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9 MARCH 1987

MILITARY STANDARD

INTEROPERABILITY STANDARDS FOR INFORMATION AND RECORD TRAFFIC EXCHANGE MODE VI

AMSC N/A

AREA TCTS/SLHC

FOREWORD

1. This military standard is approved and mandatory for use by all Departments and Agencies of the Department of Defense in accordance with Department of Defense Directive Number 4640.11, December 21, 1987 (appendix A).

2. Beneficial comments (recommendations, additions, deletions) and any pertinent data that may be of use in improving this document should be addressed to:

Joint Tactical Command, Control and Communications Agency
ATTN: C3A-ADW-S
11440 Isaac Newton Square North
Reston, Virginia 22090-5006

by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

3. Originally, Military Standard 188 (MIL-STD-188) covered technical standards for tactical and long haul communications, but later evolved through revisions (MIL-STD-188A, MIL-STD-188B) into a document applicable to tactical communications only (MIL-STD-188C).

4. The Defense Communications Agency (DCA) published DCA circulars (DCAC) promulgating standards and engineering criteria applicable to the long haul Defense Communications System (DCS) and to the technical support of the National Military Command System (NMCS). The Joint Tactical Communications Office (JTCO) published specifications promulgating standards applicable to the joint tactical communication system known as the TRI-TAC system.

5. As a result of a Joint Chiefs of Staff (JCS) action, standards for all military communications are now being published in a MIL-STD-188 series of documents. The MIL-STD-188 series is subdivided into a MIL-STD-188-100 series covering common standards for tactical and long haul communications, a MIL-STD-188-200 series covering standards for tactical communications only, and a MIL-STD-188-300 series covering standards for long haul communications only. Emphasis is being placed on developing common standards for tactical and long haul communications published in the MIL-STD-188-100 series.

6. This document is the result of JCS action requiring that the technical characteristics of channel coordination procedures, previously contained in various specifications and DCACs, be updated and published in the MIL-STD-188 series of standards. This document contains the technical requirements for Mode VI. The current MIL-STD-188 series for information and record traffic exchange is as follows:

a. MIL-STD-188-171: Mode I
b. MIL-STD-188-172: Mode II
c. MIL-STD-188-173: Mode V
d MIL-STD-188-174 Mode VI
e MIL-STD-188-277: Mode VII

7. This document supersedes MIL-STD-188-116-4 and paragraph 3.2.4.2, all subparagraphs, and Appendix I of the Joint Tactical Communications Office specification TT-A3-9013-0048B.

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APPENDIXES

1. SCOPE

1.1 Purpose. The purpose of this document is to ensure interoperability and to promote commonality of communications equipment and subsystems using Mode VI channel coordination procedures. An additional objective of this document is to prevent proliferation of equipment serving the same or similar function. The variety of equipment shall be the minimum necessary to support the missions of the armed forces in accordance with Department of Defense Directive 4630.5, Compatibility and Interoperability of Tactical Command, Control, Communications, and Intelligence Systems.

1.2 Scope. This document specifies the minimum requirements necessary to implement information and record traffic exchange among data communications systems employed in long haul and tactical communications networks. It is not the intent of this document to specify any particular hardware or software design or implementation. Message formats are not included in this document.

1.3 Application. This document is applicable to the design and development of new equipment, assemblages, and systems. Existing systems that are undergoing major modification or rehabilitation shall comply with the standards contained in this document subject to the applicable requirements of current procurement regulations. This document shall not be used solely to justify retrofit of existing systems. This document, in whole or in part, is applicable only to the extent specified in the procurement documents of an equipment item or system.

1.4 System standards and design objectives. The parameters and other requirements specified in this document are mandatory system standards if the word "shall" is used in connection with the parameter value or requirment under consideration (see appendix A). Nonmandatory system standards and design objectives are identified as optional by the word "should" in connection with the parameter value or requirement under consideration. For a definition of the terms "system standards" and "design objectives" see FED-STD-1037A. Information paragraphs, shown as notes, have been included to better define certain methods currently in use.

1.5 Tailoring. As a minimum, only those features or functions specified herein, that are necessary to ensure interoperability among systems shall be implemented in an equipment item. While every effort has been made to include all the features necessary for protocol implementation, certain aspects depend on system application and must be tailored by the specification writer. These aspects include alarm functions, Mode VI block group size, data rates, codes, message formats, etc.

2. APPLICABLE DOCUMENTS

2.1 Government documents

2.1.1 Standards. The following standards form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the current issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto.

STANDARDS

FEDERAL

FED-STD-1037A	Glossary of Telecommunication Terms
FIPS PUB 17-1	Character Structure and Character Parity Sense for Serial-By-Bit Data Communications in the Code for Information Interchange

2.2 Order of precedence. In the event of a conflict between this document and the references cited herein, the text of this document takes precedence. Nothing in this standard, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.3 Source of documents. Copies of the referenced federal standards are available from:

Single Stock Point Department of Defense
Commanding Officer
Naval Publications and Forms Center
5801 Tabor Avenue
Philadelphia, PA 19120-5099

For specific acquisition functions, these documents should be obtained from the contracting activity or as directed by the contracting activity.

3. DEFINITIONS

3.1 Definitions of terms. Definitions of terms used in this document shall be as specified in FED-STD-1037A. Those definitions of terms unique to information and record traffic exhange and not defined in FED-STD-1037A are provide below.

3.1.1 Bit error ratio (BER). BER is the error ratio measured at loop rate.

3.1.2 Character set. The synchronous character set used in the Mode VI protocol consists of 256 octets and is in compliance with the eight-bit environment of FIPS PUB 17-1. The octets are divided into two 128-character codes, one containing an odd number of logical 1 bits per each octet and the other set containing an even number of logical 1 bits per each octet. The octet set containing the odd number of logical 1 bits maps directly into the eight bit American Standard Code for Information Interchange (ASCII) character set, i.e., the odd parity eight-bit code. The set of octets used for control and framing has an even number of logical ones (an all-logical 0 octet is considered to have an even number of logical ones).

3.1.3 Data rate. The data rate is the rate, in bits per second (bps), at which Mode VI octets are transferred between terminals (transmitter and receiver).

3.1.4 Loop rate. The loop rate is the rate at which bits are exchanged between terminal devices and transmission/cryptographic equipment.

3.1.5 Mode I. Mode I is an automatic repeat-request (ARQ) channel coordination procedure which provides for synchronous, simultaneous, duplex data transfer. It is designed to be used over terrestrial links. Messages are structured into blocks. Blocks are transmitted to the receiver. The receiver positively acknowledges error-free blocks and negatively acknowledges blocks with errors. All blocks that are negatively acknowledged are retransmitted. A block of data cannot be transmitted until the previous block has been positively acknowledged. In block-by-block operation, no portion of the next block shall be transmitted until the block has been acknowledged. In continuous operation, the next block may be transmitted up to, but not including, the ETX/ETB characters.

