit long).

1.09 The code used is the 1968 (X3.4) version of ASCII (American National Standard Code for Information Interchange). Figure 4 illustrates the 1968 version of ASCII with the 1963 version shown to the right and slightly smaller. The 1963 version is shown also because standard 8A1 systems use this version, though some existing 8A1 systems have been modified in the field to use the current (1968 ASCII) terminology for control characters (by changing keytops on the keyboards) and, in a few cases, to change the code combination for ACK also. The current terminology is used in this publication and in all publications on the 9140 station controller.

1.10 The 9140 accepts signals with input distortion of up to 45 percent. Its output distortion to the terminal is 0.5 to 5.0 percent. With signal regeneration (strap option), distortion to the channel is also 0.5 to 5.0 percent. Without signal regeneration, the output distortion to the channel is approximately that of the terminal (6.0 percent or

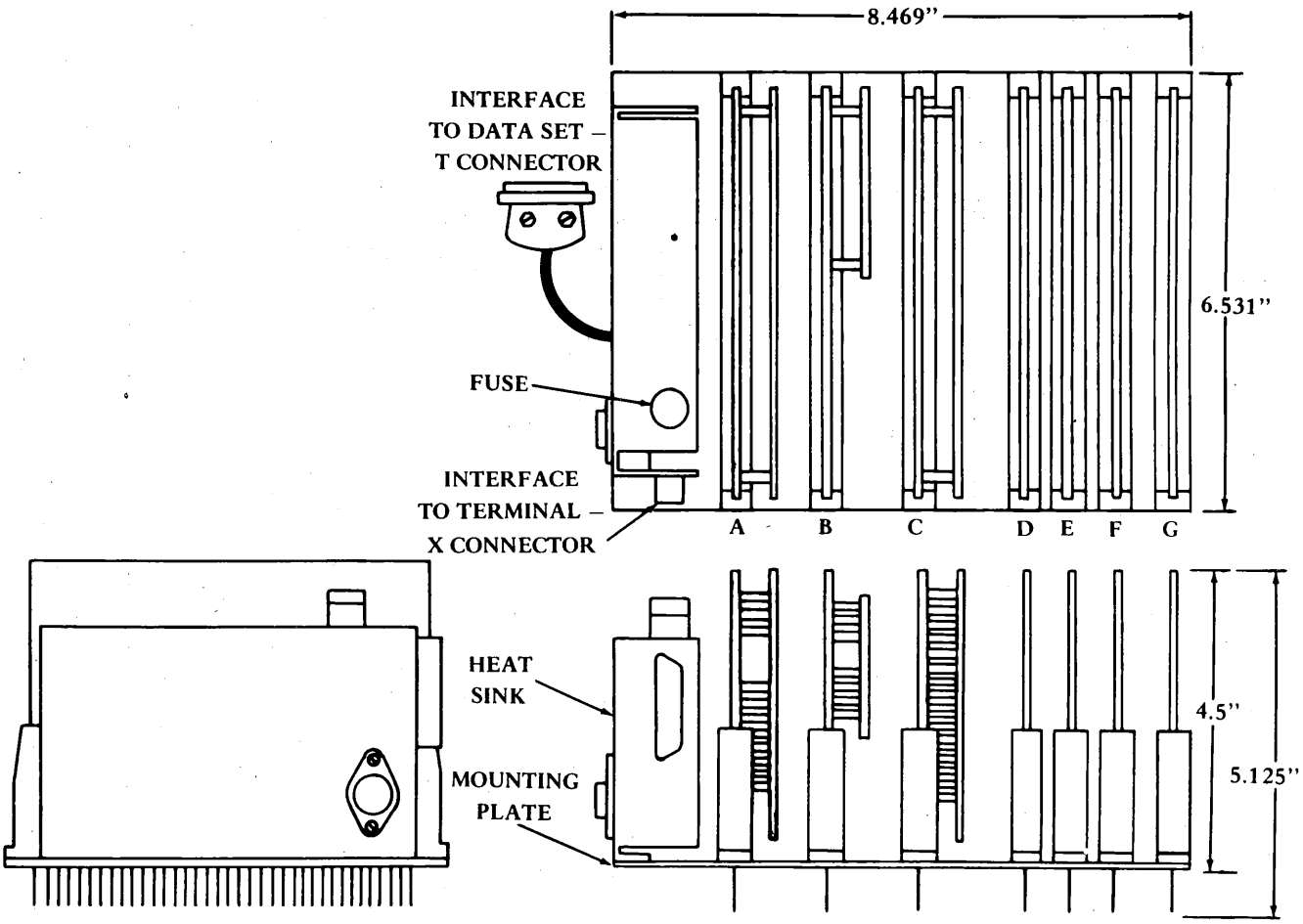


Figure 2 - Dimensions of 9140 Station Controller

less for 33 type terminals, and 12 percent or less for 35 type terminals).

2. DESCRIPTION

STANDARD 8A1-TYPE OPERATION

2.01 Standard 8A1-type systems consist of a 35A line controller (LINCO), a maximum of 25 send-receive sets, and a number of receive-only sets, interconnected on private lines. (The number of receive-only sets is limited only by traffic load considerations.) The system line controller selectively polls all sending stations in the system, permitting each station with traffic available to send a message to one or more receivers by addressing them directly. Answer-back responses are used to allow the sending station and line controller to react to off-line or out-of-service conditions; a message cannot be sent until an answer-back response has been received from each station addressed. If a receiver is unable to receive a message when addressed, the line controller sends an answer-back for it, intercepting the message for manual retransmission by the line controller operator. Only one station can send at a time, though any number can receive. Half-duplex (HDX) facilities are used.

2.02 System activity is initiated by the line controller beginning its polling cycle by generating a line break (300 milliseconds of spacing line) followed by a 200-millisecond pause and EOT (to reset all stations to the select, nonprint condition). It then begins the transmission of the first transmitter start code.

A. Control Codes

2.03 The following control codes are used by the 9140 station controller and the line controller.

Transmitter Start Codes (TSCs) and Responses

2.04 The transmitter start code is a two-character sequence; the first character is DLE, and the second may be any one of the 32 alpha block graphics (printing characters) in the ASCII. However, the second

