MIL-STD-188-347
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SUPERSEDING
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DCAC 330-175-1
31 JULY 1963

MILITARY STANDARD

STANDARDS FOR
LONG HAUL COMMUNICATIONS
EQUIPMENT TECHNICAL DESIGN STANDARDS
FOR
DIGITAL END INSTRUMENTS AND ANCILLARY DEVICES

SLHC

DEPARTMENT OF DEFENSE
WASHINGTON, DC 20301

STANDARDS FOR LONG HAUL COMMUNICATIONS

EQUIPMENT TECHNICAL DESIGN STANDARDS FOR
DIGITAL END INSTRUMENTS AND ANCILLARY DEVICES

MIL-STD-188-347

1. This Military Standard is approved for use by all Departments and Agencies of the Department of Defense.

2. Recommended corrections, additions, or deletions should be addressed to Commander, U.S. Army Communications-Electronics Engineering Installation Agency, ATTN: SCCC-CED-STS, Fort Huachuca, Arizona 85613.

FOREWORD

MIL-STD-188-347 provides technical design standards and test criteria for digital end instruments and ancillary devices for use in the terminal area of a long haul communications subsystem.

This standard supersedes paragraphs 3.4.1 and 3.4.4 of DCAC 330-175-1, DCS Engineering-Installation Standards Manual.

Digital end instruments included in this standard but not a part of DCAC 330-175-1 are low speed page printers, high speed line printers, optical character recognition equipment, and synchronous regenerative repeaters.

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FIGURES

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FIGURES (continued)

FIGURES (continued)

1. SCOPE

1.1 *Purpose.* The purpose of this standard is to provide technical design standards and test criteria for digital end instruments and ancillary devices for use in the terminal area of a long haul communications system. This standard is approved for use in designing, installing, and operating new communications facilities, and in upgrading existing subsystems and equipment.

1.2 *Application.* This standard applies to terminal area communications subsystems and to terminal area subsystems requiring the use of digital end instruments and ancillary devices.

1.3 *Objective.* The objective of this standard is to achieve compatibility and interoperability and enhance commonality among digital end instruments and ancillary devices used in the terminal areas of long haul communications systems.

2. REFERENCED DOCUMENTS

2.1 *Government Documents.*

2.1.1 *Specifications.*

2.1.1.1 *Federal Specifications.*

Federal Specification UU-T-120, Tape, Teletypewriter, Perforator.

Interim Federal Specification G-C-00116, Card, Tabulating.

2.1.2 *Standards.*

2.1.2.1 *Federal Standards.*

Federal Information Processing Standards, Publication 1 (FIPS PUB 1), Code for Information Interchange. (Adopts American National Standards Institute (ANSI) Standard X3.4-1967 in whole and ANSI X3.4-1968 in part.)

Federal Information Processing Standards, Publication 2 (FIPS PUB 2), Perforated Tape Code for Information Interchange. (Adopts ANSI X3.6-1965 in whole.)

Federal Information Processing Standards, Publication 3 (FIPS PUB 3), Recorded Magnetic Tape for Information Interchange (800 CPI, NRZI). (Adopts ANSI X3.22-1967 in whole.)

Federal Information Processing Standards, Publication 7 (FIPS PUB 7), Implementation of the CII (Code for Information Interchange) and related Media Standards.

Federal Information Processing Standards, Publication 13 (FIPS PUB 13), Rectangular Holes in 12-row Punch Cards (FIPS 13). (Adopts ANSI X3.21-1967 in whole.)

Federal Information Processing Standards, Publication 14 (FIPS PUB 14), promulgated ANSI X3.26-1970, Hollerith Punched Card Code.

Federal Information Processing Standards, Publication 15 (FIPS PUB 15), promulgated FIPS 15, Subsets of ASCII.

Federal Information Processing Standards, Publication 16 (FIPS PUB 16), Bit Sequencing of CII in Serial-by-Bit Data Transmission (Adopts ANSI X3.15-1966 in whole).

Federal Information Processing Standards, Publication 17 (FIPS PUB 17), Character Structure and Character Parity Sense for Serial-by-Bit Data Communication in the CII (Adopts ANSI X3.16-1966 in whole).

Federal Information Processing Standards, Publication 18 (FIPS PUB 18), Character Structure and Character Parity Sense for Parallel-by-Bit Data Communication in the CII (Adopts ANSI X3.25-1968 in whole).

(Government activities should obtain copies of FIPS PUB's from established sources within their organizations. If not available locally, purchase orders should be submitted to: General Services Administration, Printer Supply Division, Bldg 197, Washington, D. C., 20402. Refer to FIPS PUB by number. Non-Government activities may obtain copies from: American National Standards Institute, 1430 Broadway, New York, New York 10018.)

2.1.2.2 *Military Standards.*

MIL-STD-188-100, Common Long Haul and Tactical Communications Standards.

MIL-STD-188-120, Standard Telecommunications Terms and Definitions (to be published).

MIL-STD-188-300, System Design Standards Applicable to the Defense Communications System.

MIL-STD-1280, Keyboard Arrangements.

2.1.3 *Other Government Documents.*

2.1.3.1 *Military Handbooks.*

(C) MIL-HDBK-232, Military Standardization Handbook, Red/Black Engineering-Installation Guidelines (U).

MIL-HDBK-411, Long Haul Communications (DCS) Power and Environmental Control for Physical Plant.

2.1.3.2 *Defense Communications Agency Circulars (DCAC).*

DCAC 370-D195-1, Tests and Evaluation, DCS AUTODIN Interface Category I Testing.

DCAC 370-D195-2, Tests and Evaluation, DCS AUTODIN TEMPEST Category I Testing.

DCAC 370-D195-3, Tests and Evaluation, DCS AUTODIN Category III Operational and Acceptance Test.

2.1.3.3 *National Communications Security/Emanation Security Information Memoranda (NACSEM).*

(C) NASCEM 5100, Compromising Emanations Laboratory Test Standard, Electromagnetics (U).

(S) NASCEM 5200, Compromising Emanations Design Handbook (U) (to be published).

2.2 *Non-Government Documents.*

2.2.1 *American National Standards Institute (ANSI) Standards.*

ANSI X3.4-1968, Code for Information Interchange. (FIPS PUB 1 is X3.4-1968 less "New Line" Convention.)

ANSI X3.6-1965, Perforated Tape Code for Information Interchange (FIPS PUB 17). ANSI X3.15-1966, Code for Information Interchange in Serial-by-Bit Data Transmission (FIPS PUB 16).

ANSI X3.16-1966, Character Structure and Character Parity Sense for Serial-by-Bit Data Communication in the American National Standard Code for Information Interchange (FIPS PUB 17).

ANSI X3.17-1966, Character Set for Optical Character Recognition.

ANSI X3.21-1967, Rectangular Holes in Twelve-Row Punched Cards (FIPS PUB 13).

ANSI X3.22-1967, Recorded Magnetic Tape for Information Interchange (800 CPI, NRZI) (FIPS PUB 3).

ANSI X3.25-1968, Character Structure and Character Parity Sense for Parallel-by-Bit Data Communication in the American National Standard Code for Information Interchange (FIPS PUB 18).

ANSI X3.26-1970, Hollerith Punched Card Code (FIPS PUB 14).

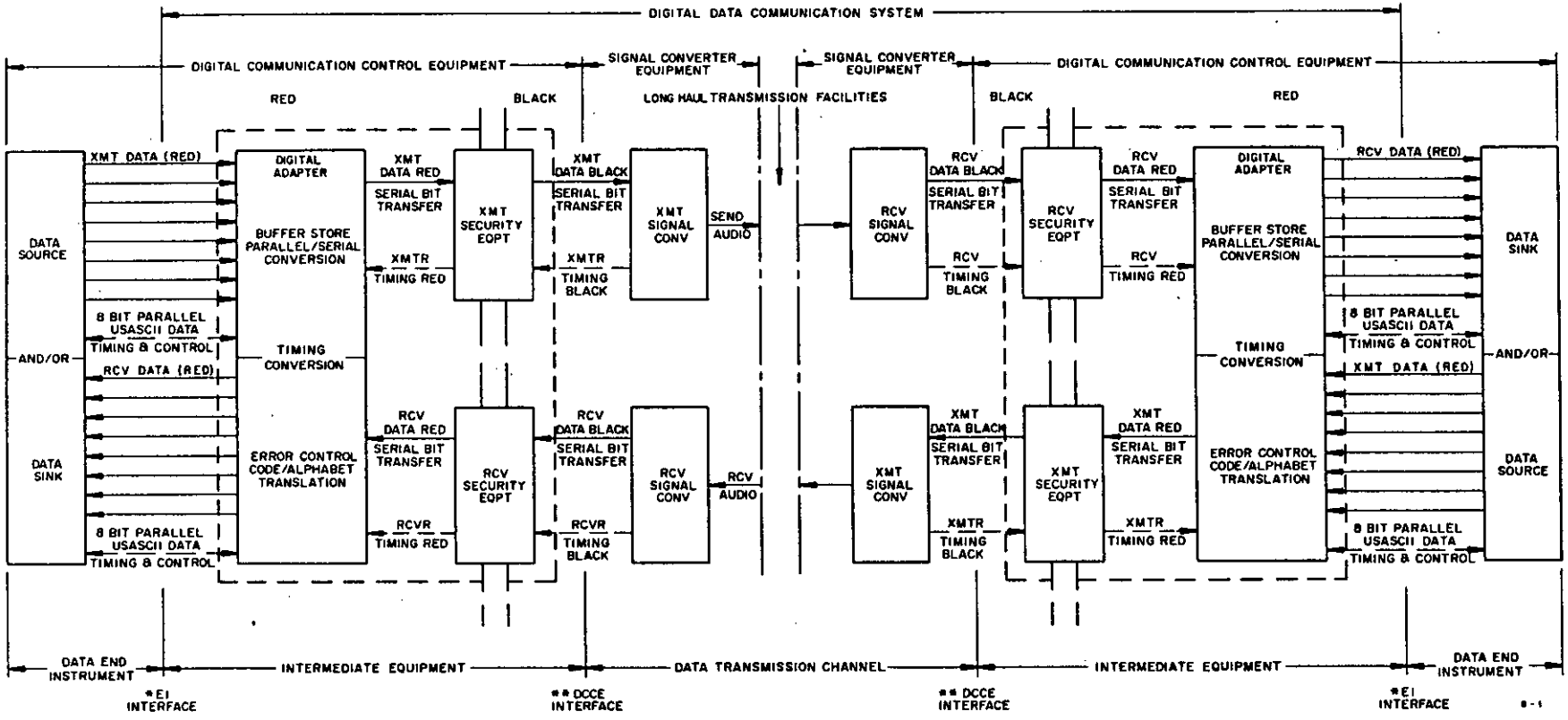
3. TERMS AND DEFINITIONS. Terms and definitions pertaining to this document are contained in MIL-STD-188-120, Standard Telecommunications Terms and Definitions.

4. SUBSYSTEM INTERFACE STANDARDS

4.1 *General digital equipment standards.* Digital terminals convert user information into electrical signals for transmission at standard modulation rates and after transmission reconverts the signals to user information. Digital communications control equipment consists of assemblies of digital equipment in standard organizational formats. These assemblies are composed of two functional blocks -- the digital end instrument and the intermediate equipment. In practice, some of the functions of the intermediate equipment frequently are carried out by the digital end instrument. For the purposes of standardization, however, the functional block structure shown by figure 1 will be used as a reference.

4.1.1 *Functional blocks.* The digital station equipment includes the digital end instrument which generates digital signals from user information or converts digital signals into user information, or both. As required, the station equipment also contains a digital adapter which may provide timing and buffering, rate conversion, serial to parallel conversion, error control, and signaling and supervision. Cryptographic equipment may be provided to perform all functions associated with encryption, timing, and synchronization. Where the low level or high level digital interface is insufficient for transmission over the subscriber loop a modem may be provided to transform the digital signal into a signal suitable for transmission over the specific loop. Where the digital signal can be passed over the loop but is distorted, attenuated, or otherwise affected beyond recognition, the loop can be made usable by employing regenerators at the ends and at intermediate points as needed.

4.1.2 *Digital end instrument interface.* A low level digital interface, either serial (bit sequential) or parallel (character or word sequential) as described in 4.3.1.3, MIL-STD-188-100, is the standard method of station equipment interface. The standard low level digital interface shall be applicable to signal, clock, and control circuits for all digital communications where a binary interface appears. Data transfer may be by either the parallel-by-bit or serial-by-bit method. Figure 1 shows a typical equipment arrangement for the parallel-by-bit method. In the simplest configuration the digital end instrument is connected directly to the loop in which case the end instrument interface (EI interface) also becomes the loop interface. For multi-instrument operation one digital adapter could provide several identical or different EI interfaces. The cryptographic equipment (KG) usually interfaces with the digital adapter (DA) bit sequentially, or with the EI. The signal converter, modem or regenerator (or line driver) usually interfaces bit sequentially with the KG or the DA or the EI. Low level interfaces (1 milliampere at 6 volts direct current) are standard, however high level interfaces (20 or 60 milliamperes at 60 or 130 volts direct current) may be used on existing equipment.



* EI END INSTRUMENT (DATA SOURCE AND/OR DATA SINK)

** DCCE DIGITAL COMMUNICATION CONTROL EQUIPMENT (EQUIPMENT COMPRISING THE INTERMEDIATE EQUIPMENT AND THE DATA END INSTRUMENT)

Figure 1. Typical digital communication control equipment interfaces.

4.1.3 *Digital interface limitations.* Binary direct current (dc) signals over a metallic path are influenced mainly by the distributed capacitance of the path which results in signal distortion. As a result, the effective path length for binary dc signals, including clock, timing, and control signals, depends on the transmission rate, the tolerable signal distortion, and the type of wire or cable employed. For typical applications, technical characteristics, and limitations of low level digital interfaces (balanced and unbalanced) see 4.3.1.3, MIL-STD-188-100.

4.2 *Modulation and data signaling rates.* Modulation rates for digital transmission shall be as specified in 4.3.1.1, MIL-STD-188-100. These rates include all bits transmitted over the link (*i.e.*, those bits necessary to transmit the users' traffic, detect and correct errors, and provide system framing characteristics). Data transmission usually is accomplished by converting the binary dc signal into a quasi-analog form for transmission over channels which will not transmit signals in the dc digital form. Transmission also may be TDM/PCM (see 4.5.3, MIL-STD-188-100). In all digital data systems, the modulation rate of the quasi-analog signal shall be expressed in baud. The quasi-analog signal does not have to be in binary form since multilevel (m-ary) modulation schemes also are being used for converting the binary dc signal into quasi-analog form. For binary modulation of the quasi-analog signal, the numerical value of the data signaling rate at the dc side of the synchronous conversion device (modem) in bits per second will be the same as the modulation rate at the quasi-analog side of the synchronous device. This is not true for start-stop systems, *i.e.*, the data signaling rate expressed in bits per second is not numerically the same as modulation rate in baud. For start-stop systems, the modulation rate of transmission shall be expressed in baud to avoid confusion.

4.3 *Serial and parallel interfaces.* Serial or parallel interfaces shall be used as required. Typically the transfer of information across the end instrument interface is on a bit-serial, character-serial or bit-parallel, character-serial basis representing the coded character set.

4.4 *Standard code for information interchange.* FIPS PUB 1 specifies that the standard code for information interchange shall be the American Standard Code for Information Interchange (ASCII) (fig. 2). This standard code shall be used in those networks of the Federal Government whose primary function is the transmission of record communications or the transmission of data related to information processing. FIPS PUB 7 (supplement to FIPS PUBS 1, 2, and 3) prescribes the means of implementing the code in media, such as perforated tape, magnetic tape, and punched cards. Other standards which deal with the use of the Standard Code for Information Interchange are FIPS PUB 15, Subsets of the Standard Code for Information Interchange; FIPS PUB 16, Bit Sequencing of the Code for Information Interchange in Serial-by-Bit Data Transmission; and FIPS

	128-SYMBOL PRINTING SET								
COLUMN →	0	1	2	3	4	5	6	7	
b7 b6 b5	0 0 0	0 0 1	0 1 0	0 1 1	1 0 0	1 0 1	1 1 0	1 1 1	ROW ↓
b4 b3 b2 b1	←NON-PRINTING-(14)→		←96-SYMBOL PRINTING SUBSET→						
0 0 0 0	NUL	DLE	SP	0	@	P	`	p	0
0 0 0 1	SOH	DC1	!	1	A	Q	a	q	1
0 0 1 0	STX	DC2	"	2	B	R	b	r	2
0 0 1 1	ETX	DC3	#	3	C	S	c	s	3
0 1 0 0	EOT	DC4	$	4	D	T	d	t	4
0 1 0 1	ENQ	NAK	%	5	E	U	e	u	5
0 1 1 0	ACK	SYN	&	6	F	V	f	v	6
0 1 1 1	BEL	ETB	' (APOS)	7	G	W	g	w	7
1 0 0 0	BS	CAN	(	8	H	X	h	x	8
1 0 0 1	HT	EM	)	9	I	Y	i	y	9
1 0 1 0	LF	SUB	*	:	J	Z	j	z	10
1 0 1 1	VT	ESC	+	;	K	[	k	{	11
1 1 0 0	FF	FS	,	<	L	\	l	|	12
1 1 0 1	CR	GS	-	=	M	]	m	}	13
1 1 1 0	SO	RS	.	>	N	^	n	~	14
1 1 1 1	SI	US	/	?	O	_	o	DEL	15

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Figure 2. American Standard Code for Information Interchange (ASCII).

PUB 17, Character Structure and Character Parity Sense for Serial-by-Bit Data Communication in the Code for Information Interchange. For additional information beyond that contained in this standard, see Appendix B of MIL-STD-188-100.

4.4.1 *Basic code.* The standard code is composed of seven units (bits) as provided in FIPS PUB 1 (ANSI X3.4-1968). One parity unit may be added for error detection as provided in FIPS PUB 17 (ANSI X3.16-1966). The coded character set shall be transmitted low order first as required by FIPS PUB 16; thus bit b_1 shall appear on-line first and bit b_7 last, followed by the parity bit. FIPS PUB 16 does not specify whether or not a character parity bit shall or shall not be transmitted, nor does it specify the total number of bits per character, the bit rate, or the transmission technique.

4.4.2 *Parity bit.* The parity bit is used as provided in ANSI X3.25-1968 and FIPS PUB 17. For transmission from end instruments, the eighth bit, when used for parity purposes, is set so that the sum of binary 1's of the 8-bit code character is always odd for synchronous transmission and even for asynchronous transmission. At reception, the detection of an even sum of binary ones for synchronous transmission or an odd sum of binary 1's for asynchronous transmission indicates a character error. The parity bit is even when recording on paper tape and edged-punched cards and thus must be reversed from odd to even when receiving synchronously. (AUTODIN uses odd/even techniques for internal system controls, error detection/correction, etc. where communications terminal equipment will transmit those control characters for channel control and coordination using even parity).

4.5 *Character interval, standard coded character set.* Synchronous or asynchronous operation may be used.

4.5.1 *Synchronous operation.* The standard character interval structure for synchronous transmission shall consist of 8 bits (7 ASCII bits plus 1 character parity bit), having equal time interval (fig. 3).

4.5.2 *Asynchronous operation (start-stop).*

4.5.2.1 *Transmitting, start-stop.* The preferred standard start-stop character interval shall consist of 10 signal elements having equal time intervals; one "0" (spacing) start element, seven ASCII elements, one character parity element, and one (marking) stop element. The intercharacter interval (the time between the end of the stop element and the beginning of the next start element) may be any length and is of the same sense as the stop element, *i.e.*, marking. An 11-unit character interval is permissible where such operation is technically more satisfactory, provided that one of the standard modulation rates is employed (fig. 4).

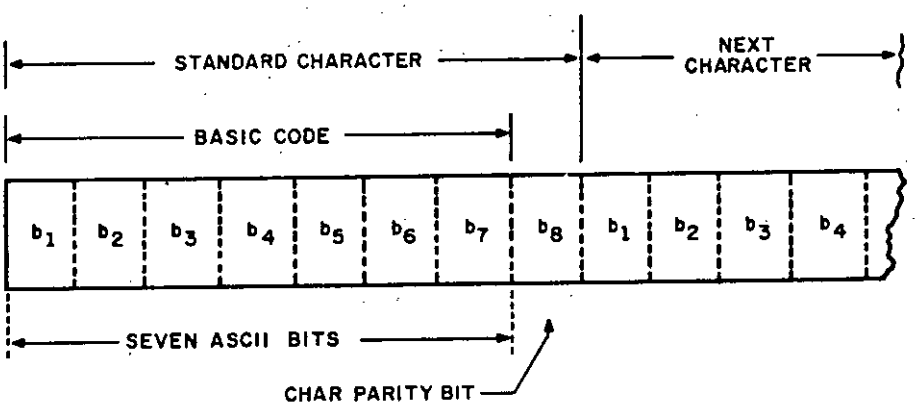
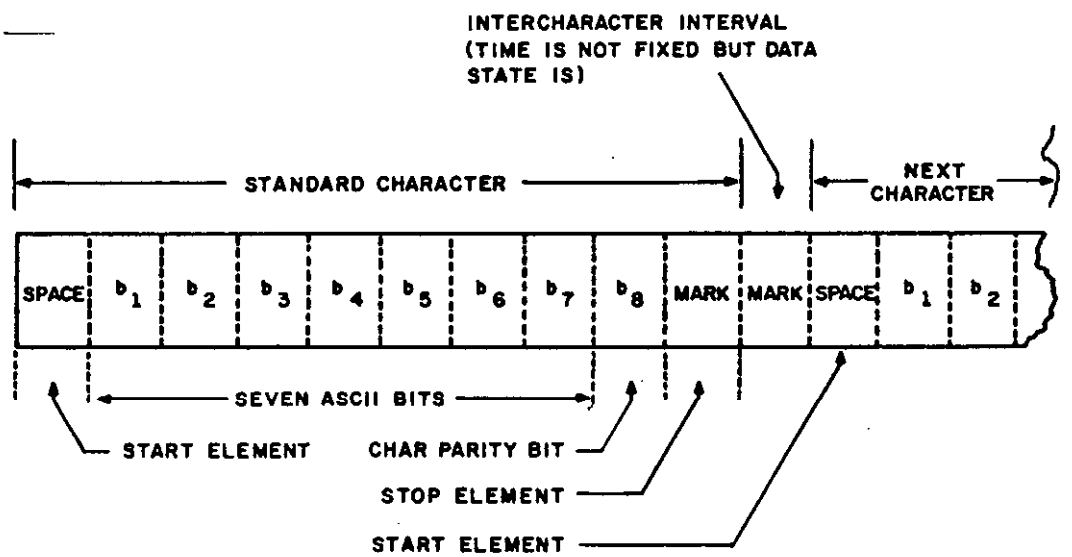


Figure 3. Standard character interval structure for synchronous transmission.



NOTES: 1. TEN UNITS CODE IS STANDARD FOR ASYNCHRONOUS TRANSMISSIONS.

2. ELEVEN UNIT CODE, WITH STOP ELEMENT TWO ELEMENTS WIDE, MAY BE REQUIRED ON EQUIPMENT USING REGENERATORS.

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Figure 4. Standard character interval structure for asynchronous transmission.

4.5.2.2 *Receiving, start-stop.* The standard start-stop character interval (as regards functioning of the receiver apparatus) shall be 9.6 units, that is, the receive device shall be prepared to accept correctly the next character interval by not more than 9.6 unit intervals from the beginning of the start pulse. The receiver device shall operate with an intercharacter interval of any length.

4.6 *Character interval, interim coded character set (asynchronous).*

4.6.1 *Transmitting, start-stop.* The start-stop character interval for five-unit code, (see fig. 5) printing telegraph, transmitting equipment shall be seven units; a one-unit start element, five one-unit intelligence elements, and a one-unit stop element. (The designer is reminded that there is currently in widespread use transmitting equipment which uses a 7.42 character interval.)

4.6.2 *Receiving, start-stop.* The start-stop character interval (as regards the functioning of the receiver apparatus) shall be 6.6 units, that is, the receive device shall be prepared to accept correctly the next character interval by not more than 6.6 unit intervals from the beginning of the start pulse. The receive device shall operate with an intercharacter interval of any length.

4.7 *Error control.* Figure 1 shows the general concept for incorporating a serial stream input and output of data which is applicable to the error control systems based either on block-by-block or character-by-character error correction through the use of decision feedback and retransmission, or forward-acting error correction. See 4.4.2, *Parity bit*, and figure 6 for DCS AUTODIN parity checking rules.

4.8 *Transmission modes.* Transmission modes shall conform to the requirements of 4.3.1.6.1, MIL-STD-188-100.

4.9 *Security requirements.* When encryption of data is required, cryptographic equipment may be used to perform all functions associated with encryption, timing, and synchronization. Documents that should be used for guidance when engineering systems that require security restrictions are:

(a) (C) MIL-HDBK-232, Military Standardization Handbook, Red/Black Engineering-Installation Guidelines (U).

(b) (C) NACSEM 5100, Compromising Emanations Laboratory Test Standard, Electromagnetics (U).

(c) (S) NACSEM 5200, Compromising Emanations Design Handbook (U) (to be published).

CHARACTERS			CODE SIGNALS							
LOWER CASE	UPPER CASE COMM	UPPER CASE WEATHER	START	1	2	3	4	5	STOP	ITA NO. 2 UPPER CASE *
A	–	↑		▨	▨				▨	
B	?	⊕		▨			▨	▨	▨	
C	:	○			▨	▨	▨		▨	
D	$	↗		▨			▨		▨	WRU
E	3	3		▨					▨	
F	!	→		▨		▨	▨		▨	UNASSIGNED
G	&	↘			▨		▨	▨	▨	UNASSIGNED
H	STOP	↓				▨		▨	▨	UNASSIGNED
I	8	8			▨	▨			▨	
J	'	↙		▨	▨		▨		▨	AUD SIGNAL
K	(	←		▨	▨	▨	▨		▨	
L	)	↖			▨			▨	▨	
M	.	.				▨	▨	▨	▨	
N	,	◐				▨	▨		▨	
O	9	9					▨	▨	▨	
P	0	0			▨	▨		▨	▨	
Q	1	1		▨	▨	▨		▨	▨	
R	4	4			▨		▨		▨	
S	BELL	BELL		▨		▨			▨	'(APOS)
T	5	5						▨	▨	
U	7	7		▨	▨	▨			▨	
V	;	ⓘ			▨	▨	▨	▨	▨	=
W	2	2		▨	▨			▨	▨	
X	/	/		▨		▨	▨	▨	▨	
Y	6	6		▨		▨		▨	▨	
Z	"	+		▨				▨	▨	+
BLANK									▨	
SPACE						▨			▨	
CAR. RET.							▨		▨	
LINE FEED					▨				▨	
FIGURES				▨	▨		▨	▨	▨	
LETTERS				▨	▨	▨	▨	▨	▨	

NOTE: UPPER CASE H (COMM) MAY BE STOP OR *

▨ MARKING PULSE

SPACING PULSE

* THIS COLUMN SHOWS ONLY THOSE CHARACTERS WHICH DIFFER FROM THE AMERICAN VERSION.

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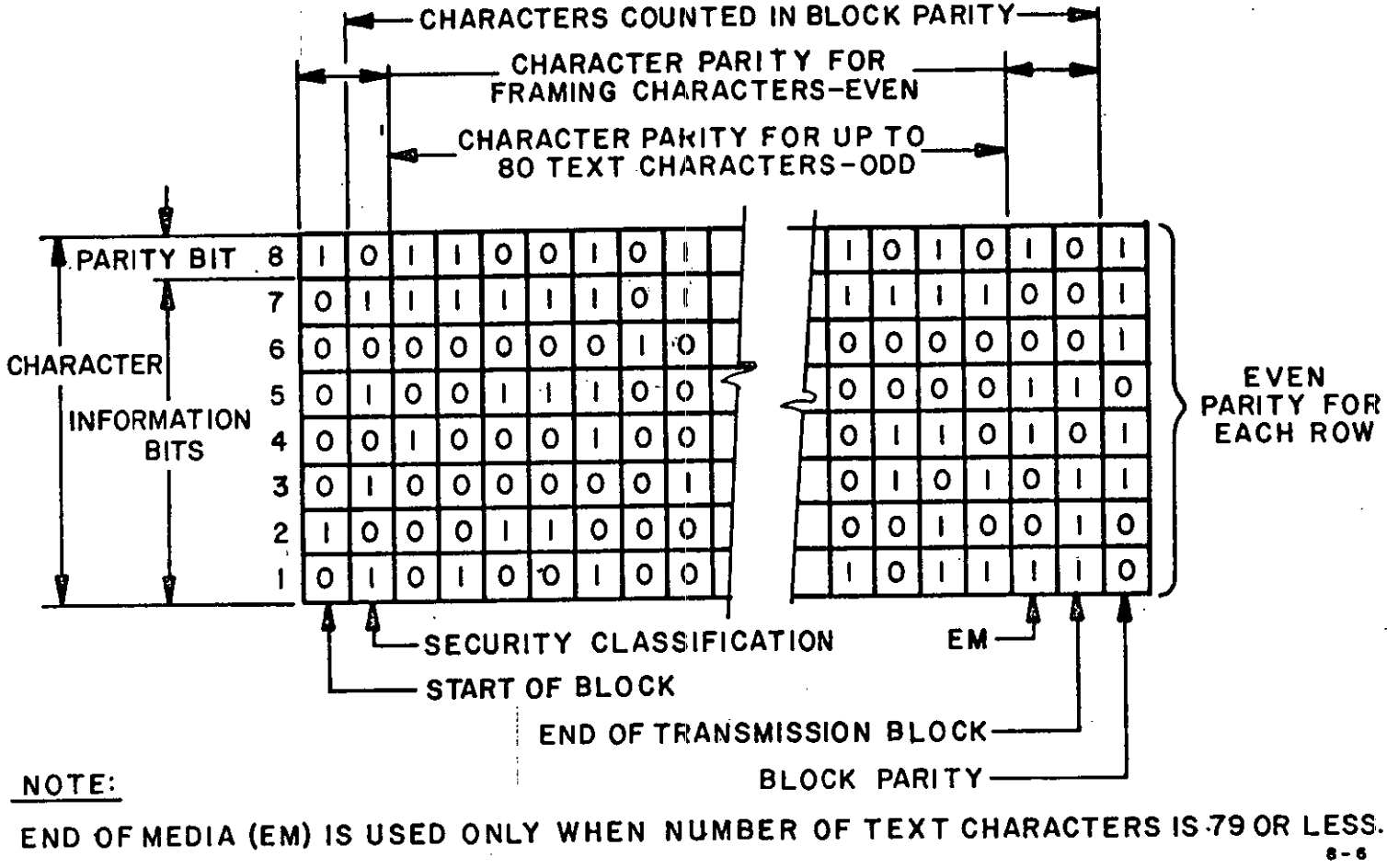
Figure 5. International Telegraph Alphabet No. 2, American version, teletypewriter signaling code.



NOTE:

END OF MEDIA (EM) IS USED ONLY WHEN NUMBER OF TEXT CHARACTERS IS 79 OR LESS.

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Figure 6. Parity checking rules for the DCS AUTODIN.

4.10 *Digital interface electrical characteristics.*

4.10.1 *Standard low level digital interface.* The digital interface shall conform to the standard low level digital interface requirements stated in 4.3.1.3, MIL-STD-188-100.

4.10.2 *Interim high level digital interface.* The high level digital interface, described in MIL-STD-188-100, is for informational purposes only. For new equipment or systems, the standard low level digital interface shall be used.

4.10.3 *Logical and signal sense at digital interface.* Logical and signal sense at digital interface shall conform to the requirements of 4.3.1.5, MIL-STD-188-100.

4.10.4 *Grounds.* Refer to MIL-HDBK-232 for requirements covering protective and signal grounds.

5. EQUIPMENT TECHNICAL DESIGN STANDARDS

5.1 *Digital end instruments.* This section deals with the performance standards for equipment connected to the terminal of a circuit in which the received or transmitted signals are in digital form. Performance standards are discussed for the types of digital end instruments listed below:

(a) Teletypewriters.

(b) Punched Card Readers.

(c) Card Punches.

(d) Magnetic Tape Readers/Recorders.

(e) Paper Tape Readers.

(f) Paper Tape Punches.

(g) Low Speed Page Printers.

(h) High Speed Line Printers.

(i) Optical Character Recognition Equipment.

(j) Synchronous Regenerative Repeaters.

5.2 *Teletypewriter.* This section deals with the basic performance standards for teletypewriter equipment operating at modulation rates up to and including 150 baud. This includes keyboard printers, receive-only page printers, keyboard senders, automatic send-receive equipment which combine printers, keyboards, tape readers, tape punches and other combinations of this type. The equipment shall be configured to permit either half-duplex or full-duplex operation on an optional basis.

5.2.1 *Coded character set.* The standard coded character set shall be the ASCII as specified in 4.4, *Standard code for information interchange.*

5.2.2 *Interim coded character set.* Because of the widespread use of five-unit, start-stop equipment, the interim standard coded character set shown in figure 5 shall be used for equipment presently in existence and for modifications for additions to existing equipment where it is impractical or impossible to use the standard code. The standard seven-unit coded character set shall be used for new equipment.

5.2.3 *Modulation rate.* The standard modulation rates for teletypewriters operating below 150 bauds shall be a nominal 50 or 75 bauds.

5.2.4 *Character interval.* The standard character interval for transmitting devices shall be as specified in 4.5, *Character interval, standard coded character set,* of this standard. Because of the widespread use of the five-unit start-stop equipment, the character interval for this code shall be as specified in 4.6, *Character interval interim coded character set (asynchronous)*, of this standard.

5.2.5 *Synchronization.* Transmitting devices shall operate in either the asynchronous or synchronous mode. The mode of operation shall be selectable. When operating in the synchronous mode, intermediate equipment will be required and will normally be in the parallel-by-bit mode.

5.2.6 *Signaling sense.* Closed circuit signaling shall be used in which current flows when the transmitting device is at rest. In the neutral signaling mode, the start pulse shall be a no current or zero voltage interval and the stop pulse a current or positive voltage interval. The latter condition represents a marking state. In the polar signaling mode the start pulse shall be a reverse current or negative voltage interval, referenced to signal ground, and the stop pulse shall be a forward current or positive voltage interval. A mark shall be represented by a forward current or positive voltage interval, and a space shall be represented by a reverse current or negative voltage interval.

5.2.7 *Signal levels.* The standard low level interface shall use low level polar signaling; however, on an interim basis high level polar signaling may be used. High level polar and neutral signaling may be used only on existing equipment. Signaling modes are listed below. Neutral signaling is shown only for information purposes.

Mode	Current (mA)	Potential Balance (%)	Voltage (dc)
Polar (low level)	1 max	±5	6 ±1
Polar (high level)	20	±5	60
Neutral	20 or 60	±5	130

5.2.8 *Interchange circuits across end instrument interface.* These standards apply to both synchronous and asynchronous equipment. The interchange functions and circuits of this section define a means of exchanging control and data signals. The interface characteristics, specified for the digital interface in 4.1.2, *Digital end instrument interface,* shall apply to these circuits. They are to be regarded as basic or minimal characteristics and may be supplemented as needed (fig. 7).

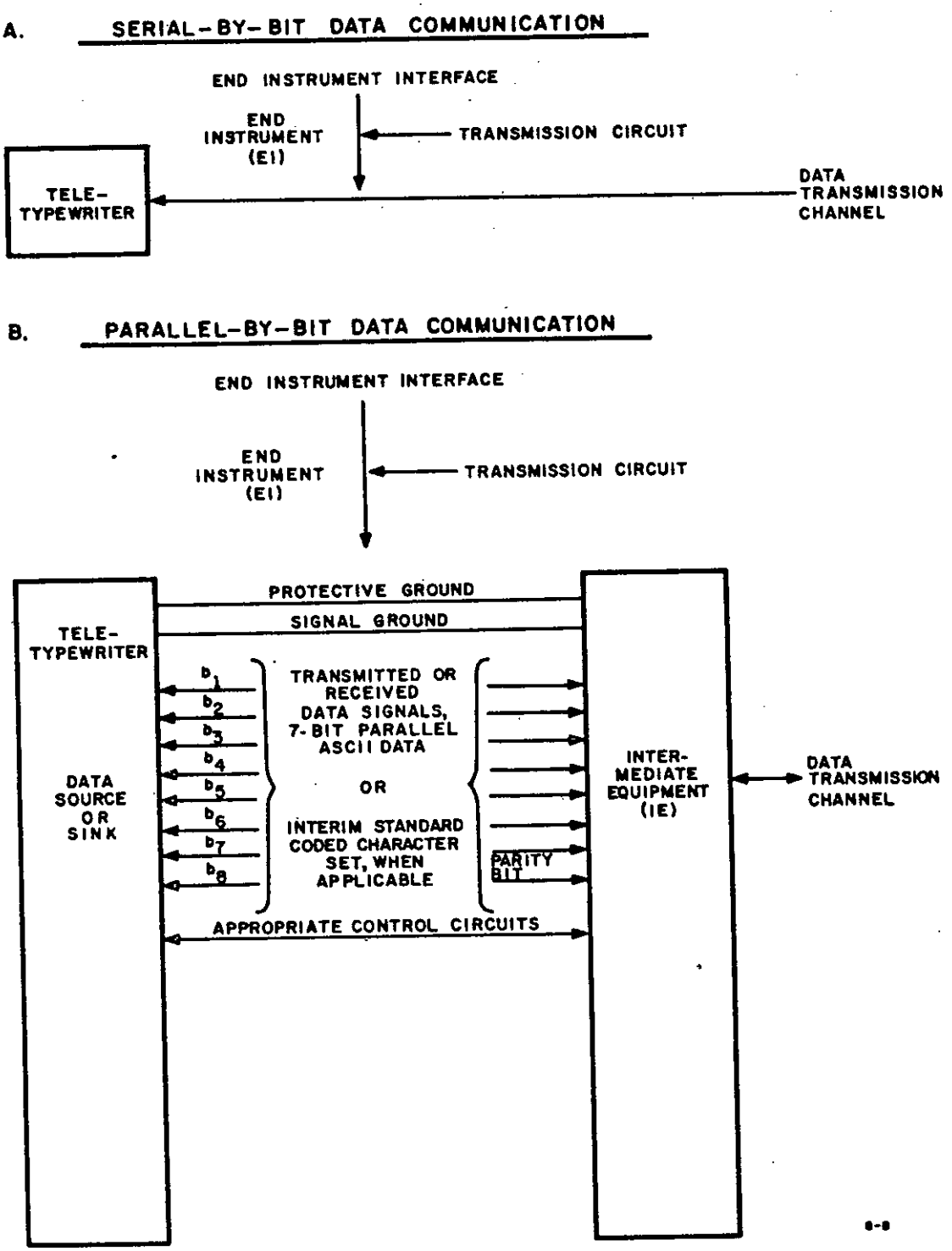


Figure 7. Typical end instrument interface interchange circuits for teletypewriters.

5.2.9 *Operating modes.* Instruments shall be configured for either half-duplex or full-duplex operation.

5.2.10 *Tape transmission.* In new tape transmitting instruments, the perforation and printing representing the initial character to be transmitted shall be visible to the operator before transmission is started.

5.2.11 *Tape sensing.* Either serial or parallel sensing shall be used in the tape reading process, but the tape shall not be altered in the operation.

5.2.12 *Tape width.* A minimum tape width of 1 inch (with tolerances as specified in Federal Specification UU-T-120) is established for systems using three information levels between the guiding edge and the feed hole. Minimum tape widths of eleven-sixteenths and seven-eights of an inch (with tolerances as specified in Federal Specification UU-T-120) are established for systems using two information levels only between the guiding edge and the feed hole.

5.2.13 *Chadded tape.* Where perforated tape is used, holes shall be punched (chadded) completely.

5.2.14 *Paper rolls.* Paper rolls (friction feed) shall be 8-1/2 inches in width and 5 inches in diameter. The paper shall conform to specifications applying to paper as follows:

Ply	Federal Stock No. for Roll (Friction Feed)
1	7530-205-2118
2	7530-205-2117
3	7530-285-5030
4	7530-205-2130
5	7530-286-7766

5.2.15 *Fanfold forms.* Fanfold forms (sprocket feed) shall be 8-1/2 inches wide. Each fold shall measure 5 by 8-1/2 inches. The forms shall conform to specifications applying to paper as follows:

Ply	Federal Stock No. for Fanfold (Sprocket Feed)
1	7530-803-8040
2	7530-753-4713
3	7530-286-7768
4	7530-205-2226
5	7530-543-7412

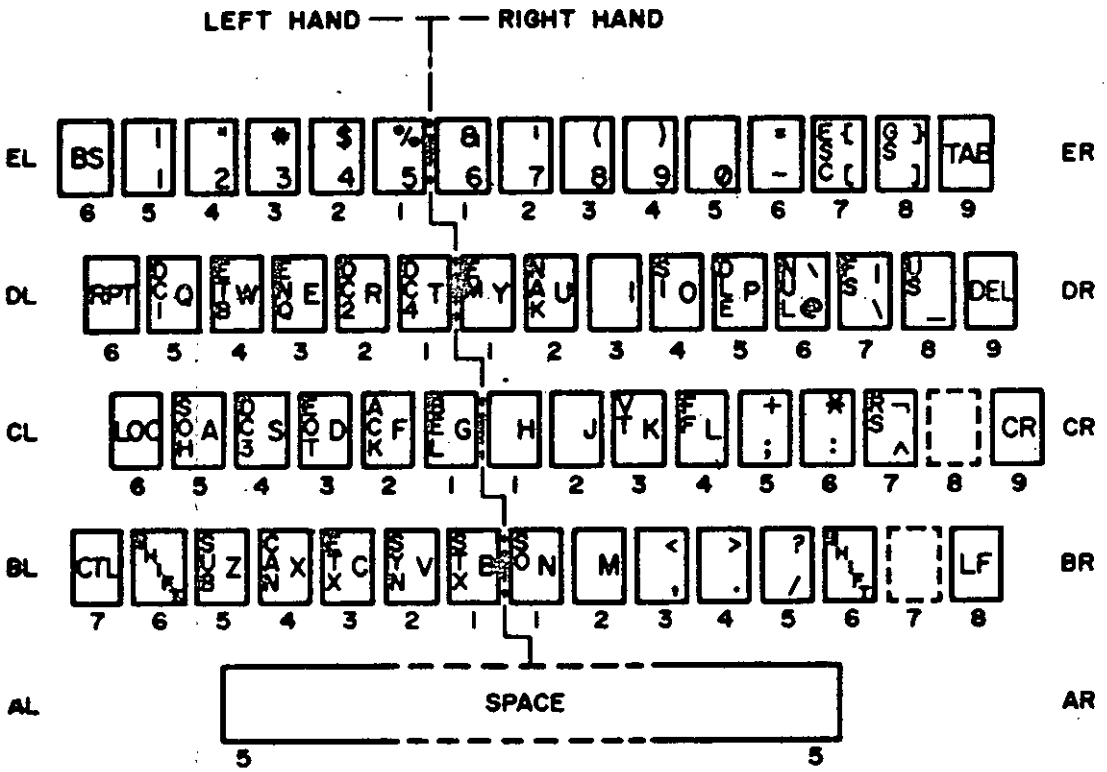
5.2.16 *Security requirements.* See 4.9, *Security requirements*.