3.1.6 Mode II. Mode II is a non-ARQ channel coordination procedure that provides for asynchronous, simultaneous, independent, duplex data transfer. No acknowledgment procedure is implemented.

3.1.7 Mode V. Mode V is an ARQ channel coordination procedure that provides for asynchronous, simultaneous, independent, duplex data transfer. It is designed to be used over terrestrial links. Error-free messages are positively acknowledged. Messages with errors are rejected by the receiver, and retransmission is requested.

3.1.8 Mode VI. Mode VI is an ARQ channel coordination procedure that provides for synchronous, simultaneous, duplex data transfer. It is designed to be used over terrestrial and satellite links. Messages are structured into blocks. Each block has a unique number associated with it. Error-free blocks are positively acknowledged. Blocks containing errors are negatively acknowledged. All acknowledgments, positive and negative, have the unique block number associated with them. The blocks of a message are organized into block groups. All blocks in a block group are transmitted whether or not the preceding blocks have been positively acknowledged. Any blocks not positively acknowledged are retransmitted. All blocks in a block group must be positively acknowledged before transmission of the next block group is initiated.

3.1.9 Mode VII. Mode VII is an ARQ channel coordination procedure that provides for synchronous, simultaneous, independent, duplex data transfer. It is designed to be used over terrestrial and satellite links. Messages are structured into frames. Frames without errors are acknowledged. All frames received with errors are retransmitted.

3.2 Abbreviations and acronyms. Abbreviations and acronyms used in this document are as defined in FED-STD-1037A and are provided in appendix B.

4. GENERAL REQUIREMENTS

4.1 Mode VI channel coordination procedures. The Mode VI channel coordination procedure provides for synchronous, simultaneous, duplex data transfer. Mode VI is designed to be used over terrestrial and satellite links, and its major features include a unique identification scheme to identify control and data characters, high-integrity, and the ability to accommodate satellite link path delays.

4.2 Duplex operation. Duplex operation shall be achieved by providing both transmitter and receiver functions at each end of the transmission link. These transmitters and receivers shall be capable of simultaneously sending and receiving messages.

4.3 Characters. Mode VI operation shall use three types of generic characters: data, control, and framing. These characters are identified in the bit stream by their sequence and position relative to other characters. The following types of generic characters shall be used:

4.3.1 Data characters. There are 128 data characters, and these shall be as defined in table I. Data characters shall be eight bits long and shall have an odd number of logical 1 bits.

4.3.2 Control and framing characters. There are also 128 characters available for use as control and framing characters, and table II identifies those currently defined for use. Control and framing characters shall also be eight bits long with an even number of logical 1 bits. Characters having an even number of logical 1 bits, and which are not an assigned control or framing (except BP) character, shall be treated as errors.

4.3.3 Framing characters. Framing characters serve to delineate the beginning and end of each block of data that comprise the transmission of a message. Two framing characters precede the block and two succeed the block (see figures 1, 2, 3, and 4). Framing characters shall be eight bits long with an even number of logical 1 bits per character (except BP). The framing characters are:

a. Start of header (SOH)
b. Select (SEL) character
c. Start of text (STX)
d. Block number (BN)
e. End of transmission block (ETB)
f. End of text (ETX)
g. Block parity (BP)

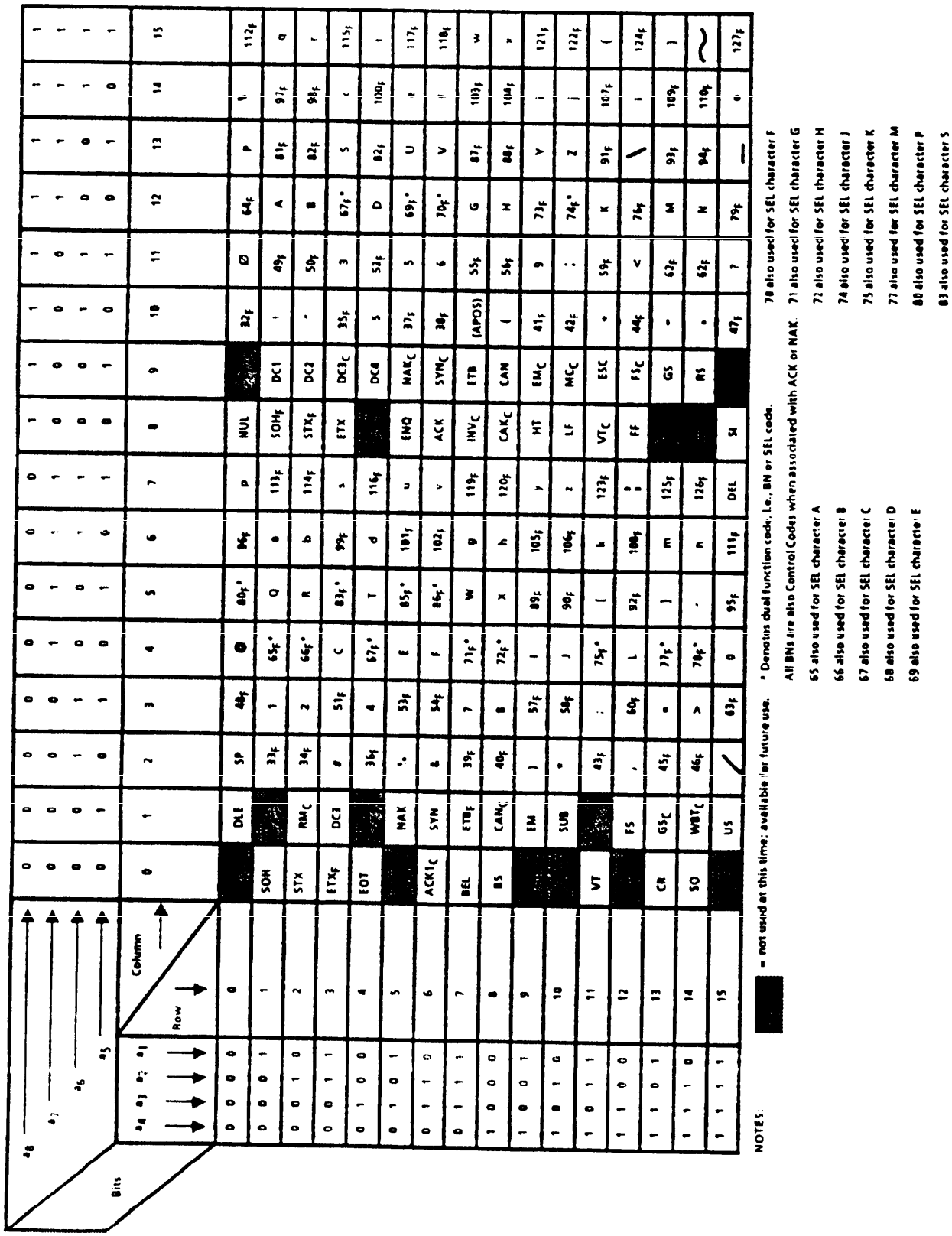
4.4 High integrity. Message integrity is accomplished by positive acknowledgment of error-free received messages. Messages are structured, by the transmitter, into blocks of up to 80 data characters; normal block size is 80 data characters. These blocks are transmitted to the receiver, which must positively acknowledge error-free receipt of each block. Blocks with errors are negatively acknowledged by the receiver and retransmitted by the transmitter. A control character hierarchy, which is discussed in subsequent sections, accomplishes the message block and acknowledgment process.