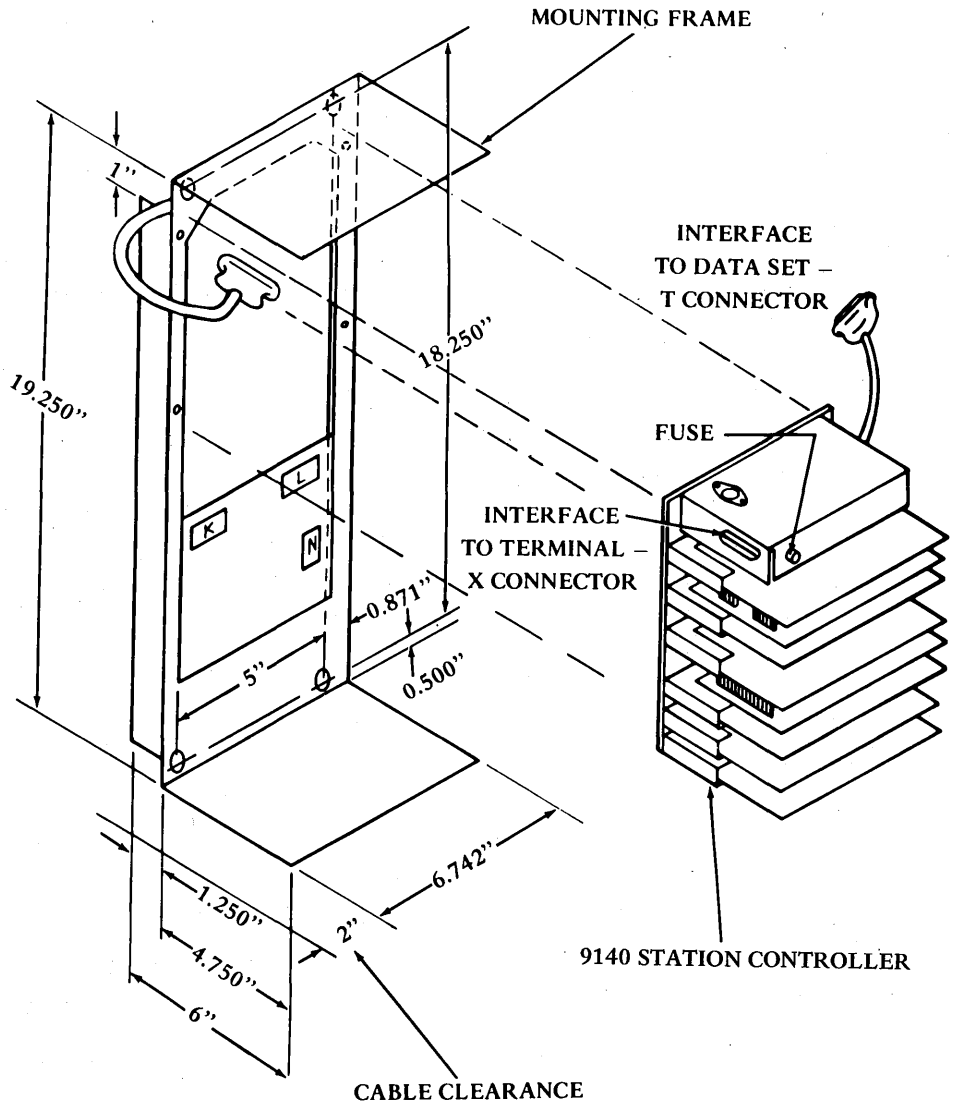


Figure 3 - Mounting Frame for the 9140 Station Controller

TABLE B

EIA RS-232-B INTERFACE BETWEEN COMMUNICATIONS CHANNEL AND 9140

PIN	SIGNAL NAME AND DESCRIPTION	WIRING DIAGRAM ABBREVIATION	EIA DESIGNATION
1	Protective Ground	FRAME GRD	AA
2	Transmitted Data – To Channel – Serial data from the station controller to the channel	–	BA
3	Received Data – From Channel – Serial data from the channel to the station controller	–	BB
4	Request to Send – To Channel a. No channel control card – ON when Data Set Ready is ON b. Channel control card – ON when an answer-back response or message is being sent	RTS	CA
5	Clear to Send – From Channel – ON to allow station controller to transmit (strap option in controller for data sets not having this lead)	CTS	CB
6	Data Set Ready – From Channel – ON condition allows Request to Send to be ON (strap option in controller for data sets not having this lead)	DSR	CC
7	Signal Ground	GRD	AB
8	Carrier Detect – From Channel – Not used	–	CF
12	Local Mode – To Channel – OFF whenever power is supplied to the station controller	–	–
20	Data Terminal Ready – To Channel – ON whenever power is supplied to the station controller	DTR	CD

TABLE C

EXTENDED EIA RS-232-B INTERFACE BETWEEN 9140 AND TERMINAL

PIN	SIGNAL NAME AND DESCRIPTION	WIRING DIAGRAM ABBREVIATION	EIA DESIGNATION
1	Protective Ground	FRAME GRD	AA
2	Transmitted Data – From Terminal – Serial data from the terminal to the station controller	–	BA
3	Received Data – To Terminal – Serial data from the station controller to the terminal	–	BB
4	Request to Send – From Terminal – ON when the terminal has a message to send and a bid entered	RTS	CA
5	Clear to Send – To Terminal – ON when the terminal is allowed to send	CTS	CB
6	Data Set Ready – To Terminal – ON condition turns terminal motors on	DSR	CC
7	Signal Ground	GRD	AB
8	Carrier Detect – To Terminal – Not used	–	CF
12	Selected to Send – To Terminal – ON condition turns reader motor on (individual motor control only)	STS	–
13*	Auxiliary Receive Control – To Terminal – ON when the terminal has been selected to receive and the third CDC (optional) has been detected	–	–
14*	Alarm – To Terminal – ON for approximately 400 milliseconds when a line break is received while the terminal is sending	–	–
19	Selected to Receive – To Terminal – ON when the terminal is selected to receive	STR	–
20	Data Terminal Ready – From Terminal – ON when the terminal is ready to receive a message	DTR	CD
21	Signal Quality Detector – To Terminal – Pulses OFF for approximately one-half bit when a vertical parity error is detected in received data (optional)	SQD	–

*These signal levels do not meet EIA Standard RS-232-B. An ON condition is approximately +12 v dc and an OFF condition is ground.

Bits b_7 b_6 b_5	$0\ 0\ 0$	$0\ 0\ 1$	$0\ 1\ 0$	$0\ 1\ 1$	$1\ 0\ 0$	$1\ 0\ 1$	$1\ 1\ 0$	$1\ 1\ 1$
b_4 b_3 b_2 b_1 ROW ↓ / COLUMN →	0	1	2	3	4	5	6	7
0 0 0 0 0	NUL	DLE	SP	0	@	P	`	p
0 0 0 1 1	SOH	DC1	!	1	A	Q	a	q
0 0 1 0 2	STX	DC2	"	2	B	R	b	r
0 0 1 1 3	ETX	DC3	#	3	C	S	c	s
0 1 0 0 4	EOT	DC4	$	4	D	T	d	t
0 1 0 1 5	ENQ	NAK	%	5	E	U	e	u
0 1 1 0 6	ACK	SYN	&	6	F	V	f	v
0 1 1 1 7	BEL	ETB	'	7	G	W	g	w
1 0 0 0 8	BS	CAN	(	8	H	X	h	x
1 0 0 1 9	HT	EM	)	9	I	Y	i	y
1 0 1 0 10	LF	SUB	*	:	J	Z	j	z
1 0 1 1 11	VT	ESC	+	;	K	[	k	{
1 1 0 0 12	FF	FS	,	<	L	\	l	|
1 1 0 1 13	CR	GS	-	=	M	]	m	}
1 1 1 0 14	SO	RS	.	>	N	↑	n	~
1 1 1 1 15	SI	US	/	?	O	←	o	DEL

PREVIOUSLY UNASSIGNED

Note: Shaded boxes indicate characters with bit 8 "1" for even parity.