5.2.17 *Transmitting devices.* Teletypewriter transmitting (sending) devices shall meet the minimum performance requirements listed below.

5.2.17.1 *Distortion margin.* Total distortion introduced to the transmission facilities attributable to the sending device shall not exceed that indicated below:

Type	Selection Mode	Mark (%)	Space (%)
Electro-mechanical	Sequential	5	5
Electro-mechanical	Coincident	3	3
Electronic	Sequential	3	3
Electronic	Coincident	3	3

5.2.17.2 *Keyboard arrangements.* Keyboard arrangements shall be in accordance with MIL-STD-1280. Keyboard instruments using the standard code shall use the keyboard shown in figure 8. Keyboard instruments using the interim standard code shall use keyboards with communication or weather symbols shown in figure 9.



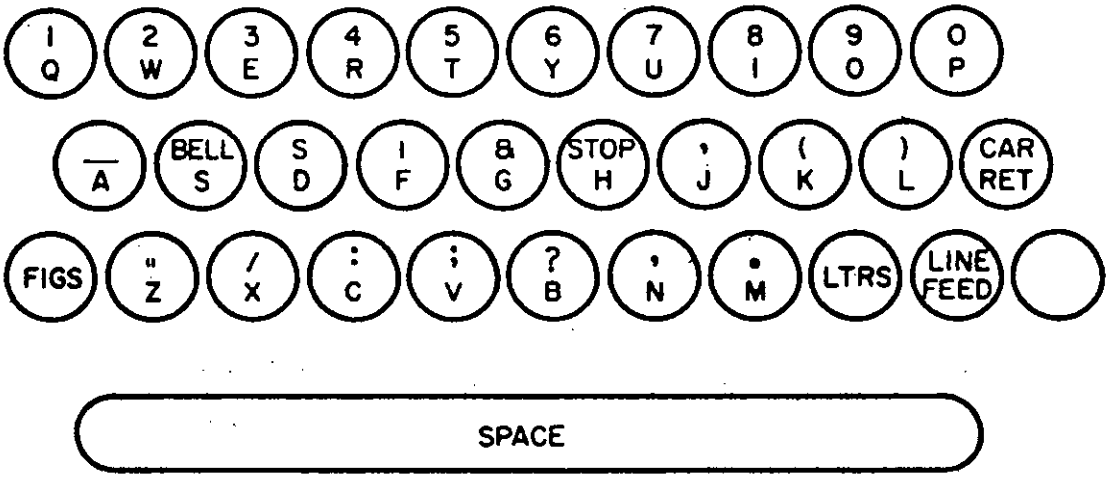
NOTES:

1 PHYSICAL CHARACTERISTICS AND LOCATIONS (i.e. SIZE, SHAPE, SKEW, ETC.) OF SPACE BAR OR KEYS ARE NOT TO BE INFERRED

2 ARRANGEMENT TYPE I, CLASS I AS PER MIL-STD-1280

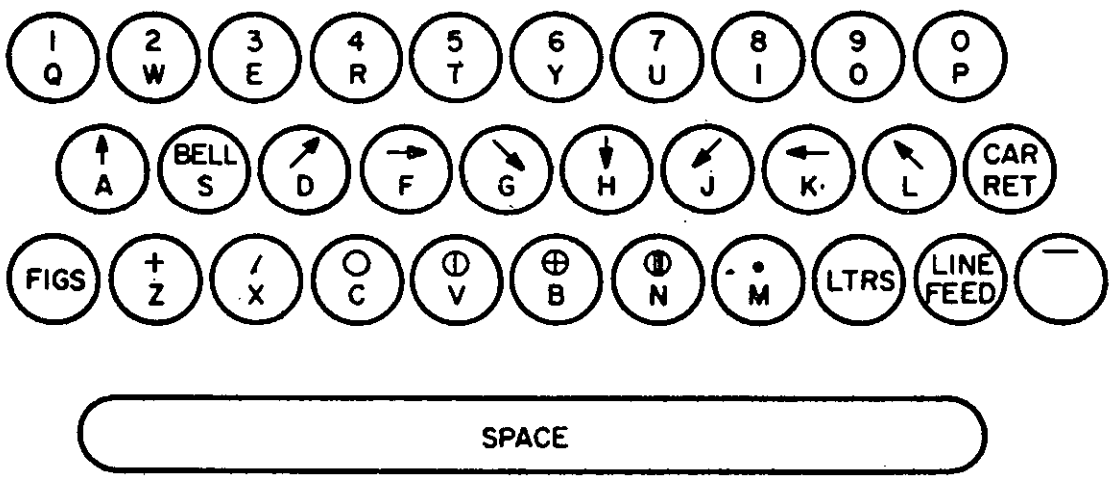
8-9

Figure 8. Standard code keyboard arrangement.



NOTE: UPPER CASE H MAY BE STOP OR #

THREE ROW COMMUNICATION KEYBOARD



THREE ROW WEATHER KEYBOARD

8-10

Figure 9. Interim code keyboard arrangements.

5.2.17.3 *Character synchronization.* When operated in the synchronous mode, low level application, the sensitivity of the instrument shall be such that an external synchronizing pulse of not more than 1 volt peak-to-peak shall be required to produce proper character release from the device. Character release shall occur provided the leading edge of the start pulse of the character to be released does not vary more than 4 percent with relation to the leading edge of the synchronizing pulse and has no constant phase delay in excess of 2.0 milliseconds with relation to the leading edge of the synchronizing pulse. In existing equipment only, using high level neutral operation, an external synchronizing pulse of 20 milliseconds and 60 milliamperes from a 130 volts dc source shall cause character release from the device. Character release shall occur provided the leading edge of the start pulse of the character to be released contains no phase delay greater than 10 percent (2 milliseconds) of the synchronizing pulse with relation to the leading edge of the synchronizing pulse and does not vary more than 4 percent.

5.2.18 *Line relay characteristics.* A standard line relay for military applications is not specified. Polar line relays shall meet the requirements of 5.2.18.1, *Electromechanical polar relays*, or 5.2.18.2, *Electronic polar relays*, whichever is applicable. Relays shall be of a plug-in type configured for an international octal base with pin connections as viewed from the bottom of the socket as follows:

Pin No.	Connection
1	Coil #1 positive termination (potential causing relay armature to make to marking contact)
2	Coil #2 negative termination
3	Coil #2 positive termination
4	Space contact
5	Ground of relay case, if applicable
6	Armature (tongue) of relay
7	Marking contact
8	Coil #1 negative termination

5.2.18.1 *Electromechanical polar relays.* There are no standard electromechanical polar relays specified for US military applications. The minimum acceptable performance characteristics are specified in the following paragraphs.

5.2.18.1.1 *Side stable.* The relays shall be side stable, that is, they shall remain in the last signaled contact position.

5.2.18.1.2 *Operating differential.* The operating differential shall be 5 milliamperes (maximum).

5.2.18.1.3 *Distortion.* Total distortion introduced into the transmission facilities, attributable to the relay, shall be less than two percent.

5.2.18.1.4 *Winding current.* The operating current per winding shall not exceed 80 milliamperes.

5.2.18.1.5 *Winding dc resistance.* The relay shall contain two operating windings each having a dc resistance of not less than 100 ohms and not greater than 200 ohms.

5.2.18.1.6 *Winding reactance.* Not specified.

5.2.18.1.7 *Contact material.* Not specified. Extreme operating conditions: 150 milliamperes; 260 volts. Typical battery source impedance: 160 ohms.

5.2.18.2 *Electronic polar relays.* Great care must be made in accepting an electronic (solid state) substitute for the electromechanical polar relay. It shall meet the following minimum required performance standards.

NOTE: With the shift from high to low level operation, the need for this device is minimal.

5.2.18.2.1 *Side stable.* The relays shall be side stable, that is, they shall remain in the last signaled contact position.

5.2.18.2.2 *Operating differential.* The operating differential shall be 2 milliamperes (maximum).

5.2.18.2.3 *Modulation rates.* Modulation rates up to 4800 bauds are considered desirable. However, to minimize the relay's response to transients, it may be useful to dampen the relay in a manner that limits its operation in a given application to ranges under 100, 500, 1000, 1500, 2500, 5000, etc. bauds.

5.2.18.2.4 *Distortion.* Total distortion introduced into the transmission facilities, attributable to the relay, shall be less than 1 percent.

5.2.18.2.5 *Winding current.* The relay shall contain the equivalent circuitry for two independent windings. This equivalent circuitry shall pass currents up to and including 80 milliamperes.

5.2.18.2.6 *Winding dc resistance.* The relay shall contain the equivalent circuitry for two independent windings, and this equivalent circuitry shall present an almost pure resistive load to the source of not less than 100 ohms and not more than 200 ohms.

5.2.18.2.7 *Winding reactance.* The winding reactance shall be essentially zero ohms at the applicable modulation rate.

5.2.18.2.8 *Output characteristics.* The output impedance shall be less than 50 ohms. The maximum signal current shall be 150 milliamperes. The maximum potential applied across the mark and the tongue or space and tongue shall be 260 volts.

5.2.18.2.9 *Output impedance.* The output impedance shall be less than 50 ohms. The potential applied across the mark and tongue or space and tongue shall not exceed 260 volts.

5.2.18.2.10 *Contacts.* The relay shall contain the equivalent circuitry for an electromechanical relay armature and two independent and isolated contacts. The equivalent circuitry shall be capable of carrying up to and including 0.150 ampere of current at 260 volts. (The maximum voltage referenced to signal ground shall be 130 volts.)

5.2.18.2.11 *International octal base pin connections.* Relays shall be of a plug-in type configured for an international octal base as described in paragraph 5.2.17.

5.2.18.2.12 *Circuit isolation.* Circuit isolation shall not be less than 75 dB (50 megohms) between connections within the relay as follows:

Any Input	to	Armature
Any Input	to	Contact #1 output
Any Input	to	Contact #2
Any Input	to	Ground
Output Contact #1	to	Ground
Output Contact #2	to	Ground
Output Contact #1	to	Armature made to Contact #2
Output Contact #2	to	Armature made to Contact #1

5.2.19 *Receiving devices.* Teletypewriter receiving devices shall meet the minimum performance requirements in 5.2.19.1 through 5.2.19.3 below:

5.2.19.1 *Distortion margin.* Receiving devices shall tolerate signal distortion as follows:

	Electromechanical		Electronic	
Distortion	Mark (%)	Space (%)	Mark (%)	Space (%)
Switched Bias	45	45	49	49
Bias	45	45	49	49
End	45	45	49	49
Cyclic	22.5	22.5	24.5	24.5

5.2.19.2 *Printing line.* Printing instruments used in narrative communication shall print 80 characters to the line. Printing instruments used in exchange of weather symbols or data information shall print 76 characters to the line. The printing instrument shall provide for end-of-line sensing with automatic line feed and carriage return. Except for optical character recognition equipment, the standard type style shall be Gothic.

5.2.19.3 *Input sensitivity.* The input sensitivity of the instrument shall be such that, when used in conjunction with high level signaling, a signal value of not more than 2 milliamperes greater than the average value of current present in the circuit for the symmetrical signal test condition (ac reversals) shall result in operation of the receive device, and conversely, a signal value of not more than 2 milliamperes less than the average value shall result in release of the receive device. When operating in the neutral signal mode, the average value of current shall be 10 or 30 milliamperes. When operating in the polar signal mode, the average value of current shall be 0 milliamperes. When the instrument is used in conjunction with low level signaling, a signal value of not more than 0.5 volt change from the average value of voltage present in the circuit for the symmetrical signal test condition (ac reversals) shall result in operation of the receive device.

5.3 *Punched card readers.* Card readers translate punched hole information from a card into electrical signals. Readers are classified as low speed, 10-50 cards per minute, medium speed, 50-200 cards per minute, and high speed, 200 cards per minute and higher. The signal characteristics, interchange circuits across the end instrument interface, physical equipment characteristics, and equipment performance apply to low speed, medium speed, and high speed units unless stated otherwise.

5.3.1 *Signal characteristics.* The digital interface electrical characteristics specified for interface signals and circuits in 4.10, *Digital interface electrical characteristics*, shall apply.

5.3.1.1 *Character interval.* The standard character interval shall be the same as that specified in 4.4.1, *Basic code*, and 4.5, *Character interval, standard coded character set.*

5.3.1.2 *Modulation rate.* The modulation rate at the end instrument interface for punched card readers shall conform to the requirements of 4.2, *Modulation and data signaling rates*. The preferred rates for low speed punched card readers shall be such that they will maintain the serial bit stream modulation rates of 150 and 300 bauds at the digital communications equipment interface when connected to the intermediate equipment. The preferred rates for medium and high speed readers shall be 600, 1,200, and 2,400 bauds.

5.3.2 *Card codes.*

5.3.2.1 *Coded character set*. The standard coded character set shall be the punched card code as specified in FIPS PUB. 14, Hollerith Punched Card Code (ANSI Standard X3.26-1969) and shown in figure 10.

5.3.2.2 *Card code structure*. Because of the widespread and predominant use of the 80-column, 12-row card having the Hollerith card code structure, the standard punched card code shall be the Hollerith code (fig.10) which gives the Hollerith punchings for all of the 128 ASCII characters in columns 0 through 7. Columns 8 through 15 constitute the Hollerith punch card code as extended to 256 characters. All 256 character punchings are a national standard pursuant to ANSI X3.26-1970 and a Federal Standard by FIPS PUB 14. Figure 11 is a cross reference from the Hollerith hole-patterns to the ASCII graphic and control characters plus the 128 additional, as yet, undefined characters of an expanded ASCII.

5.3.2.3 *AUTODIN punched card code.* This information is supplied for information purposes. As of May 1968, AUTODIN Digital Subscriber Terminal Equipment has a capability of operating with 64-hole patterns. However, only 50-hole patterns are active and not all of these are the same as the standard in figure 10. The AUTODIN interim punched card code is shown in figure 12.

5.3.2.4 *Extended binary coded decimal interchange code (EBCDIC) card code.* Because of its widespread use the EBCDIC card code is shown in figure 13 for informational purposes only. EBCDIC card code shall not be used on new equipment.

b8 b7b6b5		0 000	0 001	0 010	0 011	0 100	0 101	0 110	0 111	1 000	1 001	1 010	1 011	1 100	1 101	1 110	1 111	
bbbb 4321	COL ROW	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	COL ROW
0000	0	NUL 12-0-9-8-1	DLE 12-11-9-8-1	SP NO PCH	0 0	@ 8-4	P 11-7	& 8-1	p 12-11-7	11-0-9-8-1	12-11-0-9-8-1	12-0-9-1	12-11-9-8	12-11-0-9-6	12-11-8-7	12-11-0-8	12-11-9-8-4	0
0001	1	SOH 12-9-1	DC1 11-9-1	! 12-8-7	1 1	A 12-1	Q 11-8	a 12-0-1	q 12-11-8	0-9-1	9-1	12-0-9-2	11-8-1	12-11-0-9-7	11-0-8-1	12-11-0-9	12-11-9-8-5	1
0010	2	STX 12-9-2	DC2 11-9-2	" 8-7	2 2	B 12-2	R 11-9	b 12-0-2	r 12-11-9	0-9-2	11-9-8-2	12-0-9-3	11-0-9-2	12-11-0-9-8	11-0-8-2	12-11-0-8-2	12-11-9-8-6	2
0011	3	ETX 12-9-3	DC3 11-9-3	# 8-3	3 3	C 12-3	S 0-2	c 12-0-3	s 11-0-2	0-9-3	9-3	12-0-9-4	11-0-9-3	12-0-8-1	11-0-8-3	12-11-0-8-3	12-11-9-8-7	3
0100	4	EOT 9-7	DC4 9-8-4	$ 11-8-3	4 4	D 12-4	T 0-3	d 12-0-4	t 11-0-3	0-9-4	9-4	12-0-9-5	11-0-9-4	12-0-8-2	11-0-8-4	12-11-0-8-4	11-0-9-8-2	4
0101	5	ENQ 0-9-8-5	NAK 9-8-5	% 0-8-4	5 5	E 12-5	U 0-4	e 12-0-5	u 11-0-4	11-9-5	9-5	12-0-9-6	11-0-9-5	12-0-8-3	11-0-8-5	12-11-0-8-5	11-0-9-8-3	5
0110	6	ACK 0-9-8-6	SYN 9-2	& 12	6 6	F 12-6	V 0-5	f 12-0-6	v 11-0-5	12-9-6	9-6	12-0-9-7	11-0-9-6	12-0-8-4	11-0-8-6	12-11-0-8-6	11-0-9-8-4	6
0111	7	BEL 0-9-8-7	ETB 0-9-6	' 8-5	7 7	G 12-7	W 0-6	g 12-0-7	w 11-0-6	11-9-7	12-9-8	12-0-9-8	11-0-9-7	12-0-8-5	11-0-8-7	12-11-0-8-7	11-0-9-8-5	7
1000	8	BS 11-9-6	CAN 11-9-8	(12-8-5	8 8	H 12-8	X 0-7	h 12-0-8	x 11-0-7	0-9-8	9-8	12-8-1	11-0-9-8	12-0-8-6	12-11-0-8-1	12-0-9-8-2	11-0-9-8-6	8
1001	9	HT 12-9-5	EM 11-9-8-1	) 11-8-5	9 9	I 12-9	Y 0-8	i 12-0-9	y 11-0-8	0-9-8-1	9-8-1	12-11-9-1	0-8-1	12-0-8-7	12-11-0-1	12-0-9-8-3	11-0-9-8-7	9
1010	10	LF 0-9-5	SUB 9-8-7	* 11-8-4	: 8-2	J 11-1	Z 0-9	j 12-11-1	z 11-0-9	0-9-8-2	9-8-2	12-11-9-2	12-11-0	12-11-8-1	12-11-0-2	12-0-9-8-4	12-11-0-9-8-2	10
1011	11	VT 12-9-8-3	ESC 0-9-7	+ 12-8-6	; 11-8-6	K 11-2	[12-8-2	k 12-11-2	{ 12-0	0-9-8-3	9-8-3	12-11-9-3	12-11-0-9-1	12-11-8-2	12-11-0-3	12-0-9-8-5	12-11-0-9-8-3	11
1100	12	FF 12-9-8-4	FS 11-9-8-4	, 0-8-3	< 12-8-4	L 11-3	\ 0-8-2	l 12-11-3	| 12-11	0-9-8-4	12-9-4	12-11-9-4	12-11-0-9-2	12-11-8-3	12-11-0-4	12-0-9-8-6	12-11-0-9-8-4	12
1101	13	CR 12-9-8-5	GS 11-9-8-5	- 11	= 8-6	M 11-4	] 11-8-2	m 12-11-4	} 11-0	12-9-8-1	11-9-4	12-11-9-5	12-11-0-9-3	12-11-8-4	12-11-0-5	12-0-9-8-7	12-11-0-9-8-5	13
1110	14	SO 12-9-8-6	RS 11-9-8-6	. 12-8-3	> 0-8-6	N 11-5	^ 11-8-7	n 12-11-5	~ 11-0-1	12-9-8-2	9-8-6	12-11-9-6	12-11-0-9-4	12-11-8-5	12-11-0-6	12-11-9-8-2	12-11-0-9-8-6	14
1111	15	SI 12-9-8-7	US 11-9-8-7	/ 0-1	? 0-8-7	O 11-6	_ 0-8-5	o 12-11-6	DEL 12-9-7	11-9-8-3	11-0-9-1	12-11-9-7	12-11-0-9-5	12-11-8-6	12-11-0-7	12-11-9-8-3	EC 12-11-0-9-8-7	15

8-11

Figure 10. Standard Hollerith punched card code.

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

*11/10 and similar entries on this figure (number/number) refer to the matrix (column/row) on figure 10

8-12

Figure 11. Hollerith hole pattern cross referenced to ASCII.

	12	11	0		12	12 11	11 0	12 9
	&	-	0	SP	{	|	}	
	-	/	0	SP	~	na	^	
	+	-	0	Blk	?	na	!	
1	A	J	/	1	a	j	¬	
	A	J	&	1	na	na	na	
	A	J	/	1	na	na	na	
2	B	K	S	2	b	k	s	
	B	K	S	2	na	na	na	
	B	K	S	2	na	na	na	
3	C	L	T	3	c	l	t	
	C	L	T	3	na	na	na	
	C	L	T	3	na	na	na	
4	D	M	U	4	d	m	u	
	D	M	U	4	na	na	na	
	D	M	U	4	na	na	na	
5	E	N	V	5	e	n	v	
	E	N	V	5	na	na	na	
	E	N	V	5	na	na	na	
6	F	O	W	6	f	o	w	
	F	O	W	6	na	na	na	
	F	O	W	6	na	na	na	
7	G	P	X	7	g	p	x	DEL
	G	P	X	7	na	na	na	na
	G	P	X	7	na	na	na	na
8	H	Q	Y	8	h	q	y	
	H	Q	Y	8	na	na	na	
	H	Q	Y	8	na	na	na	
9	I	R	Z	9	i	r	z	
	I	R	Z	9	na	na	na	
	I	R	Z	9	na	na	na	

	12	11	0	
8-1				'
				na
				na
8-2	[	]	\	:
	na	na	_	'
	na	na	≠	b
8-3	.	$	,	#
	.	[	,	#
	.	$	,	=
8-4	<	*	%	@
	<	*	%	>
	)	*	(	'
8-5	(	)	_	'
	+	]	?	:
	[	]	~	:
8-6	+	;	>	"
	(	;	$	)
	<	;	/	>
8-7	!	^	-?	"
	*	!	'	"
	≠	^	≠	✓

← Standard Hollerith
← AUTODIN
← JCS Pub 7
na means not assigned

8-13

Figure 12. Interim AUTODIN punched card code.

Bits xxxx 4567	Hexadecimal Row	Digit Punches	00				01				10				11				Bits x0,x1
			00	01	10	11	00	01	10	11	00	01	10	11	00	01	10	11	Bits x2,x3
			0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	Hex. Col.
			12				12	12		12	12	12		12	12				Zone Punches
				11				11	11	11		11	11	11		11			
					0		0		0	0	0		0	0			0		
			9	9	9	9	9	9	9	9									Digit Punches
0000	0	8-1	*1 NUL	*2 DLE	*3	*4	*5 SP	*6 &	*7 -	*8					*9 {	*10 }	*11 \	*12 0	8-1
0001	1	1	SOH	DC1					*13 /		a	j	¬		A	J	*14	1	1
0010	2	2	STX	DC2		SYN					b	k	s		B	K	S	2	2
0011	3	3	ETX	DC3							c	l	t		C	L	T	3	3
0100	4	4									d	m	u		D	M	U	4	4
0101	5	5	HT		LF						e	n	v		E	N	V	5	5
0110	6	6		BS	ETB						f	o	w		F	O	W	6	6
0111	7	7	DEL		ESC	EOT					g	p	x		G	P	X	7	7
1000	8	8		CAN							h	q	y		H	Q	Y	8	8
1001	9	8-1		EM							i	r	z		I	R	Z	9	9
1010	A	8-2					¢	]	*15 |	:									8-2
1011	B	8-3	VT					$	.	#									8-3
1100	C	8-4	FF	FS		DC4	<	*	%	@									8-4
1101	D	8-5	CR	GS	ENQ	NAK	(	)	_	'									8-5
1110	E	8-6	SO	RS	ACK		+	;	>	=									8-6
1111	F	8-7	SI	US	BEL	SUB	!	^	?	"									8-7
			12				12				12	12		12	12	12		12	Zone Punches
				11				11				11	11	11		11	11	11	
					0				0		0		0	0	0		0	0	
			9	9	9	9									9	9	9	9	

Card Hole Patterns
*1, 12-0-9-8-1
*2, 12-11-9-8-1
*3, 11-0-9-8-1
*4, 12-11-0-9-8-1
*5, No Punches
*6, 12
*7, 11
*8, 12-11-0
*9, 12-0
*10, 11-0
*11, 0-8-2
*12, 0
*13, 0-1
*14, 11-0-9-1
*15, 12-11

8-14

Figure 13. EBDIC card code.

5.3.3 *Code compatibility.* The punched card reader shall sense the codes punched on a standard 80-column, 12-row card in the standard punched card code contained in FIPS PUB 14. If punched card reader cannot translate the coding sensed to the ASCII code (FIPS PUB 1), it shall transfer the sense of the coding to an external device that can translate the sensed coding into the standard line code.

5.3.4 *Interchange circuits across end instrument interface.* These standards apply to both synchronous and asynchronous equipment. The interchange functions and circuits of this section define a means of exchanging control and binary digital signals. Figure 14 shows typical end instrument interface interchange circuits for punched card readers. Interchange circuits shown in 5.3.4.1 and 5.3.4.2 may be adopted as required.

5.3.4.1 *Data ready circuit.* Signals on this circuit shall be originated by the card reader as indication that it is ready to transmit data.

5.3.4.2 *Alarm stop circuit.* Signals on this circuit shall be originated by the card reader upon detection of loss of card motion during the read time, the absence of a card in position to be read prior to transmission of an end of message sequence, a fully loaded card hopper, or an invalid character (multipunch or lack of punch).

5.3.4.3 *Operator alarm circuit.* Signals on this circuit shall advise the intermediate equipment of the existence of a condition requiring operator attention. The digital interface electrical characteristics specified in 4.10, *Digital interface electrical characteristics*, for interface signals and circuits shall apply.

5.3.4.4 *Data transfer control circuit.* Signals on this circuit shall be originated by the intermediate equipment to provide stepping control of the punched card reader in order to maintain the standard modulation rate.

5.3.4.5 *Offset stacking control circuit.* Signals on this circuit shall be originated by the intermediate equipment to cause the card reader to offset or otherwise identify the header cards of each message, a "cancel message" card, and a card containing errors.

5.3.5 *Equipment characteristics.* The physical and technical characteristics of a punched card reader are dictated by its application, while its electrical and signal characteristics are dictated by its associated digital communications equipment requirements. Accordingly, the operational relationship of the instrument with other equipment shall be a function of its intended application.

5.3.6 *Equipment performance.*

5.3.6.1 *Distortion.* Punched card readers shall not produce more than 1% M - 1% S distortion of the signal element for electronic devices and 3.5% M - 3.5% S

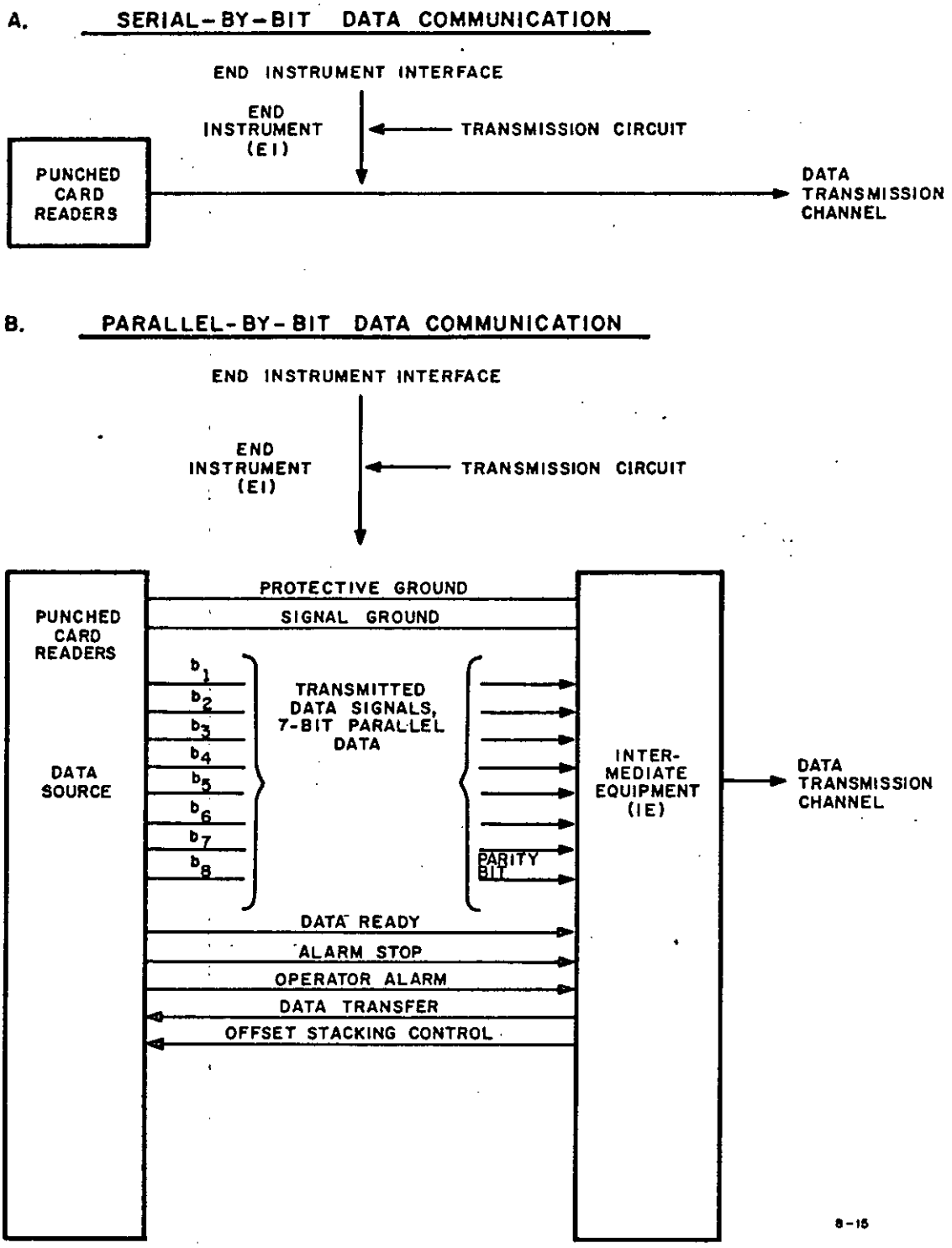


Figure 14. Typical end instrument interface interchange circuits for punched card readers.

distortion for electromechanical devices, as measured in relation to the theoretically correct unit interval duration.

5.3.6.2 *Card reading.* There are essentially two methods in reading cards: the column-by-column serial method in which the cards are moved length-wise under the reading heads; and the row-by-row parallel method in which the cards are moved in the direction of their width under the reading heads. No standards are specified at this time for the method of reading the cards. It should be noted, however, that there is an ever increasing trend in favor of the column-by-column or serial method.

5.3.6.3 *Card sensing.* Punched card readers can be classified broadly by the four methods used for sensing the information contained on punched cards: electrical contact (brush), mechanical probe, photoelectric, and pneumatic.

5.3.6.3.1 *Electrical contact method.* In the electrical contact (brush) method, the cards pass between a contact roller and a set of brushes. The cards serve as an insulator, preventing electrical contact being made between the roller and brushes. When a hole passes between the roller and brush, an electrical circuit is completed, indicating the presence of the hole.

5.3.6.3.2 *Mechanical probe method.* In the mechanical probe method, the cards pass under a set of probes which protrude through the card when a hole is present. The probe movement indicates the presence of a hole.

5.3.6.3.3 *Photoelectric method.* In the photoelectric method the card passes between a beam of light and a sensing device such as photoelectric sensor. Since the card is opaque, the light beam will not be sensed unless there is a hole in the card. When a hole is present the light sensor is activated and the presence of the hole is indicated. Advantages of this technique include reading any type of punched card, reduction in wear and tear on the card, a capacity to operate at high speeds, and to read holes whose spacing is outside the tolerance limits of mechanical readers.

5.3.6.3.4 *Pneumatic method.* In the pneumatic method, thermocouples sense whether or not a stream of air is passing through any holes in the cards. This type of reader is new and without the field experience needed to determine service requirements and reliability. There is the possibility that contamination of the sensing elements during use may reduce reliability.

5.3.6.4 *Media.* The punched card reader shall read punched cards conforming to Interim Federal Specification, G-C-00116, Card, Tabulating.

5.3.7 *Security requirements*. See paragraph 4.9, *Security requirements*.

5.4 *Card punches.* The card punch is an end instrument designed to record information on paper cards. The data signals required to activate the punch may be generated by data communications systems, an off-line keyboard, or other digital instrumentation. The standards of this section are applicable to equipment embodying a receiving selector mechanism, thus permitting the card to be perforated from either a line signal or from a keyboard. Punches are classified either as low speed, 150 and 300 bauds, or as medium and high speed, 600 and 1,200 bauds and higher. The specifications for signal characteristics, interchange circuits across the end instrument interface, equipment characteristics, and equipment performance stated in 5.4.1 through 5.4.4 below apply to low, medium and high speed units.

5.4.1 *Signal characteristics.* The digital interface electrical characteristics specified for interface signals and circuits in 4.10, *Digital interface electrical characteristics*, shall apply.

5.4.1.1 *Coded character set.* The standard coded character set shall be as specified in 4.4, *Standard coded character set*.

5.4.1.2 *Character interval.* The standard character interval shall be as specified in 4.4.1, *Basic code*, and 4.5, *Character interval, standard coded character set*.

5.4.1.3 *Card code structure.* The card code structure shall be as specified in 5.3.2.2, *Code card structure*.

5.4.1.4 *Code compatibility.* The card punch shall use the Hollerith punched card code as specified in FIPS PUB 14. Data presented to the card punch in the form of the ASCII code shall be translated to the Hollerith code. Translation may be accomplished internally or externally to the card punch.

5.4.1.5 *Modulation rate.* The standard modulation rate requirement at the end instrument interface shall be as specified in 5.3.1.2, *Modulation rate*.

5.4.2 *Interchange circuits across the end instrument interface.* The interchange circuits given in this section define a means of exchanging control and binary data signals. They are to be regarded as basic (or minimal) ones and are to be supplemented as needed (fig. 15).

5.4.2.1 *Received data signals.* Signals on these circuits are transmitted by the intermediate equipment to the card punch.

5.4.2.2 *Information transfer.* Typically the transfer of information from the intermediate equipment across the card punch interface shall be on a bit-parallel, character-serial basis.

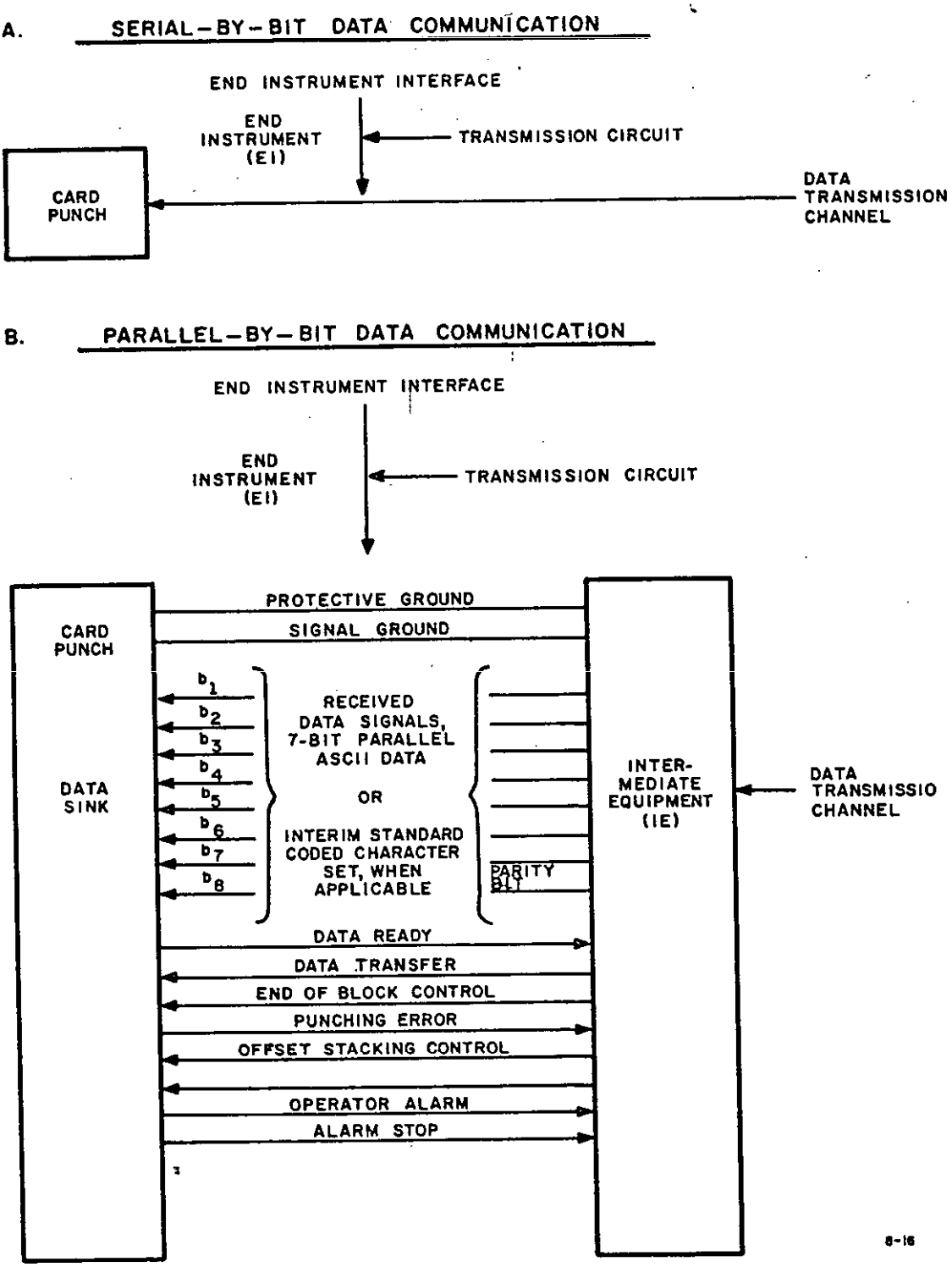


Figure 15. Typical end instrument interface interchange circuits for card punches.

5.4.2.3 *Punch ready circuit.* Signals on this circuit originate from the card punch and indicate that the punch is prepared to receive data from the intermediate equipment.

5.4.2.4 *Data transfer control circuit.* Signals on this circuit are originated by the intermediate equipment to provide stepping control of the card punch in order to maintain the standard modulation rate.

5.4.2.5 *End of block control circuit.* Signals on this circuit originate from the intermediate equipment and indicate that the end of the block has been reached.

5.4.2.6 *Punching error control circuit.* Signals on this circuit originate from the card punch when a punching error is detected.

5.4.2.7 *Offset stacking control circuit.* Signals on this circuit originate from the intermediate equipment and instruct the card punch to offset stack or otherwise identify selected cards (*e.g.*, message header, cancel message, card in error).

5.4.2.8 *Operator alarm circuit.* Signals on this circuit originate from the card punch when a condition exists that requires operator attention (*e.g.*, low card supply).

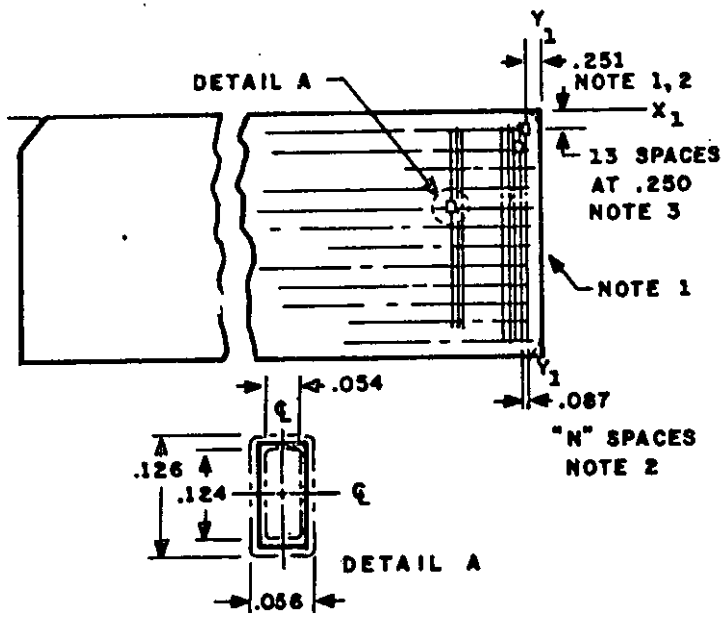
5.4.2.9 *Alarm stop circuit.* Signals are originated by the EI equipment upon detection of card motion during the punch time, the absence of a card in position to be punched, or a fully loaded card stacker.

5.4.3 *Equipment characteristics.* The physical and technical characteristics of the card punch are dictated by its application, while its electrical and signaling characteristics are dictated by the associated DCE requirements.

5.4.4 *Equipment performance.*

5.4.4.1 *Card punching.* The card punch shall record the incoming information signals on paper cards in the form of punched holes (fig. 16), as required by FIPS PUB 13. Card punches generally are not classified as column-by-column or row-by-row punches, even though they may fall into these categories. Most card punches operate on a row-by-row parallel basis, which requires 80 punching dies and a total of 12 punches per card. Column-by-column or serial card punches require 12 punching dies and a total of 80 punches per card.

5.4.4.2 *Card code structure.* Because of the widespread and predominant use of the 80-column, 12-row card using the Hollerith card code structure, the standard card code structure shall be the Hollerith code (fig. 11) as required by FIPS PUB 14.



HOLE SIZE AND LOCATION

NOTES:

(1) Y-Y IS PERPENDICULAR TO X—X AND INTERSECTS THE MID-POINT OF RIGHT EDGE OF CARD.

(2) VERTICAL CENTERLINE OF HOLES MAY VARY +0.010 FROM Y—Y AT TIME OF PUNCHING (SEE 2.2.3.2) AND +0.018 AT TIME OF READING.

(3) HORIZONTAL CENTERLINE OF HOLES MAY VARY +0.010 FROM X—X AT TIME OF PUNCHING (SEE 2.2.3.2) AND +0.018 AT TIME OF READING.

8-17

Figure 16. Data card hole dimensions.