Table I. American Standard Code for Information Interchange (ASCII) and Mode VI data characters.

Bits a_7 a_6 a_5				Column →	0 0 0	0 0 1	0 1 0	0 1 1	1 0 0	1 0 1	1 1 0	1 1 1
a_4	a_3	a_2	a_1	Row ↓	0	1	2	3	4	5	6	7
0	0	0	0	0	NUL	DLE	SP	0	@	P	`	p
0	0	0	1	1	SOH	DC1	!	1	A	Q	a	q
0	0	1	0	2	STX	DC2	"	2	B	R	b	r
0	0	1	1	3	ETX	DC3	#	3	C	S	c	s
0	1	0	0	4	EOT	DC4	$	4	D	T	d	t
0	1	0	1	5	ENQ	NAK	%	5	E	U	e	u
0	1	1	0	6	ACK	SYN	&	6	F	V	f	v
0	1	1	1	7	BEL	ETB	' (APOS)	7	G	W	g	w
1	0	0	0	8	BS	CAN	(	8	H	X	h	x
1	0	0	1	9	HT	EM	)	9	I	Y	i	y
1	0	1	0	10	LF	SUB	*	:	J	Z	j	z
1	0	1	1	11	VT	ESC	+	;	K	[	k	{
1	1	0	0	12	FF	FS	,	<	L	\	l	:
1	1	0	1	13	CR	GS	-	=	M	]	m	}
1	1	1	0	14	SO	RS	.	>	N	^	n	~
1	1	1	1	15	SI	US	/	?	O	_	o	DEL

Note: Bit position a_8 (not shown) shall be generated such that the character shall have an odd number of logical 1 bits.
a_1 = LSB; a_8 = MSB

Table II. Mode VI data, control, and framing eight-bit environment character set.



NOTES:
- = not used at this time; available for future use.
- * Denotes dual function code, i.e., BN or SEL code.
- All BNs are also Control Codes when associated with ACK or NAK.
- 65 also used for SEL character A
- 66 also used for SEL character B
- 67 also used for SEL character C
- 68 also used for SEL character D
- 69 also used for SEL character E
- 70 also used for SEL character F
- 71 also used for SEL character G
- 72 also used for SEL character H
- 74 also used for SEL character J
- 75 also used for SEL character K
- 77 also used for SEL character M
- 80 also used for SEL character P
- 83 also used for SEL character S

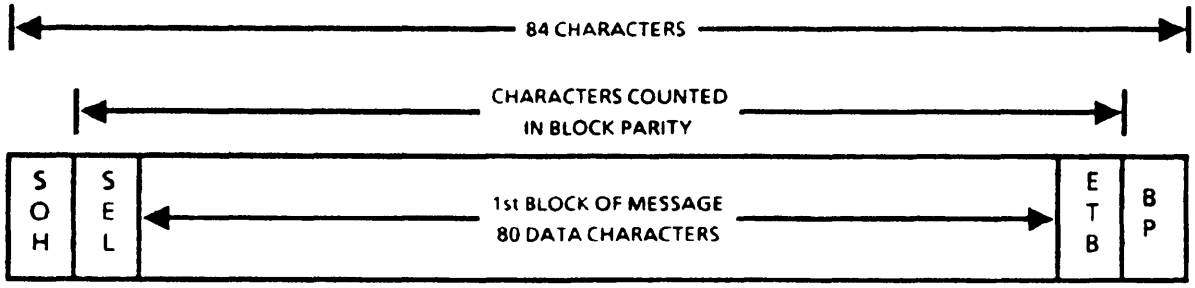


Figure 1. Mode VI - normal block - 1st block of message.

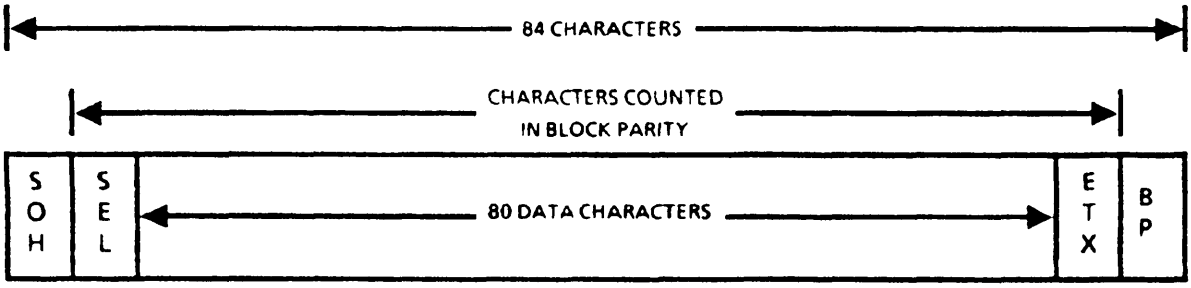
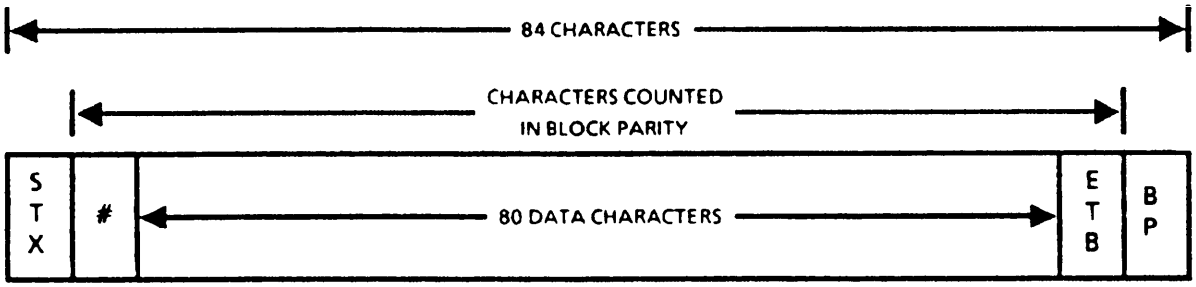


Figure 2. Mode VI - normal block - one block message.