Example: Bits 1 through 7 of the bit permutation for the character M are 101001, respectively. 1 = Mark, 0 = Space

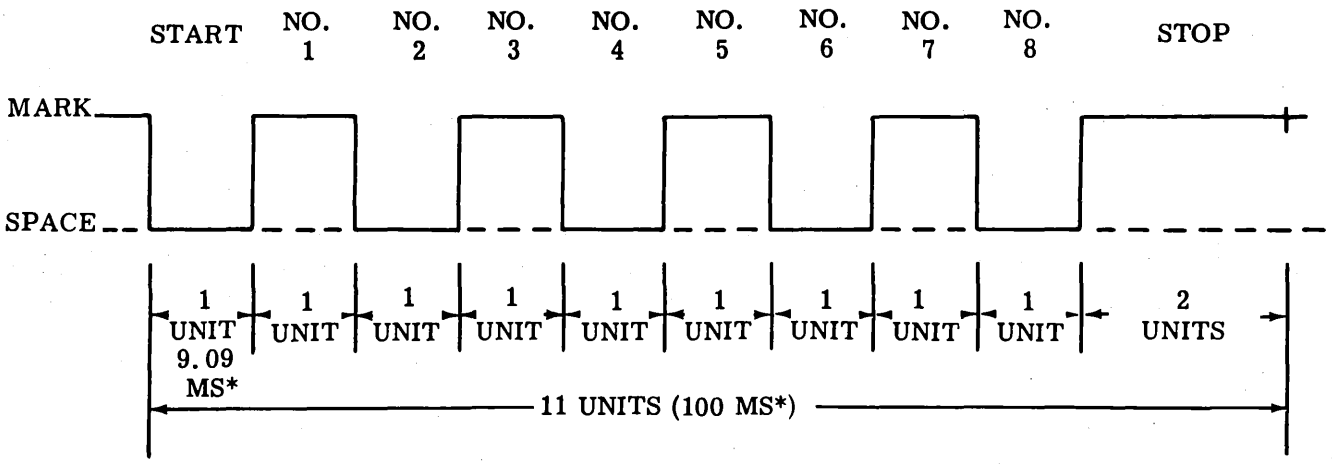
Controls and Their Meanings:

NUL(L)=Null
SOH =Start of Heading
SOM =Start of Message
STX =Start of Text
EOA =End of Address
ETX =End of Text
EOM =End of Message
EOT =End of Transmission
ENQ =Enquiry
WRU =Who Are You
ACK =Acknowledge
RU =Are You
BEL(L)=Bell
BS =Backspace
FE_O =Format Effector

HT =Horizontal Tabulation
LF =Line Feed
VT =Vertical Tabulation
FF =Form Feed
CR =Carriage Return
SO =Shift Out
SI =Shift In
DLE=Data Link Escape
DC_0=Device Control 0
DC_1 =Device Control 1
DC_2 =Device Control 2
DC_3 =Device Control 3
DC_4 =Device Control 4
NAK=Negative Acknowledge
ERR=Error

SYN(C) =Synchronous Idle
ETB =End of Transmission Block
LEM =Logical End of Media
CAN =Cancel
S_0 through S_7=Separators
EM =End of Medium
SUB =Substitute
ESC =Escape
FS =File Separator
GS =Group Separator
RS =Record Separator
US =Unit Separator
SP =Space
ALT MODE=Alternate Mode
DEL =Delete

Figure 4 - ASCII (X3.4 – 1968 With 1963 Version (Small Print) Shown on Right)



*Based on transmission rate of 100 words per minute.

Figure 5 - Wave Pattern for Letter "U" (With Even Parity Bit)

character is usually limited to one of the 26 alphabetic characters. When a TSC is generated, all stations detect it, but only the station controller programmed for the code responds. One of five conditions may exist at the polled station:

(1) Traffic to be sent from tape (keyboard sending is not possible). If a bid was placed and a TSC is detected by the 9140, the tape reader starts and the terminal SEND lamp lights.

(2) No traffic. \ ACK automatically sent by 9140.

(3) No traffic and not ready to receive (maintenance condition or off-line). BEL BEL or \ ACK automatically sent (9140 programming option).

(4) Alarm condition. \ ACK automatically sent regardless of whether traffic is available.

(5) Unable to respond (circuit or equipment failure). Line controller disconnects sender after idle line time-out elapses.

2.05 When traffic is to be sent the 9140 starts the station tape reader, causing it to send the tape, headed by a short tape leader of DELETE characters and followed by a call directing code.

2.06 When a maintenance condition (low paper or low tape (35 type sets in SEND-RECEIVE PUNCH ON mode only)) or printer off-line condition exists at the polled station when it has no traffic available, the 9140 – if so programmed – responds with the not-ready-to-receive answer-back sequence BEL BEL. This response causes the line controller to indicate a maintenance (MTC) alarm and polls the next station. Because of the inability of the 9140 to distinguish between the terminal being in an actual maintenance condition and its merely being off-line for tape preparation, the not-ready-to-receive response may be eliminated and \ ACK sent at all times when the station has no traffic available.

Call Directing Codes (CDCs) and Responses

2.07 CDCs consist of a two-character sequence composed of any combination of two of the 32 alpha block graphics in the ASCII. However, CDCs are usually limited to combinations of the 26 alphabetic characters. CDCs are separated from each other and the start-of-text code (STX) by a DELETE character. After sending this DELETE, the transmitter is stopped by the 9140 to allow time for an answer-back response. CDCs are received by all stations but are recognized only by the station or stations programmed for them. One of two conditions may exist at the called station:

(1) Station ready to receive.

(2) Station not ready to receive due to being off-line, low paper, low tape, or turned off.

2.08 When a called station is ready to receive, its station controller responds to the CDC with \ ACK answer-back, the same as for the no-traffic response to a TSC. On detecting the ACK character, the sending station may continue with other CDCs or send STX, depending on what the operator punched in the tape.

2.09 When a called station is not ready to receive, it does not respond to its CDC.

2.10 Each station may be programmed for two or (optionally) three CDCs. Call directing codes are normally assigned to entire stations without regard to the medium (paper or tape) on which the message will be received. However, the third CDC option provides on-line punch control for 35 and 37 type ASR sets without auxiliary RO sets. With this option, the station may be called in by any of three CDCs, two of which will enable the printer only and one of which will enable both the printer and the punch.

2.11 A group or broadcast CDC can be assigned to some or all receivers in the system. When this is done, only one station in the group or system is programmed to send an answer-back response to the CDC, since multiple responses would result in a garble.

Start-of-Text Code (STX)

2.12 After the last CDC in the tape, the sending station transmits STX, followed by DELETE. Each selected receiver is then conditioned by its 9140 to allow printing (and punching), while each unselected receiver is locked out. Receiving stations copy no CDCs or responses but only the text following STX.