5.4.4.3 *Code translation.* The card punch shall translate the input standard coded character set to the Hollerith code (fig. 11). The code translation may be accomplished internally bv the card punch, or by an external device.

5.4.4.4 *Card printing.* The card punch module shall print the selected punched characters on the card at a speed determined by the standard modulation rates (low speed only).

5.4.4.5 *Off-line mode.* The card punch module shall operate off-line in conjunction with the keyboard in the preparation of punched cards (low speed only).

5.4.4.6 *Media.* The card punch shall record information on cards conforming to Interim Federal Specification G-C-00116, Card, Tabulating.

5.4.5 *Security requirements*. See paragraph 4.9, *Security requirements*.

5.5 *Magnetic tape readers/recorders.* The standard defined in this section are applicable to block and incremental magnetic readers/recorders and to magnetic tapes and reels. Standards for both 800 CPI, NRZI (characters per inch, nonreturn to zero-change on one) and 1600 CPI, PE (phase encoded) recording techniques are defined.

5.5.1 *References.* Federal Information Processing Standards Publication 3 (FIPS PUB 3) has adopted the American National Standards Institute (ANSI) X3.22-1967 in its entirety. Reference will be made to the below documents throughout this standard.

(a) FIPS PUB 1, Code for Information Interchange.

(b) FIPS PUB 3, Recorded Magnetic Tape for Information Interchange (800 CPI, NRZI).

5.5.2 *Physical characteristics.* Magnetic tape units which include mechanical, electronic, and electrical subsystems vary considerably in performance, size, weight and packaging. Standardization of physical characteristics is not appropriate at this time.

5.5.3 *Performance characteristics.* The block magnetic tape unit operates in a start-stop mode, recording or reading entire blocks in one operation from start to stop of tape motion. The incremental magnetic tape unit records information on tape in one character increments with the tape advancing one character interval per start-stop action. The incremental magnetic tape unit reads information in one

block increments as does the block magnetic tape unit. Both block and incremental magnetic tape units record blocks which shall be a minimum of 18 characters and a maximum of 2,048 characters in length.

5.5.3.1 *Tape speed rates.* The majority of block recorders currently available advance the tape at speeds between 37.5 and 200 inches per second. Every effort should be made to standardize on three speeds between the above boundaries. As a design objective, the speeds shall be 75, 150, or 200 inches per second. The employment of incremental recorders in terminal type configurations has increased at a rapid rate coincident with the growth in applications of minicomputers. These recorders are inexpensive but effective in asynchronous operations. Stepping rates vary between 50 and 500 steps per second. As a design objective the speed (stepping rates) shall be 300 steps per second.

5.5.3.2 *Codes/formats/character sets.* The standard code shall be the ASCII as specified in FIPS PUB 1. Two formats are specified for this standard as follows:

(a) Nine track, 800 CPI, NRZI as specified in 5 and 6, FIPS PUB 3.

(b) Nine track, 1,600 CPI, PE. An ANSI standard is being developed but has not been published as of this date. Upon adoption by FIPS, the 1,600 CPI, PE standard will be adopted for this standard. The formats are basically the same, except as follows:

(1) The longitudinal redundancy check character and cyclic redundancy check character are deleted for the 1,600 CPI recordings.

(2) The tape blocks begin and end with a series of 41 synchronization characters for the 1,600 CPI recordings.

5.5.3.3 *Media.* The physical characteristics of tape reels and magnetic tape for use with magnetic tape units shall be in accordance with FIPS PUB 3, which is adopted for this standard.

5.5.3.4 *Controls.* Controls may be divided into three areas of consideration, as follows:

(a) Front panel operator controls.

(b) Electrical signal controls.

(c) Operation/mechanical controls.

5.5.3.4.1 *Front panel operator controls.* Front panel operator controls shall make provision for:

(a) Disabling of servo system in order that tapes may be loaded and unloaded.

(b) Rewind of tape to load point marker.

(c) Selection of tape unit control from either a remote source (intermediate equipment) or operator control panel (lockout).

5.5.3.4.2 *Electrical signal controls.* Electrical signal controls are discussed in detail in 5.5.5.2, *Controls*.

5.5.3.4.3 *Operation/mechanical controls.* Operation/mechanical controls shall make provision for:

(a) File protection through insertion or deletion of a file protect ring in the tape reel.

(b) Insertion of the ring allows information to be recorded or read on the tape.

(c) Deletion of the ring allows read only.

5.5.3.5 *Indicators.* Visual indicators shall be provided to indicate:

(a) Unit ready.

(b) File protect.

(c) Tape indicate.

5.5.3.5.1 *Unit ready indicator.* The unit ready indicator shall signify that the magnetic tape is loaded properly, the servo system has positioned the tape and is operating correctly, and the magnetic tape unit is ready to receive commands.

5.5.3.5.2 *File protect indicator.* The file protect indicator shall signify that the file protect ring is not positioned in the tape reel.

5.5.3.5.3 *Tape indicate light.* The tape indicate light shall signify that the end of the tape marker has been sensed.

5.5.3.6 *Error/fault conditions.* The following checks shall be provided with errors indicated by electrical signal. Visual indicators may be provided in addition to the electrical signals.

(a) Vertical parity check.

(b) Echo check.

(c) Rate check (block recorders only).

(d) Longitudinal redundancy check (NRZI only).

(e) Cyclic redundancy check (NRZI only).

(f) Envelope check (PE only).

5.5.3.6.1 *Vertical parity check.* Vertical parity shall be checked during both record and read operations. Vertical parity checking shall be provided for both odd and even parity.

5.5.3.6.2 *Echo check.* Echo checks are conducted during the recording operations and are read checks to verify that data has been recorded as intended (example: read after write).

5.5.3.6.3 *Rate check.* Rate checks for block recorders are made to determine whether or not characters are transferred and recorded at the proper rate. This ensures proper tape packing density. Rate check errors may reflect possible dropped characters in a block being recorded. Rate checks are not applicable with incremental recorders because data are recorded in a psuedo-asynchronous mode.

5.5.3.6.4 *Longitudinal redundancy and cyclic redundancy checks.* Longitudinal redundancy and cyclic redundancy checks are described in detail in FIPS PUB 3. These two checks are used in NRZI recordings only.

5.5.3.6.5 *Envelope check.* The envelope check is used in phase encoded recording. The check is a measure of signal magnitude from the reproduce electronics of the magnetic tape unit. Low reproduce signal amplitude often indicates an error condition which may require action changes in the software or hardware.

5.5.4 *Maintenance characteristics.* The majority of failures encountered in magnetic tape units are in the mechanical portion of the unit. Further, servo systems for advancing and handling the magnetic tape are complex and difficult to maintain. Tape units which employ the pinch roller technique for tape motion are unreliable and shall be considered only for low tape speeds. Every effort shall be made to simplify the mechanical subsystems. Mechanical portions of the unit shall be modular to facilitate maintenance and repairs. Electronic and electrical subsystems also shall be modular and packaged for ease of replacement and alignment.

5.5.5 *Electrical characteristics.*

5.5.5.1 *Data signals/transfer rates.* The transfer of information (data bits) shall be on a bit-parallel, character-serial basis for both record and read. A clock signal from the intermediate equipment shall accompany each data character as it is transferred to the magnetic tape unit in the record mode. The transfer rate shall be checked by the rate check (see 5.5.3.6.3, *Rate check*). During the read mode the magnetic tape unit shall deliver a clock signal to the intermediate equipment. The transfer rate during read is not checked. Since tape speeds have not been specified, transfer rates cannot be specified at this time.

5.5.5.2 *Controls.* The control circuitry is used for tape unit status, error alarms, transport commands, and electronic subsystems control. The control circuits shall include:

(a) Forward.

(b) Reverse.

(c) Rewind.

(d) Record.

(e) Read.

(f) Unit ready.

(g) File protect.

(h) Tape indicate.

(i) Load point.

(j) Error alarm.

(k) Unit select.

(l) Remote/local.

5.5.5.2.1 *Forward control.* The forward control shall advance the tape toward the end of tape marker at the speeds indicated in 5.5.3.1, *Tape speed rates*. Record or read shall be performed in the forward mode.

5.5.5.2.2 *Reverse control.* The reverse control shall advance the tape toward the load point marker at the same speed as the forward command. Only the read function is required in the reverse mode. The requirement for reverse mode is optional in low performance recorders.

5.5.5.2.3 *Rewind control.* The rewind control shall advance the tape to the load point marker at high speed. Neither record nor read is permitted in this mode.

5.5.5.2.4 *Record control.* The record control shall instruct the electronic subsystem that data are to be recorded.

5.5.5.2.5 *Read control.* The read control shall instruct the electronic subsystem that data are to be read from the tape. Skew compensation shall be provided as an integral part of the read electronics. For 800 CPI, the skew compensation shall determine accurately characters which are misaligned to the maximum extent outlined in FIPS PUB 3. For 1,600 CPI, the ratio 1:2 shall be specified in equipment procurement.

5.5.5.2.6 *Unit ready control.* The unit ready control shall indicate to the intermediate equipment that all functions described in 5.5.3.5.1, *Unit ready indicator*, have been performed.

5.5.5.2.7 *File protect control.* The file protect control shall indicate to the intermediate unit the presence or absence of the file protect ring.

5.5.5.2.8 *Tape indicate control.* The tape indicate control shall signify to the intermediate equipment that the end of tape marker has been sensed.

5.5.5.2.9 *Load point control.* The load point control shall indicate to the intermediate equipment that the load point marker has been sensed.

5.5.5.2.10 *Error alarm control.* The error alarm control shall indicate to the intermediate equipment that one or more of the errors discussed in 5.5.3.6, *Error/fault conditions*, have been detected. This signal does not preclude the use of individual signals to indicate each of the errors discussed in 5.5.3.6, *Error/fault conditions*.

5.5.5.2.11 *Unit select control.* The unit select control shall be activated from the intermediate unit before any tape operations may begin.

5.5.5.2.12 *Remote/local control.* The remote/local control shall indicate the status of the operator control outlined in 5.5.3.4.1(c), *Front panel operator controls*.

5.5.6 *Security requirements.* See paragraph 4.9, *Security requirements.*

5.6 *Paper tape readers.* The function of paper tape readers is to provide an electrical output corresponding to the information contained on the paper tape. Paper tape readers are classified as low speed (below 20 characters/second) and high speed (above 20 characters/second). Low speed paper tape readers shall operate at speeds in characters per second corresponding to the preferred modulation rates of 50, 75 and 150 bauds when connected to the intermediate equipment. For high speed paper tape readers, the preferred modulation rates shall be 300, 600, 1,200 and 2,400 bauds. One-inch paper tape readers shall read either 5-level or 8-level code. The following requirements apply to both low speed and high speed units, except for 5.6.2.3, *Reader ready circuit*; 5.6.2.4, *Alarm stop circuit*; 5.6.2.5, *Operator alarm circuit*; 5.6.2.6, *Data transfer control circuit*; 5.6.2.7, *Alarm stop condition*; and 5.6.2.2, *Electrical signal characteristics*, which apply to high speed only.

5.6.1 *Signal characteristics.* The digital interface electrical characteristics specified for interface signals and circuits in 4.10, *Digital interface electrical characteristics*, shall apply.

5.6.1.1 *Coded character set.* The standard coded character set shall be the standard 7-unit ASCII code as specified in 4.4, *Standard code for information interchange.* However, because of the widespread use of 5-unit, start-stop equipment, the interim standard coded character set ITA-2 shall be used for the equipment presently in existence and for modifications or additions to existing equipment where it is impractical or impossible to use the standard code. The standard 7-unit ASCII set shall be used for new equipment.

5.6.1.2 *Synchronization.* The paper tape reader shall operate in either the synchronous or asynchronous mode.

5.6.2 *Interchange circuits across the end instrument interface.* These standards apply to both synchronous and asynchronous operational equipment. The interchange functions and circuits of this section define a means of exchanging control and binary data signals. They are to be regarded as basic (or minimal) ones, being supplemented as needed (fig. 17).

5.6.2.1 *Information transfer*. Typically the transfer of information across the tape reader interface shall be on a bit-parallel, character-serial basis.

5.6.2.2 *Electrical signal characteristics.* The digital interface electrical characteristics specified in 4.10, *Digital interface electrical characteristics*, for interface signals and circuits shall apply.

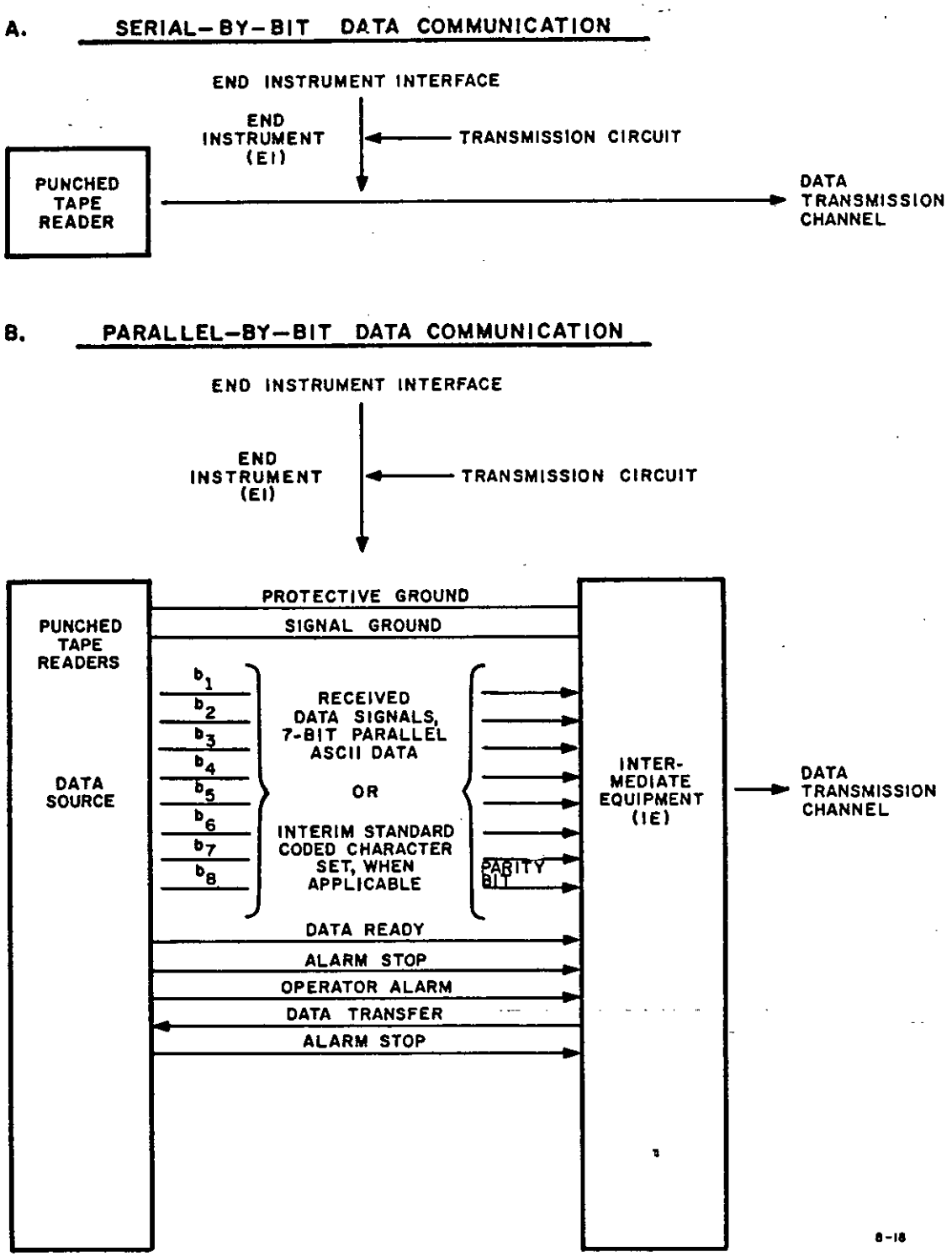


Figure 17. Typical end instrument interface interchange circuits for punched tape readers.

5.6.2.3 *Reader ready circuit.* Signals on this circuit are originated by the tape reader as an indication that it is ready to transmit data.

5.6.2.4 *Alarm stop circuit.* Signals on this circuit are originated by the tape reader upon detection of a "tape out" or "tight tape" or "loss of tape" or "tape not in motion" condition and sent to the intermediate equipment.

5.6.2.5 *Operator alarm circuit.* The signals on this circuit advise the intermediate equipment of the existence of a condition requiring operator attention such as "tape out," "tight tape," "loss of tape," or "tape not in motion."

5.6.2.6 *Data transfer control circuit.* Signals on this circuit are originated by the intermediate equipment to provide stepping control of the tape reader in order to maintain the standard modulation rate.

5.6.2.7 *Alarm stop condition.* The intermediate equipment on receipt of an "alarm stop" condition signal as specified in 5.6.2.5, *Operator alarm circuit,* shall initiate an operator alarm and shall stop the tape reader. When manual intervention is necessary the tape reader shall be stopped by a signal condition on the data transfer control circuit.

5.6.3 *Equipment characteristics.* The physical and technical characteristics of a tape reader are dictated by its application, while its electrical and signaling characteristics are dictated by its associated subscriber terminal equipment requirements. Accordingly, the operational relationship of the instrument with other equipment shall be a function of its intended application.

5.6.4 *Equipment performance.*

5.6.4.1 *Distortion.* The distortion percentages in this paragraph are applicable at the standard modulation rates. For electromechanical equipment, the total output distortion (including bias, fortuitous, cyclic, or characteristic) shall not exceed 3% M - 3% S. The total output distortion shall not exceed 1% M - 1% S for equipment incorporating electronic output circuitry.

5.6.4.2 *Tape sensing.* Coincident selection readers, in which all hole sensor mechanisms of the tape reader sense the tape simultaneously, is the preferred method of sensing. However, sequential selection readers, in which the hole sensor mechanisms are successively presented to the tape to determine the presence or absence of a hole, are permitted. Tape readers shall sense the tape without mutilating it in the process.

5.6.4.2.1 *Mechanical readers.* Mechanical readers are provided with sensing pins, in number equal to the number of levels in the code. When the tape is stationary,

the sensing pins press against it and, if holes are present, one or more pins will pass through permitting an associated contact assembly to operate and thereby establish an electrical contact. Mechanical readers are used to read all types of punched tape, including both chad tapes (where the hole or chad is punched completely out of the tape) and chadless tapes (where the hole is only partially punched out of the tape). Mechanical readers are relatively inexpensive and reliable, particularly in the sensing of holes which may be obscured by loose chads, dirt, or lint. The limiting performance factors are reading speed and tape wear. Sensing can be accomplished by spring loaded pins, star wheels, brushes, or similar techniques.

5.6.4.2.2 *Pneumatic readers.* Pneumatic readers operate by passing streams of air through holes in the tapes. Thermocouples sense whether or not air is passing through a tape hole. Advantages of this technique include reading any type of punched tape, reduction in wear and tear on the tape, a capacity to operate at high speeds, and the ability to read holes whose spacing is outside the tolerance limits of mechanical readers. This type of reader is still new and without the field experience needed to determine service requirements and reliability. There is the possibility that contamination of the thermocouple sensing elements during use may reduce reliability.

5.6.4.2.3 *Photoelectric readers.* The primary advantage of photoelectric readers is their capacity to operate at high speeds. Practically all photoelectric readers employ friction drives rather than the sprocket wheel drives used in mechanical and pneumatic readers. As the operating speed is increased, the tape drive mechanism fails before the photoelectric sensor. Current photoelectric readers employ silicon cells rather than photovoltaic cells. Reliability is thus improved, since the photovoltaic cells require a warmup period for efficient functioning and apparently are not able to distinguish a hole from a no-hole condition until after this period.

5.6.4.2.3.1 *Transmitted light readers.* Transmitted light photoelectric tape readers are designed with the light source and sensor on opposite sides of the tape. The signal-to-noise ratio is, therefore, the ratio between the response of the photocell to the full intensity of the light source and the light passing through the tape. It is virtually impossible for photoelectric readers to read chadless tape. Translucent tapes also pose a problem to transmitted light photoelectric readers, since they find it progressively more difficult to discriminate between hole and no-hole as tape opacity diminsishes. Oil impregnation of tape (used to lengthen tape punch life) reduces opacity and may reduce the signal-to-noise ratio below the level required for reliable operation.

5.6.4.2.3.2 *Reflected light readers.* Reflected light photoelectric tape readers are designed with the light source and the photoelectric sensors on the same side of the tape. The signal-to-noise ratio in this case is the ratio of the response to the

change in reflected light between the hole and no-hole conditions. On printed tape, this is the difference between the response to the coded black spots and the white background of the tape. With punched tape, a flat, nonreflecting surface is used behind the holes, thus providing artificial black spots. Reflected light readers have had difficulty in discriminating between black dots, coded holes, and dirty tape marks.

5.6.4.2.4 *Dielectric sensing readers.* In dielectric sensing readers, the punched tape forms the dielectric of a capacitor whose capacitance is changed as a hole passes the read station. Unlike photocell sensors, dielectric readers are insensitive to environmental dust and low-quality paper. Since lamps and photocells are not used, there is no problem of long-term drift and aging.

5.6.4.3 *Perforated paper tape.* Perforated paper tape with fully punched round holes (chadded) shall have either five or eight information tracks, with a hole representing a "mark" or "one" and no-hole represents a "space" or "zero" (fig. 18; FIPS PUB's 2, 18 and 19).

5.6.5 *Security requirements*. See paragraph 4.9, *Security requirements*.

5.7 *Paper tape punches.* The paper tape punch is an end instrument designed for the recording of information on punched paper tape. The drive pulses required to activate the punch may be furnished by a typewriter keyboard, data communications circuits, or other digital instrumentation. Hence, some configurations comprise a completely self-contained punch system with alphanumeric keyboard, while other tape punched layouts are designed to operate from signals coming from outside sources. The standards of this section are applicable to equipment embodying a receiving selector mechanism that permits the perforation of a tape from a line signal, which passes through the intermediate equipment, or from a keyboard.

5.7.1 *Signal characteristics.* The digital interface electrical characteristics specified for interface signals and circuits in 4.10, *Digital interface electrical characteristics*, shall apply.

5.7.1.1 *Coded character set.* The standard coded character set shall be the standard 7-unit coded as specified in 4.4, *Standard code for information interchange.*

5.7.1.2 *Character interval.* The standard character interval shall be the same as specified in 4.5, *Character interval, standard coded character set.*

5.7.1.3 *Modulation rates.* The standard modulation rate requirements of the tape punch interface are specified in 4.2, *Modulation and data signaling rates.*

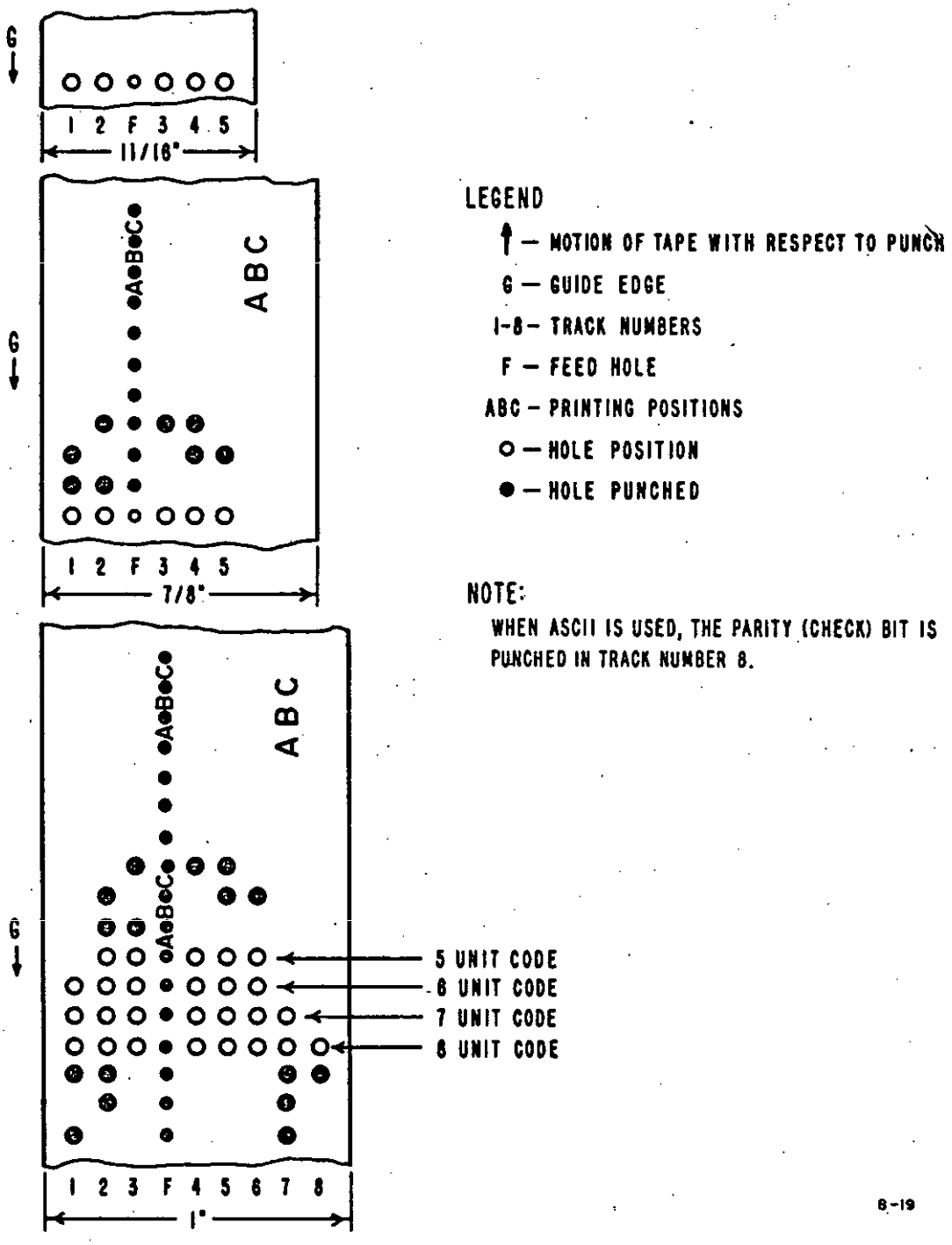


Figure 18. Standard printing and punching plan for paper tape.

5.7.1.4 *Synchronization.* The receiving devices operate in either the synchronous or asynchronous mode.

5.7.2 *Interchange circuits across the end instrument interface.* These standards apply to both synchronous and asynchronous equipment. The interchange functions and circuits of this section define a means of exchanging control and digital signals. They are to be regarded as basic (or minimal) ones (fig. 19). The interchange functions and circuits may be supplemented as needed.

5.7.2.1 *Information transfer.* The transfer of information from the intermediate equipment shall be on a bit-parallel, character-serial basis representing the standard ASCII coded character set.

5.7.2.2 *Signal condition.* The marking or spacing signal condition shall be held for the total duration of each signal element.

5.7.2.3 *Electrical signal characteristics.* The requirements of 4.10, *Digital interface electrical characteristics*, shall apply to the interface between the intermediate equipment and the tape punch, and to the interface between the keyboard and the tape punch. These standards also apply to interface signals and circuits.

5.7.2.4 *Data ready circuit.* Signals on this circuit shall originate from the tape punch as an indication to the intermediate equipment that it is ready to operate (*i.e.*, prepared to receive data).

5.7.2.5 *Alarm stop circuit.* Signals shall originate from the tape punch upon detection of an "out-of-tape" condition, and shall be provided to the intermediate equipment to indicate this condition.

5.7.2.6 *Operator alarm circuit.* This circuit shall be used only to indicate to the intermediate equipment that a low tape supply exists and requires an operator's attention.

5.7.2.7 *Data transfer control circuit.* Signals on this circuit shall be originated by the intermediate equipment to provide stepping control of the tape punch in order to maintain the standard modulation rate.

5.7.2.8 *Punching error circuit.* Signals on this circuit shall be originated by the tape punch upon detection of a punching error. The tape punch shall verify and identify correct punch operation on a character-by-character basis within one character interval after a character is punched.

5.7.2.9 *Tape feedout control circuit.* This circuit shall be used only by the intermediate equipment to cause the tape punch to feed out an adjustable amount of blank tape up to a maximum of 18 inches following the "end of message"

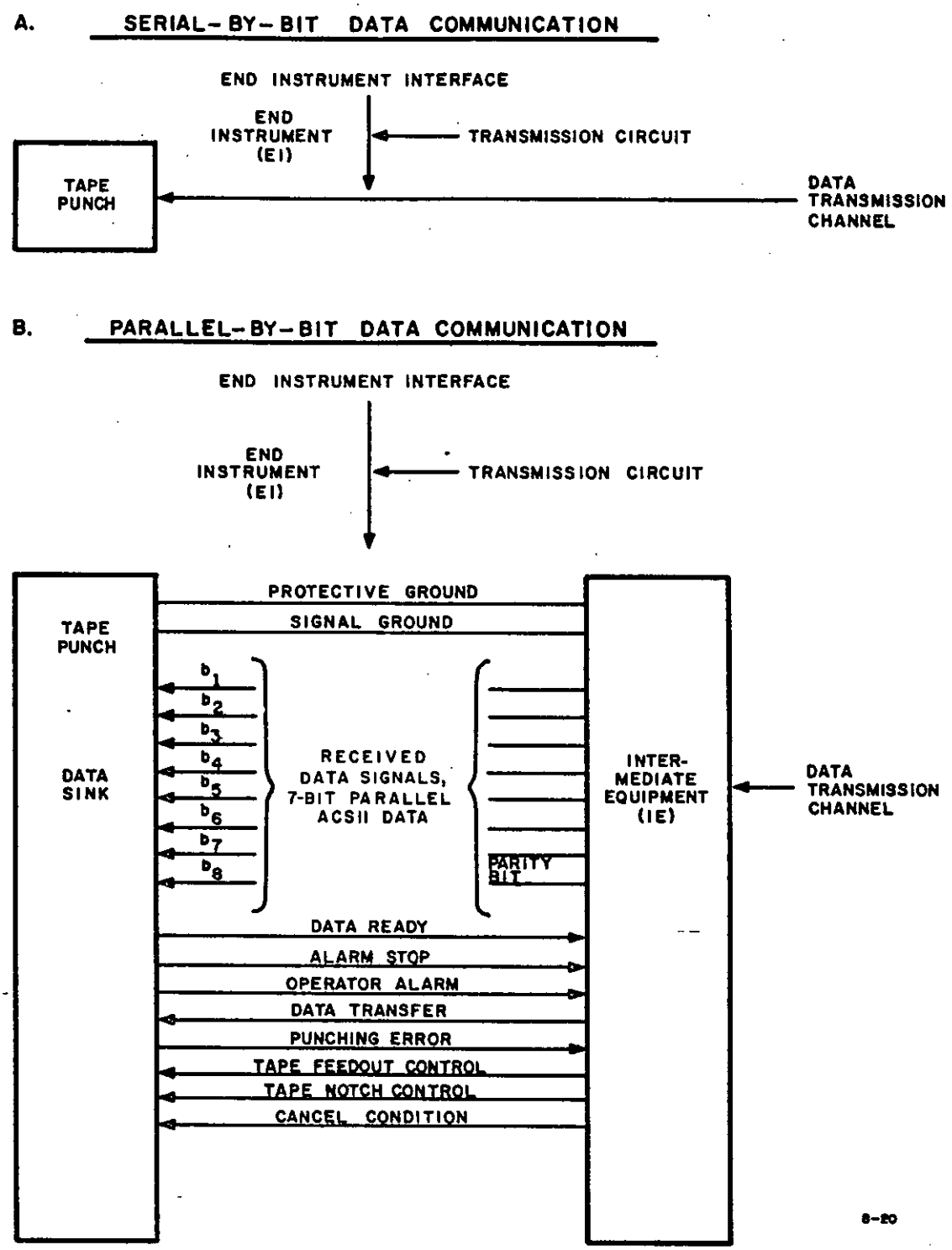


Figure 19. Typical end instrument interface interchange circuits for tape punches.

to provide separation between messages. The start of a new message shall cause the feeding of blank tape to stop after a minimum of 10 blanks have been fed out.

5.7.2.10 *Tape notch control circuit.* This circuit shall be used by the intermediate equipment to notch the tape during one character interval upon detection of a punching error. The tape shall be notched within two character intervals after a character is punched.

5.7.2.11 *Cancel condition circuit.* The signal on this circuit shall cause the tape to be notched three times, corresponding to three consecutive intervals, when a "cancel" (CNCL) indication is received.

5.7.3 *Equipment characteristics.* The physical and technical characteristics of the tape punch are dictated by its application, while its electrical and signaling characteristics are dictated by its associated subscriber terminal equipment requirements. Accordingly, the operational relationship of the instrument with other equipment shall be a function of its intended application.

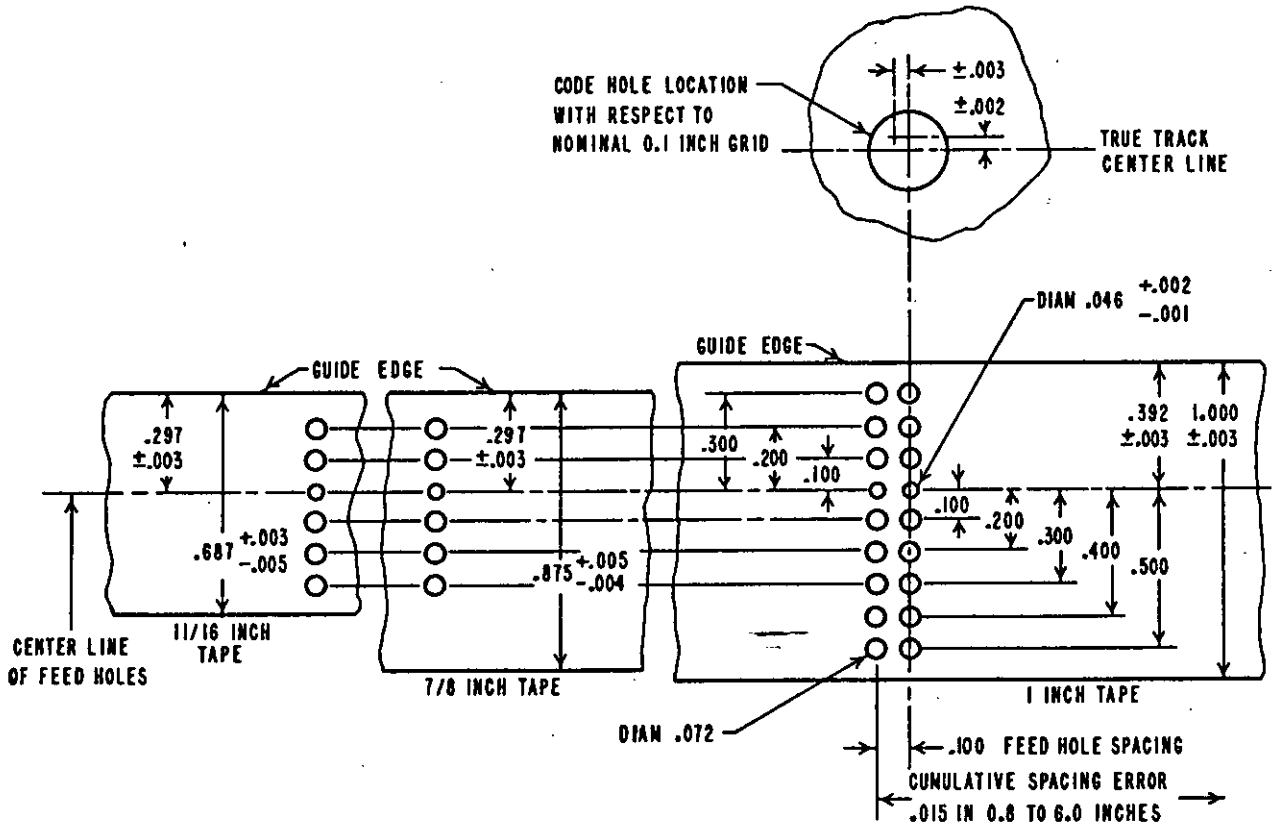
5.7.4 *Equipment performance.*

5.7.4.1 *Distortion.* The distortion percentages specified are applicable at the standard modulation rates. With electromechanical equipment incorporating electronic serial input circuitry, the punch shall operate without error if the input distortion is equal to or less than the following:

Distortion	Mark (%)	Space (%)
Switched bias	45	45
Bias	45	45
End	45	45
Cyclic	24.5	24.5

5.7.4.2 *Tape punching.* The paper tape punch shall record the incoming information signals on paper tape as punched round holes (chadded)/no-holes in columns across the tape (fig. 20).

5.7.4.3 *Character printing.* The tape punch module shall have the option of printing the selected punched characters on the tape at the standard modulation rates. A printed character may be displaced by not more than 8-character intervals from its punched position on the tape.



NOTES
1—UNLESS OTHERWISE INDICATED ALL TOLERANCES ARE ±.002

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Figure 20. Punching standard for paper tapes.

5.7.4.4 *Off-line operation.* The tape punch module shall permit the off-line preparation of punched paper tape by using the keyboard.

5.7.4.5 *Takeup reel.* The tape punch module shall have a 10.5-inch diameter tape takeup reel.

5.7.4.6 *Perforated paper tape.* The standard for chadded perforated paper tape is described in 5.6.4.3, *Perforated paper tape.*

5.7.5 *Security requirements.* See paragraph 4.9, *Security requirements.*

5.8 *Low speed page printers.* This section deals with the performance standards of low speed page printers operating at modulation rates of 150 bauds and below. Intermediate equipment is required for the operation of this printer.

5.8.1 *Printer speed/modulation rates.* The low speed page printer shall operate at the modulation rates as specified in 4.2, *Modulation and data signaling rates.* The modulation rates shall be 50 75, and 150 bauds.

5.8.2 *Codes/formats/character sets.*

5.8.2.1 *Coded character set.* The standard coded character set shall be the ASCII as specified in 4.4, *Standard code for information interchange.*

5.8.2.2 *Character interval.* The standard character interval shall be the same as that specified in 4.4.1, *Basic code,* and 4.5, *Character interval, standard coded character set.*

5.8.3 *Media.*

5.8.3.1 *Paper type.* The page printer shall print on roll paper or fanfold paper in accordance with 5.2.14, *Paper rolls,* and 5.2.15, *Fanfold forms.*

5.8.3.2 *Paper handling.* The page printer shall handle single or multiple ply paper, without jamming, from rolls or fanfold supply. The paper shall be advanced by means of sprocket or friction feed.

5.8.3.3 *Character spacing and line capacity.* The page printer shall print 10 characters per inch horizontally, six lines per inch vertically, and up to 80 characters per line.

5.8.3.4 *Printing.* The page printer shall print the selected characters of the applicable coded character set. The page printer shall produce a minimum of an original and four legible copies. The type font shall be Gothic.

5.8.3.5 *Paper supply.* The paper supply shall be from rolls or fanfold, and the page printer shall store one full (5-inch) roll or a minimum of 1,500 feet of fanfold paper.

5.8.3.6 *Low paper condition.* The page printer shall detect when the paper supply has diminished to a 5-minute supply and shall provide a signal to the intermediate equipment to indicate this condition (see 5.8.7.3.3, *Operator alarm circuit*).

5.8.3.7 *Out of paper condition.* The page printer shall detect an "out of paper" condition and shall provide a signal to the intermediate equipment to indicate this condition (see 5.8.7.3.4, *Alarm stop circuit*).

5.8.4 *Format requirements.* As a minimum, the page printer shall perform functions indicated by the following format requirements when received from the intermediate equipment.

5.8.4.1 *SP (space).* Controls the movement of the printing position, one printing position forward at a time.

5.8.4.2 *HT (horizontal tabulation).* Controls the movement of the printing position to the next in a series of predetermined positions along a printing line.

5.8.4.3 *LF (line feed).* Controls the movement of the printing position to the next line.

5.8.4.4 *VT (vertical tabulation).* Controls the movement of the printing position to the next in a series of predetermined printing lines.

5.8.4.5 *CR (carriage return).* Controls the movement of the printing position to the first printing position on the same printing line.

5.8.5 *Format effector control signals.* As a minimum, the page printer, when used to monitor card reception, shall recognize the following format effector control signals when received from the intermediate equipment, and perform the functions described.

5.8.6 *Controls and indicators.* The page printer shall include the following controls and indicators:

(a) Power on/off switch and an associated indicator.

(b) Local CR (carriage return) control.

(c) Local LF (line feed) control.

(d) Indicator to show that a low paper supply condition exists. This indicator shall be activated by the signal described in 5.8.3.6, *Low paper condition.*

5.8.7 *Electrical characteristics.*

5.8.7.1 *Synchronization.* The low-speed page printer shall operate in the character synchronous mode.

5.8.7.2 *Page printer interface.* Interchange functions and circuits provide a means of exchanging control and binary digital signals. The interchange circuits described below are to be regarded as basic (or minimal) ones, and may be supplemented as needed (fig. 21).

5.8.7.2.1 *Electrical signal characteristics.* The digital interface electrical characteristics specified in 4.10, *Digital interface electrical characteristics,* for interface signals and circuits are applicable to this requirement.

5.8.7.2.2 *Received data circuit signals.* Signals on these circuits shall be transmitted by the intermediate equipment to the page printer.

5.8.7.2.3 *Information transfer.* Typically, the transfer of information from intermediate equipment to the end instrument interface shall be on a bit-parallel, character-serial basis representing the standard ASCII coded character set.

5.8.7.2.4 *Signal condition.* The marking or spacing signal conditions shall be held for the total duration of each signal element.

5.8.7.3 *Control circuit signals.*

5.8.7.3.1 *Printer ready circuit.* Signals on this circuit shall originate from the page printer and indicate that the page printer is prepared to receive data from the intermediate equipment.

5.8.7.3.2 *Data transfer control circuit.* Signals on this circuit shall be originated by the intermediate equipment to provide stepping control of the page printer in order to maintain the standard modulation rates.

5.8.7.3.3 *Operator alarm circuit.* Signals on this circuit shall originate from the page printer when a condition exists that requires operator attention, *e.g.*, low-paper supply.