NOTE: # = Block Number

Figure 3. Mode VI - normal block - text block.

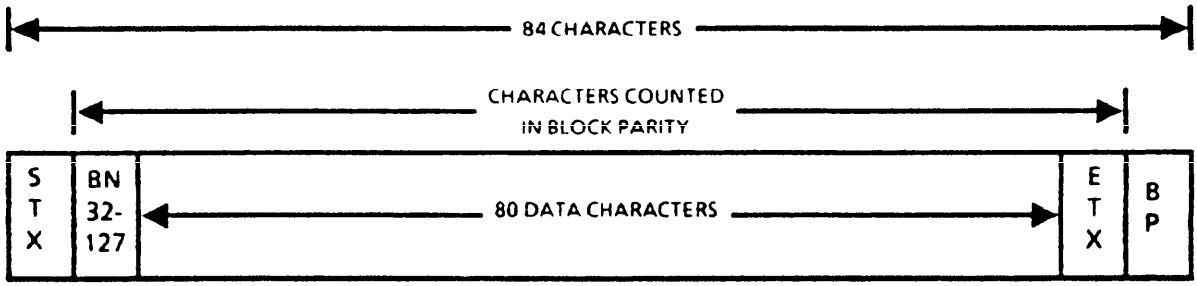


Figure 4. Mode VI - normal block - last block of messasge - text block.

4.5 Path delay accommodation. Accommodation is achieved by requiring that a message block be acknowledged with a time period that is greater than a satellite link round-trip delay. The message blocks are organized into block groups of up to 96 blocks. All blocks in a block group are transmitted whether or not preceding blocks have been positively acknowledged; however, all blocks in a block group must be positively acknowledged before transmission of the following block group is initiated.

4.6 Octet code. The requirement to transmit the total 128 characters of ASCII necessitated the development of an eight-bit (octet) coded control system that is transparent to all data characters. The eight-bit Mode VI code is compliant with FIPS PUB 17-1, eight bit environment character structure. The eight-bit (octet) character structure has no parity bit. The Mode VI code is divided into two 128 eight bit character groups. One character group consists of an even number of logical 1 or logical 0 bits and the other character group consists of an odd number of logical 1 bits. The even number logical 1 bits eight bit environment character group is used by the Mode VI protocol for control and framing. Characters in the Mode VI protocol are transmitted serial-by-bit, serial-by-character in compliance with FIPS PUB 17-1.

5. DETAILED REQUIREMENTS

5.1 Mode VI protocol. This document describes an information exchange protocol for a synchronous transmission system. The protocol provides for duplex exchange capability, automatic acknowledgment of receipt of message blocks, automatic error detection capability with subsequent retransmission, message block accountability, safe message store, and channel synchronization, with provision to compensate for long haul path delay.

5.2 Mode VI message block and message block groups. Messages transmitted using the Mode VI protocol shall be divided into message blocks and message block groups. Block groups shall consist of 16, 32, 64, or 96 blocks. Each message block shall consist of no more than 80 data characters and four framing characters (see figures 1, 2, 3 and 4). Each character of the Mode VI block shall consist of eight bits. No idle or control characters shall be sent within a message block, except as noted in 5.3.2 and 5.6. A block group containing an ETX block shall end that block group.

5.3 Message block structure. Message blocks shall consist of normal blocks or short blocks.

5.3.1 Normal message blocks. Normal blocks shall contain 80 data characters and four framing characters (see figures 1, 2, 3, and 4).

5.3.2 Short message blocks. Short message blocks shall consist of from 0 to 79 data characters (see figures 5 through 12), four framing characters, and an End of Medium (EM) control character. The total length of the short message block may vary from 5 to 84 characters. Short blocks may be used at any time and may be intermixed with normal blocks. The criteria to transmit short blocks shall be specified in the applicable procurement document. All Mode VI systems shall be capable of accepting any length short block.

5.4 Data formats. The protocol shall support the following data codes in the data portion of each block.

a. American Standards Code for Information Interchange (ASCII) and the Mode VI data character set (odd number of logical 1 bits per character, see tables I and II).

b. Other data codes and binary bit streams.

5.4.1 ASCII. The protocol shall support the synchronous ASCII character set (see table I) with odd parity for data. This ASCII set correlates to the Mode VI data character set (see table II).

5.4.2 Other data codes and binary bit streams. Other data codes such as Binary Coded Decimal (BCD), Extended Binary Coded Decimal Interchange Code (EBCDIC), FIELDATA, etc., and binary bit streams such as PIXEL codes in digital facsimile, shall be supported as seven-bit segments with an eighth bit added to produce an odd number of logical 1 bits. Where a segment does not contain seven bits, the remainder of the segment shall be coded as logical 1 bits (see appendix C).