Inhibit Codes

2.13 Any character in a group having bit 4 marking and bits 5, 6, and 7 spacing, or a NUL character, will effect a timing change in the line controller message control circuits. This timing change (from 1.0 seconds to 3 seconds maximum idle line) allows transmission to stop while form effector functions (horizontal and vertical tabulation, form feed, etc) occur. These codes are not detected by the 9140; the sending transmitter is stopped by logic in the 35 or 37 ASR terminal.

End-of-Transmission Code (EOT)

2.14 EOT is the system disconnect code. It restores all logic in the system, except for alarms, to the select, nonprint condition. EOT must follow the message text in the tape, or the line controller will disconnect and alarm the sender itself.

B. Line Procedure

2.15 Line procedure in a standard 8A1-type selective calling system depends on the line controller and 9140 station controller programming selected. All variations of system operation are shown graphically on Figure 6 except line controller response to abnormal operation of polled station. After detecting any deviation from normal station response, excessive idle line time, excessive tape leader, or more than 30 identical characters of text, the line controller seizes the line (by sending break, pause, EOT as explained in 2.02) and resumes polling.

Polling

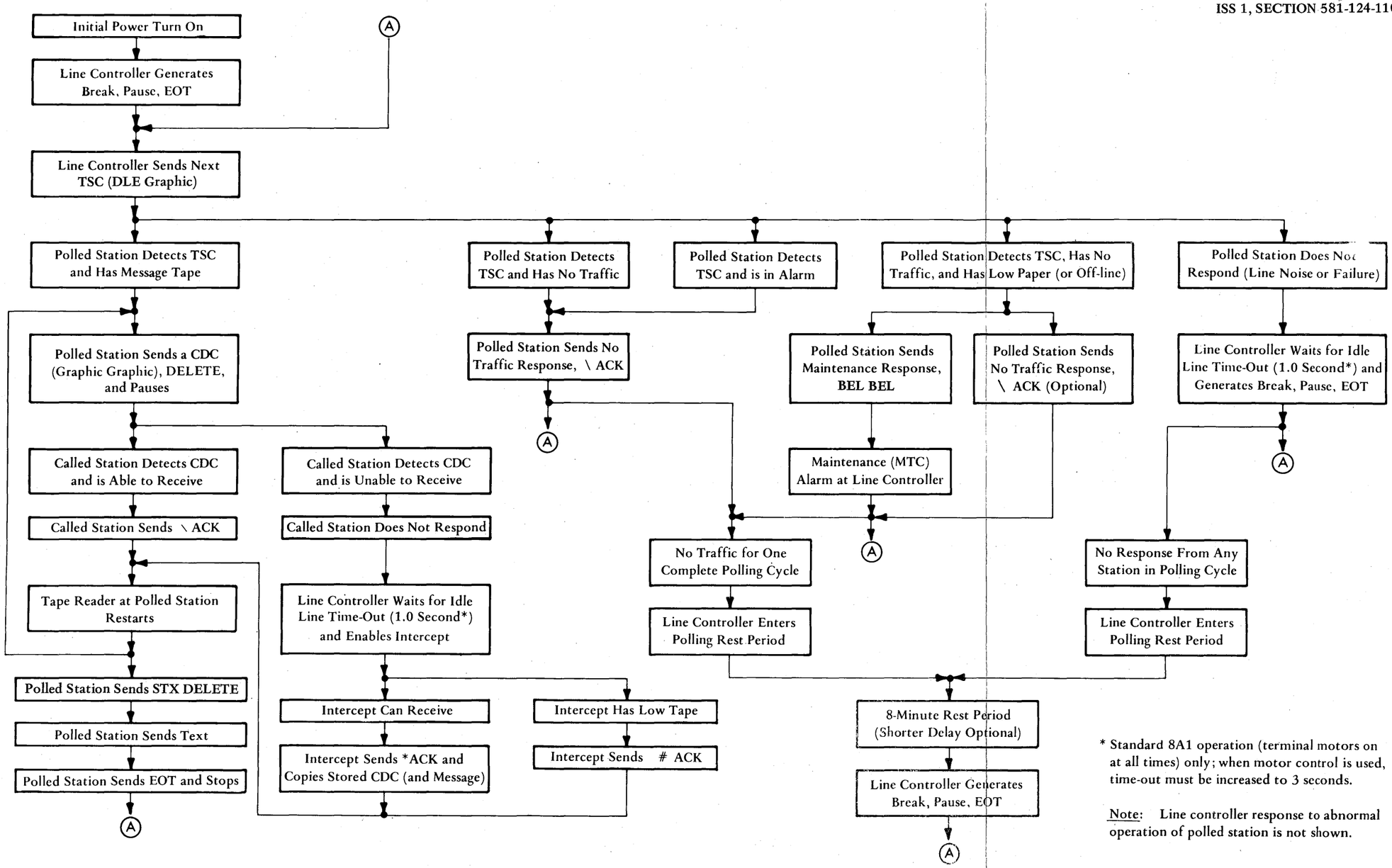
2.16 The line controller polling cycle consists of the transmission of 25 TSCs, one for each possible sending station in the system. Systems with less than 25 senders have the same TSC programmed in more than one position in the cycle or have the unprogrammed positions skipped from the polling cycle (or a combination of both). A multiple polling option is available which allows stations with a high volume of traffic to be polled up to six times per cycle (in succession), even if all the remaining TSC positions are used for other senders. The line controller polls continuously unless it completes a polling cycle during which no traffic was sent. In that case, it enters a polling rest period of eight minutes (optionally less). Polling may also be controlled manually. With a 9140 system, the polling rest period is usually reduced to 30 seconds since the 9140 equipped station cannot "wake-up" the line controller.

Sending and Receiving

2.17 Messages are prepared for transmission by the operator punching a tape consisting of a DELETE leader, the CDC assigned to each receiving station addressed, STX, DELETE, CR LF, text, EOT, and the tape trailer (Figure 7). This tape is placed in the reader and a bid to send entered. When the station is polled, the 9140 starts the tape reader, causing the first CDC to be sent. After the DELETE character following the CDC, the 9140 stops the tape reader for an answer-back response to be received. (When the motor control option is used, the operator returns the MOTORS switch to AUTO after making the tape. The 9140 then turns the motors on automatically as soon as the TSC is detected and starts the transmitter after a one-to-two second delay for the motors to reach their operating speed.)

2.18 Upon detecting the CDC, the 9140 station controller in the called station sends a \ ACK answer-back if the terminal is ready to receive and makes no response if the terminal is not ready to receive. When there is no response to a CDC, the line controller times out for 1.0 second (without motor control) or 3 seconds (with motor control) and enables the intercept. If the intercept can copy the message, it sends an *ACK answer-back; if it cannot (because of low tape), it sends a \ ACK answer-back, unless it is wired to stop polling. The intercept begins copying with the CDC, which is stored by the line controller.