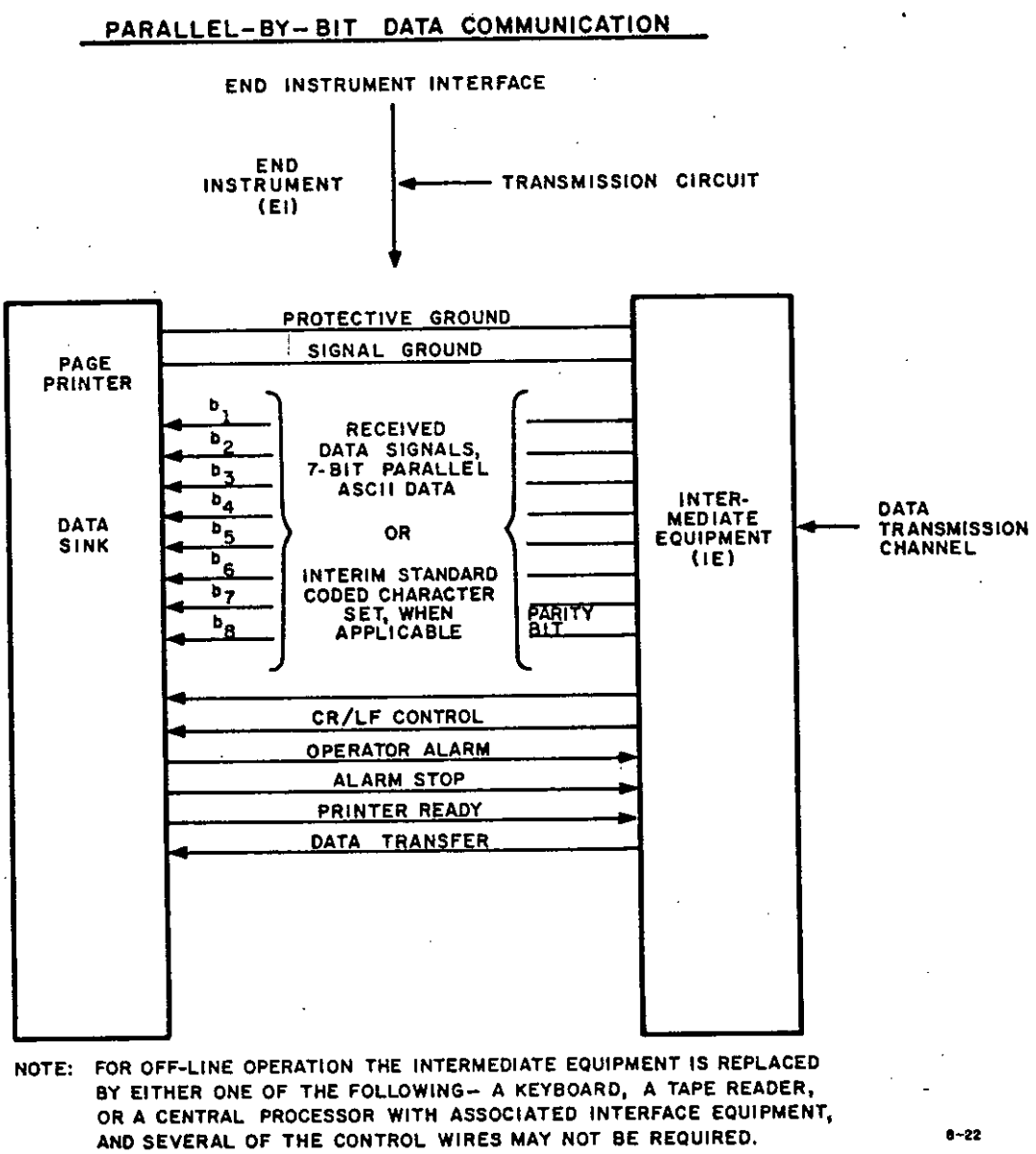


Figure 21. Typical end instrument interface interchange circuits for page printers.

5.8.7.3.4 *Alarm stop circuit.* Signals on this circuit originate from the page printer when a condition exists that requires operator attention, *e.g.*, "out of paper". Upon receipt of the "alarm stop" condition, the intermediate equipment shall initiate an operator alarm and stop the page printer by means of a signal condition on the data transfer control circuit.

5.8.8 *Optional configurations.* The low speed page printer may be configured to provide additional functions. See note in figure 21.

5.8.9 *Security requirements.* See paragraph 4.9, *Security requirements*.

5.9 *High speed line printers.* High speed line printers may be classified as either impact or nonimpact types. Impact printers operate by means of a series of print hammers which strike a ribbon and paper to print selectable data characters. Nonimpact printers operate by means of various photographic or graphic techniques to produce data characters on film or special paper.

5.9.1 *Impact printers.* The three basic types of impact printers are drum, chain, and bar. Some advantages impact printers offer over nonimpact printers are better print quality, simpler control circuits, multiple copy output (up to six copies), no associated odors, less radio frequency interference, and lower paper cost. A general description of the operational and technical characteristics of impact high speed line printers follows in 5.9.1.1 through 5.9.1.3 below.

5.9.1.1 *Drum printers.* Drum printers are by far the most popular type of high-speed line printers. They will print at speeds from 300 to 1,200 lines per minute. Drum printers feature a rapidly rotating drum with as many complete character sets as there are print columns (12 to 160). A complete character set shall consist of 64 alphanumeric and special characters as required by FIPS PUB 15. Solenoid-driven hammers are provided for each print column position. Each hammer strikes at the instant the selected character reaches the printing position. Therefore only the characters on a given line of print which are alike are printed simultaneously. Only one revolution of the drum is required to print each line. Therefore, the time to print a line is a function of drum rotation speed. As a result, short lines take as long to print as long lines. The print hammer and hammer control is the key to speed. The hammer must be very fast, timed accurately, and free from any tendency to bounce. Low hammer mass is a most important factor in obtaining these characteristics. A basic problem of drum printers is vertical alignment of the characters on each line across the page. This problem increases directly as a function of printer speed and is caused by variations in the timing of the printer hammers. This same timing problem is present in chain and bar printers, but the effect is less objectionable since it causes variations in the character spacing instead of vertical misalignment of characters on a line.

5.9.1.2 *Chain printers.* Chain printers employ an endless chain of type faces that travels horizontally across the face of the paper. There is a hammer for each print position. The hammer controls are timed electrically with respect to the moving chain of type, so that as the desired character lines up with the correct print position, the hammer strikes the ribbon and paper against the type face, causing the character to be printed. Improved vertical and horizontal character alignment is obtained with chain printers.

5.9.1.3 *Bar printers.* The bar printer is similar to the chain printer but substitutes thin metal bars or "typebars" for the chain as the means of presenting the complete character complements to each active column position. The characters are assembled on a thin metal bar, which can be removed by the operator and replaced with a choice of three optional bars of 13, 39, or 63 characters.

5.9.2 *Nonimpact high speed line printers.* Because of the limited use of this type of printer, the standards set forth herein apply only to impact high speed line printers. In recognition of the extensive research and development efforts to perfect this type of equipment, however, a brief description of the various types of nonimpact printers that have been developed is presented for tutorial purposes.

5.9.2.1 *General.* The five techniques by which nonimpact printing can be accomplished are video-electrostatic, video-photographic, matrix-electrostatic, matrix-electrosensitive, and electrostatic deflective. Nonimpact printers can operate at far greater speeds than impact printers. However, radio frequency interference levels are very high, requiring shielding at extra cost, to meet military specifications. The acoustic noise level and mechanical wear of nonimpact printers is much lower than that of impact printers. In general, presently available nonimpact printers are limited to producing only one copy per printer.

5.9.2.2 *Video-electrostatic printers.* In the video-electrostatic printing process, images of symbols to be printed are optically projected by a cathode ray tube onto electrostatically charged sensitized paper, and a latent electrostatic pattern is formed. These electrostatic patterns are developed into visible images by brushing the surface of the paper with a dry powdered ink consisting of small black particles of thermosetting plastic. The ink particles adhere to the latent electrostatic pattern thereby developing legible symbols. The developed paper is subjected to heat and pressure, melting the particles and fusing them to the paper. This results in permanent copy that can be handled without smudging or smearing.

5.9.2.3 *Video-photographic printers.* In the video-photographic printer process, images formed on the face of a cathode ray tube are photographed by a camera to produce a microfilm which then is used to prepare photo reproduced page output. The images on the face of the cathode ray tube are formed by directing the electron beam through a mask within the tube or by a dot matrix projection

technique to form the desired character image. The camera itself is simple. No shuttering system is required because the entire interior of the system is lightsealed. Each frame of the microfilm may remain exposed until a film advance signal is received. Fast page printing speeds are possible (10 or more frames or pages per second). Alternately, photosensitive paper may be exposed directly by the cathode ray tube with or without simultaneous exposure of the microfilm.

5.9.2.4 *Matrix-electrostatic printers.* This type of printer forms a single hard copy by charging electrically a special conductive paper using multiple styli, usually formed in a 5- by 7- inch dot matrix. The paper then is passed through a cloud of dry powered ink which adheres to the charged pattern. The paper is next subjected to heat and pressure to provide permanent copy that can be handled without smudging or smearing.

5.9.2.5 *Matrix-electrosensitive printers.* This type of printer operates similarly to the matrix-electrostatic type printer except that the permanent record is made by an electrical current from the matrix styli. The current destroys the white surface of a highly conductive black-backed paper, and no further processing is required.

5.9.2.6 *Electrostatic deflection printers.* This type of printer uses the technique of shooting a fine jet of ink in a controlled pattern on to the paper. A nonclogging distilled ink is fed to 40 ink jets, one for each two column position. Coded information to be printed is matched with its counterpart in the printer's core-storage to derive electrical deflection patterns to effect directional control of the ink jets to form the desired character. These deflection patterns then are applied to the electrostatic deflection plates for each ink jet during the printing process. The nondrying ink used in this process is fixed to the paper by absorption instead of deposition by evaporation. Only paper with suitable absorbtion characteristics can be used. The type ink used serves to prevent the jet tubes from clogging when the printer is not in use.

5.9.3 *Impact high speed line printer standards.* The standards set forth below apply only to impact high speed line printers.

5.9.3.1 *Physical characteristics.* High speed line printers vary considerably in size, speed, weight and packaging. For this reason, standards for physical characteristics are not applicable with the exception of those cited in 5.9.3.2, *Design.*

5.9.3.2 *Design.* The physical design characteristics applicable to this standard are as follows:

(a) Paper supply.

(b) Printed copy stacker.

(c) Printer copy egress.

(d) Penetration/impact adjustment.

5.9.3.2.1 *Paper supply.* The paper supply compartment shall be easily accessible to the operator for loading. As a minimum, the paper supply compartment shall accommodate a 12-inch stack of any printable media (5.9.4.3, *Media*).

5.9.3.2.2 *Printed copy stacker.* A printed copy stacker shall be provided, and shall accommodate at least a 3-inch stack of printed copy.

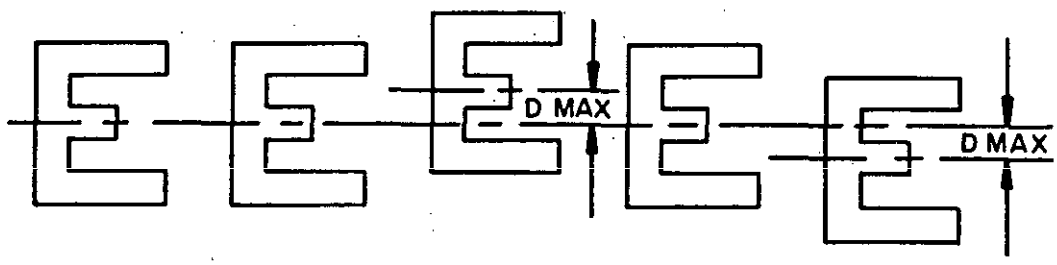
5.9.3.2.3 *Printed copy egress.* The printed copy shall come out from the top of the printer. A tear bar shall be provided and shall be located from 10 to 14 single spaced lines from the line being printed. Printed copy shall be readable to the operator in front of the printer as it clears the tear bar. It shall be possible to tear out messages as received without impeding printing of following messages.

5.9.3.2.4 *Penetration/impact adjustment.* The printer mechanism shall provide for gang adjustment of the penetration/impact of the print hammer to compensate for ribbon age, and for the variable thickness of printable medium and ribbon. The printer mechanism also shall provide for maintenance adjustment of the individual print hammer penetration/impact.

5.9.4 *Performance characteristics.* High speed line printers are used to produce high speed printouts of alphanumeric information received from the intermediate equipment. Performance is described below.

5.9.4.1 *Speeds/rates.* The high speed line printer shall print 80-column lines at a rate of 600 lines per minute. The printing speed shall be measured by printing 80-column lines using any mix of the characters specified in 5.9.4.2, *Codes/formats/character sets.*

5.9.4.2 *Codes/formats/character sets.* The standard code at the printer input shall be the ASCII code as defined in FIPS PUB 1. The high speed line printer shall print 10 characters per inch horizontally and 6 lines per inch vertically. When properly adjusted and maintained, the high-speed line printer shall print a complete line of "E" characters so that all characters are not more than ±0.008 of an inch from a common horizontal centerline. The line printer shall print a complete line of any sequence of printable characters so that all the characters are not more than ±0.010 of an inch from a common horizontal centerline (fig. 22). The minimum number of printable characters for each of the 80 printing positions shall be 64 as required by FIPS PUB 15 (DO: 96 and 128 characters). The 64 characters shall correspond to columns 2, 3, 4, and 5 of the ASCII code table set forth in the referenced standard. The space (SP) character in column 2 shall correspond to the blank (space). The type font shall be Gothic.



D MAX = ±0.008" FOR A COMPLETE LINE OF "E" CHARACTERS.
D MAX = ±0.010" FOR A COMPLETE LINE OF RANDOM CHARACTERS.

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Figure 22. Tolerable vertical misalignment.

5.9.4.3 *Media.* The high speed line printer shall print on 9-1/2-inch wide, (which is standard) continuous fanfold, sprocket fed media with lateral sprocket hole spacing of 9 ±0.030 inches (adjustable by on-site maintenance personnel), however widths up to 15 inches may be used if deemed necessary. Form lengths of 8-1/2, 11, and 14 inches of the following types of media shall be accommodated:

(a) Single-ply paper.

(b) Multi-ply paper including 2, 3, 4, and 5 ply with carbons.

(c) Multilith master.

(d) Ditto master.

5.9.4.4 *Controls.* Controls may be divided into two areas of consideration:

(a) Operator controls.

(b) Electrical signal controls.

5.9.4.4.1 *Operator controls.* As a minimum operator controls shall make provision for:

(a) Disabling of transport power in order that paper may be loaded, ribbon changed, etc.

(b) Selection of printer control from either a remote source (intermediate equipment) or operator control panel.

(c) Start of printer.

(d) Stop of printer.

(e) Advancement of media to new line by pushbutton.

(f) Advancement of media to new form by pushbutton during stop only.

5.9.4.4.2 *Electrical signal controls.* Electrical signal controls are discussed in detail in 5.9.7.2, *Controls.*

5.9.5 *Indicators.* Visual indicators shall be provided to indicate the following functions:

(a) POWER ON shall indicate that power is applied to the transport.

(b) UNIT READY shall indicate that media is loaded, the transport is operating properly and the printer is ready to receive commands. Detected errors, power off, or depression of the stop control shall remove the printer from the UNIT READY state.

(c) ERROR ALARM shall indicate to the operator that errors have occured, which include but are not restricted to those listed in 5.9.6, *Error/fault conditions.*

5.9.6 *Error/fault conditions.* The following conditions shall be detected and an appropriate electrical signal be provided to the intermediate equipment. Visual indicators may be provided in addition to the electrical signal, as follows:

(a) Parity error.

(b) Media failure.

(c) Mechanical transport failure.

5.9.6.1 *Parity error.* Parity error checking shall be provided at the printer electrical input as described in 5.9.7.1, *Data signals/transfer rates.*

5.9.6.2 *Media failure.* Media failure shall be detected and indicated if the media is out, torn, jammed, or otherwise has failed.

5.9.6.3 *Mechanical transport error.* Mechanical transport failure such as loss of ribbon, print hammer jam, total failure to print buffered data, and other major transport failures shall be indicated electrically.

5.9.7 *Electrical characteristics.*

5.9.7.1 *Data signals/transfer rates.* The transfer of information (data bits) shall be on a bit-parallel, character-serial basis. The high speed line printer shall accept the 7-bit ASCII characters at a minimum rate of 10,000 characters per second. A clock pulse shall be provided to the printer with each character transfer.

5.9.7.2 *Controls.* Control circuitry is used for printer format control and printer status. The control circuits shall include:

(a) The unit ready signal shall indicate to the intermediate equipment all functions described in 5.9.5(b), *Indicators,* for unit ready indicators.

(b) The remote/local signal is synonymous to an on-line/off-line signal which indicates the state of the operator control described in 5.9.4.4.1(b), *Operator controls.*

(c) The form feed signal shall advance the media to the next form. The high speed line printer shall position the media to cause 1-inch (6 single-spaced lines) margins below and above page perforation in the media. See 5.9.4.3, *Media,* for media specification standards.

(d) The new line function shall advance the media to the next line to be printed. The design of the high speed line printer shall permit selection of single spaced (6 lines per inch), double spaced (3 lines per inch), and triple spaced (2 lines per inch) printouts within the area between the 1-inch margins specified in (c) above.

(e) The error alarm shall indicate to the intermediate equipment that one or more of the errors discussed in 5.9.6, *Error/fault conditions,* have been detected. This signal does not preclude the use of individual signals to indicate each of the error/fault conditions listed in 5.9.6, *Error/fault conditions.*

5.9.8 *Security requirements*. See paragraph 4.9, *Security requirements*.

5.10 *Optical character recognition equipment.* Optical character recognition equipment (OCRE) encompasses a wide range of technical characteristics,

applications, and prices. OCRE for communications applications varies from sophisticated message entry systems to low performance page readers fed manually. Message entry systems using OCRE may not only read messages but perform communications functions such as validation, routing, line coordination, and message accountability. These systems frequently may be used off-line as well as on-line, outputting the messages on paper tape or cards. Error correction using a keyboard and visual display, and multifont recognition are features found in many of the larger systems. Inexpensive, low performance OCRE is available for low volume applications where the use of sophisticated high performance OCRE is not feasible economically. OCRE varies considerably in performance, speed, size, weight and packaging. This standard addresses OCRE as a digital end instrument, not as a complete message entry system. OCRE as addressed here reads typed characters and outputs the data characters by electrical signal directly to a computer or digital control device (intermediate equipment). This standard describes OCRE which recognizes only one upper case font. This is not intended to preclude the use of multifont OCRE, or OCRE for message entry systems.

5.10.1 *References.*

(a) FIPS PUB 1, Code for Information Interchange.

(b) ANSI X3.17-1966, Character Set for Optical Character Recognition.

5.10.2 *Design.* The physical design characteristics applicable to this standard are:

(a) Input page stacker.

(b) Output page stacker.

5.10.2.1 *Manual feed OCRE.* Manual feed, page at a time, OCRE is lower in cost and is acceptable for purposes of this standard when user requirements permit. However, if an input page stacker is provided, it shall hold a minimum of 50 pages.

5.10.2.2 *Output page stacker.* All OCRE shall provide an output page stacker. This stacker shall hold a minimum of 50 pages. Optional stackers for rejected pages are acceptable.

5.10.3 *Performance characteristics.* OCRE may be divided into two broad categories: high performance OCRE; and low performance OCRE. High performance OCRE generally is employed in large telecommunications centers and is characterized by high reading rates, automatic feed, and multifont capability. Low performance OCRE generally is characterized by small size, low cost, low reading rate, use of a single font, and manual feed.

5.10.3.1 *Speeds/rates.* Low performance OCRE shall have a minimum reading rate of 50 characters per second. High performance OCRE shall have a minimum reading rate of 300 characters per second.

5.10.3.2 *Codes/formats/character sets.* The output electrical signal code shall be as defined in FIPS PUB 1. The input page format shall be DD Form 173, JOINT MESSAGEFORM (fig. 23), with all lines and printing in drop out blue (not visible to the optical reader). OCRE shall, as a minimum, read the character format defined below:

(a) Horizontal spacing of 10 characters per inch.

(b) Vertical spacing of 6 characters per inch.

(c) The standard characters set shall be that defined in ANSI X3.17-1966, Size A.

5.10.3.3 *Controls.* Controls may be divided into the categories of operator controls and electrical signal controls. Electrical control signals are discussed in detail in 5.10.7.2, *Control signals.* Operator controls shall be provided as follows:

(a) The power on or off control shall connect or disconnect power to the unit.

(b) The start OCRE read cycle control shall initiate the read operation.

(c) The stop OCRE read cycle control shall terminate the read operation.

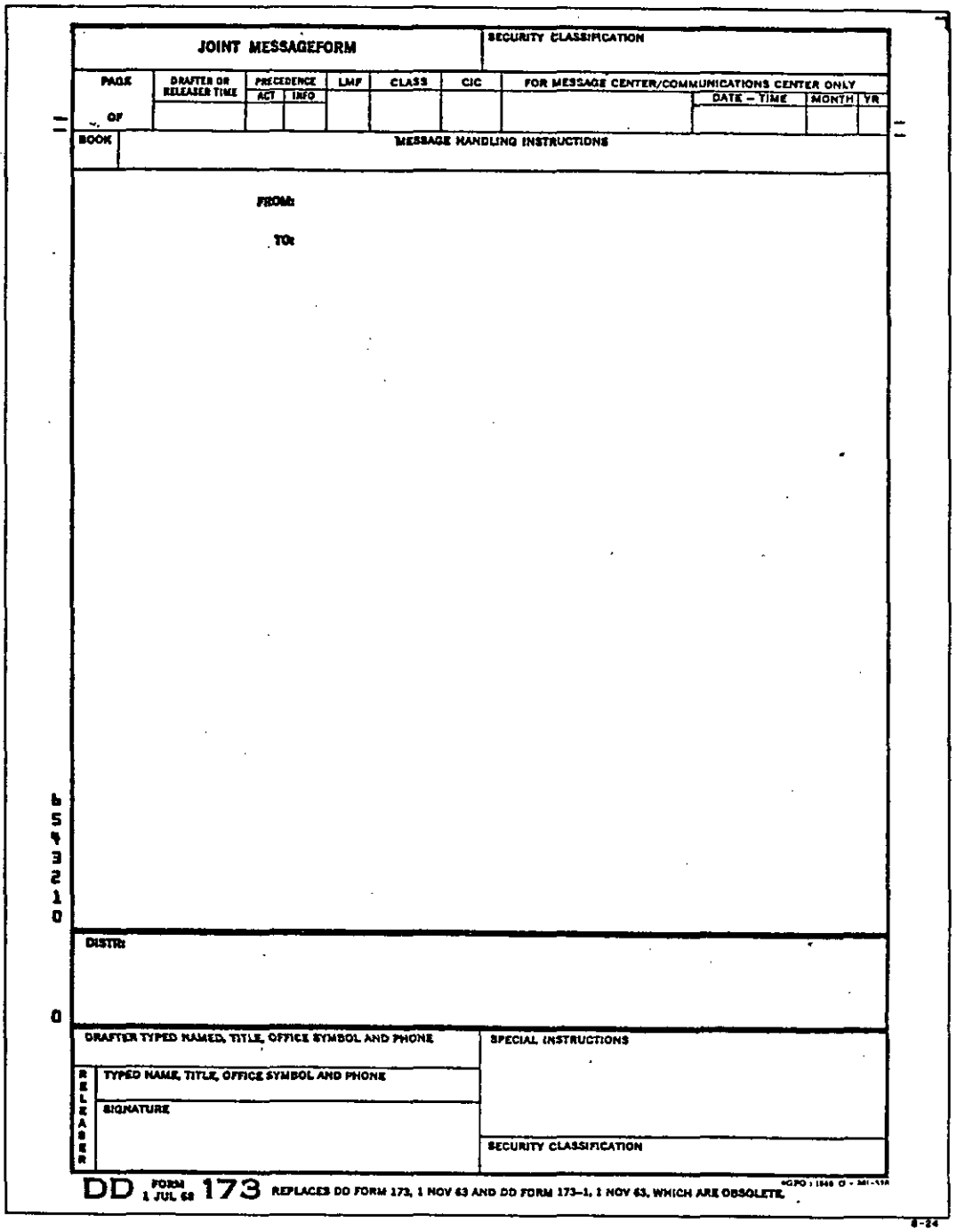
(d) The clear document control shall remove document(s) from the OCRE read mechanism and activate the clear document signal.

(e) The end of file control shall activate the end of file signal discussed in detail in 5.10.6.2 (b), *Control signals.*

5.10.4 *Indicators.* The following visual indicators shall be provided:

(a) The POWER ON indicator shall indicate that power is applied to the unit.

(b) The DATA REJECT and DATA MISFEED indicators shall indicate to the operator that the conditions described in 5.10.5, *Error/fault conditions,* have been detected.



JOINT MESSAGEFORM

SECURITY CLASSIFICATION

PAGE OF	DRAFTER OR Rreleaser TIME	PRECEDENCE ACT	PRECEDENCE INFO	LMF	CLASS	CIC	FOR MESSAGE CENTER/COMMUNICATIONS CENTER ONLY DATE – TIME	MONTH	YR

BOOK

MESSAGE HANDLING INSTRUCTIONS

FROM:

TO:

DISTR:

DRAFTER TYPED NAMED, TITLE, OFFICE SYMBOL AND PHONE

SPECIAL INSTRUCTIONS

RELEASER

TYPED NAME, TITLE, OFFICE SYMBOL AND PHONE

SIGNATURE

SECURITY CLASSIFICATION

DD FORM 1 JUL 68 173 REPLACES DD FORM 173, 1 NOV 63 AND DD FORM 173-1, 1 NOV 63, WHICH ARE OBSOLETE.

*GPO : 1968 O - 301-139

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Figure 23. DD Form 173, JOINT MESSAGEFORM.

5.10.5 *Error/fault conditions.* The following conditions shall be detected and indicated by electrical signal to the intermediate equipment.

(a) The data reject conditions shall indicate that an unrecognizable character has been found.

(b) The document misfeed condition shall indicate that the DD Form 173 on which the message being transmitted has been typed is skewed, torn, jammed, or otherwise not being fed through the reading mechanism properly.

5.10.6 *Electrical characteristics.*

5.10.6.1 *Data signals/transfer rates.* The OCRE shall transfer information on a bit-parallel, character-serial basis. A clock pulse shall be provided by the OCRE with each character transfer.

5.10.6.2 *Control signals.* The control circuitry is used for status purposes only. Since the OCRE will be a read-only device working on a character transfer basis to the intermediate equipment, only status is required. The control signals shall include but not need be limited to:

(a) A start read cycle signal to indicate to the intermediate equipment that the OCRE is initiating a read operation and that character information is forthcoming.

(b) An end of file signal to indicate to the intermediate equipment that character transfer is complete for a given message, record, or file.

(c) A clear document signal to indicate to the intermediate equipment that the operator has terminated the read operation and the intermediate equipment is to clear all previous characters received during that transmission period. The clear document signal shall be activated only if characters have been transferred during the transmission period.

5.10.7 *Environmental characteristics.* Unusual environmental conditions such as found in the tropics, jungles, polar regions, *etc.*, are not considered in this standard.

5.10.8 *Temperature requirements.* OCRE shall operate in an ambient temperature range of from 16° C to 30° C without special external blowers or air conditioning units.

5.11 *Synchronous regenerative repeaters.* Synchronous regenerative repeaters reshape and retime digital signals. Retiming characteristics shall make a regenerative

repeater distinct from a nonregenerative repeater. A regenerative repeater shall both reshape and retime the signal. A nonregenerative repeater shall only reshape the signal.

5.11.1 *Electrical characteristics.*

5.11.1.1 *Dc input/output characteristics.* All data signals shall be ±6-volt low level signals in accordance with 4.3.1.3, MIL-STD-188-100.

5.11.1.2 *Modulation rate*. A modulation rate of from 25 to 50,000 bauds is desirable.

5.11.1.3 *Unit interval signals.* The device shall accept unit interval signals only.

5.11.1.4 *Propagation delay time.* An internal equipment propagation delay time of greater than one-half and less than two unit intervals at the applicable modulation rate is desired.

5.11.1.5 *Remote user.* No requirement exists for remote user removal or insertion of the regenerative repeater from or into a channel.

5.11.1.6 *Distortion.* Synchronous repeater input accepting capabilities shall be:

Distortion	Mark (%)	Space (%)
Switched bias	49	49
Bias	49	49
Cyclic	49	49
Fortuitous	49	49

These distortion figures assume the input signal modulation rate and the clock signals are within 1 percent of each other and are applicable to either externally or internally clocked repeaters. The synchronous regenerative repeater shall generate an alarm if the input signal exceeds an unacceptable distortion figure for a three second period. The maximum unacceptable distortion figure shall be 49%. The distortion figure may be selectable with suggested figures of 30, 35, 40 or 45 per cent. The synchronous regenerative repeater shall continue to regenerate the data and maintain its phase relationship to the clock as stated in 5.11.2.1.2, *Clock synchronization,* after the alarm has been generated.

5.11.2 *Control signals.*

5.11.2.1 *Synchronous repeaters controlled by station clocks.*

5.11.2.1.1 *Timing source.* See 4.3.1.6, MIL-STD-188-100.

5.11.2.1.2 *Clock synchronization.* When controlled by station or master clocks (external clocks), the input signal clock timing relationship should be arranged so that the phase of the incoming signal may be shifted 270 degrees from the center of the unit interval at the applicable modulation rate to synchronize the two clocks. The decision as to whether or not the phase adjustment be manual, semiautomatic, or automatic is the option of the using activity. The adjustment of the phase of the input signal/clock relationship should be reflected in a similar shift in the phase of the output data signal. The output data signal should maintain the phase of the station clock supplied to the regenerative repeater.

5.11.2.1.3 *Modulation rate.* The clock modulation rate shall be supplied at twice the applicable signal modulation rate.

5.11.2.2 *Synchronous repeaters not controlled by station clocks.*

5.11.2.2.1 *Timing source.* The clock signal for a synchronous regenerative repeater operating in a facility without a station clock shall be derived from time base generator providing clock signals to a number of regenerative repeaters. The synchronous regenerative repeater shall operate as specified in 5.11.2.1.2, *Clock synchronization*.

5.11.2.2.2 *Frequency control.* Each repeater shall derive all of its timing information required for operation, specified in 5.11.2.1.2, *Clock synchronization*, from an external time signal for each of the modulation rates specified in 5.11.1.2, *Modulation rate.*

5.11.2.2.3 *Frequency control stability.* The means for setting the modulation rate shall incorporate a technique similar to tuning a radio receiver, *e.g.*, setting the control dial to the gross modulation rate would then allow the AFC to lock on to the input signal modulation rate. A 5-second lock-on time is considered adequate. This means that within 5 seconds of receipt of an initial input signal, the correct input signal/clock phase relationship will be established. The stability of the regenerative repeater frequency control shall be such that the loss of the input signal for periods of 1 second or at 50.0 kilobauds shall not cause the input signal/clock phase relationship to deviate in excess of 4 percent of the duration of the unit interval upon resumption of input signaling. For lower modulation rates, the hold-in time shall be inversely proportional to the modulation rate.

5.11.3 *Security requirements*. See paragraph 4.9, *Security requirements*.

6. TEST METHODS, COMMUNICATIONS LINE END INSTRUMENTS

6.1 *General.* This section sets forth guidelines for testing the equipment parameters and performance for the communications line end instruments specified in section 5. The tests described in this section are listed below:

Test Method Number	Subject	Paragraph In Standard
6.2.1	Modulation rate of start-stop telegraph signals	5.2.3
6.2.2	Input sensitivity of printing telegraph equipment	5.2.7 5.2.19.3
6.2.3	Transmitter character interval synchronization in teletypewriters	5.2.17.3
6.2.4	Teletypewriter transmission distortion	5.2.17.1
6.2.5	Receiver margin on start-stop teletypewriters	5.2.4 5.2.19.1
6.2.6	Side stability of electromechanical relays used in teletypewriters	5.2.18.1.1
6.2.7	Distortion in electromechanical relays used in teletypewriters	5.2.18.1.3
6.2.8	Winding resistance of electromechanical relays used in teletypewriters	5.2.18.1.5
6.2.9	Input sensitivity (operating differential) of electromechanical relays used in teletypewriters	5.2.7 5.2.19.3
6.2.10	Side stability of electronic relays used in teletypewriters	5.2.18.2.1
6.2.11	Distortion in electronic relays used in teletypewriters	5.2.18.2.4
6.2.12	Output impedance of electronic polar relays used in teletypewriters	5.2.18.2.9
6.2.13	Circuit isolation in teletypewriters	5.2.18.2.12

Test Method Number	Subject	Paragraph In Standard
6.2.14	Input impedance (windings) of electronic polar relays used in teletypewriters	5.2.18.2.6
6.2.15	Input sensitivity (operating differential) of electronic polar relays used in teletypewriters	5.2.7 5.2.19.3
6.2.16	Dc input/output characteristics of synchronous regenerative repeaters	5.11.1.1
6.2.17	Modulation rate coverage of synchronous regenerative repeaters	5.11.1.2
6.2.18	Equipment propagation delay time of synchronous regenerative repeaters	5.11.1.4
6.2.19	Distortion in synchronous regenerative repeaters	5.11.1.6
6.2.20	Distortion alarm in synchronous regenerative repeaters	5.11.1.6
6.2.21	Control signals in synchronous regenerative repeaters	5.11.2.1.2 5.11.2.2.2
6.2.22	Frequency control stability of synchronous regenerative frequency control	5.11.2.2.3

6.2 *Description of test methods.* The methods provide step-by-step procedures to be followed for the testing of end instrument equipment characteristics. Test setups are given and the required testing apparatus is assigned a reference item number. Tables in the appendix specify test apparatus operating features correlated to the specified reference number. In general, the test methods do not repeat the standard values specified in section 5. However, these values are repeated where necessary in order to clarify a step. Reference should be made to the paragraph in section 5 cited in the test method.

6.2.1 *Modulation rate of start-stop telegraph signals.*

6.2.1.1 *Scope.* This method is used to measure the modulation rate of stop-start telegraph signals.

6.2.1.2 *Applicability.* The parameters tested shall conform to the requirements specified in the paragraph cited below:

Item	Paragraph
Modulation rate	5.2.3

6.2.1.3 *Apparatus.* The required test equipment is listed below:

Test Unit	Schematic Reference	Item No. in Appendix
Telegraph Distortion Measuring Set (TDMS)	A	332 or 323
Modulation Rate Meter	B	13
Oscilloscope	C	206
Oscillator	D	120
Stop Watch	–	207
Tuning Fork or Vibrating Reed Stroboscope	–	208
Capacitor	H	418
Capacitor	I	419
Capacitor	L	418
Resistor	J	420
Resistor	K	421

6.2.1.4 *Procedures.*

6.2.1.4.1 *Measurement of modulation rate using a TDMS.* This method is applicable to all types of printing telegraph transmitters, and tests may be applicable either at the transmitter output or remotely from a control center.

6.2.1.4.1.1 *TDMS with distortion meter.*

Step 1. Connect equipment as shown in figure 24.

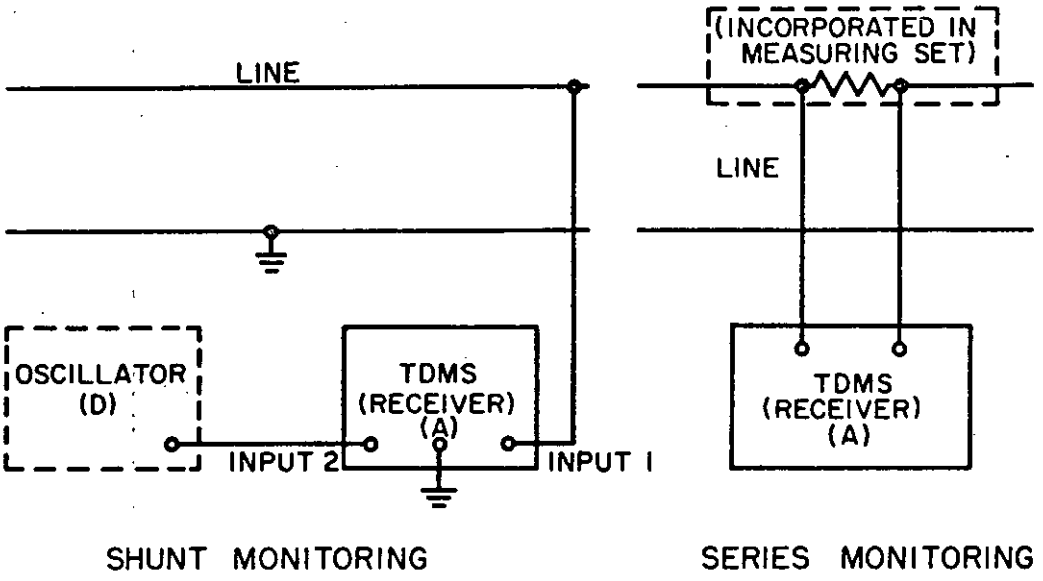


Figure 24. Measurement of modulation rate of start-stop telegraph signals using a start-stop distortion measuring set.

Step 2. Switch TDMS A time-base to modulation rate and character interval of line or machine under test.

Step 3. Set TDMS meter to record average distortion.

Step 4. Switch TDMS meter to each transition and record distortion reading.

Step 5. Estimate mean position of last transition.

Step 6. Determine whether or not incoming signals are fast or slow by using early or late peak controls (early equals fast).

NOTE. Alternative to step 6, refer to the cathode ray display sometimes associated with the meter indication. A character shorter than that indicated on the graticule will indicate that the modulation rate of the signal is too high. A long character will indicate that the modulation rate is too low.

$$\text{Modulation rate error} = \frac{\text{last transition distortion}}{\text{number of last transition}}$$

(*e.g.*, for 6 percent distortion observed on the stop (6th) transition of a 5-unit code signal, the modulation rate error = 1 percent.) The above formula assumes that there is no distortion other than bias distortion.

6.2.1.4.1.2 *TDMS with cathode ray tube.*

Step 1. Connect equipment as shown in figure 24.

Step 2. Set TDMS switch to expected character length.

Step 3. Set oscillator D to frequency, $f = \frac{\text{modulation rate}}{2}$

Step 4. Set TDMS time-base to "continuous".

Step 5. Adjust TDMS modulation rate so that markers on circular trace on cathode ray tube screen do not rotate.

Step 6. Switch time-base to start-stop.

NOTE. A single radial line of dots on a decaying spiral will result. If more than one line of dots appears, there will have been a gross error in the setting of the modulation rate controls.

Step 7. Disconnect oscillator D.

Step 8. Apply signal to be measured (normally by input select switch).

NOTE. A dot will appear on the spiral trace for each transition of the signal. For zero-signal distortion, the dot pattern will appear on a vertical radial line. Signal distortion will cause individual dots to be displaced from this line.

A difference between the modulation rate of the signal and that of the set will cause the mean line through the dots to be displaced, pivoting about the start of the spiral trace.

Step 9. Estimate mean distortion of last transition using scale at circumference of cathode ray display.

NOTE. $$\text{Modulation rate error} = \frac{\text{last transition distortion}}{\text{number of last transition}}$$

Incoming modulation rates that are greater than that of TDMS A will cause all transitions to be displaced against the direction of rotation of the spiral. Conversely, lower modulation rates will cause transitions to be displaced in the direction of rotation of the spiral. The above formula assumes that there is no distortion other than bias distortion.

Step 10. Count number of revolutions made by display in a period of about 15 seconds (preferably measured by a stop watch).

Step 11. Calculate modulation rate error from:

$$\text{Modulation rate error (in \%)} = \frac{\text{No. of revolutions}}{\text{time (sec)}} \times \frac{1}{\text{Modulation Rate}} \times 100$$

6.2.1.4.2 *Measurement of modulation rate using a cathode ray oscilloscope and an oscillator.* This is a suitable alternate to 6.2.1.4.1 when a TDMS is not available.

Step 1. Connect equipment as shown in figure 25.

Step 2. Switch oscilloscope C time base switch to off.

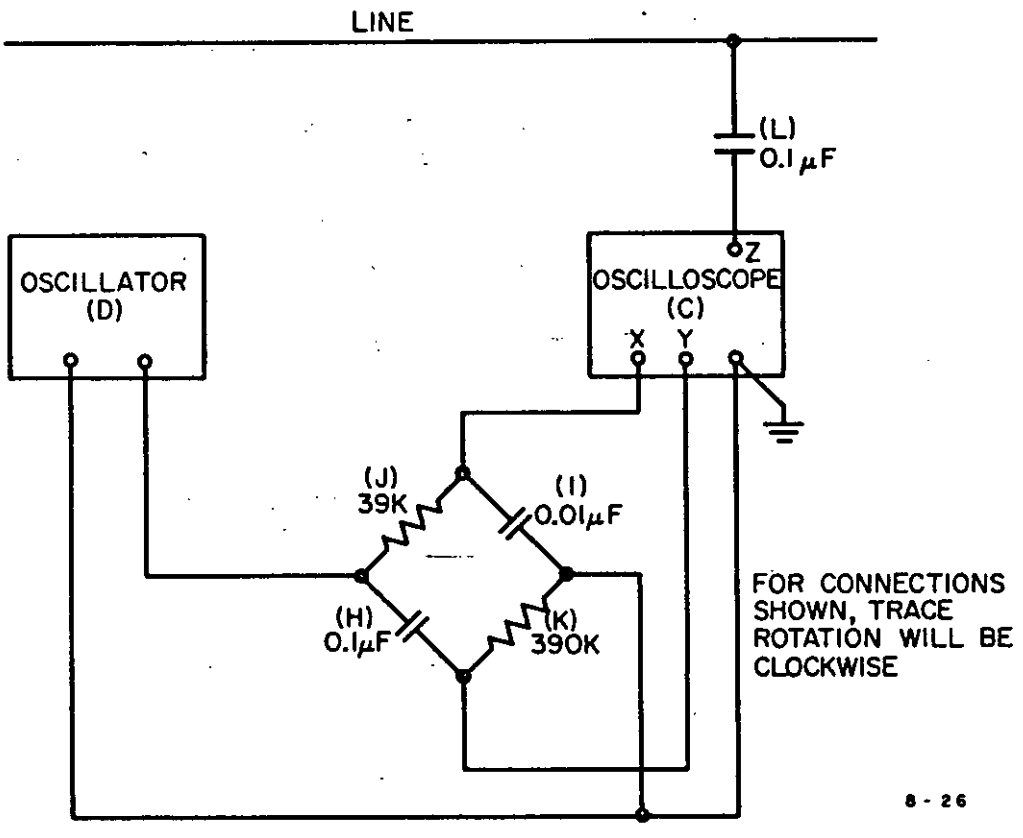


Figure 25. Measurement of modulation rate of start-stop telegraph signals using an oscilloscope and oscillator.