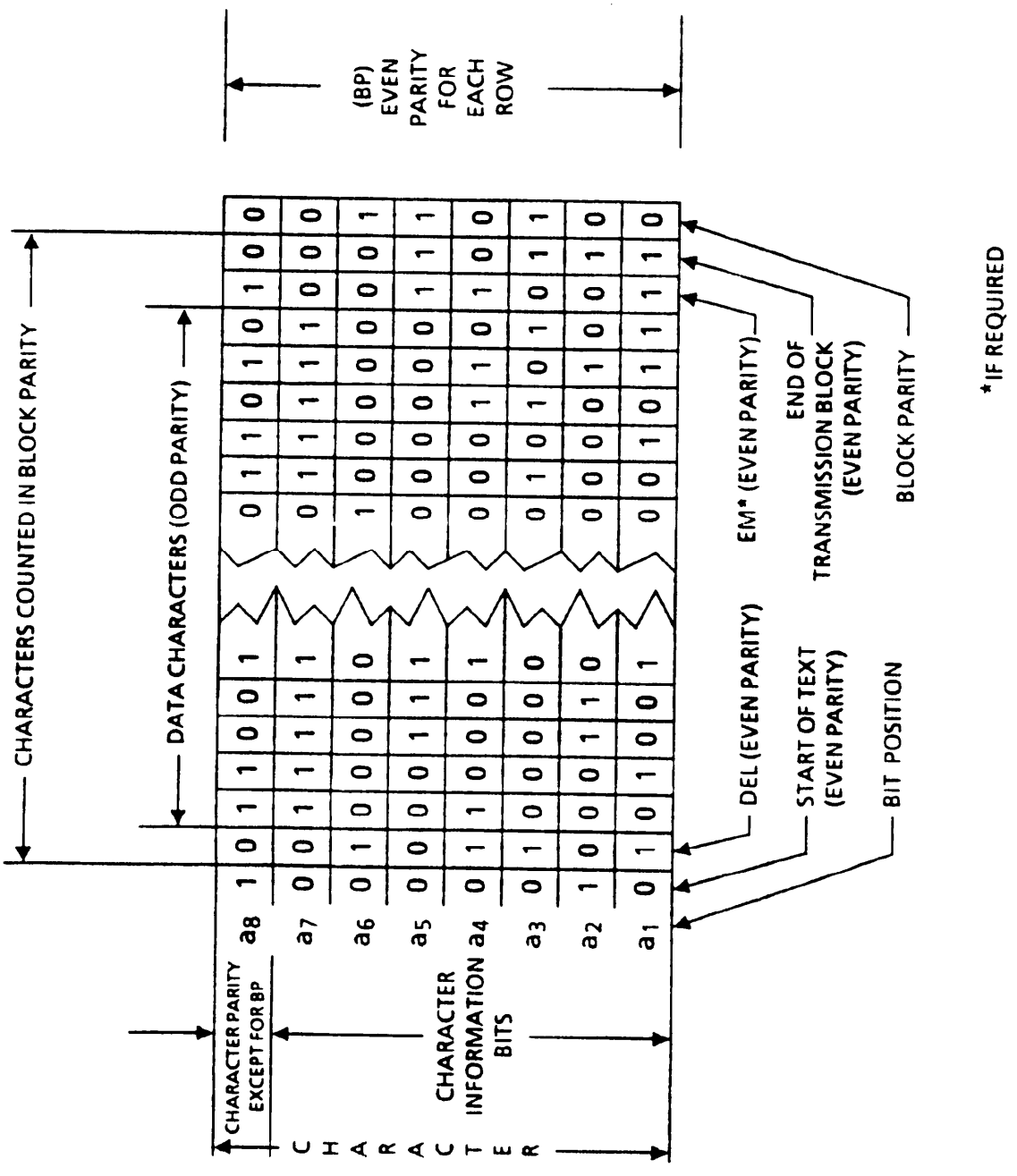


Figure 5. Mode VI message block construction.

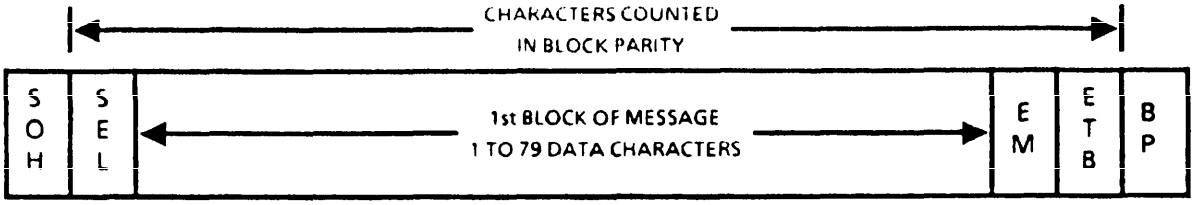


Figure 6. Mode VI - short block - 1st block of message.

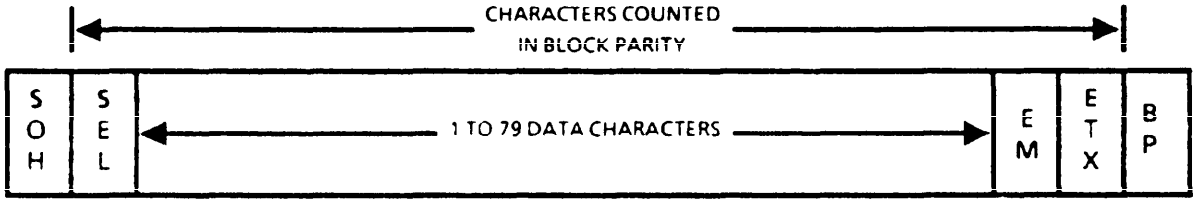


Figure 7. Mode VI - short block - one block message.

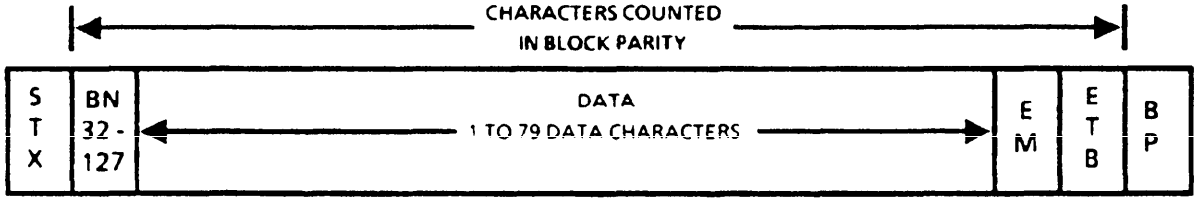


Figure 8. Mode VI - short block - text block.

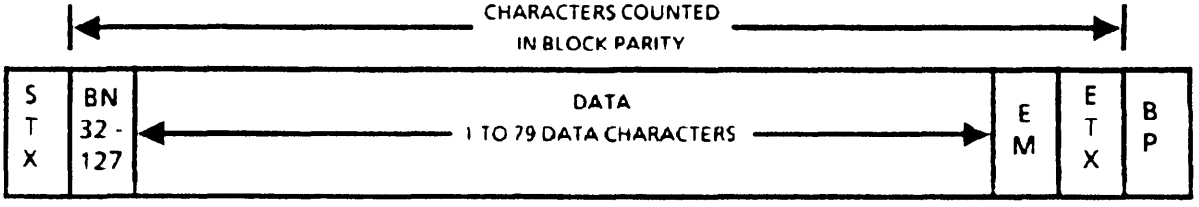


Figure 9. Mode VI - short block - last block of message - text block.

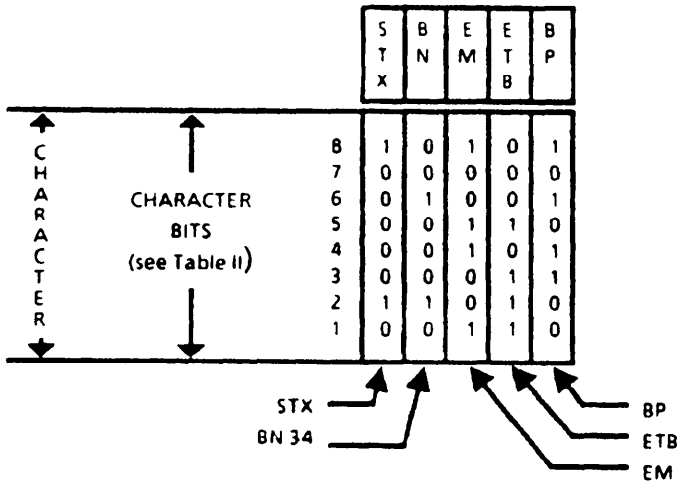


Figure 10. Example of EM block.