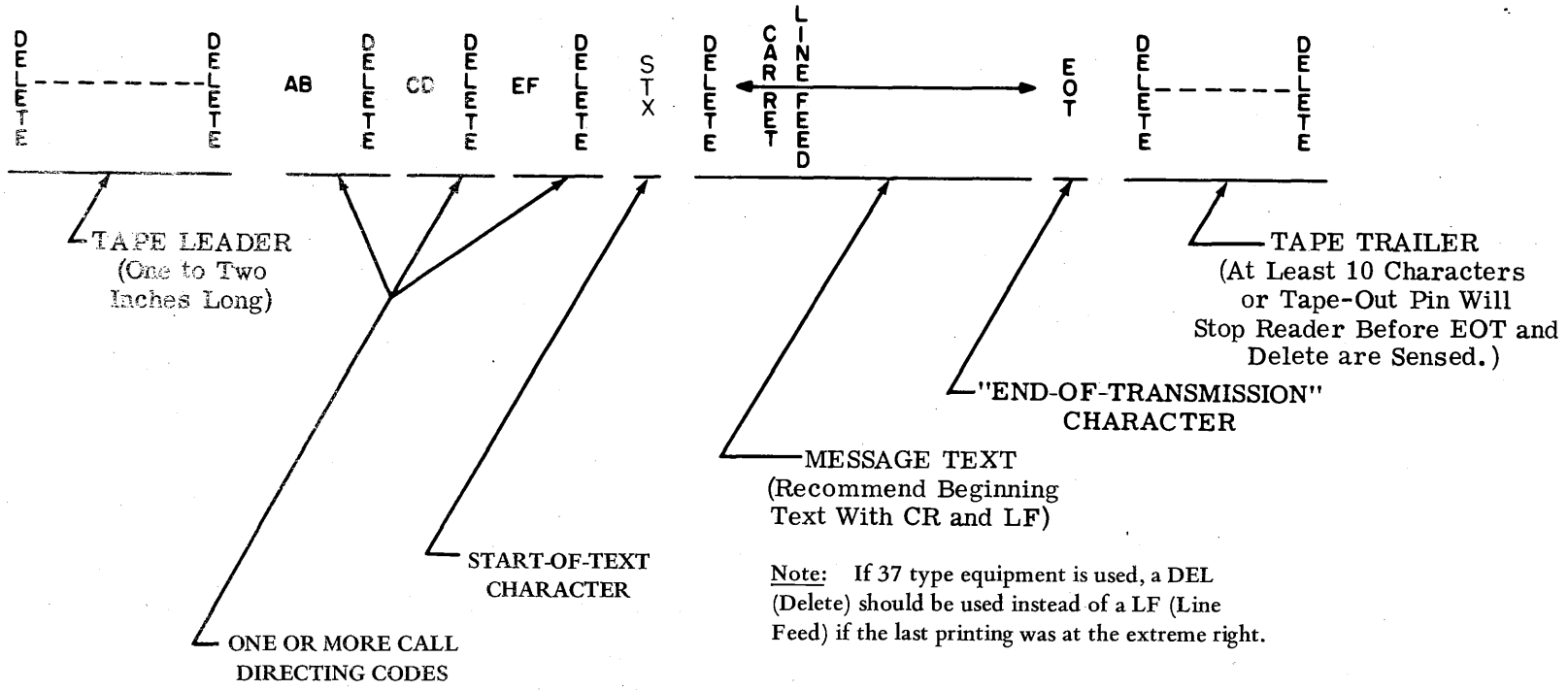
2.19 The graphic character of the answer-back (\, *, or #) is printed at a sending station equipped with a 9140 station controller, as it is at an 8A1 station (to notify the operator that the message will be copied by either the called station, the intercept, or not at all). In either case, the ACK of the answer-back restarts the reader. If there are additional CDCs in the tape, they are sent and responded to.



* Standard 8A1 operation (terminal motors on at all times) only; when motor control is used, time-out must be increased to 3 seconds.

Note: Line controller response to abnormal operation of polled station is not shown.

Figure 6 - Standard 8A1-Type System Operation



Note: If 37 type equipment is used, a DEL (Delete) should be used instead of a LF (Line Feed) if the last printing was at the extreme right.

Figure 7 - Tape Message Format

Note: If no receiver is able to copy a message (# ACK response from intercept), it will be sent from the reader regardless and be lost, since the 9140 detects only the ACK character of the answer-back. Consequently, the line controller operator must replace the tape promptly when it becomes low. If the tape is not replaced promptly, the line controller operator must send a message to the last station to send to notify its operator that the message may not have been delivered. If desired, however, this requirement can be eliminated by rewiring the line controller to cause it to stop polling when the intercept tape becomes low.

2.20 When the tape reader restarts after sending the last CDC, it sends STX DELETE, followed by the text beginning with CR LF (DEL, see note on Figure 7). The called station or stations begin copying with the DELETE character following the STX, and the text may also be copied by the sending station (9140 strap option). All other stations stop monitoring the line for their CDCs and TSCs. The tape reader continues to run until it sends the EOT character at the end of the message. When the 9140 detects the EOT, it shuts off the reader and drops the bid, if a SINGLE BID was entered. (A REPEAT BID can only be dropped manually.)

3. PRINCIPLES OF OPERATION

GENERAL

3.01 The 9140 station controller is an electronic module containing a voltage regulator circuit and six or seven connectors for removable circuit cards. Six of these connectors are occupied by various circuit cards, described below, and the seventh (if provided) is available for the optional channel control card. Three of these cards have plug-on "piggyback" cards also, and a fourth piggyback card is available as an option. Card connectors are identified by letters of the alphabet (Figures 1 and 2).

3.02 Connector A is occupied by card A (TP322010), which contains the CDC recognition circuitry, the master clock (bit timer), and the stop pulse extender circuit. (The stop pulse extender circuit guarantees a minimum character length on the receive data lead to the terminal – of 10.625 bits with 11-unit code – regardless of line signals. If the electronic selector of the 9140 should run out of synchronism, this circuit prevents the mechanical selector in the terminal from running out of synchronism as well, resulting in faster resynchronization capability of the terminal with respect to the line.) A piggyback crystal card, A-3A (TP303803), is part of the master clock circuit. A second piggyback card, A-1 (TP322409), is present in some versions of the 9140 to provide an additional (third) CDC.

3.03 Connector B contains card B (TP322011), which includes the receive/transmit distributor (register number 1) and associated control logic. Card B also has a piggyback card, B-1 (TP322411), to provide vertical parity error detection. This card prevents the 9140 from detecting control codes, CDC characters, or TSC characters with odd parity (an odd number of marking bits in each character), and also supplies a signal on detection of a character with a parity error (signal quality detector, SQD) which may be used to light an external lamp or drive an external error counter.

3.04 Connector C is occupied by card C2 (TP322013). This card contains the 9140 receive control logic. The programmable answer-back characters and motor control circuit are contained on piggyback card C2-2.