Step 3. Adjust oscillator D frequency to

$$f = \frac{\text{modulation rate (bauds)}}{2}$$

Step 4. Adjust oscilloscope brightness to produce marker on trace.

NOTE. The number of markers will vary in accordance with the smallest element with a unit code, so that a 7.0-unit code produces one marker while a 7.5-unit code will produce two markers (the latter signal having twice the basic frequency).

Differences between the modulation rate and oscillator D frequency will cause the marker to rotate in the direction of the trace if the modulation rate is too low, and against the direction of rotation if it is too high.

Step 5. Count number of revolutions made by marker in 15 seconds.

Step 6. Calculate modulation error rate from:

Modulation rate error =

$$\frac{\text{rate of revolution of marker (rev/sec) X 100\%}}{\text{oscillator frequency (Hz)}}$$

6.2.1.4.3 *Measurement of modulation rate using a modulation rate meter.* This method is simple and convenient to apply, but the availability of this test instrument is limited.

Step 1. Connect equipment as shown in figure 26.

Step 2. Record modulation rate meter reading of modulation rate.

6.2.1.4.4 *Measurement of modulation rate using a stroboscope disc and tuning fork stroboscope.* This is a stroboscopic method of checking the speed of motor-driven machines, and is, of course applicable only to motor-driven transmitters.

Step 1. Arrange machine so strobe disc can be seen.

Step 2. Tap strobe tuning fork to induce vibration.

Step 3. View disc, with motor running.

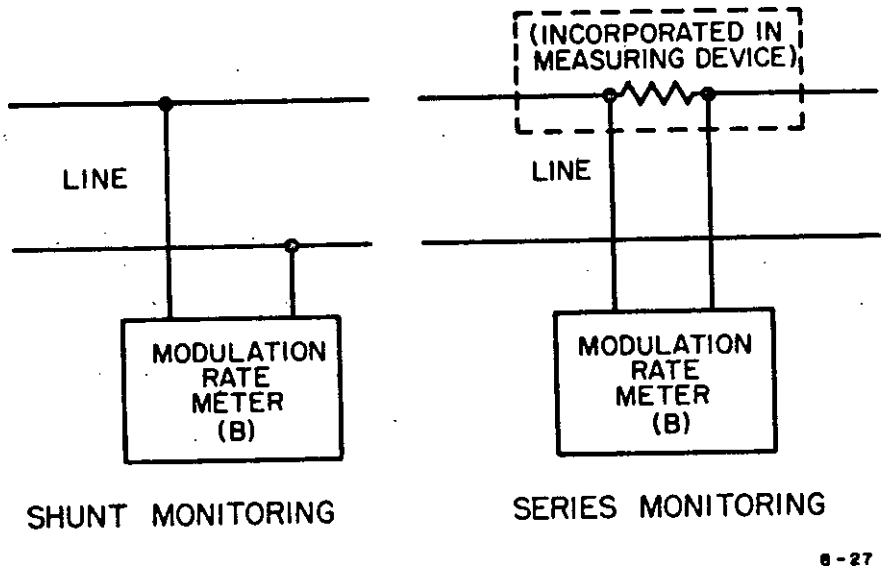


Figure 26. Measurement of modulation rate of start-stop telegraph signals using a modulation rate meter.

NOTE. Rotation of the image in the direction of rotation of the motor indicates that the speed is fast. Image rotation against the direction of motor rotation from that seen with the motor at rest indicates a gross speed error.

Step 4. Determine speed error from:

Speed error (modulation rate error) =

$$\frac{\text{observed revolutions of image (rev/sec) X 100\%}}{\text{nominal motor speed (rev/sec)}}$$

NOTE. Certain machines may be equipped for variable speed operation by gear change. In these circumstances, it will be necessary to check that the gears appropriate to the desired modulation rate have been fitted.

6.2.2 *Input sensitivity of printing telegraph equipment.*

6.2.2.1 *Scope.* This method is used to measure the input sensitivity of printing telegraph equipment.

6.2.2.2 *Applicability.* The parameters tested shall conform to the requirements specified in the paragraphs cited below:

Item	Paragraph
Input sensitivity (polar relay driven receiver)	5.2.7 5.2.19.3

6.2.2.3 *Apparatus.* The required test equipment is listed below:

Test Unit	Schematic Reference	Item No. in Appendix
Telegraph Distortion Measuring Set (TDMS)	A	322 or 123
Power Supply	B	558
Power Supply	C	559
Voltmeter	D	14
Milliammeter (Zero Center)	G	15

Test Unit	Schematic Reference	Item No. in Appendix
Milliammeter (Zero Center)	H	9
Resistor	I	422
Variable Resistor	J	423
Resistor	K	424
Variable Resistor	L	425

6.2.2.4 *Procedure.*

Step 1. Connect equipment as shown in figure 27.

Step 2. Set TDMS A to steady mark.

Step 3. Adjust variable resistor J (or L) to obtain current for signaling.

Step 4. Switch TDMS A to steady space.

Step 5. Read milliammeter to see that same current is obtained as in step 3.

Step 6. Set TDMS A to produce 1-to-1 reversals at the modulation rate of receiver under test.

Step 7. Check to see that receiver is responding to step 6.

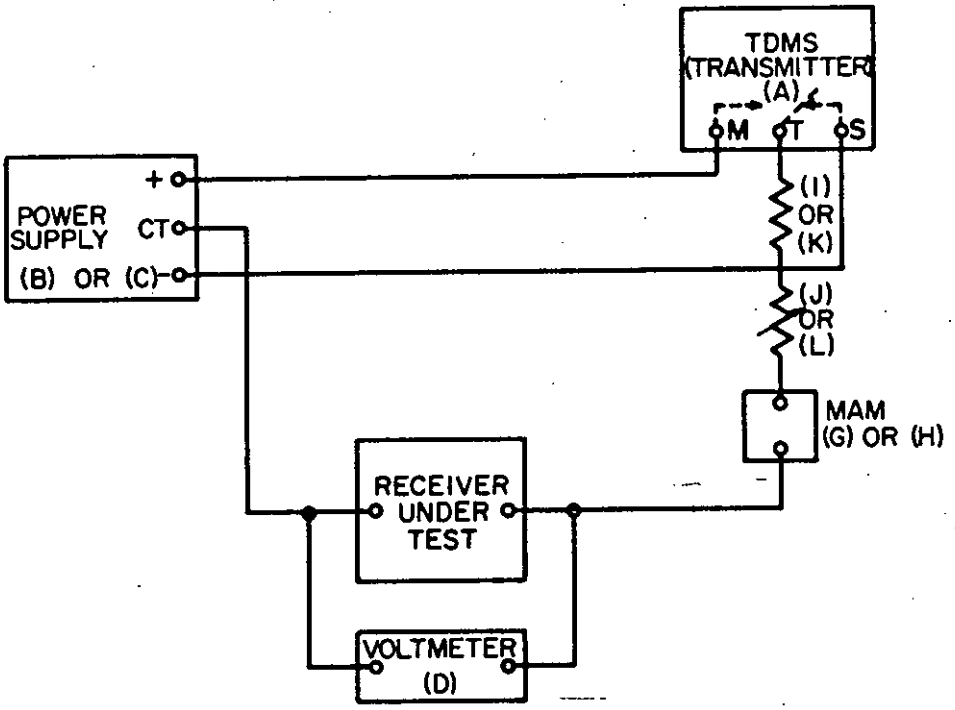
Step 8. Set TDMS A to undistorted test message.

Step 9. Check copy for accuracy.

6.2.3 *Transmitter character interval synchronization in teletypewriters.*

6.2.3.1 *Scope.* This method is used to measure the character/bit count integrity on asynchronous-to-synchronous telegraph equipment.

6.2.3.2 *Applicability.* The parameters tested shall conform to the requirements specified in the paragraph cited below:



	TEST CIRCUIT CURRENT AMPERES	TEST CIRCUIT VOLTAGE (VOLTS)	POWER SUPPLY	AMMETER	RESISTOR
HIGH LEVEL SIGNALING	.002	–	C	G	I & J
LOW LEVEL SIGNALING	.0001	.5	B	H	K & L

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Figure 27. Measurement of input sensitivity of a polar relay driven receiver.

Item	Paragraph
Transmitter character synchronization	5.2.17.3

6.2.3.3 *Apparatus.* The required test equipment is listed below:

Test Unit	Schematic Reference	Item No. in Appendix
Cathode Ray Oscilloscope, Dual Trace	A	209
Pulse Generator	B	121, or 122 plus 561, or 123
Power Supply	C	559

6.2.3.4 *Procedure.*

Step 1. Connect equipment as shown in figure 28.

Step 2. Set pulse generator to output release pulses at the rate, amplitude, and duration specified for circuit in which coil normally is used.

Step 3. Adjust oscilloscope A so that sweep frequency is locked to output of pulse generator B.

Step 4. Adjust oscilloscope Y1 and Y2 gain to give displays about 1 inch high.

Step 5. Adjust oscilloscope so that both X sensitivities are equal.

Step 6. Record oscilloscope reading of interval between start of release pulses and onset of transmitter pulses.

NOTE. Certain sophisticated distortion measuring sets and signal generators, permanently wired in test positions, may be switched to perform the same functions as pulse generator B and cathode ray oscilloscope A in this method. Measurement is as above, the signal generator providing the release pulse and the built-in oscilloscope being used to measure the signal timing.

6.2.4 *Teletypewriter transmitter distortion.*

6.2.4.1 *Scope.* This method is used to measure teletypewriter transmitter distortion.

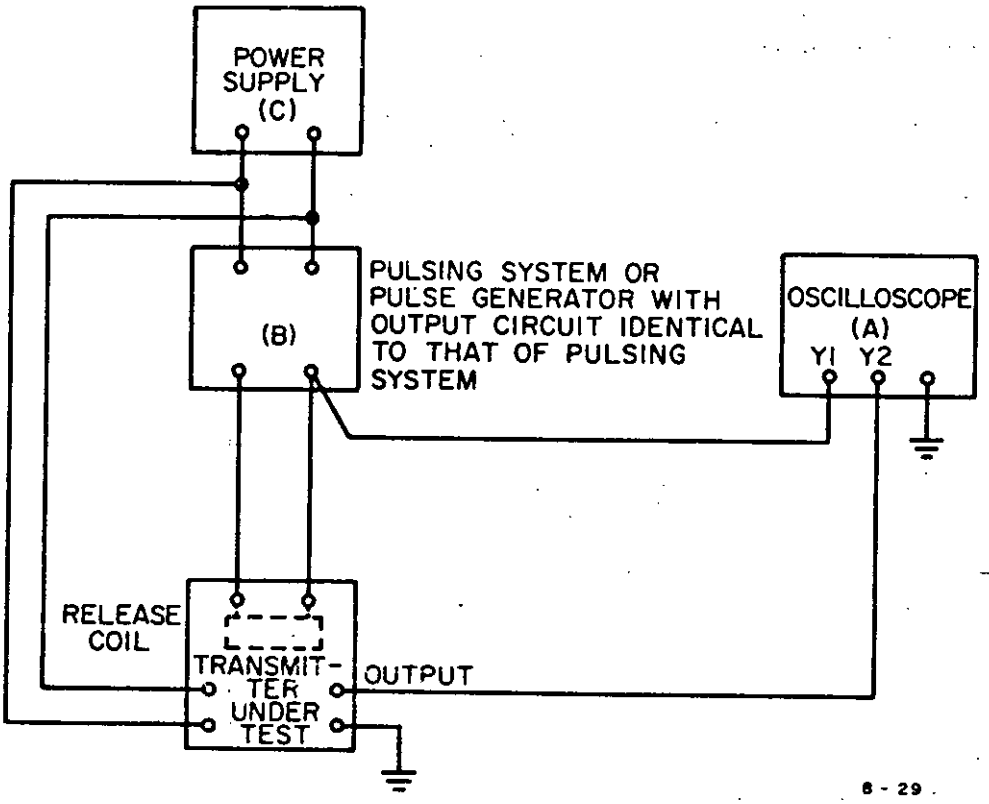


Figure 28. Measurement of relationship between transmitter release pulse and transmitter signal.

6.2.4.2 *Applicability.* The parameters tested shall conform to the requirements specified in the paragraph cited below:

Item	Paragraph
Transmitting devices (distortion margin)	5.2.17.1

6.2.4.3 *Apparatus.* The required test equipment is listed below:

Test Unit	Schematic Reference	Item No. in Appendix
Telegraph Distortion Measuring Set (TDMS)	A	322
Power Supply	B	559
Resistor	C	426
Telegraph Distortion Measuring Set (TDMS-Receiver)	D	323
Start-Stop Oscilloscope	E	210
Telegraph Distortion Analyzer	F	321

6.2.4.4 *Procedure.*

6.2.4.4.1 *Measurement of transmitter distortion using a digital distortion measuring set with meter readout.*

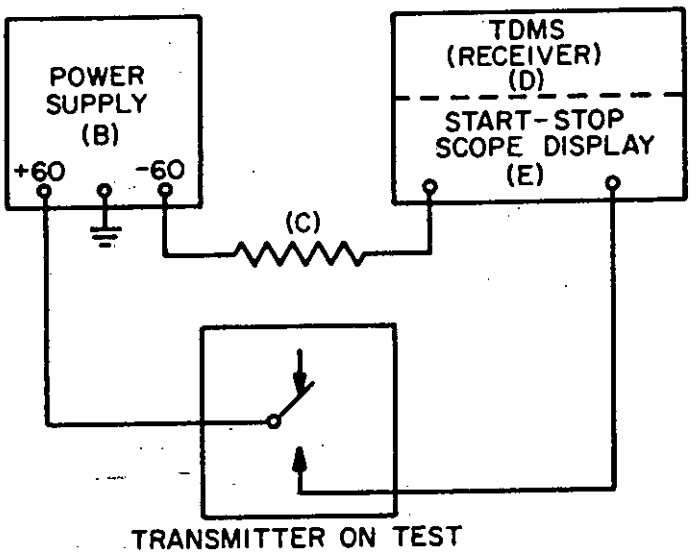
Step 1. Connect equipment for either polar or neutral operation as shown in figure 29.

Step 2. Set TDMS A to signal to be measured (*e.g.*, modulation rate, polar or neutral operation, synchronous or start-stop transmission).

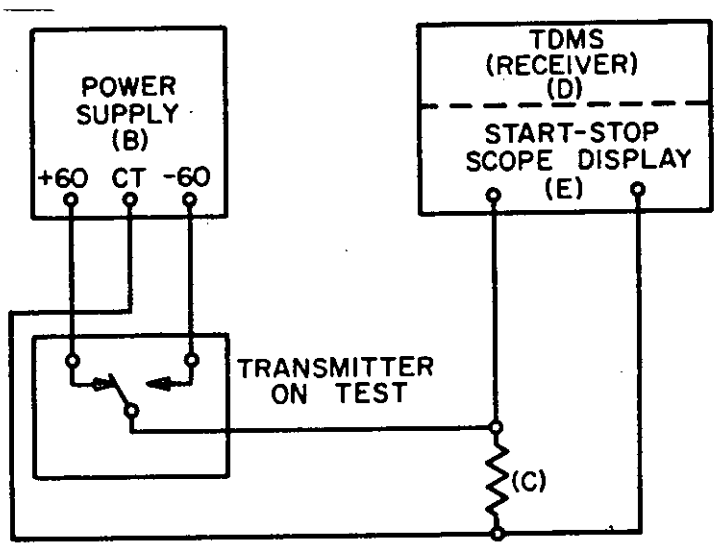
NOTE. For neutral measurements, use the intensity facility on the associated cathode ray display unit to identify the trigger points of the transitions being measured by TDMS A.

Step 3. Operate transmitter under test.

Step 4. Switch TDMS A meter to read total peak distortion.



NEUTRAL OPERATION



POLAR OPERATION

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Figure 29. Measurement of teletypewriter transmitter distortion using a digital distortion measuring set.

Step 5. Record TDMS maximum distortion reading over period of 30 seconds.

NOTE. When it is desired to analyze distortion, observe individual transitions using the early or late peak and SPACE/MARK or MARK/SPACE transition controls of TDMS A.

6.2.4.4.2 *Measurements of transmitted distortion using a cathode ray display type instrument.*

Step 1. Connect the equipment for either neutral or polar operation as shown in figure 30.

Step 2. Set TDMS to signal to be observed.

NOTE. Synchronous signals can be observed; the modulation rate must be adjusted manually. It will not usually be possible to obtain exact synchronism.

For neutral measurements, use intensity facility on start-stop oscilloscope E to identify the trigger points of the transitions being measured by TDMS D.

Step 3. Operate transmitter under test.

NOTE. In start-stop measurement, the transitions will appear on oscilloscope display E as bright dots on a decaying spiral making one revolution per code element.

Step 4. Record distortion from scale at the periphery of the spiral.

6.2.4.4.3 *Measurement of algebraic sum of transmitter distortion using a telegraph distortion analyzer.*

Step 1. Connect equipment for either neutral or polar operation as shown in figure 31.

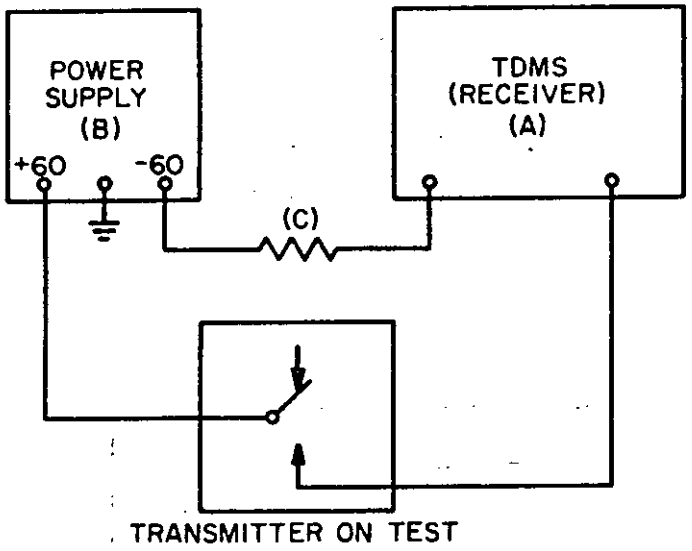
Step 2. Adjust distortion analyzer F to include range of total distortion in increments not to exceed 1 percent (preferably 0.5 percent).

Step 3. Cause transmitter on test to operate for minimum of 10^4 transitions.

Step 4. Read and record distortion counters.

6.2.5 *Receiver margin on start-stop teletypewriters.*

6.2.5.1 *Scope.* This method is used to measure the receiver margin on start-stop teletypewriters.



NEUTRAL OPERATION

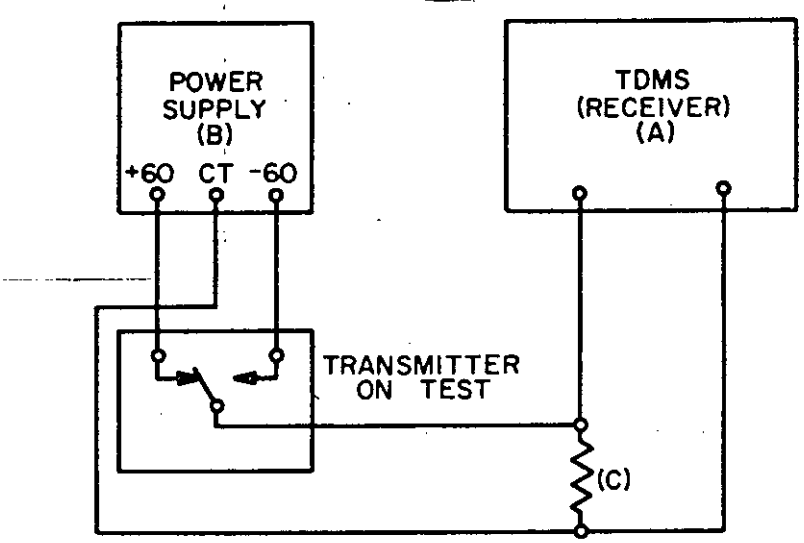


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Figure 30. Measurement of teletypewriter transmitter distortion using a cathode ray display distortion measuring set.

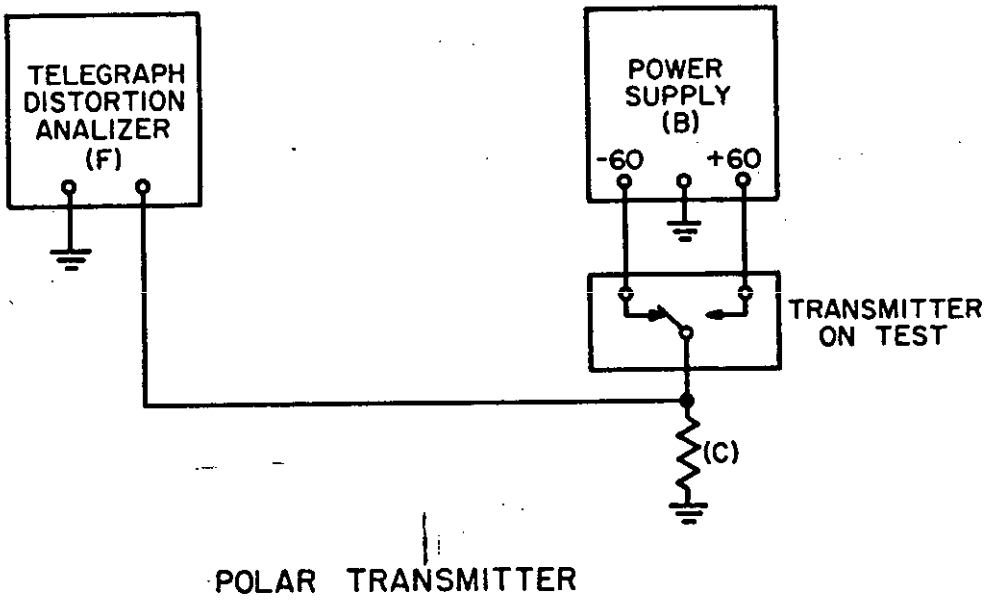


Figure 31. Use of telegraph distortion analyzer.

6.2.5.2 *Applicability.* The parameters tested shall conform to the requirements specified in the paragraphs cited below:

Item	Paragraph
Character interval	5.2.4
Receiving devices (distortion margin)	5.2.19.1

6.2.5.3 *Apparatus.* The required test equipment is listed below:

Test Unit	Schematic Reference	Item No. in Appendix
Telegraph Distortion Measuring Set (TDMS)	A	322
Telegraph Distortion Measuring Set (TDMS-Receiver)	B	323
Variable Resistor	C	417
Power Supply	D	559
Oscillator	E	124
Telegraph Relay	F	911
Milliammeter	G	15
Milliammeter	H	9
Variable Resistor	I	427
Variable Resistor	J	423

6.2.5.4 *Procedure.*

6.2.5.4.1 *Measurement of receiver margin.*

6.2.5.4.1.1 *American method.*

Step 1. Connect equipment as shown in figure 32.

Step 2. Set teletypewriter receiver range finder to mid-scale.

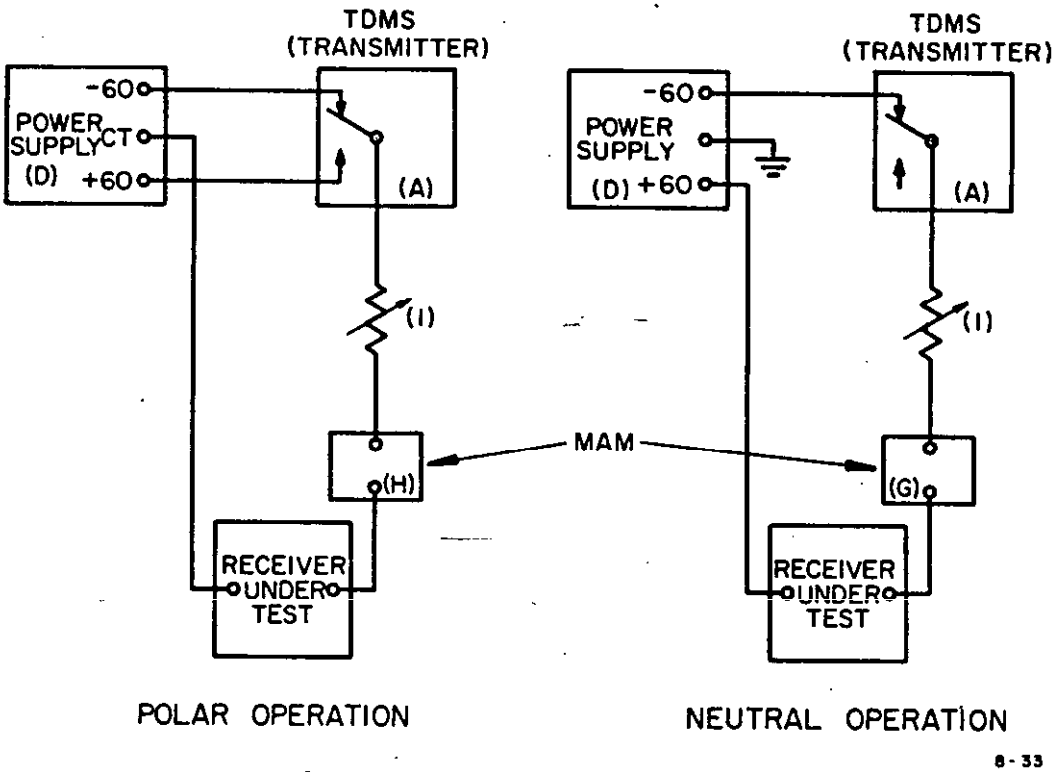


Figure 32. Measurement of receiver margin on start-stop teletypewriters.

Step 3. Set circuit current to correct level for receiver under test.

Step 4. Set TDMS A to suit receiver under test.

Step 5. Switch TDMS A to "Quick Brown Fox" test message.

Step 6. Adjust TDMS to zero transmission distortion.

Step 7. Apply marking and spacing bias in appropriate steps until errors are observed.

Step 8. Reduce distortion in 1-percent steps until the receiver prints at least 69 consecutive characters (*i.e.*, one sentence) without error.

Step 9. Record distortion setting.

Step 10. Repeat steps 6 through 9 for end distortion.

Step 11. Apply switched bias distortion.

Step 12. Repeat steps 6 through 9.

6.2.5.4.1.2 *CCITT method.*

Step 1. Repeat steps 1 through 6 of 6.2.5.4.1.1, *American method.*

Step 2. Apply early and late distortion in appropriate steps until errors are observed.

Step 3. Reduce distortion in 1-percent steps until the receiver prints at least 69 consecutive characters without error.

Step 4. Record distortion level.

Step 5. Repeat steps 2 through 4 alternating early and late distortion.

6.2.5.4.2 *Measurement of receiver performance on a 6.6-unit character interval.*

Step 1. Connect equipment as shown in figure 32.

Step 2. Adjust TDMS A for 7-unit operation.

Step 3. Set TDMS A for character consisting of first two elements space and remainder mark.

NOTE. For a 7-unit receiver and with undistorted output, set TDMS A modulation-rate to $\frac{7.0}{6.6}$ of the receiver nominal rate.

Step 4. Verify and record that printer operates in a consistent manner and does not run out of phase.

6.2.5.4.3 *Measurement of receiver tolerance to cyclic distortion.*

Step 1. Connect equipment as shown in figure 33.

Step 2. Adjust telegraph distortion measuring sets A and B to suit the characteristics of receiver under test.

Step 3. Adjust circuit current to suit receiver under test.

Step 4. Adjust variable resistor J for appropriate relay input current.

Step 5. Transmit TDMS "The Quick Brown Fox" message undistorted.

Step 6. Apply from 50 to 60 Hz to relay winding.

Step 7. Record TDMS B reading of cyclic distortion.

Step 8. Control resistor C to achieve maximum cyclic distortion that can be tolerated by receiving device without error.

Step 9. Record cyclic distrotion of step 8.

6.2.6 *Side stability of electromechanical relays used in teletypewriters.*

6.2.6.1 *Scope.* This method is used to measure the side stability of electromechanical relays used in teletypewriters.

6.2.6.2 *Applicability.* The parameters tested shall conform to the requirements specified in the paragraph cited below:

Item	Paragraph
Side stable	5.2.18.1.1

6.2.6.3 *Apparatus.* The required test equipment is listed below:

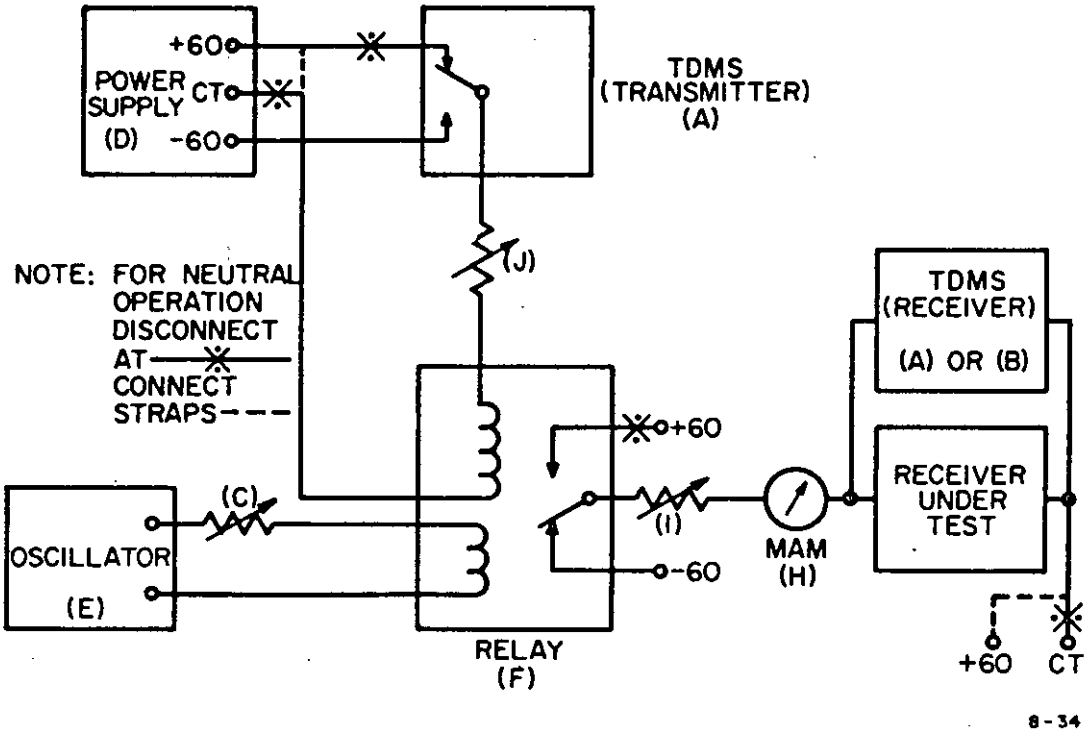


Figure 33. Measurement of receiver tolerance to cyclic distortion on start-stop teletypewriters.

Test Unit	Schematic Reference	Item No. in Appendix
Signal Generator	A	116
Fixed Resistor	B	406
Oscilloscope	C	203
Ohmmeter	D	12
Power Supply	E	556
Switch, Single-Pole	F	909
Milliammeter	G	8
Relay Holder and Connector	H	910

6.2.6.4 *Procedure.*

6.2.6.4.1 *Measurement of side stability caused by a brief pulse in the same direction as last energization.*

Step 1. Connect equipment as shown in figure 34.

Step 2. Set signal generator A for pulses of 30 V amplitude and 3 milliseconds duration with 30 milliseconds period.

NOTE. The relay will be positioned so that one outer contact touches the tongue contact.

Step 3. Ensure that ohmmeter D and oscilloscope C are connected across touching contacts.

Step 4. Record whether or not ohmmeter D is unsteady or indicates continuously.

NOTE. For more detailed observation, refer to the cathode ray oscilloscope C, which, in the absence of unwanted disturbance, will show a straight line. (The time-base should be set free-running.)

Step 5. Vary pulse generator output pulse duration slowly from 1 to 5 milliseconds.

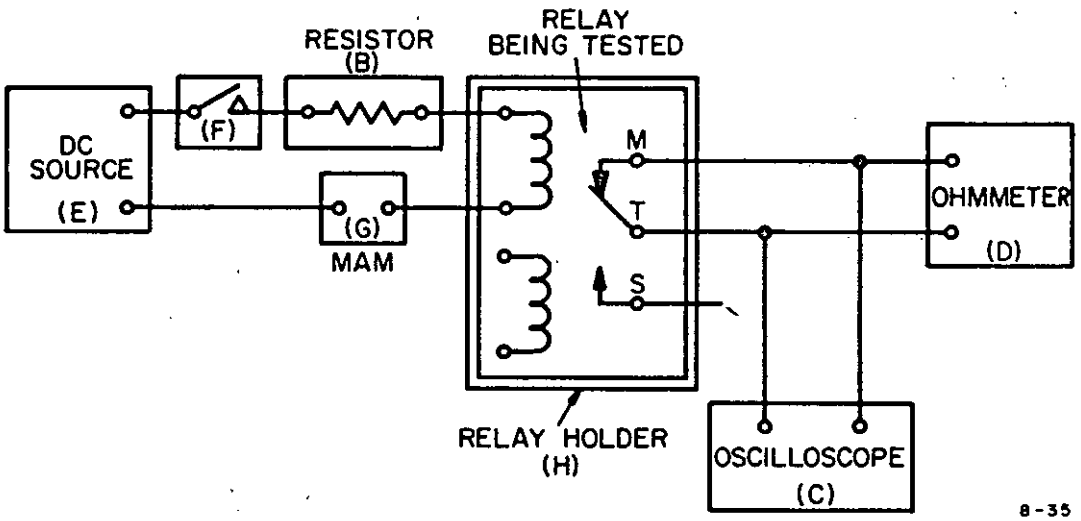


Figure 34. Measurement of contact disturbances caused by a brief pulse in the same direction as the last energization, electromechanical relays used in teletypewriters.

Step 6. Record whether or not ohmmeter D was unsteady or indicated continuously during step 5.

Step 7. Connect ohmmeter D and oscilloscope C to other outer contacts.

Step 8. Reverse relay winding connections.

Step 9. Repeat steps 2 through 6.

6.2.6.4.2 *Measurement of side stability caused by a sudden interruption of winding energization.*

Step 1. Connect equipment as shown in figure 35.

Step 2. Set adjustable dc power source E to given reading of 20 mA on milliammeter G.

Step 3. Repeatedly operate switch F.

Step 4. Record oscilloscope C disturbances during Step 3.

Step 5. Record ohmmeter D disturbances during Step 3.

Step 6. Reverse relay winding connections.

Step 7. Connect ohmmeter D and oscilloscope C to other outer contact.

Step 8. Repeat steps 2 through 5.

6.2.7 *Distortion in electromechanical relays used in teletypewriters.*

6.2.7.1 *Scope.* This method is used to measure distortion in electromechanical relays used in teletypewriters.

6.2.7.2 *Applicability.* The parameters tested shall conform to the requirements specified in the paragraph cited below:

Item	Paragraph
Distortion	5.2.18.1.3

6.2.7.3 *Apparatus.* The required test equipment is listed below:

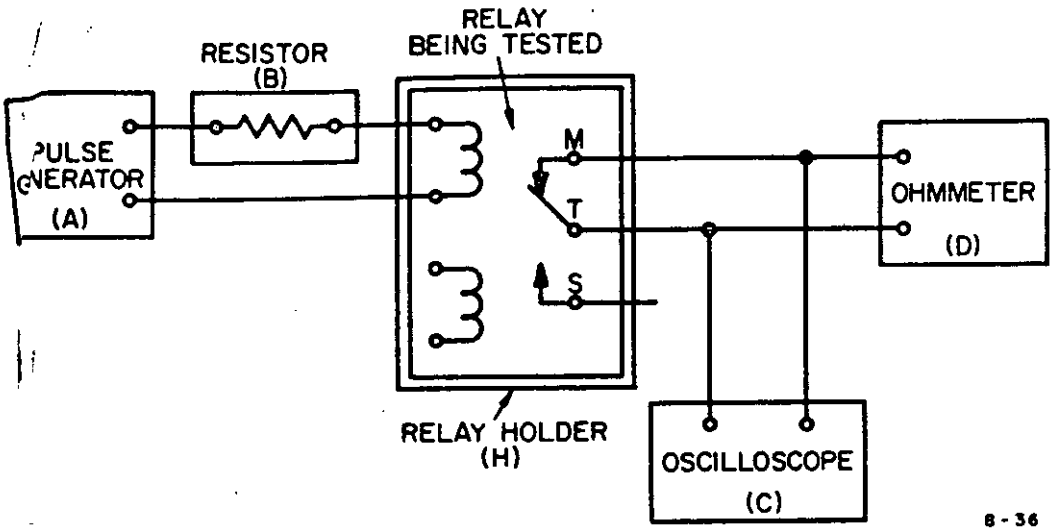


Figure 35. Measurement of contact disturbances caused by the sudden interruption of winding energization, electromechanical relays used in teletypewriters.

Test Unit	Schematic Reference	Item No. in Appendix
Telegraph Signal Generator and Synchronous Signal Displayer	A	117
Milliammeter	B	9
Relay Holder and Connector	C	910
Normal 115 V ac, 50 - 60 Hz Power Supply	D	--
Resistor	E	400
Zener-Diode Pair	F	401
Zener-Diode Pair	G	402
Resistor	H	403
Resistor	J	404
Resistor (3)	K	405
Oscilloscope	L	205
Power Source	M	555

6.2.7.4 *Procedure.*

6.2.7.4.1 *Approximate method.*

Step 1. Connect equipment as shown in figure 36.

Step 2. Set telegraph signal generator A to emit steady-state signal.

Step 3. Adjust telegraph signal generator A to produce deflection on milliammeter B of 20 mA.

NOTE. If the generator in use has the means for varying both the source voltage and the source resistance, use the combination of the highest source voltage and resistance which will give 20 mA.

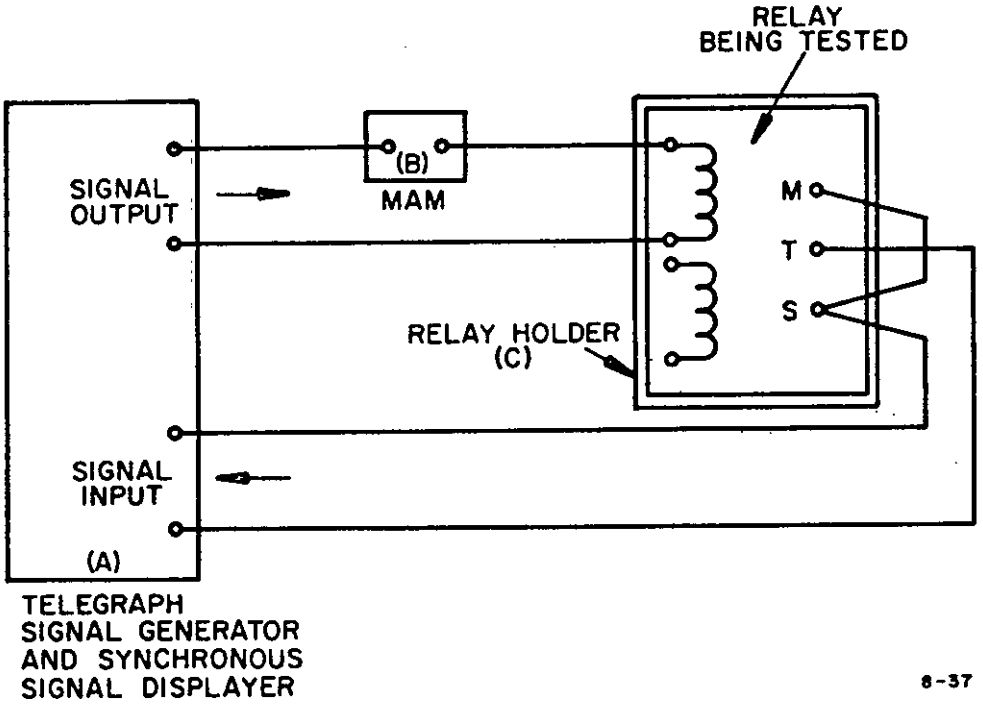


Figure 36. Approximate measurement of distortion, electromechanical relays used in teletypewriters.

Step 4. Set telegraph signal generator A to emit alternating signal elements, the alternations to be as frequent as generator will permit, provided that no interval between adjacent transitions is less than 5 milliseconds.

Step 5. Estimate and record display jitter in percent.

Step 6. If observed jitter is 2 percent or less, relay is probably in good order. Proceed with 6.2.7.4.2 to make precise measurement.

6.2.7.4.2 *More precise method.*

Step 1. Connect equipment as shown in figure 37.

Step 2. Set oscilloscope to show about 2 Hz of square wave.

Step 3. Synchronize oscilloscope using triggered mode.

Step 4. Adjust oscilloscope Y2 gain to give display about 1 to 1.5 inches high.

Step 5. Adjust oscilloscope Y1 gain to give display about 1 to 1.5 inches high.

Step 6. Use oscilloscope X-gain controls to equalize Y2 and Y1 sweep velocities.

Step 7. Use oscilloscope Y-shift control to bring center line of both displays in coincidence.

Step 8. Use oscilloscope X-shift control to bring one pair of similar transitions to coincidence.

Step 9. Record oscilloscope X-wise displacement in time between a pair of transitions in opposite sense.

NOTE. For a satisfactory relay, the displacement should not be greater than the permissible distortion specified, multiplied by 8-1/3 milliseconds. For example, if the distortion limit is 2 percent, the measured displacement should not exceed 2 percent of 8-1/3 milliseconds or 1/6 of a millisecond.

6.2.8 *Winding resistance of electromechanical relays used in teletypewriters.*

6.2.8.1 *Scope.* This method is used to measure the winding resistance of electromechanical relays used in teletypewriters.