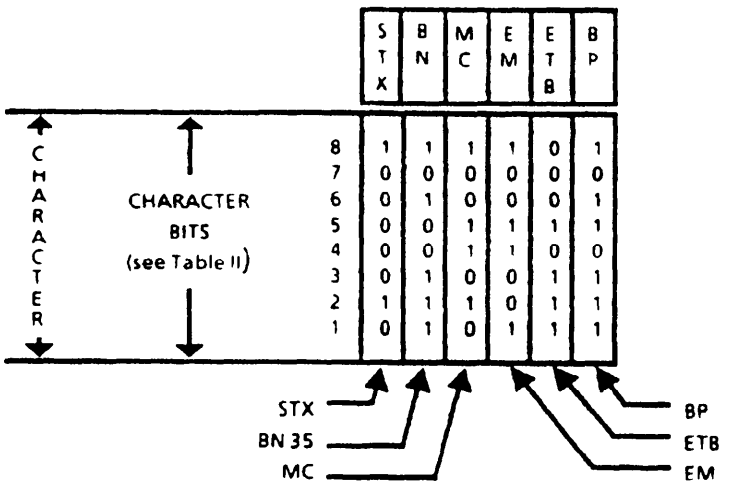


Figure 11. Example of MC block beginning/end of binary text.

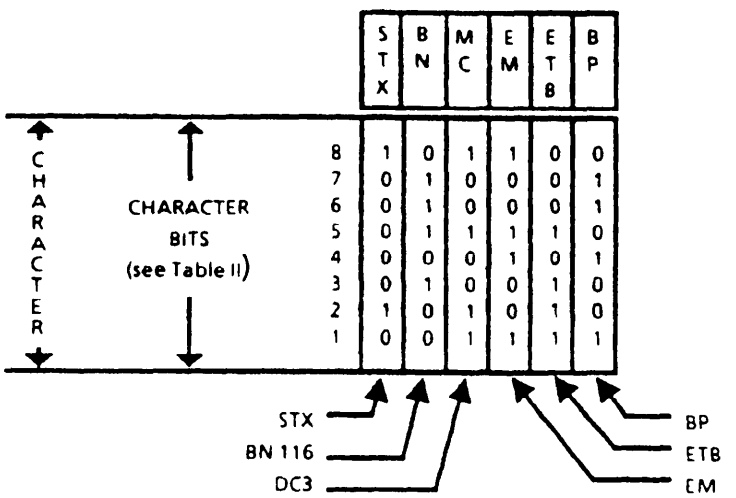


Figure 12. Example of DC3 block - end of record.

5.5 Framing characters. All framing characters, with the exception of block parity (BP), shall have an even number of logical 1 bits (see tables II and III). The even number of logical 1 bits per character (and their position) shall distinguish framing characters from data characters (see tables I and II). The following subparagraphs define the framing characters.

5.5.1 Start of header (SOH). SOH shall be the first framing character of the first (header) block of a message. There shall be only one SOH per message. The SOH shall be followed by the select (SEL) character (see figures 1, 2, 6, and 7 and tables II and III).

5.5.2 Select (SEL) character. The SEL character shall be the second framing character of the first block of a message. Allowable SEL characters are defined in tables III and IV. SEL characters are used to define media and format in which blocks are to be output by the receiver.

5.5.3 Start of text (STX). STX shall be the first framing character of all blocks after the first block of a message (see figures 3, 4, 5, 8, and 9). STX shall be followed by a block number (BN).

5.5.4 Block number (BN). A BN shall be the second framing character of all blocks, after the SOH block. The numbering sequence shall be as shown in tables II and III. Blocks within a group shall be numbered consecutively from number 32 up to a BN equal to 31 plus the size of the transfer permitted or the BN of the ETX block. The block following the SOH block shall be numbered 33.

5.5.5 End of transmission block (ETB). ETB shall be the third framing character of all blocks except the last block of a message. ETB shall be the 83rd position of a normal block or following the EM in a short block (see figures 1, 3, 6, and 8). ETB shall be followed by BP.

5.5.6 End of text (ETX). ETX shall be the third framing character of the last block of a message. ETX shall be the 83rd character position of the last normal block of a message or following the EM if a short block (see figures 2, 4, 5, 7, and 9). ETX shall be followed by BP.

5.5.7 Block parity (BP). BP shall be the last framing character of every block in the message. BP shall be formed by the binary addition without carry (modulo two) of each of the bits in each row of a block that starts with the second framing character (see figure 5) including all data characters, the EM character, if used, and ETB or ETX. The summation shall result in a character of odd or even number of logical 1 bits. The receiving terminal shall generate the binary summation of each received character, starting with the second character of each block. When ETB or ETX is detected, the next character shall be compared with the receiver-generated BP. If the received BP character and the receiver generated summation are not equal, a negative acknowledgment (NAK) sequence shall be sent.

5.6 Special short blocks. The Mode VI protocol shall implement special short blocks to support other data codes and binary bit streams (see appendix C).

5.6.1 End of medium (EM) block. This special short block shall consist of five characters: STX, BN, EM, ETB, and BP (see figure 10).

Table III. Mode VI eight bit control and framing codes.

Bits: a_4 a_3 a_2 a_1 (Row)	a_7 a_6 a_5 = 000	001	010	011	100	101	110	111
	Column 0	1	2	3	4	5	6	7
0 0 0 0 — 0			32	48	64	80*	96	112
0 0 0 1 — 1	SOH		33	49	65*	81	97	113
0 0 1 0 — 2	STX	RM	34	50	66*	82	98	114
0 0 1 1 — 3	ETX	DC3	35	51	67*	83*	99	115
0 1 0 0 — 4			36	52	68*	84	100	116
0 1 0 1 — 5		NAK	37	53	69*	85	101	117
0 1 1 0 — 6	ACK	SYN	38	54	70*	86	102	118
0 1 1 1 — 7	INV	ETB	39	55	71*	87	103	119
1 0 0 0 — 8	CAK	CAN	40	56	72*	88	104	120
1 0 0 1 — 9		EM	41	57	73	89	105	121
1 0 1 0 — 10		MC	42	58	74*	90	106	122
1 0 1 1 — 11	VT		43	59	75*	91	107	123
1 1 0 0 — 12		FS	44	60	76	92	108	124
1 1 0 1 — 13		GS	45	61	77*	93	109	125
1 1 1 0 — 14		WBT	46	62	78	94	110	126
1 1 1 1 — 15			47	63	79	95	111	127

NOTES: ■ = not used at this time; available for future use.

Bit position a_8 (not shown) shall be generated such that the character has an even number of logical 1 bits.