3.05 In connector D is located either card D1 (TP322014) or card D2 (TP303734). Card D1 contains send control logic (TSC, ACK, DC_3, (X-OFF), and DC_1 (X-ON) detection with related circuitry and terminal alarm control) while card D2 contains bias resistors needed for receive-only operation (to hold the various sending signals in the proper state for receiving).

3.06 Connector E contains card E2 (TP322451) which provides the EIA interface amplifiers and related circuitry necessary to interface the 9140 to the terminal and the channel. Also, it allows (by strap option) the sending station to copy CDCs and answer-backs being sent.

3.07 Connector F is filled by either card F1 (TP322017) or card F2 (TP322018). Card F1 has a buffer (seven pairs of inverters used to amplify the data signals) and nonprogrammable recognition of the ASCII characters SOH, STX, and EOT. Card F2 has the same buffer and character recognition circuitry as card F1 but in addition it has circuitry to substitute a programmable character in the printed text for every character received with incorrect vertical parity (register number 2 and controls) and circuitry to provide on-line punch control (when used in conjunction with card A-1).

3.08 Programming of the 9140 is done by cutting wire straps on the circuit cards. (The two cards in the mounting frame have strap options also.) There are no adjustments, controls, or indicators on either the controller or mounting frame.

OPERATION

3.09 A block diagram showing signal flow in the 9140 station controller, including all options, is given in Figure 8. The explanation of operation following is related to this figure.

A. Sending

3.10 Incoming serial signals from the channel appear on the receive data lead from the data set. They are converted from EIA bipolar signals to low level unipolar

signals, for the 9140 integrated circuit logic, by an input amplifier. From this amplifier they pass to the receive/transmit distributor (register number 1), where they are deserialized. The parallel output of the distributor is amplified by the buffer and connected to the character and code recognition gates. When the station TSC is received, it is decoded by the two TSC gates (shown as a single box in Figure 8) and a signal sent to the send control logic.

3.11 The send control logic monitors the clear to send (CTS) signal from the data set. If CTS is on and the 9140 is in the select mode from the previous detection of EOT, the send control logic responds to the TSC by sending a no-traffic answer-back response or by permitting sending to begin, depending on the status of the request to send (RTS) signal from the terminal. (Detection of STX places the send control logic in the nonselect mode.)

3.12 If there is no traffic available for transmission, RTS will be off. In this case the send control logic supplies a signal to the answer-back control logic and (if present) to the channel control logic. The channel control logic (if used) turns on RTS to the data set (already on if channel control is not used) if the data set ready (DSR) signal from the data set is on, and the answer-back control logic causes a two-character answer-back, \ ACK (or other characters) or (if so programmed and data terminal ready (DTR) is off) BEL BEL, to be shifted – in parallel – into the parallel input control of the receive/transmit distributor, after a delay of approximately 150 milliseconds. The distributor serializes the answer-back characters and presents them to an output amplifier, which converts them to EIA bipolar signals for the data set. The answer-back response appears on the 9140 send data lead. At the conclusion of sending the channel control logic (if used) turns off RTS.

3.13 If the terminal is in the send mode, a bid is entered, there are no alarms, and (with tape sending) tape is in the reader, RTS will be on. In this case the send control logic supplies a signal to the motor control logic and (if present) to the channel control logic. As with no traffic, the channel control logic turns on RTS to the data set (already on if channel control is absent). The motor control logic supplies two signals to the terminal, DSR and selected to send (STS). If motor control is used, DSR causes the terminal motor or motors to turn on; if individual motor control is used, DSR and STS cause the reader motor to turn on. After a delay of one to two seconds (to allow the motor or motors to reach their operating speed) with motor control or approximately 200 milliseconds without motor control, the send control logic supplies a clear to send (CTS) signal to the terminal, causing it to begin sending.

3.14 When the terminal begins sending, the data – in serial EIA bipolar form – appears on the send data lead. An input amplifier on this lead converts it to low level unipolar signals. In 8A1-type operation, these signals are connected to the serial input of the receive/transmit distributor and shifted through it by the clock, regenerating them to less than 5 percent distortion. The regenerated signals are connected to the input of an output amplifier and passed to the data set, on the send data lead, as EIA bipolar signals again. Consequently, the unipolar data signals are connected directly to the output amplifier to be converted back to EIA bipolar signals. This double conversion squares off the data signals but does not regenerate them; in fact, depending on the nature of the signals, it may actually introduce a small amount of distrotion (1 percent or so).

3.15 If it detects a line break while the terminal is sending, the send control logic supplies an alarm signal to the terminal for approximately 400 milliseconds. This signal lights the terminal ALARM lamp and sounds its buzzer. The terminal is also deselected at the same time.

3.16 At the end of the message the terminal sends EOT. In most versions of 8A1-type operation, this EOT is detected by the character recognition gates and a signal sent to the send control logic and the receive control logic. This signal deselects the terminal, causing the send control logic to remove CTS and stop the sender. Also, the signal to the channel control logic is removed by the send control logic causing RTS to be turned off.

3.17 The send control logic also responds to four other characters – DELETE, ACK, DC_1 (X-ON), and DC_3 (X-OFF) – which are used in certain applications:

(a) DELETE and ACK detection are used in standard 8A1-type operation only. Upon receiving a DELETE character in the send mode (from the sending tape reader), the send control logic removes CTS, stopping the tape reader. Upon receiving an ACK character (from a remote receiver or the intercept), the send control logic supplies CTS again, causing sending to resume.

Note: An option is available to stop the sender on the second non-DELETE character after one or more DELETE characters, instead of on the first DELETE character after one or more non-DELETE characters.

(b) DC_1 (X-ON) detection is normally not used, but may be used in some systems. Upon receiving a DC_1 (X-ON) character, the send control logic supplies CTS, causing sending to resume.

(c) DC_3 (X-OFF) detection may be used in some systems also. Upon receiving a DC_3 (X-OFF) character, the send control logic deselects the sender and causes the channel control logic to turn off RTS.

B. Receiving

3.18 As for sending, incoming signals from the channel are converted from EIA bipolar signals to low level unipolar signals, deserialized by the receive/transmit distributor, amplified in parallel form, and connected to the character and code recognition gates (3.10). When one of the station CDCs is received, it is decoded by one of the two (or three) pairs of CDC gates (each shown as a single box in Figure 8) and a signal sent to the receive control logic.

3.19 The receive control logic monitors the STX and EOT signals from the character recognition gates. If the set is in the select mode from the previous detection of EOT, the receive control logic responds to the CDC by sending either a ready-to-receive answer-back response or a not-ready-to-receive answer-back response (or no response – strap option), depending on the status of the data terminal ready (DTR) signal from the terminal. (The receive control logic may receive a CDC signal while it is in the nonselect mode due to the appearance of the CDC letters in the message text.)