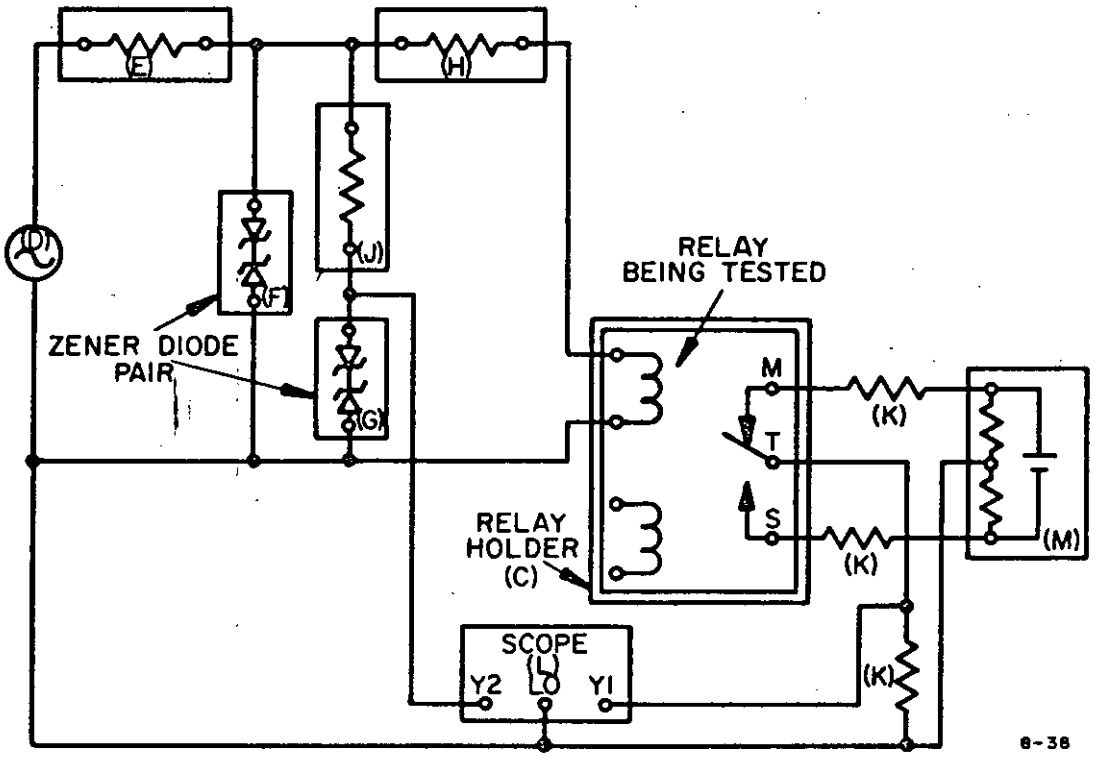


Figure 37. More precise measurement of distortion, electromechanical relays used in teletypewriters, than afforded by arrangement shown in figure 29.

6.2.8.2 *Applicability.* The parameters tested should conform to the requirements specified in the paragraph cited below:

Item	Paragraph
Windings	5.2.18.1.5

6.2.8.3 *Apparatus.* The required test equipment is listed below:

Test Unit	Schematic Reference	Item No. in Appendix
Ohmmeter	--	12

6.2.8.4 *Procedures.*

Step 1. Zero-set ohmmeter.

Step 2. Connect ohmmeter to terminals 8 and 1 of relay under test.

Step 3. Record ohmmeter reading.

Step 4. Connect ohmmeter to terminals 2 and 3 of relay under test.

Step 5. Record ohmmeter reading.

6.2.9 *Input sensitivity (operating differential) of electromechanical relays used in teletypewriters.*

6.2.9.1 *Scope.* This method is used to measure the input sensitivity (operating differential) of electromechanical relays used in teletypewriters.

6.2.9.2 *Applicability.* The parameters tested shall conform to the requirements specified in the paragraphs cited below:

Item	Paragraph
Signal levels	5.2.7
Input sensitivity	5.2.19.3

6.2.9.3 *Apparatus.* The required test equipment is listed below:

Test Unit	Schematic Reference	Item No. in Appendix
Power Source	A	551
Resistor (2)	B	407
Potentiometer	C	408
Resistor	D	409
Ohmmeter	E	12
Milliammeter	F	9
Milliammeter (2)	G	8
Resistor	H	410
Resistor	I	411
Relay Holder and Connector	J	910

6.2.9.4 *Procedures.*

6.2.9.4.1 *Measurement of input sensitivity (operating differential) polar signaling.*

Step 1. Connect equipment as shown in figure 38.

Step 2. Vary potentiometer C setting a few times from limit to limit and stop at one limit.

Step 3. Vary potentiometer C slowly towards center position while observing ohmmeter E.

Step 4. Record milliammeter F reading when ohmmeter E responds.

Step 5. Continue to vary potentiometer C setting in same direction up to limit.

Step 6. Vary potentiometer C setting slowly in other direction towards center position observing ohmmeter E.

Step 7. Record milliammeter F reading when ohmmeter E responds.

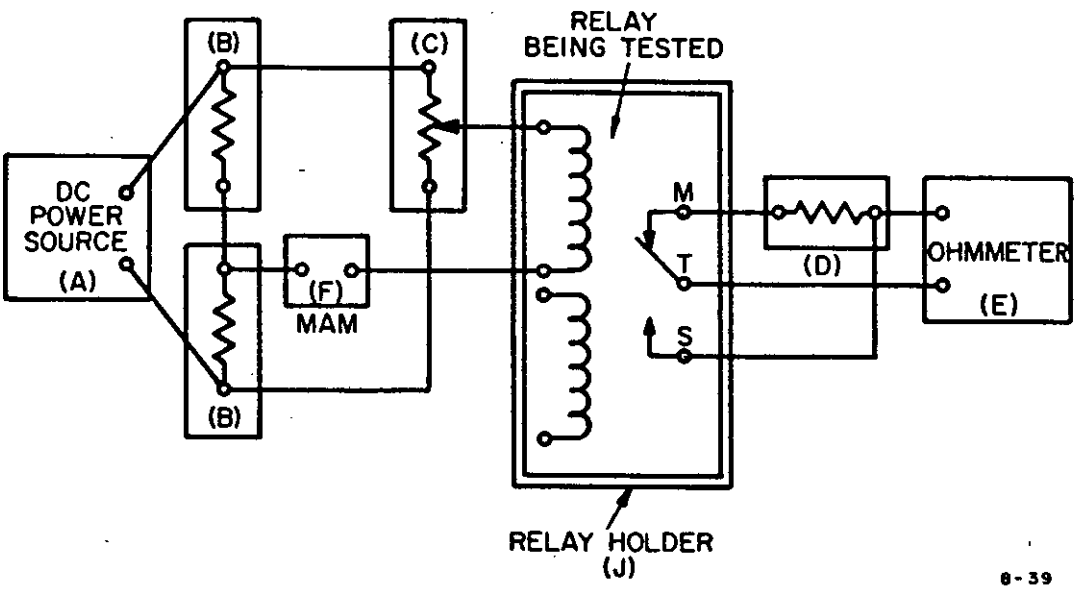


Figure 38. Measurement of operating differential--polar signaling, electromechanical relays used in teletypewriters.

NOTE. The two readings taken on milliammeter F should be between +2 mA and -2 mA.

6.2.9.4.2 *Measurement of operating differential input sensitivity neutral signaling.*

Step 1. Connect equipment as shown in figure 39.

Step 2. Set variable resistor I so that milliammeter G reads 30 mA.

Step 3. Vary potentiometer C setting a few times from limit to limit and stop at one limit.

Step 4. Vary potentiometer C slowly towards center position while observing ohmmeter E.

Step 5. Record milliammeter G reading when ohmmeter E responds.

Step 6. Continue to vary potentiometer C setting in same direction up to limit.

Step 7. Vary potentiometer C setting slowly in other direction towards center position observing ohmmeter E.

Step 8. Record milliammeter G reading when ohmmeter E responds.

NOTE. The two readings taken on milliammeter G should not differ by more than 4 mA.

If the two readings on milliammeter G are not symmetrically placed about the value of 30 mA, adjusting resistor I should make them symmetrical.

6.2.10 *Side stability of electronic relays used in teletypewriters.*

6.2.10.1 *Scope.* This method is used to measure the side stability of electronic relays used in teletypewriters.

6.2.10.2 *Applicability.* The parameters tested shall conform to the requirements specified in the paragraph cited below:

Item	Paragraph
Side stable	5.2.18.2.1

6.2.10.3 *Apparatus.* The required test equipment is listed below:

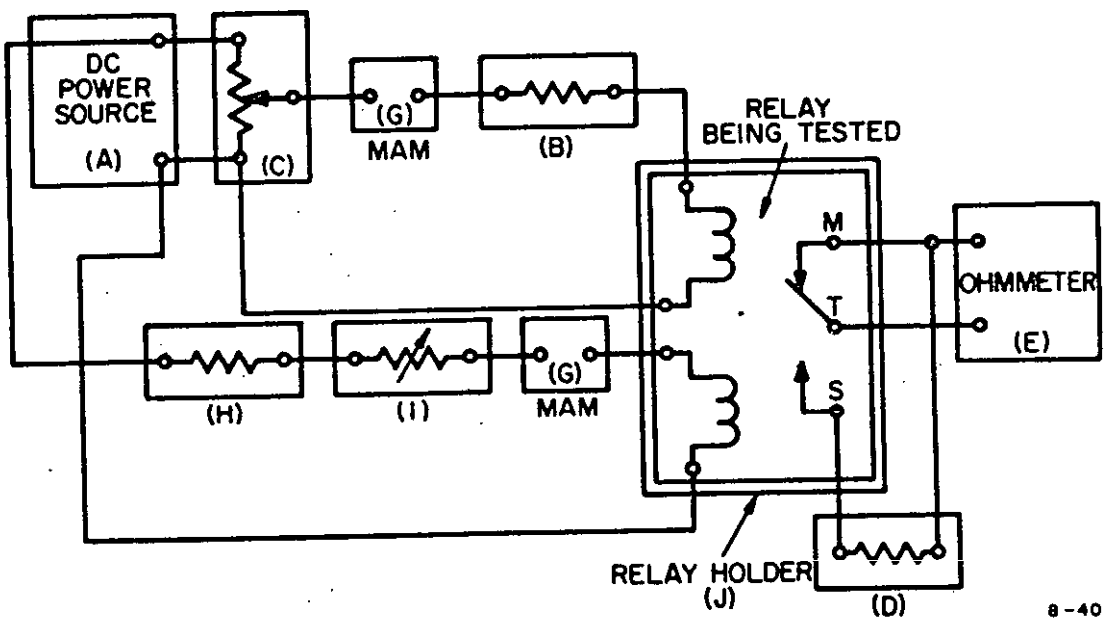


Figure 39. Measurement of operating differential--neutral signaling, electromechanical relays used in teletypewriters.

Test Unit	Schematic Reference	Item No. in Appendix
Signal Generator	A	118
Oscilloscope	B	204
Resistor	C	400
Dc Power Source	D	554
Relay Holder and Connector	E	910
Power Source	F	556
Switch, Single Throw	G	909
Milliammeter	H	8

6.2.10.4 *Procedures.*

6.2.10.4.1 *Measurement of side stability caused by a brief pulse in the same direction as last energization.*

Step 1. Connect equipment as shown in figure 40.

Step 2. Adjust signal generator A to obtain output pulses of 10 V amplitude, 100 microseconds duration, and 1000 Hz recurrence frequency.

Step 3. Adjust oscilloscope B sweep frequency to 1000 Hz.

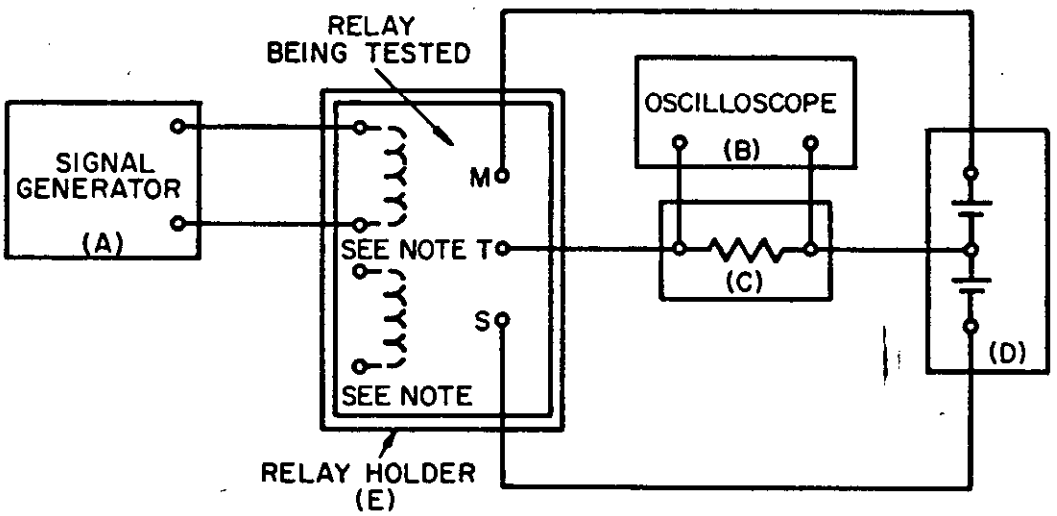
Step 4. Adjust oscilloscope B Y gain to give one inch deflection for 100 V.

Step 5. Examine trace to verify that there is no disturbance of output condition.

Step 6. Reverse the input connections to the relay under test.

Step 7. Repeat step 5.

6.2.10.4.2 *Measurement of side stability caused by sudden interruption of input current.*



NOTE: EQUIVALENT INPUT CIRCUITRY OF ELECTRONIC RELAY. 8-41

Figure 40. Measurement of output circuit disturbance caused by a brief pulse in the same direction as the last energization, electronic relays used in teletypewriters.

Step 1. Connect equipment as shown in figure 41.

Step 2. Close switch G.

Step 3. Adjust power source F to produce a reading of 29 mA on milliammeter H.

Step 4. Repeatedly operate switch and observe oscilloscope B checking to see that there is no disturbance of relay output.

Step 5. Reverse relay connections.

Step 6. Repeat step 4.

6.2.11 *Distortion in electronic relays used in teletypewriters.*

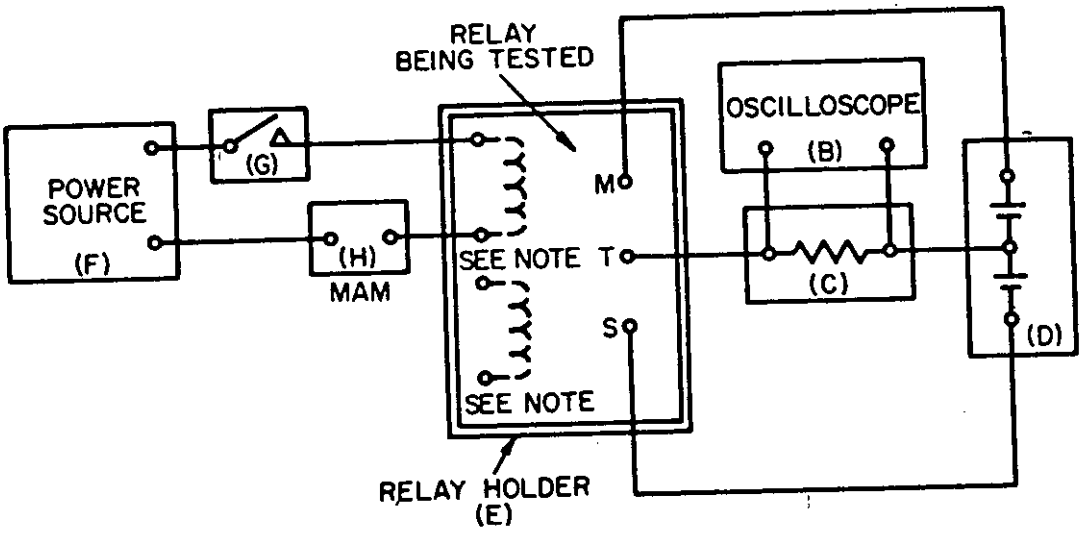
6.2.11.1 *Scope.* This method is used to measure the electronic relay distortion in teletypewriters.

6.2.11.2 *Applicability.* The parameters tested shall conform to the requirements specified in the paragraph cited below:

Item	Paragraph
Distortion	5.2.18.2.4

6.2.11.3 *Apparatus.* The requirement test equipment is listed below:

Test Unit	Schematic Reference	Item No. in Appendix
Signal Generator (Square Wave)	A	119
Resistor, Variable	B	416
Ohmmeter	C	12
Resistor	D	412
Power Source	E	554
Oscilloscope	F	205
Relay Holder	G	910



NOTE: EQUIVALENT INPUT CIRCUITRY OF ELECTRONIC RELAY.

8-42

Figure 41. Measurement of output circuit disturbance caused by a sudden interruption of the input current, electronic relays used in teletypewriters.

6.2.11.4 *Procedure.*

Step 1. Connect the equipment as shown in figure 42.

Step 2. Adjust variable resistor B (using ohmmeter C) so that total resistance of variable resistor B and relay winding is 200 ohms.

Step 3. Adjust square-wave signal generator A to deliver terminal voltage of 8 V peak-to-peak.

Step 4. Adjust square-wave signal generator A period to 200 microseconds.

Step 5. Adjust oscilloscope F sweep frequency to be locked to output of square-wave signal generator A.

Step 6. Adjust oscilloscope Y1 gain and Y2 gain to give displays about one inch high.

Step 7. Adjust oscilloscope F so that both X gains are equal.

NOTE. Bias distortion will then appear as a nonsuperimposition of the upward transitions. The separation expressed in terms of percent of the half-cycle width of the Y2 display is the magnitude of distortion. If, for example, two complete cycles are displayed in the full width of a 5-inch oscilloscope screen, the half-cycle width is 1.25 inches. The separation between upward transitions for a one-percent distortion would be 0.0125 inches. Improved accuracy may be obtained if required, by spreading the time base.

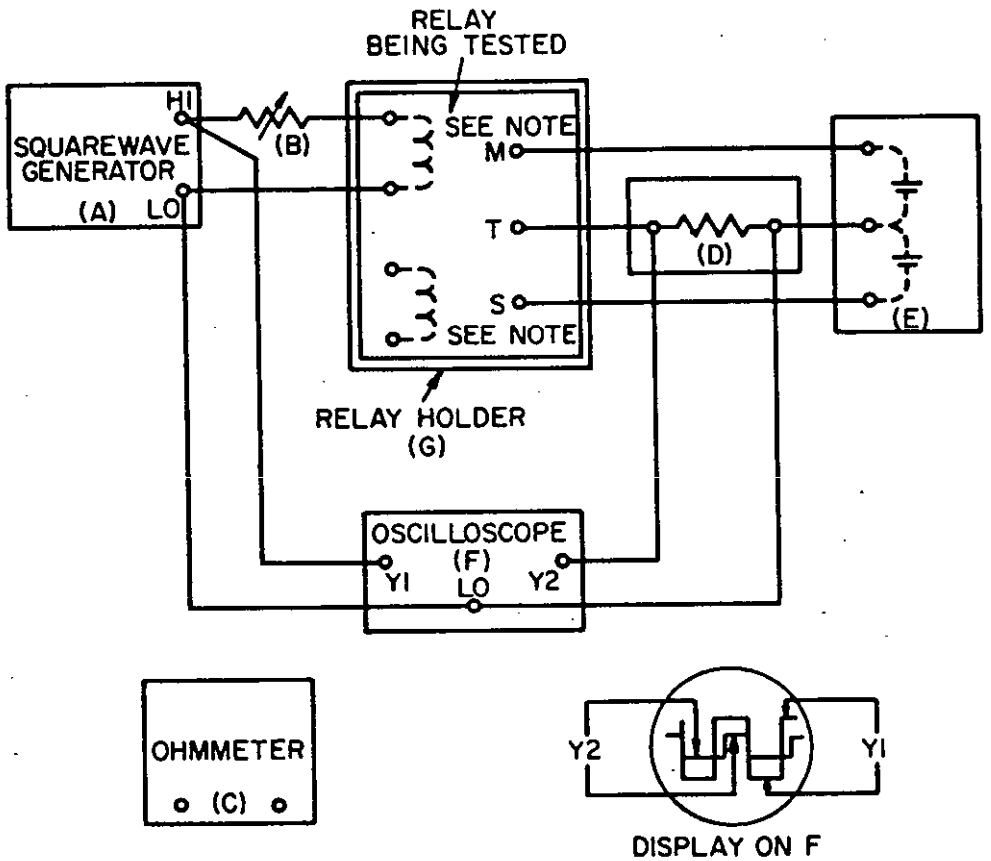
6.2.12 *Output impedance of electronic polar relays used in teletypewriters.*

6.2.12.1 *Scope.* This method is used to measure the output impedance of electronic polar relays used in teletypewriters.

6.2.12.2 *Applicability.* The parameters tested shall conform to the requirements specified in the paragraph cited below:

Item	Paragraph
Output impedance	5.2.18.2.9

6.2.12.3 *Apparatus.* The required test equipment[3] is listed below:



NOTE: EQUIVALENT INPUT CIRCUITRY OF ELECTRONIC RELAY.

8-43

Figure 42. Distortion attributable to an electronic relay used in teletypewriters.

Test Unit	Schematic Reference	Item No. in Appendix
Power Source	A	553
Switch, Double Pole, Double Throw (Manual)	B	908
Power Source	C	554
Resistor	D	412
Voltmeters (2)	E	7
Relay Holder and Connector	F	910

6.2.12.4 *Procedure.*

Step 1. Connect equipment as shown in figure 43.

Step 2. Set voltmeters E_1 and E_2 to first full-scale range beyond 260 V.

NOTE. This range setting is referred to hereafter as the "higher" scale range of the meter.

Step 3. Set switch B to one position.

Step 4. Check that one voltmeter E reads close to 260 V.

Step 5. Check that other voltmeter E has very small deflection.

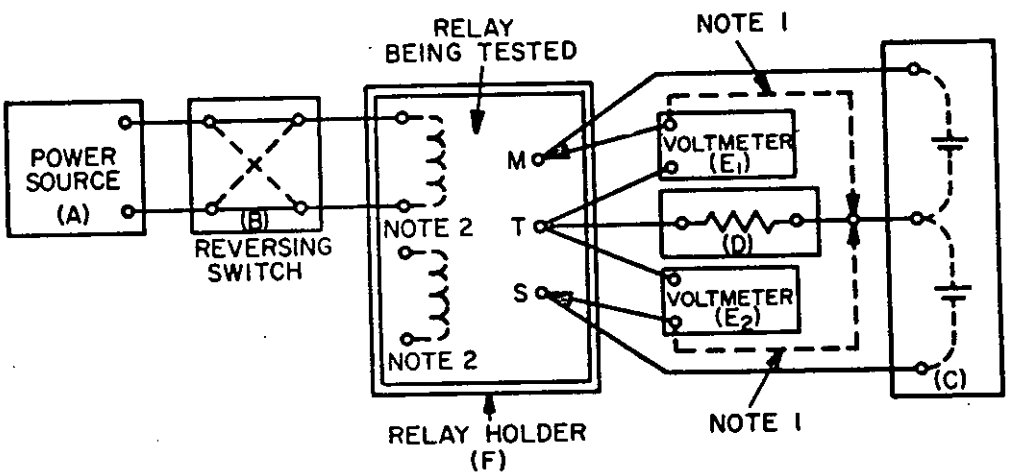
Step 6. Change range of voltmeter with small deflection to appropriate scale for accurate reading.

Step 7. Record meter (of Step 6) reading as V_R. Return the range setting to the higher scale.

Step 8. Connect other voltmeter across 850-ohm resistor D (dashed connection in figure 34).

Step 9. Record meter (of step 8) reading as V_r. Return the range setting to the higher scale.

Step 10. Calculate output impedance.



NOTES: 1. CONNECTIONS FOR MEASURING VOLTAGE ACROSS RESISTOR (D).
2. EQUIVALENT INPUT CIRCUITRY OF ELECTRONIC RELAY.

8-44

Figure 43. Measurement of output impedance, electronic polar relays used in teletypewriters.

NOTE. The output impedance R (in ohms) is equal to $\frac{V_R}{V_r}$ X 850.

Step 11. Repeat steps 1 and 2.

Step 12. Change switch B to its other position.

Step 13. Repeat steps 4 through 10.

6.2.13 *Circuit isolation in teletypewriters.*

6.2.13.1 *Scope.* This method is used to measure the circuit isolation between the input and output circuits, between the three parts of the output circuit, and between all circuits and the frame of an electric polar relay used in teletypewriters.

6.2.13.2 *Applicability.* The parameters tested shall conform to the requirements specified in the paragraph cited below:

Item	Paragraph
Circuit isolation	5.2.18.2.12

6.2.13.3 *Apparatus.* The required test equipment is listed below:

Test Unit	Schematic Reference	Item No. in Appendix
Microammeter	A	10
Microammeter	B	11
230 V ac 50 or 60-Hz Source	C	--
Resistor	D	413
Power Source	E	553
Power Source	F	550
Switch, Double Pole, Double Throw (Manual)	G	908
Variac	H	557

6.2.13.4 *Procedures.*

6.2.13.4.1 *Input/output isolation.*

Step 1. Connect equipment as shown in figure 44.

Step 2. Connect wire X to first input terminal of relay.

Step 3. Apply wire Y to first output terminal.

Step 4. Record microammeter A reading.

Step 5. Apply wire Y to second output terminal.

Step 6. Repeat step 4.

Step 7. Apply wire Y to third output terminal.

Step 8. Repeat step 4.

Step 9. Connect wire X to second input terminal or relay.

Step 10. Repeat steps 3 through 8.

NOTE. For 75 dB isolation, microammeter reading should not exceed 3.3 microamperes.

Step 11. Connect wire X to third input terminal of relay.

Step 12. Repeat steps 3 through 8.

Step 13. Connect wire X to fourth input terminal of relay.

Step 14. Repeat steps 3 through 8.

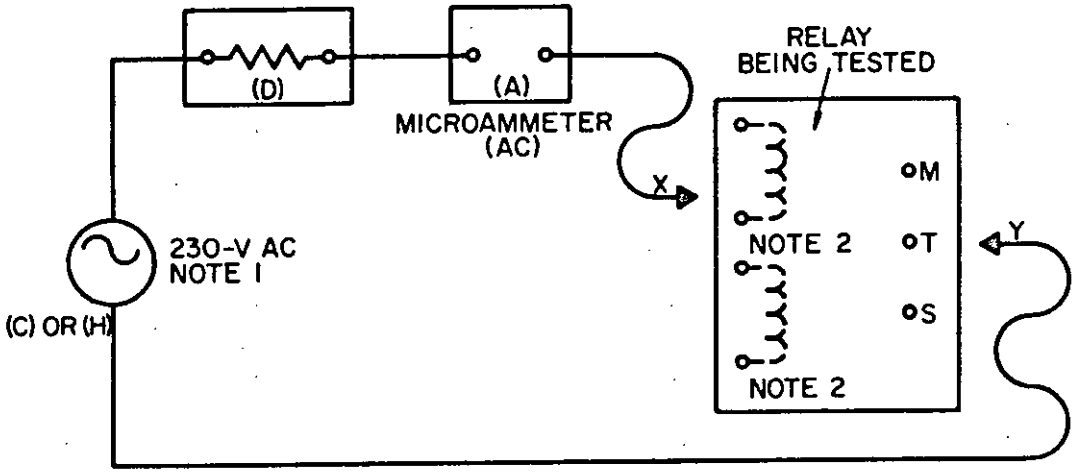
6.2.13.4.2 *Any terminal to frame.*

Step 1. Connect equipment as shown in figure 45.

Step 2. Connect wire X successively to each of seven relay terminals.

Step 3. Record microammeter A reading for each connection of step 2.

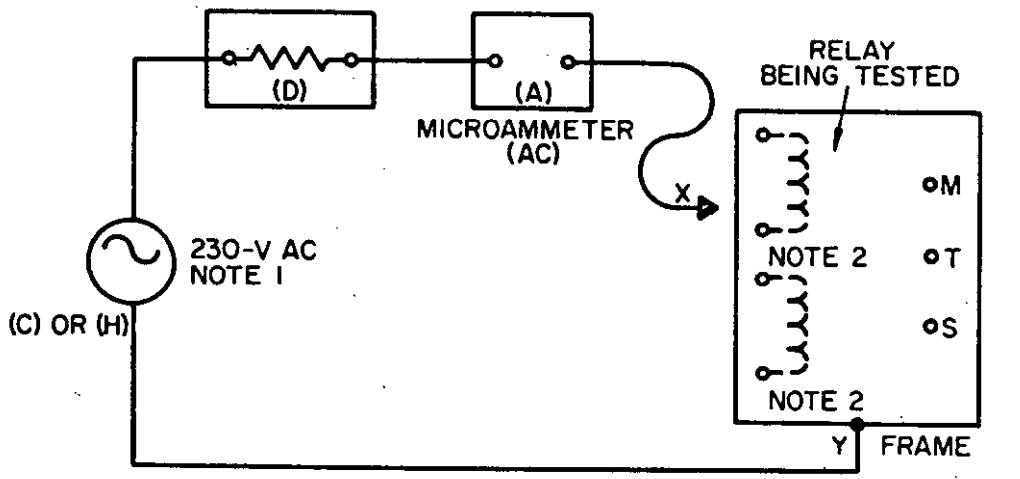
NOTE. For 75 dB isolation, microammeter reading should not exceed 3.3 microamperes.



NOTES: 1. IF 230 VOLTS AC SUPPLY IS NOT READILY AVAILABLE, USE VARIAC (ITEM 557 IN LIST OF TEST EQUIPMENT REQUIRED).
2. EQUIVALENT INPUT CIRCUITRY OF ELECTRONIC RELAY.

8-45

Figure 44. Input/output isolation, teletypewriters.



NOTES: 1. IF 230 VOLTS AC SUPPLY IS NOT READILY AVAILABLE, USE VARIAC (ITEM 557 IN LIST OF TEST EQUIPMENT REQUIRED).
2. EQUIVALENT INPUT CIRCUITRY OF ELECTRONIC RELAY.

6-46

Figure 45. Isolation--any terminals to frame--teletypewriters.

6.2.13.4.3 *Between output terminals.*

Step 1. Connect equipment as shown in figure 46.

Step 2. Set switch G to one position.

Step 3. Record microammeter B reading.

Step 4. Set switch G to other position.

Step 5. Record microammeter B reading.

NOTE. For 75 dB isolation, microammeter reading should not exceed 3.3 microamperes.

6.2.14 *Input impedance (windings) of electronic polar relays used in teletypewriters.*

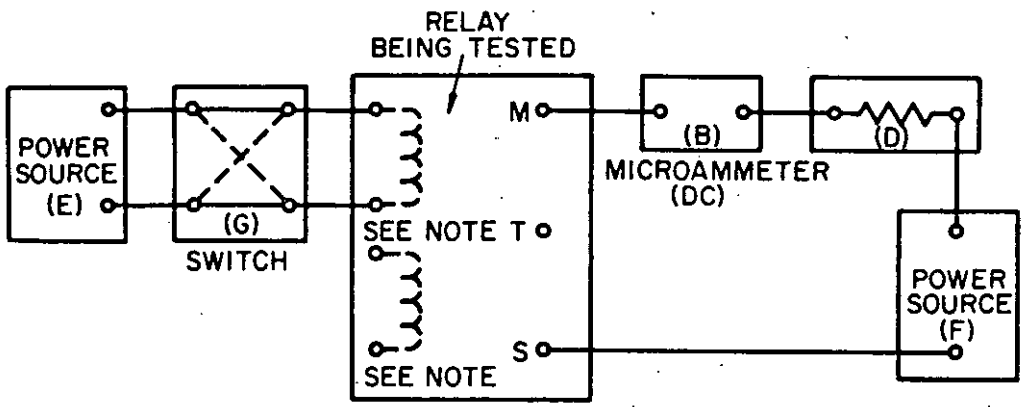
6.2.14.1 *Scope.* This method is used to measure the input impedance of electronic polar relays used in teletypewriters.

6.2.14.2 *Applicability.* The parameters tested shall conform to the requirements specified in the paragraph cited below:

Item	Paragraph
Windings	5.2.18.2.6

6.2.14.3 *Apparatus.* The required test equipment is listed below:

Test Unit	Schematic Reference	Item No. in Appendix
Signal Generator	A	119
Switch, Single-Pole Double, Throw (Manual)	B	909
Relay Holder and Connector	C	910
Resistor	D	414
Oscilloscope	E	204



NOTE: EQUIVALENT INPUT CIRCUITRY OF ELECTRONIC RELAY.

8-47

Figure 46. Isolation between output terminals, teletypewriters.

6.2.14.4 *Procedure.*

Step 1. Connect equipment as shown in figure 47.

Step 2. Set signal generator A to deliver a square wave of 3 kHz and 10 V peak-to-peak amplitude.

NOTE. The amplitude may be checked by oscilloscope E with switch B set to the left.

Step 3. Set switch B to right.

Step 4. Observe oscilloscope E display of waveform.

NOTE. This waveform should be essentially square, which indicates that no appreciable reactance exists.

Step 5. Record oscilloscope reading of peak-to-peak voltage across resistor D as V volts.

Step 6. Calculate input impedance Z.

NOTE. $Z = \frac{100}{V} - 10$

Z is in ohms

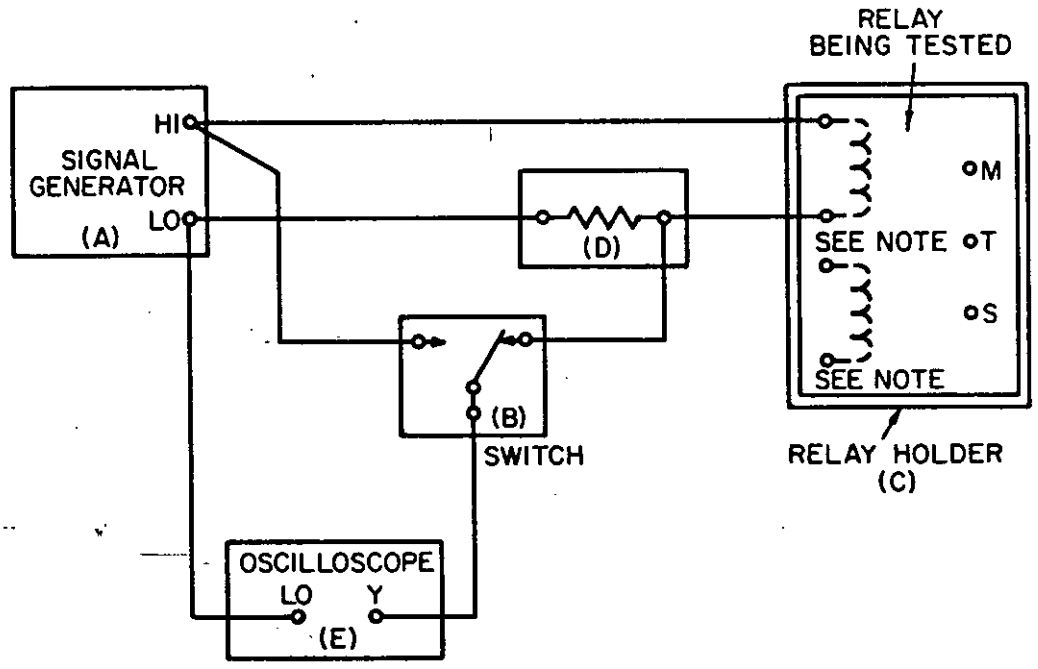
V is in volts

An impedance range of 100 to 100 ohms corresponds to a range of V between 0.9 to 0.5 volts respectively.

6.2.15 *Input sensitivity (operating differential) of electronic polar relays used in teletypewriters.*

6.2.15.1 *Scope.* This method is used to measure the input sensitivity (operating differential) electronic polar relays used in teletypewriters.

6.2.15.2 *Applicability.* The parameters tested shall conform to the requirements specified in the paragraphs cited below:



NOTE: EQUIVALENT INPUT CIRCUITRY OF ELECTRONIC RELAY.

8-48

Figure 47. Measurement of input impedance, electronic relays used in teletypewriters.

Item	Paragraph
Signal levels	5.2.7
Input sensitivity	5.2.19.3

6.2.15.3 *Apparatus.* The required test equipment is listed below:

Test Unit	Schematic Reference	Item No. in Appendix
Power Source	A	551
Resistors (2)	B	407
Potentiometer	C	408
Milliammeters (2)	D	9
Resistor	E	415
Power Source	F	552
Milliammeters (2)	G	8
Resistor	H	410
Variable Resistor	I	411
Relay Holder and Connector	J	910

6.2.15.4 *Procedure.*

6.2.15.4.1 *Measurement of input sensitivity (operating differential) polar response.*

Step 1. Connect equipment as shown in figure 48.

Step 2. Vary potentiometer C a few times from limit to limit and stop at one limit.

Step 3. Move potentiometer C slowly towards center position while watching milliammeter D_2.

Step 4. Stop potentiometer C when milliammeter D_2 responds.

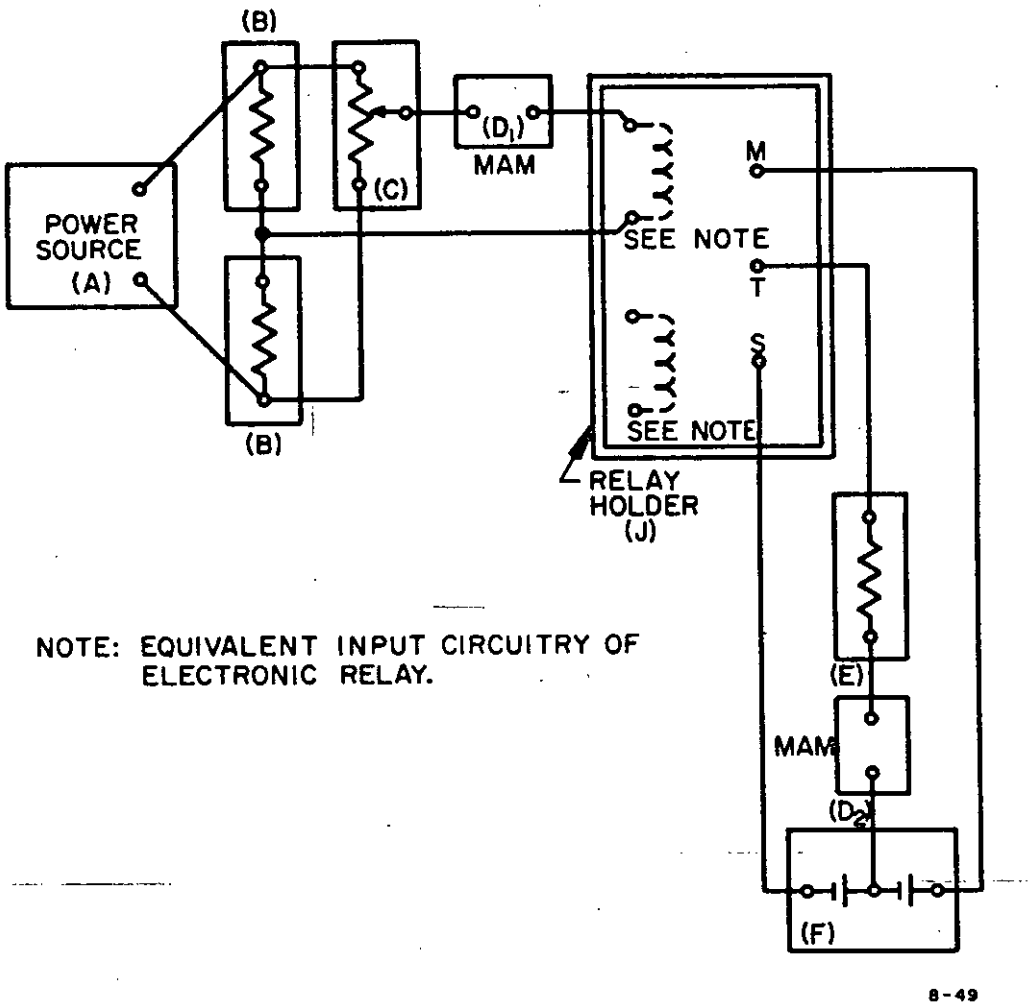


Figure 48. Measurement of operating differential--polar response, electronic relays used in teletypewriters.

Step 5. Record milliammeter D_1 reading.

Step 6. Continue to move potentiometer C in same direction to limit.

Step 7. Move potentiometer C slowly towards center position while watching milliammeter D_2.

Step 8. Repeat steps 4 and 5.

NOTE. The two readings taken on milliammeter D_1 should be between +2 mA and -2 mA.

6.2.15.4.2 *Measurement of input sensitivity (operating differential), neutral response.*

Step 1. Connect equipment as shown in figure 49.

Step 2. Adjust variable resistor I so that milliammeter G_2 reads 30 mA.

Step 3. Vary potentiometer C a few times from limit to limit and stop at one limit.

Step 4. Move potentiometer C slowly towards center position, while watching dc milliammeter D.

Step 5. Stop potentiometer C when milliammeter D responds.

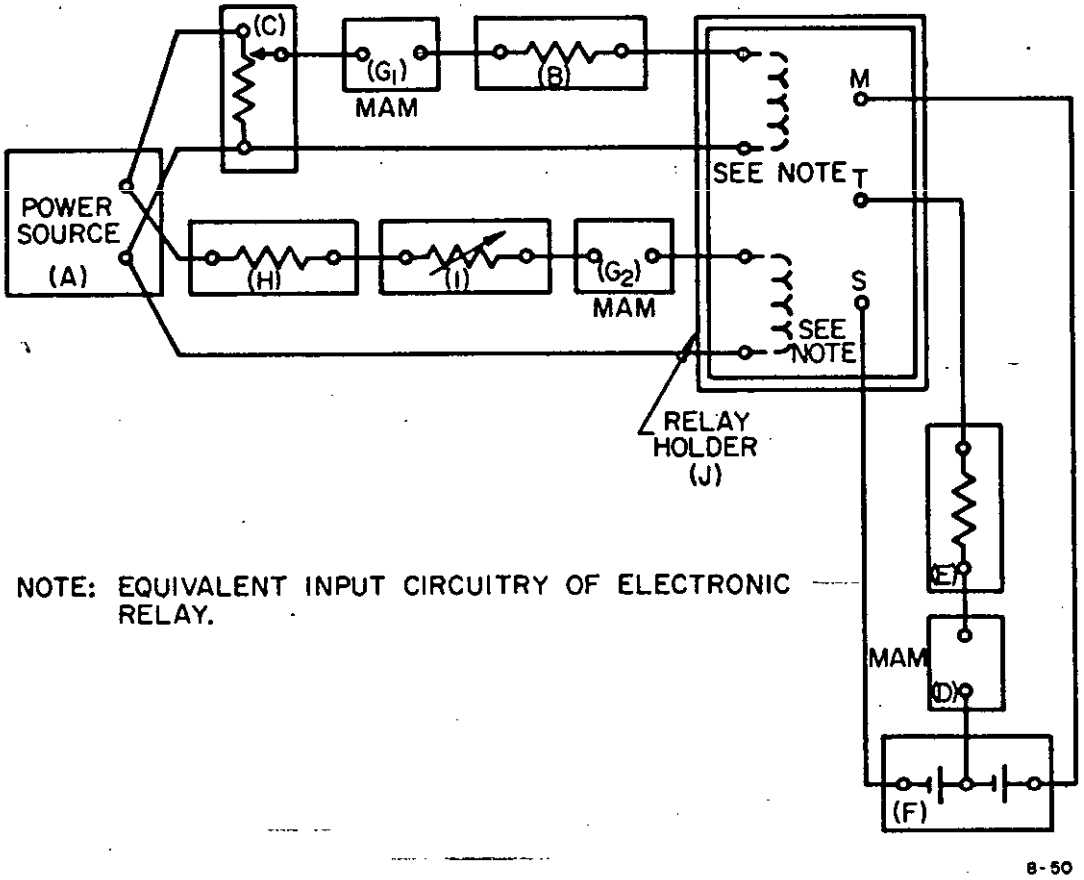
Step 6. Record milliammeter G_1 reading.