* Denotes dual function code, i.e., BN or SEL code.
All BNs are also Control Codes when associated with ACK or NAK
65 also used for SEL character A
66 also used for SEL character B
67 also used for SEL character C
68 also used for SEL character D
69 also used for SEL character E
70 also used for SEL character F
71 also used for SEL character G
72 also used for SEL character H
74 also used for SEL character J
75 also used for SEL character K
77 also used for SEL character M
80 also used for SEL character P
83 also used for SEL character S

Table IV. Mode VI select framing characters.

Select Character	Code								Identification
	a_8	a_7	a_6	a_5	a_4	a_3	a_2	a_1	
A	0	1	0	0	0	0	0	1	IA No. 2 (Note 1)
B	0	1	0	0	0	0	1	0	Identifies the source transmission media as being 7 track. (Note 1)
C	1	1	0	0	0	0	1	1	Identifies the source transmission media as being 9 track. (Note 1)
D	0	1	0	0	0	1	0	0	Card format (Note 1)
E	1	1	0	0	0	1	0	1	Reserved for future use.
F	1	1	0	0	0	1	1	0	Card format (Note 2) Activate operator alarm.
G	0	1	0	0	0	1	1	1	Reserved for future use.
H	0	1	0	0	1	0	0	0	Mode VI data code. (Note 1)
J	1	1	0	0	1	0	1	0	Reserved for future use.
K	0	1	0	0	1	0	1	1	Reserved for future use.
M	0	1	0	0	1	1	0	1	Reserved for future use.
P	0	1	0	1	0	0	0	0	Reserved for future use.
S	0	1	0	1	0	0	1	1	Activate operator alarm. (Note 3)

NOTES:

1 Select Characters A, B, C, D, and H are used by the receiver to route messages to the output device associated with the Select Character.

2 Select Character F will be inserted by the message switch as the second framing character of the first block of each card message delivered to a Mode VI channel if the header of the message indicates flash or higher precedence. It shall not be inserted by any subscriber terminal.

3 Select Character S will be inserted by the message switch as the second framing character of the first block of each paper tape message delivered to a Mode VI channel if the header of the message indicates flash or higher precedence. Select Character S shall not be generated by any terminal.

5.6.2 Mode change (MC) block. This special short block shall consist of six characters: STX, BN, MC, EM, ETB, and BP. The MC character shall have an even number of logical 1 bits. This block shall be used to define the beginning and end of the binary data portion of a message (see figure 11).

5.6.3 Record mark (DC3) block. (see figure 12.)

5.7 Message block groups. Message-block groups shall consist of 16, 32, 64, or 96 blocks. A block group containing an ETX block shall end with that block group.

5.8 Message transmission control. Message transmission using the Mode VI protocol shall be controlled by the exchange of control characters between the transmitter and receiver. Control characters shall indicate positive or negative receipt of blocks and block groups, reject blocks, cancel transmission, stop transmission, resume transmission, and establish channel synchronization. Control character sequence shall be initiated within ten character times after a request for answer, if no transmission is in progress, or upon completion of the current block transmission. The receive shall recognize the sequence when two contiguous control characters are detected, except for positive or negative acknowledgment sequences that require detection of four contiguous characters (see table V).

5.8.1 Control character response. Control characters (CC) shall be sent by the receiver, in response to a request for answer from the transmitter. The requests for an answer are ETB BP or ETX BP, File Separator (FS), and Cancel Message (CAN). When an end of block (ETB BP) or end of text (ETX BP) is received, the receiver shall respond with a position acknowledgment (ACK), NAK, reject message (RM), or wait before transmitting (WBT) sequence. When an FS sequence is received, the receiver shall respond with a vertical tabulation (VT), RM, or WBT sequence. When a cancel message (CAN) sequence is received, the receiver shall respond with CAN acknowledgment (CAK) or WBT sequence. Table V illustrates a four-character ACK and NAK sequence.

5.8.1.1 ACK. ACK 32 through ACK 127 sequence shall be sent by the receiver to signal the transmitter that the corresponding numbered block has been received correctly. The ACK sequence shall consist of four contiguous characters, ACK ACK BN BN, where BN BN is characters 32 32 through 127 127 (see tables II, III and V). ACK ACK 32 32 shall be the response to an error free SOH block.

5.8.1.2 NAK. NAK 32 through NAK 127 sequence shall be transmitted by the receiver if either a character error is detected or BPs do not match after the receipt of a properly framed block. NAK sequence is sent when an answer is requested and not at the time of detection of the error. The NAK sequence shall consist of four characters, NAK NAK BN BN, where BN BN is characters 32 32 through 127 127 (see tables II, III, and V). NAK NAK 32 32 shall be the response to an SOH block received with an error.

Table V. Example of Mode VI acknowledgment sequences.

SEQUENCES	CHARACTER BIT POSITION			
	8 7 6 5 4 3 2 1	8 7 6 5 4 3 2 1	8 7 6 5 4 3 2 1	8 7 6 5 4 3 2 1
ACK 32	ACK 0 0 0 0 0 1 1 0	ACK 0 0 0 0 0 1 1 0	32 1 0 1 0 0 0 0 0	32 1 0 1 0 0 0 0 0
NAK 32	NAK 1 0 0 1 0 1 0 1	NAK 1 0 0 1 0 1 0 1	32 1 0 1 0 0 0 0 0	32 1 0 1 0 0 0 0 0

32 bits (4 contiguous characters)

5.8.1.3 WBT. The WBT sequence shall consist of 20 contiguous WBT characters. A WBT sequence shall be sent by the receiving device under the following conditions:

a. As an answer to a properly framed block, to inform the transmitter to temporarily suspend block transmission.

b. As an answer to FS or CAN control sequence, if a reply cannot be sent within one second.

5.8.1.3.1 Restart. Restart of a block transmission shall be initiated by the absence of WBT sequences for ten seconds or the receipt of a Group Separator (GS) sequence. WBT sequence shall be transmitted at one block time or one-second intervals.

5.8.1.4 FS Twenty contiguous FS characters shall be sent by a transmitter to signify receipt of positive acknowledgment of all link blocks transmitted in the block group. The valid responses to FS are WBT, VT, or RM. The acknowledgment of FS is VT. The FS sequence shall be repeated at one-second intervals until a response is received or a ten second time-out condition is indicated.

5.8.1.5 VT. Twenty contiguous VT control characters shall be sent by the receiver in response to FS. Receipt of VT characters shall inform the transmitter transmitting the FS that the block group has been acknowledged. A VT sequence sent in response to the last group of a message shall signify to the transmitter that the message is acceptable. Once a VT sequence has been sent in response to an FS sequence for the last group of a message, an RM shall not be sent by the receiver with the intent of rejecting the previous message. A received CAN sequence shall not cancel the previously received message. If a WBT sequence is not received within ten seconds after the transmitter has received a VT sequence, the transmitter shall automatically continue transmission.