3.20 If the terminal is unable to receive a message (low paper, low tape, or off-line), DTR will be off. In this case the receive control logic, if so programmed, supplies a signal to the answer-back control logic, to the channel control logic, (if present), and to the terminal. (The receive control logic may be programmed to make no answer-back response at all, in which case it supplies no signals.) The channel control logic, as for sending, turns on RTS to the data set (already on if channel control is not used) if the DSR signal from the data set is on (if used), and the answer-back control logic causes a two-character not-ready-to-receive answer-back, BEL BEL (or other characters), to be shifted – in parallel – into the parallel input control of the receive/transmit distributor, after a delay of approximately 150 milliseconds. The distributor serializes the answer-back characters and presents them to an output amplifier, which converts them to EIA bipolar signals for the data set. The answer-back response appears on the 9140 send data lead. At the conclusion of sending the channel control logic turns off RTS.

3.21 When the off-line receiving indication option is programmed at the terminal, the signal supplied by the receive control logic to the terminal, selected to receive (STR), causes the terminal ALARM and RECEIVE lamps to light and its buzzer to sound, if it is off-line. If the terminal is placed on line after this indication and its ALARM button reset, its ALARM and RECEIVE lamps and buzzer go off and DTR is turned on, allowing it to receive the message when the station is called again. (When supplied while DTR is off, STR has a duration of about 400 milliseconds; when DTR is on, STR is on from the time the CDC is detected until the time EOT is detected.)

3.22 If the terminal is able to receive a message, DTR will be on. In this case the receive control logic supplies signals to the motor control logic, to the channel control logic (if present), to the terminal, and to the answer-back control logic. As when the terminal is unable to receive, the channel control logic turns on RTS to the data set (already on if channel control is absent). The motor control logic supplies one signal to the terminal, DSR, and the receive control logic supplies another, STR. If motor control is used, DSR causes the terminal motor or motors to turn on; if individual motor control is used, DSR and STR cause the printer and punch motors to turn on. After a delay of one to two seconds (to allow the motor or motors to reach their operating speed), with motor control, or after a delay of approximately 150 milliseconds, without motor control, the receive control logic supplies a signal to the answer-back control logic. This causes a two-character ready-to-receive answer-back, \ ACK (or other characters) to be shifted into the receive/transmit distributor, serialized, and sent out on the 9140 send data lead, as for a not-ready-to-receive answer-back response (3.20). At the conclusion of sending the channel control logic turns off RTS.

Third Answer-Back to CDC

3.23 Depending on the additional customer provided input, there can be a variety of answer-back responses to the CDC. There can be one positive and one negative, or one positive and two negative, or two positive and one negative answer-back to a CDC.

3.24 One Positive and One Negative Answer-Back to the CDC: With straps 73 and 74 open, operation is as described in 3.20 through 3.22.

3.25 One Positive and Two Negative Answer-Backs to the CDC: With strap 73 closed and strap 74 open, and the terminal is ready to receive, the positive answer-back is sent to the CDC. If the terminal is not ready to receive, and the external initialize optional answer-back signal is off, then the normal answer-back to a CDC will be sent. If the external signal is on, the normal negative answer-back is disabled and the new negative answer-back is enabled. The three answer-backs will be generated when the following signal combinations are present:

	DTR (ON)	DTR (OFF)
Initialize Optional A/B (ON)	Positive A/B	Optional Negative A/B
Initialize Optional A/B (OFF)	Positive A/B	Normal Negative A/B

3.26 Two Positive and One Negative Answer-Back to the CDC: With strap 73 open and strap 74 closed, the external initialize optional answer-back signal off, and the

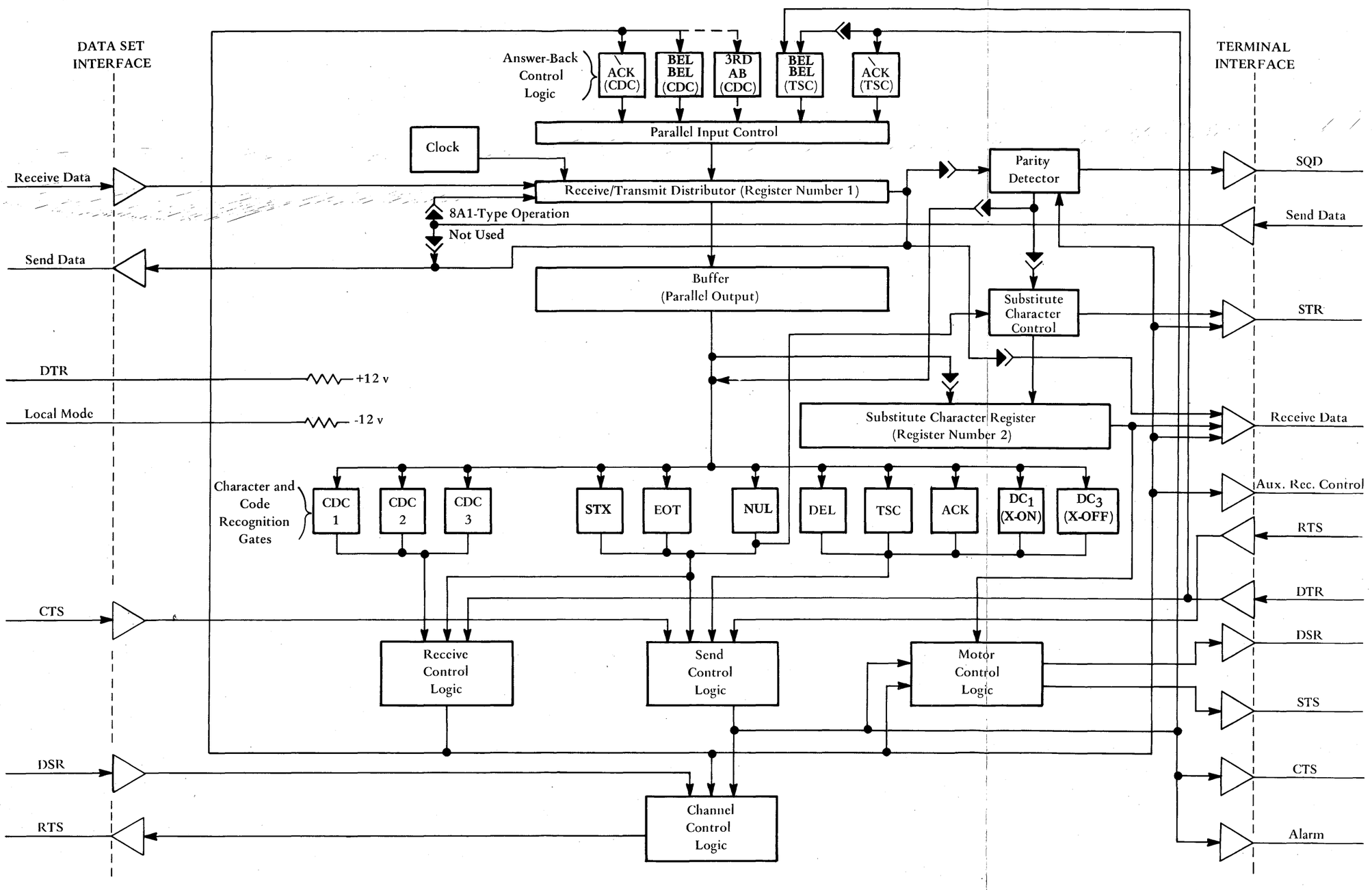


Figure 8 - Signal Flow in 9140 Station Controller

terminal is ready to receive, the normal positive answer-back is enabled. If the external signal is on, the normal answer-back is disabled and the optional answer-back is enabled. The three answer-backs will be generated when the following signal combinations are present:

	DTR (ON)	DTR (OFF)
Initialize Optional A/B (ON)	Optional Positive A/B	Negative A/B
Initialize Optional A/B (OFF)	Normal Positive A/B	Negative A/B

3.27 When the receive control logic receives an STX signal from the character recognition gates, it enters the nonselect mode (ignores further CDC signals) and unblinds the receive data lead to the terminal, permitting it to copy the message. If the CDC detected was CDC 3, an additional signal, auxiliary receive control, is supplied to the terminal at this time. This signal may be used to provide on-line punch control for the terminal. If the terminal is strapped for this option, its punch is blinded to the data unless auxiliary receive control is supplied, so CDC 1 and CDC 2 will unblind the printer only.

3.28 When the substitute character on error option is not used, the serial data signals from the receive/transmit distributor are connected to an output amplifier, converted to EIA bipolar signals for the terminal, and passed to it on the receive data lead. If vertical parity detection is present, the serial signals are also sent to the parity detector logic. If a character with incorrect (odd) vertical parity is shifted into the receive/transmit distributor, it is detected by the parity detector and the signal normally sent to the character and code recognition gates is omitted, preventing recognition of any character or code with incorrect parity. If the 9140 is in the nonselect (text) mode when the parity error is detected, a signal, signal quality detector (SQD), is also sent to the terminal. This signal may be used to light an external lamp or operate an external error counter.

3.29 When the substitute character on error option is used, the parallel data signals are stored in the substitute character register (register number 2) after being amplified by the buffer. They are passed to the terminal in serial form on the receive data lead as the next character is received by the receive/transmit distributor, resulting in a one-character delay between line signals and data copied by the terminal. If a character with incorrect parity is shifted into the receive/transmit distributor, it is detected by the parity detector and the signal normally sent to the substitute character control logic is omitted, as well as the signal normally sent to the character and code recognition gates. Consequently, the erroneous character stored in the receive/transmit distributor is not shifted into the substitute character register. Instead, the programmed substitute character is generated by the control logic, shifted into the substitute character register in parallel, and sent to the terminal in serial form in place of the erroneous character.

3.30 At the end of the message, the terminal receives EOT. Upon detecting it, the character recognition gates provide a signal to the receive control logic and the send control logic. This signal deselects the terminal, causing the receive control logic to remove STR, blind the terminal to further receive data signals, and return to the select mode again. However, when the substitute character option is used, a signal is produced by the substitute character control logic to hold STR on until the substitute character register is reset. This keeps the terminal motors on until EOT is copied.

CIRCUIT DESCRIPTION

3.31 A detailed circuit description of the 9140 station controller is contained in 8523WD-CD (included in wiring diagram package WDP0138), shipped with each controller. The circuit description covers versions of the 9140 which use other types of operation as well as 8A1-type operation. Refer to Table D for a glossary of terms used in 8523WD-CD.

4. FEATURES AND OPTIONS

STANDARD FEATURES

A. System Operation

4.01 Two types of system operation may be used, by means of strap options in the controller, depending on the requirements of the system.

B. Motor Control

4.02 Three terminal motor control options are available: (1) reader motor turned on when the terminal is selected to send and turned off at the end of transmission, and printer (and punch) motor turned on when the terminal is selected to receive and turned off at the end of reception (individual motor control); (2) both reader and printer (and punch) motors turned on when the terminal is selected to send or receive and turned off at the end of transmission or reception; and (3) both motors on at all times. The first two options reduce wear and power consumption. They result in a one-to-two second delay (for the motor to reach its operating speed) before a \ ACK answer-back response or message is sent. The first option requires strapping in the controller and an auxiliary motor control unit in the terminal; the second and third options are strap options only. The first and third options can be used only with 35 type terminals. More than one option can be used on a line if the system is programmed to accept the one-to-two-second motor turn-on delay or the variation in delays.

TABLE D

GLOSSARY OF TERMS USED IN 8523WD-CD

accessory	– 9140 station controller (9140 Data Terminal Accessory)
chip	– integrated circuit package
DEL	– DELETE (RUB OUT)
DLE	– Data Link Escape (8523WD-CD usage refers to full duplex operation only – not the same as the first character of a TSC in 8A1-type operation)
half-duplex operation	– 8A1-type operation
half-duplex, station to station message flow	– standard 8A1-type operation
intra-line operation	– standard 8A1-type operation
STX	– EOA
u	– μ (micro)

C. Audible Alarm When Disconnected

4.03 With this mounting frame strap option, a buzzer will sound when the ALARM lamp lights if the terminal is disconnected by the line controller while sending. Depressing the lamp resets the alarm. The buzzer may be turned off with the BUZZER OFF switch.

D. Local Copy When Sending

4.04 Messages sent by an ASR terminal are copied at the same time by its own printer when it is on-line with this controller strap option.

E. Third Answer-Back to CDC

4.05 The third answer-back to a CDC consists of two identical characters sent twice. It may be used if a station is ready to receive except for a condition which can be corrected by the processor (such as a form being out of line). When the processor receives this response, it takes the action necessary (such as sending FF – form feed) before proceeding with the message.

4.06 The third answer-back may be used to indicate a station that is not ready to receive because it is off-line. BEL BEL will be sent when the station cannot receive because of low paper.

OPTIONS

A. Additional CDC Detected

4.07 The standard 9140 station controller has two programmable CDCs but a third CDC is available with the addition of this piggyback card option. It may be used to control an auxiliary receive device or as a group or broadcast CDC.

4.08 Another use of this option permits on-line punch control on 35 type terminals. In this case, the MODE switch is set so the punch is always on-line so it may be controlled by the CDC. The terminal may then be called in by any of three CDCs, two of which will enable the printer only and one of which will enable both the printer and the punch.

B. Parity Error Detection

4.09 Characters received with incorrect parity are not detected as control codes or TSC or CDC characters when this card option is used. A signal is also produced when a character with incorrect parity is received which may be presented to an accessory (not part of the 9140) to operate an external lamp and/or a mechanical error counter.

C. Substitute Character on Error

4.10 This card option, used with parity error detection, inserts a character in the printed copy for every character received with incorrect parity. The character to be substituted is usually programmed as *, but ↑, \, or some other character may be used in some applications. This option has the advantage of identifying the characters received with incorrect parity, but erroneous characters with correct parity are nondetectable and will remain. Since about 25 percent of all transmission errors can be expected to have correct parity, retransmission of a received message must be requested if very many errors appear in it, just as with the error indication available in 4.09.