Step 7. Continue to move potentiometer C in same direction to limit.

Step 8. Move potentiometer C slowly towards center position while watching milliammeter D.

NOTE. The two readings taken on milliammeter G_1 should not differ by more than 4 mA.

If the two readings on milliammeter G_1 are not symmetrically placed about the value 30 mA, ensure that by adjusting variable resistor I they can be made symmetrical.



NOTE: EQUIVALENT INPUT CIRCUITRY OF ELECTRONIC RELAY.

Figure 49. Measurement of operating differential--neutral response, electronic relays used in teletypewriters.

6.2.16 *Dc input/output characteristics of synchronous regenerative repeaters.*

6.2.16.1 *Scope.* This method is used to measure input/output characteristics of synchronous regenerative repeaters.

6.2.16.2 *Applicability.* The parameters tested shall conform to the requirements specified in the paragraph cited below:

Item	Paragraph
Dc input/output characteristics	5.11.1.1

6.2.16.3 *Apparatus.* The required test equipment is listed below:

Test Unit	Schematic Reference	Item No. in Appendix
Data Signal/Distortion Generator	A	1121
Dual Trace Oscilloscope	B	282

6.2.16.4 *Procedure.*

Step 1. Connect the equipment as shown in figure 50.

Step 2. Connect a data signal generator to the input of the repeater.

Step 3. Monitor both the signal generator and the output of the repeater with a dual-trace oscilloscope.

Step 4. Set the data signal generator to produce ±6 V low level signals of unit interval.

6.2.16.5 *Results.* The output shall be ±6 V low level signals similar to the input.

6.2.17 *Modulation rate coverage of synchronous regenerative repeaters.*

6.2.17.1 *Scope.* This method is used to measure the modulation rate coverage of synchronous regenerative repeaters.

6.2.17.2 *Applicability.* The parameters tested shall conform to the requirements specified in the paragraph cited below:

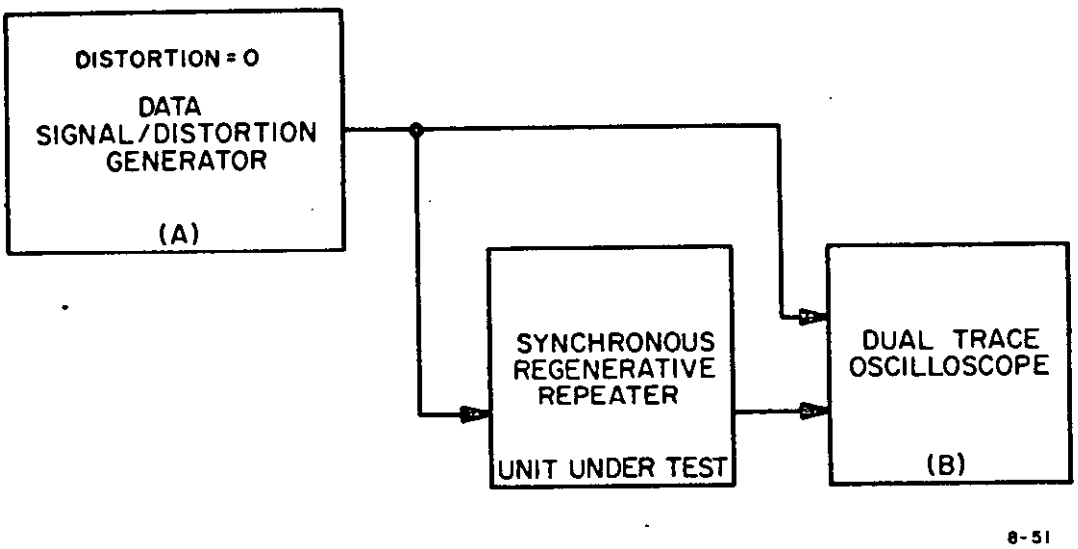


Figure 50. Test setup for dc input/output characteristics of synchronous regenerative repeaters.

Item	Paragraph
Modulation rate coverage	5.11.1.2

6.2.17.3 *Apparatus.* The required test equipment is listed below:

Test Unit	Schematic Reference	Item No. in Appendix
Data Signal/Distortion Generator	A	1121
Dual Trace Oscilloscope	B	282
Clock Generator	C	133
Switch	D	9113

6.2.17.4 *Procedure.*

Step 1. Connect the equipment as shown in figure 51.

Step 2. Vary the data signal rate to determine the maximum and minimum rate for proper operation.

Step 3. Repeat this procedure for an externally clocked repeater.

6.2.17.5 *Result.* The range of rates for proper operation shall be from 25 to 50,000 bauds for both the internally and externally clocked repeater.

6.2.18 *Equipment propagation delay time of synchronous regenerative repeaters.*

6.2.18.1 *Scope.* This method is used to measure the equipment delay time of the synchronous regenerative repeater.

6.2.18.2 *Applicability.* The parameters tested shall conform to the requirements specified in the paragraph cited below:

Item	Paragraph
Equipment propagation delay time	5.11.1.4

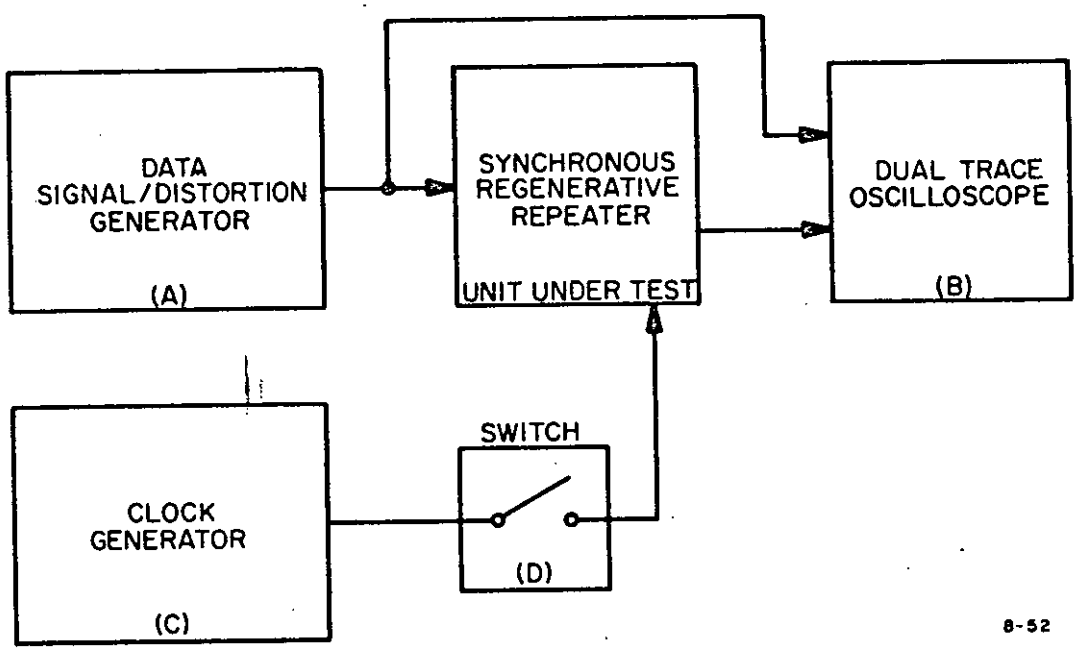


Figure 51. Test setup for modulation rate, equipment delay time, distortion, and distortion alarm of synchronous regenerative repeaters.

6.2.18.3 *Apparatus.* The required test equipment is listed below:

Test Unit	Schematic Reference	Item No. in Appendix
Data Signal/Distortion Generator	A	1121
Dual Trace Oscilloscope	B	282
Clock Generator	C	133
Switch	D	9113

6.2.18.4 *Procedure.*

Step 1. Connect the equipment as shown in figure 51.

Step 2. Vary the data signal rate over the entire operational range. Note the relative delay between the input and output of the repeater.

Step 3. Repeat this procedure for an externally clocked repeater.

6.2.18.5 *Results.* An internal equipment propagation delay time of greater than one-half and less than two unit intervals at the applicable modulation rate is desired.

6.2.19 *Distortion in synchronous regenerative repeaters.*

6.2.19.1 *Scope.* This method is used to measure the distortion of synchronous regenerative repeaters.

6.2.19.2 *Applicability.* The parameters tested shall conform to the requirements specified in the paragraph cited below:

Item	Paragraph
Distortion	5.11.1.6

6.2.19.3 *Apparatus.* The required test equipment is listed below:

Test Unit	Schematic Reference	Item No. in Appendix
Data Signal/Distortion Generator	A	1121
Dual Trace Oscilloscope	B	282
Clock Generator	C	133
Switch	D	9113

6.2.19.4 *Procedure.*

Step 1. Connect the equipment as in figure 51.

Step 2. Vary the distortion through the range 49% M-49% S and the input signal rate through its operational range. Note the points at which the repeater no longer operates properly.

Step 3. Repeat this procedure for an externally clocked repeater, ensuring that the input modulation rate and the clock signals are within 1 percent of each other.

6.2.19.5 *Results.* The repeater, whether or not internally or externally clocked, shall operate properly throughout its range of input signal rates and through the 49% M-49% S range of distortion:

Distortion	Mark (%)	Space (%)
Switched Bias	49	49
Bias	49	49
Cyclic	49	49
Fortuitous	49	49

6.2.20 *Distortion alarm in synchronous regenerative repeaters.*

6.2.20.1 *Scope.* This method is used to confirm inclusion of the distortion alarm in synchronous regenerative repeaters.

6.2.20.2 *Applicability.* The parameters tested shall conform to the requirements specified in the paragraph cited below:

Item	Paragraph
Distortion alarm	5.11.1.6

6.2.20.3 *Apparatus.* The required test equipment is listed below:

Test Unit	Schematic Reference	Item No. in Appendix
Data Signal/Distortion Generator	A	1121
Dual Trace Oscilloscope	B	282
Clock Generator	C	133
Switch	D	9113

6.2.20.4 *Procedure.*

Step 1. Connect the equipment as shown in figure 51.

Step 2. Vary the distortion (both mark and space) until the repeater alarm is activated. Find these points over the entire range of acceptable input signal rates. Note the state of the repeater under alarm conditions.

Step 3. Repeat this procedure for an externally clocked repeater, ensuring that the input modulation rate and the clock signals are within 1 percent of each other.

6.2.20.5 *Result.* The alarm of the repeater, whether or not internally or externally clocked, shall be activated, and the output shall assume a marking state, when the input signal exceeds a distortion figure of 49 percent for a three second period.

6.2.21 *Control signals in synchronous regenerative repeaters.*

6.2.21.1 *Scope.* This method is used to confirm proper operation of control signals in synchronous regenerative repeaters.

6.2.21.2 *Applicability.* The parameters tested shall conform to the requirements specified in the paragraphs cited below:

Item	Paragraph
Control signals, externally clocked	5.11.2.1.2
Control signals, internally clocked	5.11.2.2.2

6.2.21.3 *Apparatus.* The required test equipment is listed below:

Test Unit	Schematic Reference	Item No. in Appendix
Data Signal/Distortion Generator	A	1121
Dual Trace Oscilloscope	B	282
Clock Generator	C	133
Switch (externally clocked)	D	9114
Switch (internally clocked)	D	9113
Phase Shifter	E	373

6.2.21.4 *Procedures.*

Step 1. Control signals-- externally clocked. Connect the equipment as shown in figure 52. Set the clock modulation rate at twice the signal modulation rate. Mark the occurrences of the clock signals on the face of the oscilloscope. Remove the clock signal from the oscilloscope and replace it with the repeater output signal. By means of the phase shifter, vary the input signal/clock phase relationship. By noting the relationship of the input signal and the occurrences of the clock signals, determine the maximum phase shift, early and late, that the repeater can withstand while maintaining proper operation. Note the phase relationship between the output signal and the clock signal.

Step 2. Control signals-- internally clocked. Connect the equipment as shown in figure 53, with a switch in the output of the data signal generator open. Determine the amount of time necessary to obtain proper repeater operation after the closure of the switch. Determine this time over the entire range of acceptable input signal rates.

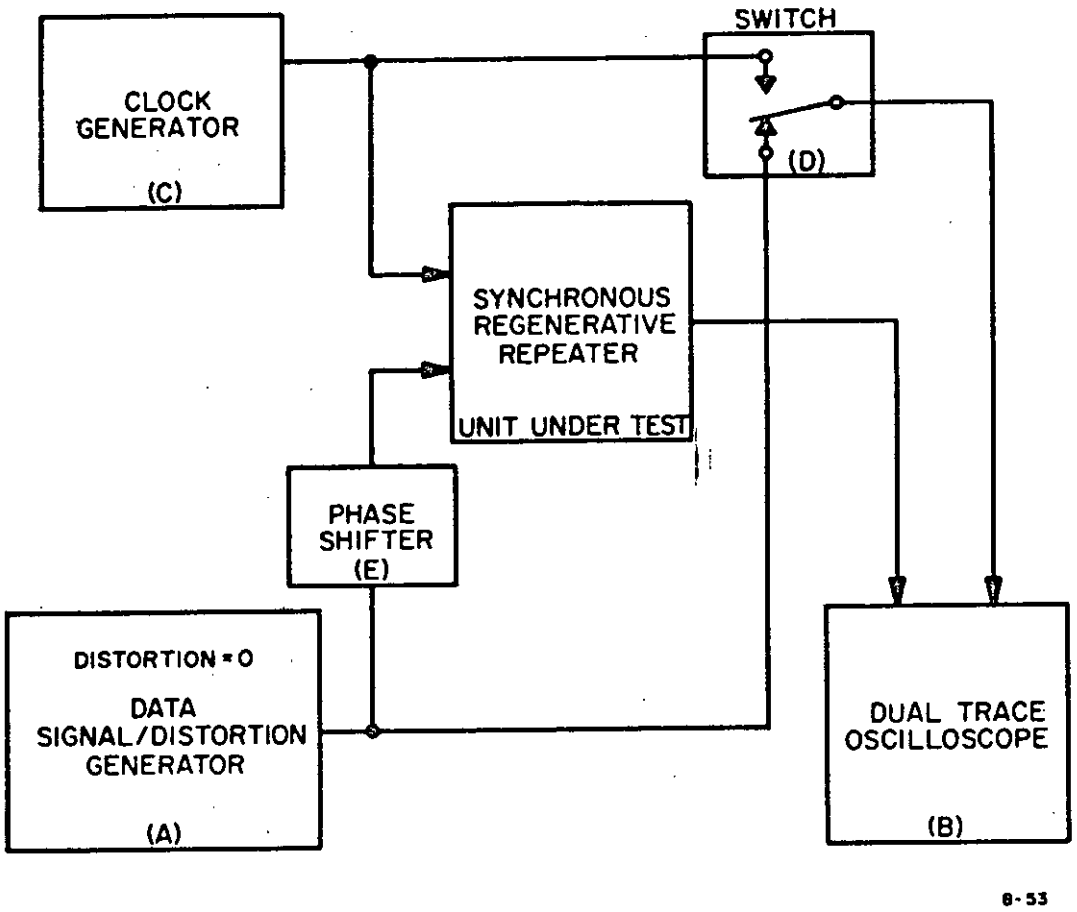


Figure 52. Test setup for control signals, internally clocked, and frequency control stability of synchronous regenerative repeaters.

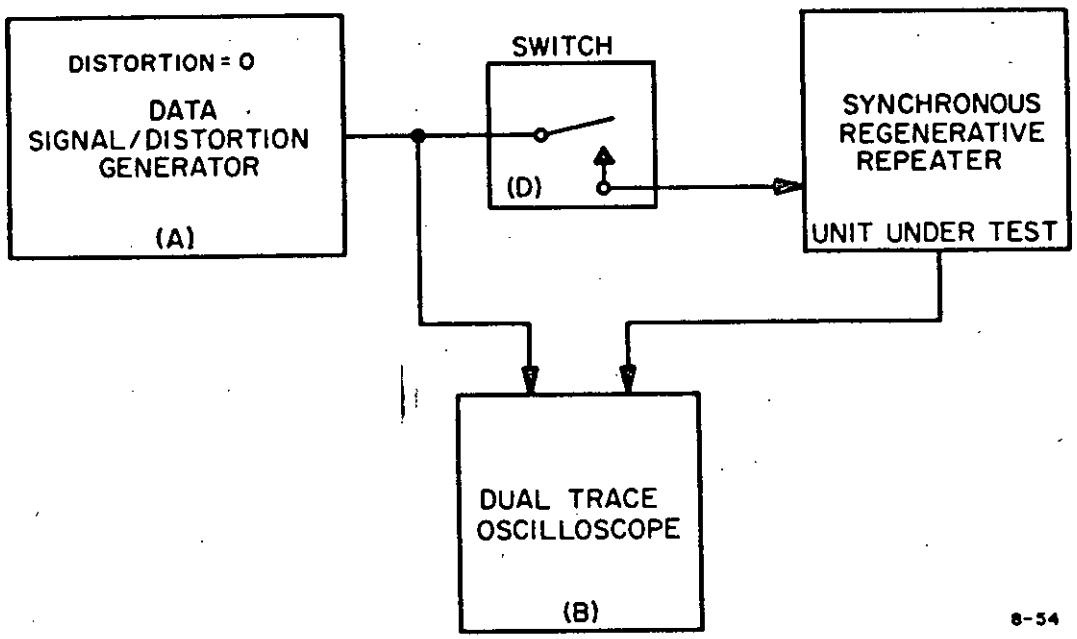


Figure 53. Test setup for control signals, externally clocked, of synchronous regenerative repeaters.

6.2.21.5 *Results.*

6.2.21.5.1 *Control signals--externally clocked.* The repeater shall operate properly as the phase of the input signal is shifted 270 degrees early and late, from the clock phase. The output shall maintain the phase of the clock.

6.2.21.5.2 *Control signals--internally clocked.* The repeater shall obtain proper operation within five seconds after receipt of the input signal.

6.2.22 *Frequency control stability of synchronous regenerative repeaters.*

6.2.22.1 *Scope.* This method is used to measure the frequency control stability of the regenerative repeaters.

6.2.22.2 *Applicability.* The parameters tested shall conform to the requirements specified in the paragraph cited below:

Item	Paragraph
Frequency control stability	5.11.2.2.3

6.2.22.3 *Apparatus.* The required test equipment is listed below:

Test Unit	Schematic Reference	Item No. in Appendix
Data Signal/Distortion Generator	A	1121
Dual Trace Oscilloscope	B	282
Switch	C	9113

6.2.22.4 *Procedure.*

Step 1. Connect the equipment as shown in figure 53. Monitor the clock and the input signal with the oscilloscope.

Step 2. Set the generator at 50 kilobaud. Mark the transition points of the repeater output on the face of the receiver to establish the clock timing and, therefore, the unit interval. Also mark the transition points of the input signal on the face of the receiver to establish the initial input signal/clock phase relationship. Open the input circuit for a short period of time. Upon reclosing the circuit, again determine the input signal/clock phase relationship. Calculate the

deviation of this relationship from the initial relationship in terms of a percentage of the unit interval. Using this method, determine the open circuit time period which will result in a 4 percent deviation. Repeat this procedure for lower modulation rates.

6.2.22.5 *Results.* For an input signal/clock phase relationship deviation of 4 percent, the allowable open input circuit time shall be 1 second or greater at 50 kilobaud per second. This time shall be even greater (inversely proportional to the modulation rate) at lower modulation rates.

7. TEST METHODS, COMPUTER TERMINAL DIGITAL END INSTRUMENTS

7.1 *General.* This section contains operational test methods for computer terminal digital end instruments to verify performance standards described in section 5. All of the tests in this section assume the general terminal configuration shown in figure 54. The digital end instrument under test will be set up and tested as a peripheral device off of a communications computer processor which has met the provisions and intent of DCAC 370-D195-1, DCAC 370-D195-2, and DCAC 370-D195-3. The services of a Government-approved data processing installation shall be required to create and to verify the test messages described in this section. The tests described in this section are listed below:

Test Method Number	Subject	Paragraph
7.2.1	Code compatibility of punched card readers and punches	5.3.3 5.4.4.1
7.2.2	Modulation rate of punched card readers	5.3.1.2
7.2.3	Alarm stop circuit of punched card readers	5.3.4.2
7.2.4	Offset tracking control circuit of punched card readers and punches	5.3.4.5 5.4.2.7
7.2.5	Modulation rate of card punches	5.4.1.5
7.2.6	Operator alarm of card punches	5.4.2.8
7.2.7	Off-line mode capability of card punches	5.4.1.5
7.2.8	Record block length of magnetic test equipment	5.5.3
7.2.9	Character packing density of magnetic tape equipment	5.5.3.2a-b
7.2.10	Physical characteristics of tape reels and magnetic tape	5.5.3.3
7.2.11	Indicators used in magnetic tape equipment	5.5.3.5.1-3
7.2.12	Controls used in magnetic tape equipment	5.5.5.2.1-5
7.2.13	Speed of paper tape punches and readers	5.6

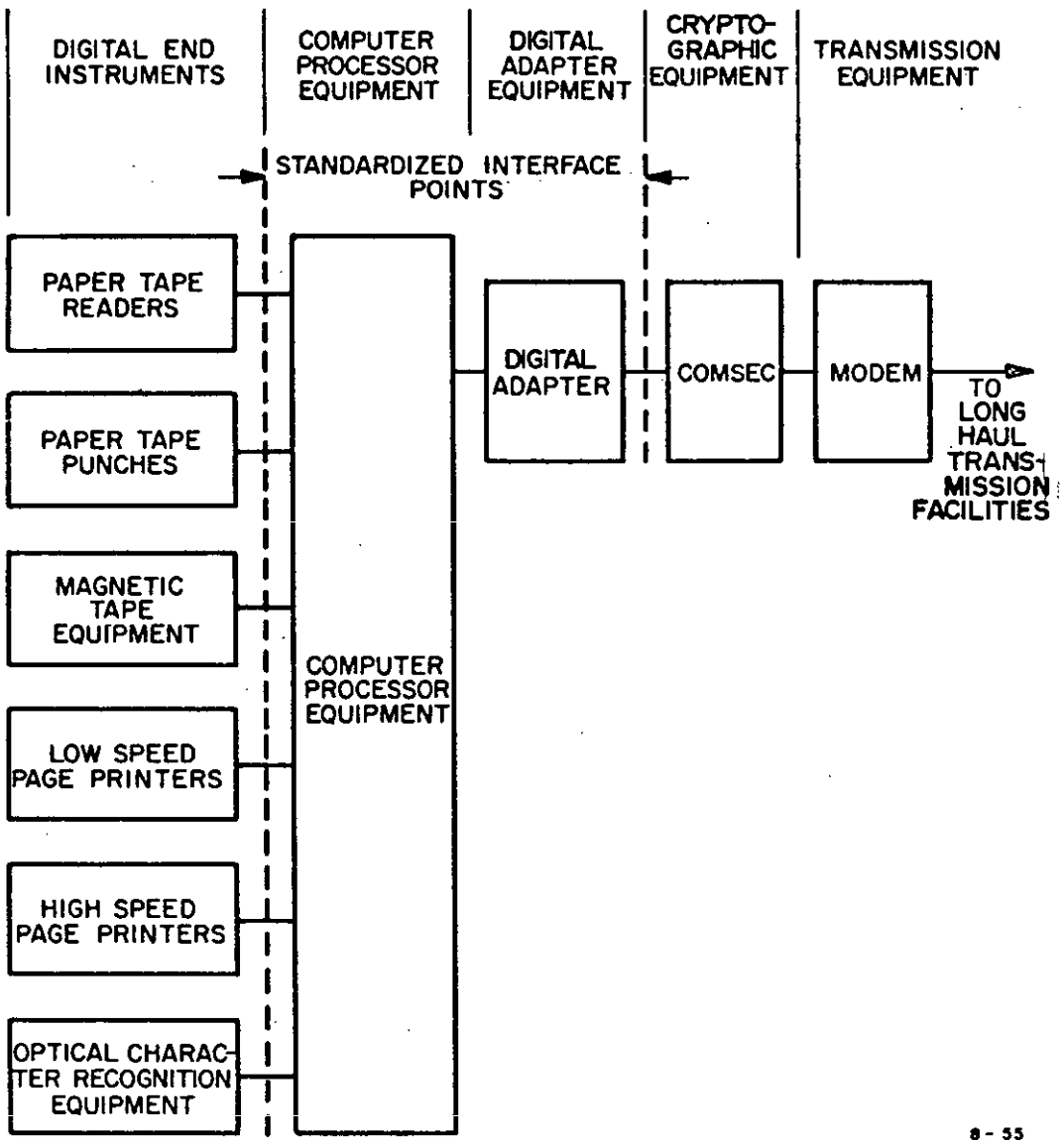


Figure 54. Typical computer terminal setup.

Test Method Number	Subject	Paragraph
7.2.14	Coded character set for paper tape readers and punches	5.6.1.1 5.7.1.1
7.2.15	Indicators used in paper tape punches and readers	5.6.2.3-5 5.7.2.4-6 5.7.2.9-11
7.2.16	Printing speed of low speed page printers	5.8.1
7.2.17	Character set used in low speed page printers	5.8.2.1
7.2.18	Media of low speed page printers	5.8.3.1 5.8.3.3-4
7.2.19	Indicators used in low speed page printers	5.8.3.6 5.8.3.7
7.2.20	Speed of high speed line printers	5.9.4.1
7.2.21	Codes/formats/character sets	5.9.4.2
7.2.22	Speed of optical character recognition equipment	5.10.3.1
7.2.23	Codes/formats/character sets of optical character recognition equipment	5.10.3.2
7.2.24	Controls to operate optical character recognition equipment	5.10.3.3a-e
7.2.25	Indicators used on optical character recognition equipment	5.10.4a-b

7.2 *Description of test methods.* The test methods provide step-by-step procedures to be followed for testing computer terminal digital end instrument equipment characteristics. Test setups are given and the required testing apparatus is assigned a reference item number. The appendix lists the operating characteristics of the required test apparatus correlated to the specified reference number. In general, the test methods do not repeat the standard values specified in section 5. These values are repeated, however, where necessary to clarify a step. Reference should be made to the paragraphs in section 5 cited in the test method.

7.2.1 *Code compatibility of punched card readers and punches.*

7.2.1.1 *Scope.* This method is used to determine the code compatibility of punched card readers and punches.

7.2.1.2 *Applicability.* The parameters tested shall conform to the requirements specified in the paragraphs cited below:

Item	Paragraph
Code compatibility	5.3.3
Card punching	5.4.4.1

7.2.1.3 *Apparatus.* See 7.1, *General.* Test message A-1 (fig. 55) is required.

7.2.1.4 *Procedure.*

Step 1. Load the card reader with test message A-1.

Step 2. With the terminal placed in a self-test mode, transmit the test message to the card punch.

Step 3. Physically compare the received cards with the original test message.

7.2.1.5 *Results.* The message text received shall be identical with that transmitted.

7.2.2 *Modulation rate of punched card readers.*

7.2.2.1 *Scope.* This method is used to measure the modulation rate of punched card readers.

7.2.2.2 *Applicability.* The parameters tested shall conform to the requirements specified in the paragraph cited below:

Item	Paragraph
Modulation rate	5.3.1.2

7.2.2.3 *Apparatus.* See 7.1, *General.* Test message A-2 (fig. 56) is required.

7.2.2.4 *Procedure.*

Step 1. Place test message A-2 in the input hopper.

(MULTI-CARD)

RCCUTESTΔRU_____ØØØ1Δ_____ΔØ1ØØ-UUUU--RU_____.

-UNCLAS-THISΔISΔAΔTESTΔ_____Δ

ØØ1ΔABCΔDEFΔGHIΔJKLΔMNOΔPQRΔSTUΔVWXΔYZØΔ123Δ456Δ789Δ#%&Δ,-.Δ/<>Δ[~Λ*ΔMSGΔNOΔB-01

(TEXT LINE ØØ1 TO BE REPEATED 96 TIMES WITH EACH LINE SEQUENTIALLY NUMBERED IN THE FIRST THREE CHARACTER POSITIONS.)

RCCUTESTΔRU_____ØØØ1Δ_____ΔØ1ØØ UUUUΔ_____ΔNNNN

8-56

Figure 55. Test message A-1.

(MULTI-CARD)

RCCUTESTΔRU_____ØØØ1Δ_____Δ025Ø-UUUU--RU_____.

-UNCLAS-THISΔISΔAΔTESTΔ_____Δ

ØØ1ΔABCΔDEFΔGHIΔJKLΔMNOΔPQRΔSTUΔVWXΔYZØΔ123Δ456Δ789Δ#%&Δ,-.Δ/<>Δ[~Δ*ΔMSGΔNOΔB-01

(TEXT LINE ØØ1 TO BE REPEATED 246 TIMES WITH EACH LINE SEQUENTIALLY NUMBERED IN THE FIRST THREE CHARACTER POSITIONS.)

RCCUTESTΔRU_____ØØØ1Δ_____Δ025Ø UUUUΔ_____ΔNNNN

8-57

Figure 56. Test message A-2.

Step 2. Place reader in the self-test mode and run for 60 seconds.

Step 3. Count the number of cards and compare with the number of cards specified below:

Baud	No of cards
150	13
300	26
600	53
1200	106
2400	213

7.2.2.5 *Results.* The total number of cards read in 60 seconds must equal or exceed the figure listed at the applicable baud rate.

7.2.3 *Alarm stop circuit of punched card readers.*

7.2.3.1 *Scope.* This method is used to determine proper operation of the alarm stop circuit of punched card readers.

7.2.3.2 *Applicability.* The parameters tested shall conform to the requirements specified in the paragraph cited below:

Item	Paragraph
Alarm stop circuit	5.3.4.2

7.2.3.3 *Apparatus.* See 7.1, *General.* Test messages A-1 (fig. 55) and A-3 (fig. 57) are required.

7.2.3.4 *Procedure.*

Step 1. Simulate motion fail by disabling sensor. Clear machine after stop.

Step 2. Load approximately one-half of message A-1 in input hopper. Transmit message with terminal in self-test mode. After stop, place remainder of message A-1 in input hopper. Restart using the manufacturer's procedure.

(MULTI-CARD)

RCCUTESTΔRU_____ØØØ1Δ_____ΔØ1ØØ-UUUU--RU_____.

-UNCLAS-THISΔISΔAΔTESTΔ_____Δ

ØØ1ΔABCΔDEFΔGHIΔJKLΔMNOΔPQRΔSTUΔVWXΔYZØΔ123Δ456Δ789Δ#%&Δ,-.Δ/<>Δ[~Δ*ΔMSGΔNOΔB-01

(TEXT LINE ØØ1 TO BE REPEATED 96 TIMES WITH EACH LINE SEQUENTIALLY NUMBERED IN THE FIRST THREE CHARACTER POSITIONS.)

RCCUTESTΔRU_____ØØØ1Δ_____ΔØ1ØØ UUUUΔ_____ΔNNNN

(Note: Lace text card Ø1Ø)

8-58

Figure 57. Test message A-3.

Step 3. Load message A-1 in input hopper. Fill stacker to within one-half inch of full condition and transmit message to card punch in terminal self-test mode. Empty stacker after stop and complete transmission of message.

Step 4. Load test message A-3 in input hopper. Transmit cards to card punch with terminal in self-test mode.

7.2.3.5 *Results.* The reader shall signal an alarm condition under the conditions listed below:

(a) Loss of card motion during read time.

(b) Input hopper empty before EOM sequence.

(c) Card stacker full.

(d) Invalid character.

7.2.4 *Offset tracking control circuit of punched card readers and punches.*

7.2.4.1 *Scope.* This method is used to determine proper operation of the offset tracking control circuit of punched card reader and punch.

7.2.4.2 *Applicability.* The parameters tested shall conform to the requirements specified in the paragraphs cited below:

Item	Paragraph
Offset stacking control circuit -- reader	5.3.4.5
Offset stacking control circuit --punch	5.4.2.7

7.2.4.3 *Apparatus.* See 7.1, *General.* Test messages A-1 (fig. 55) A-2 (fig. 56), and A-3 (fig. 57) are required.

7.2.4.4 *Procedure.*

Step 1. Load reader with test messages A-1, A-2, and A-3.

Step 2. With the terminal in the self-test mode, transmit the messages to the terminal card punch.

Step 3. During transmission of test message A-2, press the CANCEL MESSAGE control on the station control panel.

7.2.4.5 *Results.*

7.2.4.5.1 *Card reader.* All cards shall pass through the reader. Header cards, card 4 of test message A-3, and the card being read when the CANCEL MESSAGE button was pushed will be offset in the reader stacker.

7.2.4.5.2 *Card punch.* Header cards, and CANCEL MESSAGE cards for test messages A-2 and A-3 shall be offset, edge notched or otherwise identified.

7.2.5 *Modulation rate of card punches.*

7.2.5.1 *Scope.* This method is used to measure the modulation rate of card punches.

7.2.5.2 *Applicability.* The parameters tested shall conform to the requirements specified in the paragraph cited below:

Item	Paragraph
Modulation rate	5.4.1.5

7.2.5.3 *Apparatus.* See 7.1, *General.* Test message A-2 (fig. 56) is required. The required test equipment is listed below:

Test Unit	Schematic Reference	Item No. in Appendix
Stop Watch	--	285

7.2.5.4 *Procedure.*

Step 1. Load the terminal card reader with test message A-2.

Step 2. Load the card punch with the number of cards listed below for the appropriate modulation rate.

Baud	No. of cards
150	13
300	26
600	53
1200	106
2400	213

Step 3. With the terminal in the self-test mode, and print function enabled, transmit cards to the punch. Record the time required to empty the punch hopper, and punch and print the required cards.

7.2.5.5 *Results.* The elapsed time shall not be more than 1 minute, 6 seconds.

7.2.6 *Operator alarm of card punches.*

7.2.6.1 *Scope.* This method is used to determine proper operation of the operator alarm of card punches.

7.2.6.2 *Applicability.* The parameters tested shall conform to the requirements specified in the paragraph cited below:

Item	Paragraph
Operator alarm circuit	5.4.2.8

7.2.6.3 *Apparatus. See* 7.1. *General.* Test message A-1 (fig. 55) is required.

7.2.6.4 *Procedure.*

Step 1. Load the card reader with test message A-1.

Step 2. Load the punch hopper with approximately 10 cards and the stacker to within 1 inch of capacity.

Step 3. With the terminal in a self-test mode, transmit cards from the reader to the punch. When a condition is reached such as out of cards or stacker full, the punch will stop. Correct the condition and restart the punch using the manufacturer's procedure.

7.2.6.5 *Results.* The punch shall stop and be capable of restart without reject for both conditions.

7.2.7 *Off-line mode capability of card punches.*

7.2.7.1 *Scope.* This method is used to determine whether or not card punches have an off-line mode capability.

7.2.7.2 *Applicability.* Parameters tested shall conform to the requirements specified in the paragraph cited below:

Item	Paragraph
Off-line mode	5.4.4.5

7.2.7.3 *Apparatus.* See 7.1, *General.* Test message A-1 (fig. 55) is required.

7.2.7.4 *Procedure.*

Step 1. Configure the punch with the keyboard in accordance with the manufacturers instructions.

Step 2. Punch 10 lines of test message A-1 and compare with the source document.

7.2.7.5 *Results.* The punch shall record correctly all characters required.

7.2.8 *Record block length of magnetic tape equipment.*

7.2.8.1 *Scope.* This method is used to confirm minimum and maximum record block lengths of magnetic tape equipment.

7.2.8.2 *Applicability.* Parameters test shall conform to the requirements specified in the paragraph cited below:

Item	Paragraph
Minimum/maximum record block lengths	5.5.3

7.2.8.3 *Apparatus.* See 7.1, *General.* Test message J-1 (fig. 58) is required.

7.2.8.4 *Procedure.*

Step 1. Mount and open a magnetic tape reel containing test message J-1 on the assigned transmit magnetic tape transport and an unused magnetic tape reel on the assigned receive magnetic tape transport.

Step 2. With the terminal placed in self-test, transmit the message to the receive magnetic transport.

Step 3. Close and remove both reels of magnetic tape. Compare the transmitted with the received magnetic tape messages utilizing the approved DPI facilities.

RDDUTESTΔRU_____ØØ1Δ_____ΔMTMS-UUUU--RU_____.

1 TEXT RECORD OF MIMIMUM CHARACTER LENGTH OF 18 CHARACTERS AND ONE TEXT RECORD OF 1200 CHARACTERS.

SPECIAL END OF TEXT BLOCK.

RDDUTESTΔRU_____ØØ1Δ_____ΔMTMS-UUUUΔ__(SPACES)__NNNN

8-59

Figure 58. Test message J-1.

7.2.8.5 *Results.* The transmitted and receive messages shall be identical and contain minimum record blocks of 18 characters and maximum record blocks of 2,048 characters as shown in test message J-1.

7.2.9 *Character packing density of magnetic tape equipment.*

7.2.9.1 *Scope.* This method is used to measure the character packing density of magnetic tape equipment.

7.2.9.2 *Applicability.* The parameters tested shall conform to the requirements specified in the paragraphs cited below:

Item	Paragraph
Character packing density of 800 CPI (characters per inch) using the NRZI (nonreturn-to-zero-change on one)	5.5.3.2a
Character packing density of 1600 CPI using the PE (phase encoded) recording method, as applicable	5.5.3.2b

7.2.9.3 *Apparatus.* See 7.1, *General.* Test messages J-2 (fig. 59) and J-3 (fig. 60) are required.

7.2.9.4 *Procedure.*

Step 1. Place the terminal in self-test.

Step 2. Transmit test message J-2 to verify requirement a, or test message J-3 to verify requirement b, from the assigned transmit magnetic tape transport. (Note: Test message J-2 will be used to verify 800 CPI, NRZI, and test message J-3 will be used to verify 1,600 CPI, PE.)

Step 3. Verify correct transmission and printing of the message.

7.2.9.5 *Results.* The transmitted and received messages shall be identical.

7.2.10 *Physical characteristics of tape reels and magnetic tape.*

7.2.10.1 *Scope.* This method is used to confirm the physical characteristics of tape reels and magnetic tape used in magnetic tape equipment.

RDDUTESTΔRU_____ØØØ2Δ_____ΔMTMS-UUUU--RU_____.

1 TEXT RECORD OF 1200 CHARACTERS IN LENGTH

SPECIAL END OF TEXT BLOCK.

RDDUTESTΔRU_____ØØØ2Δ_____ΔMTMS-UUUUΔ__(SPACES)__NNNN

Note: This test message must be recorded using a packing density of 800 CPI and the NRZI recording method.

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Figure 59. Test message J-2.

RDDUTESTΔRU_____ØØØ3Δ_____ΔMTMS-UUUU--RU_____.

3 TEXT RECORDS OF 1200 CHARACTERS EACH

SPECIAL END OF TEXT BLOCK.

RDDUTESTΔRU_____ØØØ3Δ_____ΔMTMS-UUUUΔ__(SPACES)__NNNN

Note: This test message must be recorded using a packing density of 1600 CPI and the PE recording method.

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Figure 60. Test message J-3.

7.2.10.2 *Applicability.* The parameters tested shall conform to the requirements specified in the paragraph cited below:

Item	Paragraph
Media	5.5.3.3

7.2.10.3 *Apparatus.* See 7.1, *General.*

7.2.10.4 *Procedure.* The requirement shall be verified by observation and measurement.

7.2.10.5 *Result.* The magnetic tape transport shall operate properly with the described magnetic tape reels.

7.2.11 *Indicators used in magnetic tape equipment.*

7.2.11.1 *Scope.* This method is used to confirm the proper operation of indicators used in magnetic tape equipment.

7.2.11.2 *Applicability.* The parameters tested shall conform to the requirements specified in the paragraphs cited below:

Item	Paragraph
Unit ready	5.5.3.5.1
File protect	5.5.3.5.2
Tape indicate	5.5.3.5.3

7.2.11.3 *Apparatus.* See 7.1, *General.*

7.2.11.4 *Procedure.* Proper operation of the indicators will be verified during the course of the test for codes and format.

7.2.12 *Controls used in magnetic tape equipment.*

7.2.12.1 *Scope.* This method is used to confirm proper operation of controls used in magnetic tape equipment.

7.2.12.2 *Applicability.* The parameters tested shall conform to the requirements specified in the paragraphs cited below:

Item	Paragraph
Forward	5.5.5.2.1
Reverse	5.5.5.2.2
Rewind	5.5.5.2.3
Record	5.5.5.2.4
Read	5.5.5.2.5

7.2.12.3 *Apparatus.* See 7.1, *General.* Test message J-1 (fig. 58) is required.

7.2.12.4 *Procedures.* Proper operation of the controls listed above shall be verified in conducting a message search as follows:

(a) Mount the magnetic tape containing test message J-1.

(b) With the terminal in self-test, conduct a search for message J-1.

(c) When test message J-1 has been located, transmit it to the receive magnetic tape transport.

7.2.12.5 *Results.* During the performance of the procedures outlined, verify the operation of the controls listed below:

(a) Forward.

(b) Reverse.

(c) Rewind.

(d) Record.

(e) Read.

7.2.13 *Speed of paper tape punches and readers.*

7.2.13.1 *Scope.* This method is used to measure the speeds of tape punches and readers.

7.2.13.2 *Applicability.* The parameters tested shall conform to the requirements specified in the paragraph cited below:

Item	Paragraph
Speed	5.6

7.2.13.3 *Apparatus.* See 7.1, *General.* Test messages T-1 (fig. 61) and T-2 (fig. 62) a required.

7.2.13.4 *Procedure.*

Step 1. With the terminal placed in self-test, transmit test message T-1 for low speed and test message T-2 for high speed equipment.

Step 2. Measure the length of time, in seconds, it takes for the message to be read.

Step 3. Follow the same procedure for the printer.

7.2.13.5 *Result.* The message shall be read or printed according to the following table.

Baud Rate	Time (seconds)
75	240 ±24
150	120 ±12
300	240 ±24
600	120 ±12
1200	60 ±6

7.2.14 *Coded character set for paper tape readers and punches.*

7.2.14.1 *Scope.* This method shall be used to confirm the capability of the equipment to transmit and receive the standard coded character set.

7.2.14.2 *Applicability.* The parameters tested shall conform to the requirements specified in the paragraphs cited below:

(ASCII TAPE)

```
↓↓↓↓↓↓RAAUTESTΔRU_____ØØØ5Δ_______-UUUU--RU_____.                          <<≡

    ZNRΔUUUUU                                                              <<≡
    RΔ______Z                                                              <<≡
    FMΔRU_____                                                             <<≡
    TOΔRU_____                                                             <<≡

    BT                                                                     <<≡

    -UNCLAS-ΔTHISΔISΔAΔTESTΔOFΔTHEΔAUTODINΔMODEΔIΔASCIIΔPAPERΔTAPEΔTERMINAL <<≡
                                                                  BSDSNDE
    ØØ1ΔABCDEFΔGHIJKLMNOPQΔRSTUVWXYZΔØ123456789Δ&#,.-/<>%*[^Λ!"$'()+:;=?` _EOEIUCM <<≡
                                                                  L L L4
    BT                                                              <<≡≡≡≡≡≡≡≡≡
    #ØØØ5
    NNNN                                                            ↓↓↓↓↓↓↓↓↓↓
```

(Note: A total of 225Ø characters is required in this message)

8-62

Figure 61. Test message T-1.

(ASCII TAPE)

```
↓↓↓↓↓↓RAAUTEST△RU____ØØØ5△______-UUUU--RU_____.                                        <<≡

    ZNR△UUUUU                                                                          <<≡
    R△_______Z                                                                         <<≡
    FM△RU_____                                                                         <<≡
    TO△RU_____                                                                         <<≡

    BT                                                                                 <<≡

    -UNCLAS-△THIS△IS△A△TEST△OF△THE△AUTODIN△MODE△I△ASCII△PAPER△TAPE△TERMINAL             <<≡

    ØØ1△ABCDEF△GHIJKLMNOPQ△RSTUVWXYZ△Ø123456789△&#,.-/<>%*[~^!"$'()+:;=?` _BEL SO DEL SI NUL DC4 EM  <<≡

    BT                                                                           <<≡≡≡≡≡≡≡≡≡
    #ØØØ5
    NNNN                                                                         ↓↓↓↓↓↓↓↓↓↓
```

(Note: A total of 7ØØØ characters is required in this message)   8-63

Figure 62. Test message T-2.

Item	Paragraph
Coded character set (reader)	5.6.1.1
Coded character set (punch)	5.7.1.1

7.2.14.3 *Apparatus.* See 7.1, *General.* Test message T-3 (fig. 63) is required.

7.2.14.4 *Procedure.*

Step 1. Place the data line adapter unit in self-test.

Step 2. Transmit test message T-3 from the paper tape reader to the paper tape punch. This test will validate the terminal's ability to transmit and receive an ASCII paper tape message using the 96 ASCII characters.

7.2.14.5 *Results.* The terminal will transmit and receive the message in its entirety. The received message will be a duplicate of the transmitted message.

7.2.15 *Indicators used in paper tape punches and readers.*

7.2.15.1 *Scope.* This method is used to confirm the operation of indicators used in paper tape punches and readers.

7.2.15.2 *Applicability.* The parameters tested shall conform to the requirements specified in the paragraphs cited below:

Item	Paragraph
Reader ready circuit (reader)	5.6.2.3
Alarm stop circuit (reader)	5.6.2.4
Operator alarm circuit (reader)	5.6.2.5
Data ready circuit (punch)	5.7.2.4
Alarm stop circuit (punch)	5.7.2.5
Operator alarm circuit (punch)	5.7.2.6
Tape feed-out control circuit (punch)	5.7.2.9
Tape notch control circuit (punch)	5.7.2.10
Cancel condition circuit (punch)	5.7.2.11

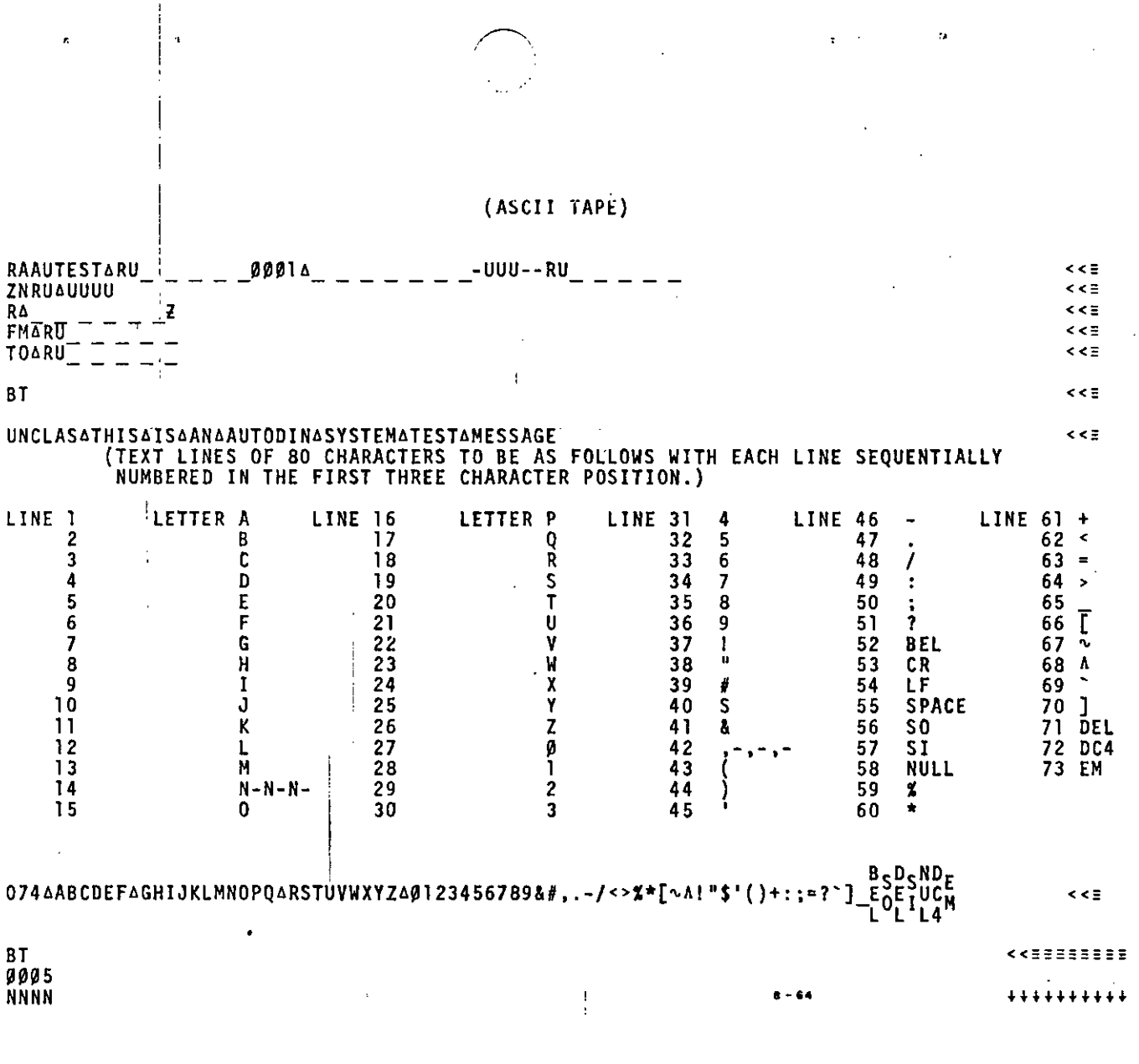

Figure 63. Test message T-3.

7.2.15.3 *Apparatus.* See 7.1, *General.*

7.2.15.4 *Procedure.* Proper operation of the indicators will be verified during the course of the test.

7.2.15.5 *Results.* The indicators used in paper tape readers shall operate as follows:

(a) Data Ready: Activated when the device is ready to transmit data.

(b) Alarm Stop: Activated when the device detects a "tape out," "tight tape," "loss of tape," or "tape not in motion" condition.

(c) Operator Alarm: Activated when an "alarm stop" condition exists.

7.2.15.5.1 The paper tape punch shall contain as a minimum the following indicators:

(a) Data Ready: Activated when the device is ready to receive data.

(b) Alarm Stop: Activated when the device detects an "out of tape" condition.

(c) Operator Alarm: Activated when an "alarm stop" condition exists.

(d) Tape Feed-Out: Activated at the start of the message or at an "end of message".

(e) Tape Notch: Activated upon detection of a punching error.

(f) Cancel Condition: Activated when a "cancel" indication is received.

7.2.16 *Printing speed of low speed page printers.*

7.2.16.1 *Scope.* This method is used to measure the printing speed of low speed page printers.

7.2.16.2 *Applicability.* The parameters tested shall conform to the requirements specified in the paragraph cited below:

Item	Paragraph
Printer speed/modulation rates	5.8.1

7.2.16.3 *Apparatus.* See 7.1, *General.* Test message I-1 (fig. 64) is required.

(ASCII TAPE)

```
                                                                                  <<≡
↓↓↓↓↓↓RAAUTESTΔRU_____ØØØ5Δ_______-UUUU--RU_____.
                                                                                  <<≡
     ZNRΔUUUUU                                                                    <<≡
     RΔ_______Ƶ                                                                   <<≡
     FMΔRU_____                                                                   <<≡
     TOΔRU_____
                                                                                  <<≡
     BT
     -UNCLAS-ΔTHISΔISΔAΔTESTΔOFΔTHEΔAUTODINΔMODEΔIΔASCIIΔPAPERΔTAPEΔTERMINAL      <<≡
                                                                          BSDSNDE
     ØØ1ΔABCDEFΔGHIJKLMNOPQΔRSTUVWXYZΔØ123456789Δ&#,.-/<>%*[~Λ!"$'()+:;=?`  _EOEIUCM  <<≡
                                                                          L L L4
                                                                          <<≡≡≡≡≡≡≡≡
     BT
     #ØØØ5                                                                ↓↓↓↓↓↓↓↓↓↓
     NNNN
```

(Note: A total of 12ØØ characters is required in this message) 8-65

Figure 64. Test message I-1.

7.2.16.4 *Procedure.*

Step 1. Transmit the self-addressed test message I-1 (1200 characters) to the automatic switching center.

Step 2. Record the time required to receive and print the message from the automatic switching center.

7.2.16.5 *Results.* The following print times at the given baud rates shall apply:

Baud Rate	Print Rate (char/sec)	Time (sec)
50	6.25	192 ±10
75	9.375	128 ±6
100	12.5	96 ±4
150	18.75	64 ±3

7.2.17 *Character set used in low speed page printers.*

7.2.17.1 *Scope.* This method is used to confirm the character set used in low speed page printers.

7.2.17.2 *Applicability.* The parameters tested shall conform to the requirements specified in the paragraph cited below:

Item	Paragraph
Coded character set	5.8.2.1

7.2.17.3 *Apparatus.* See 7.1, *General.* Test message I-1 (fig. 64) is required.

7.2.17.4 *Procedure.*

Step 1. Transmit the self-addressed test message I-1 to the automatic switching center.

Step 2. Verify that the received printed message contains the identical characters transmitted.

7.2.17.5 *Result.* The printer shall print the 96 ASCII characters specified.

7.2.18 *Media of the low speed page printers.*

7.2.18.1 *Scope.* This method is used to confirm media (size, weight, *etc.*) of low speed page printers.

7.2.18.2 *Applicability.* The parameters tested shall conform to the requirements specified in the paragraphs cited below:

Item	Paragraph
Paper type	5.8.3.1
Character spacing and line capacity	5.8.3.3
Printing	5.8.3.4

7.2.18.3 *Apparatus.* See 7.1, *General.* Test message I-1 (fig. 64) is required.

7.2.18.4 *Procedure.*

Step 1. Transmit the self-addressed test message I-1 to the automatic switching center.

Step 2. Verify specified requirements.

7.2.18.5 *Results.* The printer shall be capable of the following:

(a) Using a 5-inch roll or a minimum of 1,500 feet of fanfold paper.

(b) Printing a minimum of one original and four legible copies.

(c) Printing 10 characters per inch horizontally.

(d) Printing 6 lines per inch vertically.

(e) Printing up to 80 characters/line.

7.2.19 *Indicators used in low speed page printers.*

7.2.19.1 *Scope.* This method is used to confirm proper operation of indicators used in low speed page printers.

7.2.19.2 *Applicability.* The parameters tested shall conform to the requirements specified in the paragraphs cited below:

Item	Paragraph
Low-paper condition	5.8.3.6
Out-of-paper condition	5.8.3.7

7.2.19.3 *Apparatus.* See 7.1, *General.*

7.2.19.4 *Procedure.* During the test, conditions of "low-paper" and "out-of-paper" will be caused to exist.

7.2.19.5 *Results.* Indicators will be activated as follows:

(a) Low-paper: Activated when the device has less than a 5-minute supply of paper.

(b) Out of paper: Activated when the paper supply has been exhausted.

7.2.20 *Speed of high speed line printers.*

7.2.20.1 *Scope.* This method is used to measure the speed of high speed line printers.

7.2.20.2 *Applicability.* The parameters tested shall conform to the requirements specified in the paragraph cited below:

Item	Paragraph
Speeds/rates	5.9.4.1

7.2.20.3 *Apparatus.* See 7.1, *General*, Test message A-2 (fig. 56) is required.

7.2.20.4 *Procedure.*

Step 1. Place the terminal in self-test and assign the page printer as the receive device.

Step 2. Transmit test message A-2 (20,000 characters) from the care reader to the page printer.

Step 3. Record the time required to transmit and print the message.

7.2.20.5 *Results.*

(a) The transmit and print time shall not be greater than 250 ±12 seconds.

(b) Characters shall be printed 80 characters to a line.

(c) The printer shall be capable of printing 80 column lines at a rate of 600 lines per minute.

7.2.21 *Codes/formats/character sets.*

7.2.21.1 *Scope.* This method is used to confirm the codes/formats character sets used by high speed line printers.

7.2.21.2 *Applicability.* The parameters tested shall conform to the requirements specified in the paragraph cited below:

Item	Paragraph
Codes/formats/character sets	5.9.4.2

7.2.21.3 *Apparatus.* See 7.1, *General.* Test message A-4 (fig. 65) is required.

7.2.21.4 *Procedure.* Transmit the self-addressed test message to the automatic switching center.

7.2.21.5 *Results.* When test message A-4 is received and printed, verify the following:

(a) Characters defined in 5.9.4.2, *Codes/formats/character sets,* are printed correctly.

(b) Printed characters are spaced 10 characters per inch horizontally and 6 lines per inch vertically.

(c) The printed line of "E" characters shall be within ±0.008 of an inch of the common horizontal center line (fig. 23).

(d) The type font shall be Gothic.

(e) The tolerance on any sequence of printable characters from a common horizontal center line shall be ±0.010 of an inch.

(MULTI-CARD)

RCCUTESTΔRU_____ØØ1Δ_____ΔØ -UUUU--RU_____.

-UNCLAS-THISΔISΔAΔTESTΔ_____Δ

001 AAA AAA AAA AAA AAA AAA AAA AAA AAA AAA AAA AAA AAA AAA AAA AAA AAA AAA AAA

(TEXT LINE ØØ1 TO BE REPEATED _____ TIMES WITH EACH LINE SEQUENTIALLY
NUMBERED IN THE FIRST THREE CHARACTER POSITIONS.)

RCCUTESTΔRU_____ØØ1Δ_____ΔØ UUUUΔ_____ΔNNNN

(Note: All characters are to be punched - one character repeated per card.)

8-66

Figure 65. Test message A-4.

7.2.22 *Speed of optical character recognition equipment.*

7.2.22.1 *Scope.* This method is used to measure speed of optical character recognition equipment (OCRE).

7.2.22.2 *Applicability.* The parameters tested shall conform to the requirements specified in the paragraph cited below:

Item	Paragraph
Speeds/rates	5.10.3.1

7.2.22.3 *Apparatus.* See 7.1, *General.* Test message C-11 (fig. 66) is required. The required test equipment is listed below:

Test Unit	Schematic Reference	Item No. in Appendix
Stop Watch		385

7.2.22.4 *Procedure.*

Step 1. Load and read test message C-11.

Step 2. Record the time required to read and punch out the message.

7.2.22.5 *Result.* Processing times shall be as follows:

Type of Equipment	Reading Rate (char/sec)	Processing Time (sec)
Low performance OCRE	50	120 ±12
High performance OCRE	300	20 ±2

7.2.23 *Codes/formats/character sets of optical character recognition equipment.*

7.2.23.1 *Scope.* This method is used to confirm codes/formats/character sets used on optical character recognition equipment (OCRE).

7.2.23.2 *Applicability.* The parameters tested shall conform to the requirements specified in the paragraphs cited below:

JOINT MESSAGEFORM

SECURITY CLASSIFICATION

PAGE	DRAFTER OR RELEASER TIME	PRECEDENCE ACT	PRECEDENCE INFO	LMF	CLASS	CIC	FOR MESSAGE CENTER/COMMUNICATIONS CENTER ONLY DATE – TIME	MONTH	YR
01 OF 04	4201011				UUUU	TEST	0401117	MAR	72

BOOK NO

MESSAGE HANDLING INSTRUCTIONS

FROM: TEST DIRECTOR USASTRATCOM FT HUACHUCA AZ

TO: TEST TEAM CHIEF USASTRATCOM-EUR HEIDELBERG GER

UNCLAS

001 ABCDEFGHIJKLMNOPQRSTUVWXYZ 0123456789 $(; ./&)" :,? UNCLAS TEST

(TEST LINE ØØ1 TO BE REPEATED 72 TIMES WITH EACH LINE SEQUENTIALLY NUMBERED IN THE FIRST THREE CHARACTER POSITIONS.)

6 5 4 3 2 1 0

TEST MESSAGE C011

0

DISTR:

DRAFTER TYPED NAMED, TITLE, OFFICE SYMBOL AND PHONE

SPECIAL INSTRUCTIONS

RELEASER

TYPED NAME, TITLE, OFFICE SYMBOL AND PHONE

SIGNATURE

SECURITY CLASSIFICATION

DD FORM 1 JUL 68 173 REPLACES DD FORM 173, 1 NOV 63 AND DD FORM 173-1, 1 NOV 63, WHICH ARE OBSOLETE.

GPO : 1969 O - 36.-378

8-67

Figure 66. Test message C-11.

Item	Paragraph
Code	5.10.3.2
Format	5.10.3.2
Character set	5.10.3.2
Spacing	5.10.3.2
Media	5.10.3.2

7.2.23.3 *Apparatus.* See 7.1, *General.* Test message C-11 (fig. 66) is required.

7.2.23.4 *Procedure.*

Step 1. In verifying the requirements described below, the OCRE can be either on-line (transmitting directly to an automatic switching center) of off-line (output to 8-level paper tape which will be relayed to communications paper tape reader). If the OCRE is configured as an on-line input device, place the terminal in self-test and assign the page printer and paper tape punch as received devices for narrative traffic. Transmit test message C-11 via the OCRE. The message will be read by the OCRE and transmitted to the page printer and the paper tape punch.

Step 2. If the OCRE is configured off-line, read test message C-11. The message will be prepared in accordance with JANAP 128C procedures and will be punched out at the paper tape punch.

7.2.23.5 *Results.* Verify adherance to the following requirements:

(a) The output signal/media code shall be ASCII as defined in FIPS Pub 1.

(b) The input page format shall be in compliance to the Form DD 173, Joint Messageform.

(c) The OCRE shall read the standard character set specified in ANSI X3.17-1966, Size A.

(d) Character spacing requirements are:

(1) Vertical: 3 characters per inch.

(2) Horizontal: 10 characters per inch.

(e) The OCRE shall be capable of reading DD 173's.

7.2.24 *Controls to operate optical character recognition equipment.*

7.2.24.1 *Scope.* This method is used to conform proper operation of controls used to operate optical character recognition equipment (OCRE).

7.2.24.2 *Applicability.* The parameters tested shall conform to the requirements specified in the paragraphs cited below:

Item	Paragraph
Power on-off control	5.10.3.3a
Start OCRE read cycle control	5.10.3.3b
Stop OCRE read cycle control	5.10.3.3c
Clear document control	5.10.3.3d
End of file control	5.10.3.3e

7.2.24.3 *Apparatus.* See 7.1, *General.* OCRE test message C-11 (fig. 66) is required.

7.2.24.4 *Procedure.*

Step 1. Depress the power ON/OFF control to verify its proper operation.

Step 2. Apply power to the OCRE and prepare to read test message C-11. Depress the START OCRE read cycle control to initiate the read operation. Verify proper processing of the message.

Step 3. Prepare the OCRE to read test message C-11. Depress the START OCRE read cycle control to initiate the read operation. Prior to the completion of the read operation, depress the STOP OCRE read cycle control. When the read operation has terminated, depress the CLEAR DOCUMENT control to flush the message from the reader mechanism.

7.2.25 *Indicators used on optical character recognition equipment.*

7.2.25.1 *Scope.* This method is used to confirm proper operation of indicators used on optical character recognition equipment (OCRE).

7.2.25.2 *Applicability.* The parameters tested shall conform to the requirements specified in the paragraphs cited below:

Item	Paragraph
POWER ON indicator	5.10.4a
DATA REJECT indicator	5.10.4b
DATA MISFEED indicator	5.10.4b

7.2.25.3 *Apparatus.* See 7.1, *General.* Test message C-11 (fig. 66) is required.

7.2.25.4 *Procedure.* Verify the OCRE has the described indicators which are activated under the following conditions:

Step 1. POWER ON: Activated when power is applied to the unit.

Step 2. DATA REJECT: Activated when an unrecognizable character has been found. (Close the letter "c" in text line 001 in test message C-11 and attempt to read the message).

Step 3. DOCUMENT MISFEED: Activated when the message being read is excessively skewed, torn, jammed, or not being fed through the reading mechanism properly. (Tear page 1 of test message C-11 and attempt to read the message).

CUSTODIANS

Army - SC
Navy - EC
Air Force - 17

REVIEW ACTIVITIES

Army - SC
Navy - EC
Air Force - 17
NSA - NS
DCA - DC

PREPARING ACTIVITY

Army - SC

Project SLHC 0019

APPENDIX

TEST EQUIPMENT LIST

PREFACE

The purpose of this appendix is to present supplementary information concerning the test equipment referenced in sections 6 and 7 of this standard. This information is presented in columnar format, as follows:

a. Item No. This column lists the index numbers assigned to each piece of test equipment. The index numbers are used for cross referencing between sections 6 and 7 and the appendix.

b. Test Unit. This column lists each piece of test equipment by its common nomenclature.

c. Minimum Performance Requirements. This column lists the required operating characteristics for each piece of test equipment.

The test equipment generally used in engineering and installing telecommunications systems and subsystems is divided into 14 categories, grouped by basic type for ease in finding a particular item as well as adding new items required for future measurement techniques. The equipment categories and item numbers are as follows:

	Test Equipment	Item Numbers
A.	Meters	1-99; 0100-0199
B.	Generators	100-199; 1100-1199
C.	Indicators, Recorders, and Detectors	200-299; 2100-2199
D.	Testers, Analyzers and Measuring Sets	300-399; 3100-3199
E.	Circuit Components (Resistors, Capacitors & Diodes)	400-499; 4100-4199
F.	Amplifiers	500-549; 5100-5149
G.	Power Sources	550-599; 5150-5199
H.	Attenuators	600-649; 6100-6149
I.	Transformers	650-699; 6150-6199
J.	Waveshaping Circuits	700-749; 7100-7149
K.	Unassigned	750-799; 7150-7199
L.	Unassigned	800-849; 8100-8149
M.	Unassigned	850-899; 8150-8199
N.	Miscellaneous	900-999; 9100-9199

A. METERS (ITEMS 1-99; 0100-0199)

Item No.	Test Unit	Minimum Performance Requirements	
7	Voltmeter	Range of Voltage	2 - 300 V (multirange)
		Frequency	dc
		Sensitivity	1,000 ohms/V or better
		Accuracy	Within 2%
8	Milliammeter	Range of Current	0 - 100 mA
		Frequency	dc
		Impedance	10 ohms or less
		Accuracy	Within 5%
9	Milliammeter	Range of Current	50 - 0 - 50 mA
		Frequency	dc
		Impedance	10 ohms or less
		Accuracy	Within 2%
10	Microammeter	Range of Current	0 - 10 μA
		Frequency	25 - 100 Hz
		Impedance	50 kilohms or less
		Accuracy	Within 5%
11	Microammeter	Range of Current	0 - 10 μA
		Frequency	dc
		Impedance	50 kilohms or less
		Accuracy	Within 3%

A. METERS (ITEMS 1-99; 0100-0199)(continued)

Item No.	Test Unit	Minimum Performance Requirements
12	Ohmmeter	Range of Resistance - - - - - - 10 - 1,000 ohms Test Voltage - - - - - - - - - Between 1 and 2 V Midscale Indication - - - - - Between 100 and 300 ohms Accuracy - - - - - - - - - - - ±2%
13	Modulation Rate Meter	To measure speed in bauds of 7-unit signals at nominal rates of 50 and 75 bauds Long term accuracy to be ±0.1% or better, within the range ±1% of nominal
14	Voltmeter	Moving Coil, 0 - 10 V Accuracy - - - - - - - - - - - ±1%
15	Milliammeter	Dual Range - - - - - - - - - - 0 - 30 mA 0 - 60 mA Accuracy - - - - - - - - - - - ±1%

B. GENERATORS (ITEMS 100--199; 1100--1199)

Item No.	Test Unit	Minimum Performance Requirements	
116	Signal Generator	Waveform	Pulse, 3 ms duration
		Frequency Range	30 ms period
		Amplitude Range	50 V
		Current Rating	60 mA or more
117	Telegraph Signal Generator and Synchronous Signal Displayer	(a) Generator	
		Waveform	Square wave 100 μs rise time or less
		Bit Rate	75 bauds
		Signal Fidelity	2% or better
		Code Capability	Stop, Start, M, S, M, S, M
		Amplitude	60 V or more
		Impedance	200 ohms or less
		Current Rating	20 mA or more
		(b) Signal Displayer Display	
		Fidelity	1% or better
118	Signal Generator	Waveform	Pulse, 100 μs duration
		Frequency Range	1 ms period
		Amplitude Range	0 - 10 V
		Current Rating	100 mA or more
119	Signal Generator	Waveform	Square wave
		Frequency Range	3 - 5 kHz
		Amplitude Range	10 V peak-to-peak into 200 ohms
		Rise Time	100 μs or less

B. GENERATORS (ITEMS 100--199; 1100--1199)(continued)

Item No.	Test Unit	Minimum Performance Requirements	
119 (continued)		Impedance	Unimportant
		Accuracy	Voltage within 1% Frequency within 3%
120	Oscillator	Output Frequency	1/2, 1 or 2 times nominal modulation rate
		Output Impedance	600 ohms (minimum)
		Long-term Stability	±0.1%
		Output Voltage	0 - 15 V rms
		Note. Not to be connected to ground.	
121	Pulsing System	Pulse Duration	Adjustable, 15 - 25 ms
		Pulse Rate	Adjustable, 1 - 10 pps
		Output	Semiconductor or relay switching, 120 V, 20 W (maximum)
122	Telegraph Distortion Generator	Part of 322	
123	Telegraph Distortion Measuring Set (Transmitter)	Modulation Rate	50 and 75 bauds
		Character Length	7 unit (A 7-1/2 unit range would be desirable)
		Mode of Operation	Start/Stop
		Switching Capability	120 V, 60 mA
		Neutral	±60 V, 20 mA
		Polar	±6 V, 1 mA

B. GENERATORS (ITEMS 100--199; 1100--1199)(continued)

Item No.	Test Unit	Minimum Performance Requirements	
123 (continued)		Distortion Range	0 - 65% start signal distortion
		Distortion Accuracy	Better than 1%
		Types of Test Signal	1.1 reversals Continuous Mark Continuous Space Repetitive single character Test message of at least 69 characters
124	Oscillator	Low Frequency	20 - 100 Hz
		Output Impedance	75 ohms (to suit relay (Item No. 911))
		Output Power	3 W
133	Square Wave Generator	Frequency Range	1 Hz - 1 MHz
		Output Impedance	75 ohms, 600 ohms
		Output Level	0 - 27 volts across 600-ohm load
1121	Data Signal/Distortion Generator	Modulation Rate	25 to 50,000 baud
		Switching Capability	±6 volts
		Distortion Range	50% M-O-50% S
		Type of Test Signal	Reversals, Test message

C. INDICATORS, RECORDERS, AND DETECTORS (ITEMS 200--299; 2100--2199)

Item No.	Test Unit	Minimum Performance Requirements	
203	Oscilloscope	Number of Traces	1
		Rise Time	1 μs or less
		Low Frequency Cutoff	3 dB or less at 20 Hz
		Sweep Speed	Any speed from 50 - 150 sweeps per second
		Input Impedance	100 kilohms or more
		Sensitivity	0.5 V/cm
204	Oscilloscope	Number of Traces	1
		Rise Time	0.1 s or less
		Low Frequency Cutoff	Not worse than 3 dB down at 200 Hz
		Sweep Speed	50 - 150 sweeps per second
		Sensitivity	100 V/cm
		Input Impedance	100 kilohms or more
205	Oscilloscope	Number of Traces	2
		Rise Time	0.1 μs or less
		Low Frequency Cutoff	Not worse than 3 dB down at 200 Hz
		Sweep Speed	500 - 5,000 sweeps per second
		Sensitivity	Y1: 4V/cm; Y2: 130 V/cm
		Input Impedance	10 kilohms or more
206	Oscilloscope (Single Beam)	Input Impedance	X 100 kilohms (min.) Y In Parallel Z 100 pF (max.)

C. INDICATORS, RECORDERS, AND DETECTORS (ITEMS 200--299; 2100--2199)(continued)

Item No.	Test Unit	Minimum Performance Requirements
206 (continued)		Sensitivity - - - - - - - - - - X 0.1 V/cm Y 0.1 V/cm Z 50 V (max.) for full modulation
		3 dB Pass-band - - - - - - - - 20 Hz - 10 kHz
		Note. Z input controls trace intensity.
207	Stop Watch	Range - - - - - - - - - - - - 0 - 30 seconds Accuracy - - - - - - - - - - - ±0.1%
208	Tuning Fork or Vibrating Reed Stroboscope	Accuracy - - - - - - - - - - ±0.1% Frequency - - - - - - - - - - To suit machine design
209	Oscilloscope (Double Beam)	Input Impedance - - - - - - - Y1 } 100 kilohms Y2 } 100 kilohms Z } 100 kilohms Time-Scale Accuracy - - - - - ±5% - calibrated Sensitivity - - - - - - - - - 1 V/cm 3 dB Pass-band - - - - - - - - dc - 50 kHz
210	Start/Stop Oscilloscope	Part of Item No. 322
282	Oscilloscope	Vertical Response - - - - - - - dc - 1 MHz Vertical Sensitivity - - - - - - - 0.1 volt/cm or better Sweep Rate - - - - - - - - - - 0.1 to 2 sec/cm Sweep Width - - - - - - - - - - 10 cm minimum

C. INDICATORS, RECORDERS, AND DETECTORS (ITEMS 200--299; 2100--2199)(continued)

Item No.	Test Unit	Minimum Performance Requirements
282 (continued)		Traces - - - - - - - - - - - - 2
		Note. Must be useable with oscilloscope camera.
285	Stop Watch	Type - - - - - - - - - - - - Manual Control Timing Range - - - - - - - - - 0 - 30 minutes Timing Accuracy - - - - - - - Within 0.1 second

D. TESTERS, ANALYZERS AND MEASURING SETS (300-399; 3100--3199)

Item No.	Test Unit	Minimum Performance Requirements
321	Telegraph Distortion Analyzer	Suitable for 50 or 75 baud nominal modulation rate, neutral or polar input. Measuring in 1% steps. (Ref. AIEE Transactions Paper No. 61-60, also: P. O. Electrical Engineers Journal, April 1954 (Wheeler and Frost).
322	Telegraph Distortion Measuring Set (Digital Type)	(a) General Modulation Rate - - - 50 and 75 bauds Character Length - - - 7 units Mode of Operation - - Start/Stop (b) Transmitter Distortion Range - - - 0 - 65% in 1% steps. Accuracy 1/2% Type of Distortion - - Marking or Spacing Bias, Marking or Spacing End, Switched Bias (Alternate Mark/Space), Early or Late Transmitter - - - - - - Up to 120 V,) from Switching - - - - - 60 mA Neutral,) separate Capability Up to 60 V,) power 30 mA Polar) supply (c) Receiver Distortion Ranges - - - - - - - - - 0 - 100%) 0 - 5%) Meter read out Accuracy - - - - - - - - - 100% range to ±2% 5% range to ±1/4%, preferably 0.1% Signal Display - - - - - - The receiver includes a cathode ray oscilloscope with start/stop time base to display the waveform of the received signal.

D. TESTERS, ANALYZERS AND MEASURING SETS (300-399; 3100-3199)(continued)

Item No.	Test Unit	Minimum Performance Requirements
322 (continued)		Note. This equipment consists of 5 separate units. When only one measuring facility is required (e.g., Transmitter Distortion Generator) a minimum of 3 units are necessary. These are listed under item numbers 122, 210, 561.
323	Telegraph Distortion Measuring Set (Receiver)	This equipment consists of two units: (a) A measuring unit (b) A signal display unit To obtain a complete picture of the quality of the observed signal the two units are used together. The measuring unit may be used by itself where it is required to measure distortion only. (a) Measuring Unit Modulation Rate - - - - 50 and 75 bauds Character Length - - - 7 units Modes of Operation - - Free run with distortion indication by momentary intensification of circular cathode ray tube display Start/Stop with distortion indication by momentary intensification of decaying spiral cathode ray tube display Distortion Ranges - - - ±50% and ±5% Accuracy - - - - - - - - 50% range ±2% 5% range ±1/4%, preferably ±0.1%

D. TESTERS, ANALYZERS AND MEASURING SETS (300--399; 3100--3199)(continued)

Item No.	Test Unit	Minimum Performance Requirements	
323 (continued)		Input Sensitivity - - - -	To operate from the following voltages or currents: Neutral Signals 120 V, 60 mA 120 V, 20 mA Polar Signals ±60 V, 20 mA ± 6 V, 1 mA
		Input Impedance	
		Neutral Operation - -	300 ohms max.
		Polar Operation - - -	50 kilohms
		(b) Display Unit - - - - - - -	CRO with start/stop time base to display signal waveform applied to the measuring unit
332	Wave Analyzer	Input Impedance - - - - - - -	124 ohms
		Input Amplitude Range - - - -	-80 dBm to -40 dBm
		Frequency Range - - - - - - -	25 to 5,000 Hz
373	Phase Shifter	Frequency Range - - - - - - -	25 Hz to 50 kHz
		Input and Output Voltage - -	±6 V
		Phase Shifter Range - - - - -	±270 degrees

E. CIRCUIT COMPONENTS (RESISTORS, CAPACITORS & DIODES) (ITEMS 400–499; 4100–4199)

Item No.	Test Unit	Minimum Performance Requirements	
400	Resistor	Type	Fixed
		Resistance	1,000 ohms ±1%
		Wattage Rating	15 W or more
401	Zener Diode Pair	Configuration	Series, opposed
		Zener Voltage	70 V ±5%
		Current Rating	70 mA
		Forward Voltage Drop	0.5 V or less
402	Zener Diode Pair	Configuration	Series, opposed
		Zener Voltage	3.3 V ±5%
		Current Rating	5 mA
		Forward Voltage Drop	0.5 V or less
403	Resistor	Type	Fixed
		Resistance	2.2 kilohms ±1%
		Wattage Rating	1 W or more
404	Resistor	Type	Fixed
		Resistance	15 kilohms ±1%
		Wattage Rating	1 W or more
405	Resistor	Type	Fixed
		Resistance	1,000 ohms ±1%
		Wattage Rating	1 W or more
406	Resistor	Type	Fixed
		Resistance	300 ohms ±1%

E. CIRCUIT COMPONENTS (RESISTORS, CAPACITORS & DIODES) (ITEMS 400--499; 4100--4199)(continued)

Item No.	Test Unit	Minimum Performance Requirements	
406 (continued)		Wattage Rating	3 W or more
407	Resistor	Type	Fixed
		Resistance	120 ohms ±1%
		Wattage Rating	3 W or more
408	Resistor	Type	Variable
		Resistance	250 ohms ±5%
		Wattage Rating	5 W or more
409	Resistor	Type	Fixed
		Resistance	100 ohms ±1%
		Wattage Rating	1 W or more
410	Resistor	Type	Fixed
		Resistance	600 ohms ±1%
		Wattage Rating	1 W or more
411	Resistor	Type	Variable
		Resistance	0 - 600 ohms
		Wattage Rating	1 W or more
412	Resistor	Type	Fixed
		Resistance	850 ohms ±1%
		Wattage Rating	20 W or more

E. CIRCUIT COMPONENTS (RESISTORS, CAPACITORS & DIODES) (ITEMS 400--499; 4100--4199)(continued)

Item No.	Test Unit	Minimum Performance Requirements
413	Resistor	Type - - - - - - - - - - - - Fixed Resistance - - - - - - - - - - 20 megohms within 5% Wattage Rating - - - - - - - - 1 W or more
414	Resistor	Type - - - - - - - - - - - - Fixed Resistance - - - - - - - - - - 10 ohms ±1% Reactance - - - - - - - - - - Time constant to be less than 10 μs Wattage Rating - - - - - - - - 1 W or more
415	Resistor	Type - - - - - - - - - - - - Fixed Resistance - - - - - - - - - - 4.7 kilohms ±5% Wattage Rating - - - - - - - - 5 W or more
416	Resistor	Type - - - - - - - - - - - - Variable Resistance - - - - - - - - - - 0 - 100 ohms Reactance - - - - - - - - - - Time constant 1 μs or less Wattage Rating - - - - - - - - 1 W or more
417	Resistor (Variable)	To suit oscillator (Item No. 124) and relay (Item No. 911)
418	Capacitor	0.01 μf, 24 V (rms) ±10% Quantity 2
419	Capacitor	0.01 μf, 24 V (rms) ±10%
420	Resistor (Fixed)	39 kilohms, ±5%, 1/4 W

E. CIRCUIT COMPONENTS (RESISTORS, CAPACITORS & DIODES) (ITEMS 400-499; 4100--4199)(continued)

Item No.	Test Unit	Minimum Performance Requirements
421	Resistor (Fixed)	390 kilohms, ±5%, 1/4 W
422	Resistor (Fixed)	20 kilohms, ±10%, 1 W
423	Resistor (Variable)	20 kilohms, ±20%, 10 W
424	Resistor (Fixed)	40 kilohms, ±10%, 1/8 W
425	Resistor (Variable)	40 kilohms, ±20%, 1/8 W
426	Resistor (Fixed)	3 kilohms, ±10%, 10 W
427	Resistor (Variable)	3 kilohms, ±20%, 10 W

G. POWER SOURCES (ITEMS 550–599; 5150–5199)

Item No.	Test Unit	Minimum Performance Requirements
550	Power Source	Frequency - - - - - - - - - - dc Voltage - - - - - - - - - - 260 V within 5% Current Rating - - - - - - - - 1 mA or more Impedance - - - - - - - - - - 10 kilohms or less
551	Power Source	Frequency - - - - - - - - - - dc Voltage - - - - - - - - - - 24 V into 100 ohms within 5% Current Rating - - - - - - - - 250 mA or more Impedance - - - - - - - - - - 5 ohms or less
552	Power Source	Frequency - - - - - - - - - - dc Voltage - - - - - - - - - - +130, –130 V Current Rating - - - - - - - - 50 mA or more Impedance - - - - - - - - - - 200 ohms or less
553	Power Source	Frequency - - - - - - - - - - dc Voltage - - - - - - - - - - 9 V or more Impedance - - - - - - - - - - 10 ohms or less
554	Power Source	Frequency - - - - - - - - - - dc Voltage - - - - - - - - - - +130, –130 V within 10% Current Rating - - - - - - - - 150 mA Impedance - - - - - - - - - - 50 ohms or less
555	Power Source	Frequency - - - - - - - - - - dc Voltage - - - - - - - - - - +3 V and –3 V

G. POWER SOURCES (ITEMS 550-599; 5150-5199)(continued)

Item No.	Test Unit	Minimum Performance Requirements	
555 (continued)		Current Rating	10 mA or more
		Impedance	10 ohms or less
		Accuracy	Voltage to be within 10%
556	Power Source	Frequency	dc
		Voltage	Adjustable between 8 and 12 V
		Current Rating	20 mA or more
		Impedance	20 ohms or less
557	Variac	Voltage	300 V, 50 - 60 Hz
		Wattage Rating	50 W or better
558	Power Supply	Output Voltage	+6.0, -6 V dc (Balanced to within 5%)
		Output Current	1.0 mA
		Limits	±1 V (including ripple and regulation)
559	Power Supply	Output Voltage	+60.0, -60 V dc
		Output Current	60 mA
		Limits	±7% (including ripple and regulation)
561	Power Supply and Timebase	Part of Item No. 322	

N. MISCELLANEOUS (ITEMS 900--999; 9100--9199)

Item No.	Test Unit	Minimum Performance Requirements	
908	Switch, Double Pole, Double Throw (Manual)	Voltage Rating	10 V
		Current Rating	100 mA
		Special Features	Nonshorting
909	Switch, Single Pole, Double Throw (Manual)	Voltage Rating	30 V
		Current Rating	100 mA
		Special Features	Quick Break
910	Relay Holder and Connector	Type of Holder	Octal, Standard American
		Type of Terminals	Binding Posts
		Number of Terminals	8 (one to each point on Octal holder)
		Insulation	100 megohms between terminals
911	Telegraph Relay		
9113	Switch	Function	1 Pole, 1 Position
		Frequency Range	50 Hz - 50 kHz
9114	Switch	Function	1 Pole, 2 Positions
		Frequency Range	50 Hz - 50 kHz

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