5.8.1.6 GS. Twenty contiguous GS characters shall be sent by a receiver to signify that it is ready to receive another group of message blocks. GS shall also be sent to continue receiving message blocks after the receiver has transmitted WBT.

5.8.1.7 RM. Twenty contiguous RM control characters shall be sent by the receiver in response to a properly framed block or an FS sequence to inform the transmitter that there is a detected uncorrectable condition. An RM sequence shall be sent by a receiver when an FS sequence has been received and the current block group does not contain the required number of blocks. Upon receipt of the RM sequence, the transmitter shall cause the message to be canceled. The RM sequence shall be retransmitted upon receipt of each FS sequence and shall be retransmitted at five second intervals until a CAN sequence is received (see table VI). An RM sequence shall be sent:

a. After receipt of the first BP character of a block, which was not preceded by a CAN sequence.

b. For equipment failure.

c. Upon return from a self test.

Table VI. Mode VI - reject and cancel message procedures.

	STATE	Receiver (RCVR)	Transmitter (XMTR)	Description
TRAFFIC	IDLE	SYN →	← SYN	No data to send. New circuit established by XMTR.
	CIRCUIT ESTABLISHMENT (REJECT MESSAGE)	← Transmit MSG block RM → ← CAN CAK → ← SYN SYN →		XMTR begins transfer of message blocks. Since CKT has not been established RCVR rejects incoming message and forces XMTR to send CAN sequence. XMTR detects RM and cancels MSG. RCVR detects CAN, discards MSG being received, and sends CAK. XMTR and RCVR send SYN to maintain synchronization.
	MESSAGE CANCELLATION	← Transmit MSG block SYN/NAK-#/ACK-# → ← Transmit MSG block SYN/NAK-#/ACK-# → ← CAN CAK → ← SYN SYN →		XMTR begins transfer of msg blocks group(s). RCVR sends response to each received message block as blocks are received. XMTR sends last block of group. RCVR sends response to each received MSG block. XMTR detects uncorrectable error in MSG or response received and cancels MSG. RCVR detects CAN, discards MSG being received, and sends CAK. XMTR and RCVR send SYN to maintain synchronization.
	REJECT MESSAGE	← Transmit MSG block SYN/NAK-#/ACK-# → ← Transmit MSG block RM → ← CAN CAK →		XMTR begins transfer of MSG block group(s). RCVR sends response to each MSG block as blocks are received. XMTR sends last block of group. RCVR detects uncorrectable error in message and sends RM sequence. XMTR detects RM and cancels MSG. RCVR detects CAN, discards MSG being received, and sends CAK.
	IDLE	SYN →	← SYN	XMTR & RCVR send SYN to maintain synchronization.

5.8.1.8 CAN. Twenty contiguous CAN characters shall be sent by a transmitter to direct the receiver to discard the message currently being received. The CAN sequence shall also be initiated upon receipt of an RM sequence (see tables VI and VII). The valid response to CAN is WBT or CAK. The CAN sequence shall be repeated at five second intervals until a response is received or a ten second time-out condition is indicated. A CAN sequence shall be sent:

a. Prior to message transmission following terminal's initialization.

b. For equipment failure.

c. Upon return from a self test.

d. In response to a received RM sequence.

5.8.1.9 CAK. Twenty contiguous CAK control characters shall be sent by the receiving device in response to a CAN to acknowledge the receipt of the CAN. A CAN shall be accepted and acknowledged within and between messages. A between message CAK shall indicate receipt of the CAN and shall not cause cancellation of the previous message. A within-message CAK sequence shall inform the transmitter sending the CAN that the message being received has been discarded and that it may initiate a new message transmission.

5.8.1.10 Invalid (INV) sequence. The INV sequence shall be transmitted as twenty contiguous characters. The INV sequence shall be transmitted whenever an unexpected ACK, NAK, VT, or CAK sequence is received.

5.8.1.11 Idle line synchronization (SYN). SYN shall be transmitted continuously to maintain character synchronization whenever data or control characters are not being transmitted. No less than six contiguous SYN characters shall be transmitted between Mode VI message blocks.

5.8.1.12 End of medium (EM). The EM control character shall mark the end of data in a block containing 79 or fewer data characters. EM shall be included in the block parity check and shall be followed by ETB/BP or ETX/BP.

5.9 Traffic state. Tables VI and VII illustrate the normal Mode VI circuit establishment and transfer of data.

5.9.1 Transmitter. The transmitter shall transmit no more than the number of blocks specified by the selected block group size. After the transmission of a block group, the transmitter shall ensure that all blocks of the current group have been acknowledged before transmitting the message blocks of the next block group.

5.9.2 Receiver. The receiver shall send ACK or NAK for each properly framed block received.

5.9.3 Message block retransmission

5.9.3.1 NAK blocks. Retransmission of NAK blocks shall be accomplished at the next available block time.

Table VII. Normal Mode VI procedures.

STATE	Receiver (RCVR)	Transmitter (XMTR)	Description
TRAFFIC			
IDLE	SYN →	← SYN	No data to send. XMTR and RCVR send SYN New circuit established by XMTR.
CHANNEL ESTABLISHMENT		← CAN	XMTR sends CAN sequence.
	CAK →		RCVR detects CAN and sends CAK. RCVR clears any incomplete messages.
		← SYN	XMTR received CAK and continues sending SYN character.
	SYN →		RCVR & XMTR are in SYN sync. RCVR & XMTR are in traffic state.
DATA TRANSFER		← Transmit Msg blocks	XMTR begins transfer of MSG block group(s).
	SYN →		
		← Transmit Msg blocks	RCVR sends response to each received message block as blocks are received. XMTR sends last block of group.
	SYN/NAK-#/ACK-# →		
		← SYN	XMTR checks all responses for transmitted messages block group.
	SYN/NAK-#/ACK-# →		
		← Retransmit Msg blocks	XMTR retransmits message blocks that were not positively acknowledged (ACK).
	SYN/NAK-#/ACK-# →		
		← SYN	XMTR has received ACKs for all blocks in the group.
	SYN →		
		← FS	XMTR transmits 20 FSs.
	SYN →		
		← SYN	RCVR transmits 20 VT characters to acknowledge FS. RCVR sends SYN if GS cannot be sent immediately.
	VT →		
		← SYN	XMTR prepares to send next block group upon receipt of VT.
	SYN →		
		← SYN	RCVR sends 20 GSs to indicate ability to continue receiving.
	GS →		
		← SYN	XMTR continues traffic state or reaches end of message.
	SYN →		

5.9.3.2 Unacknowledged blocks. Upon completion of the transmission of all message blocks in a block group, the transmitter shall retransmit all message blocks for which no acknowledgments have been received. After all unacknowledged blocks have been retransmitted, the process shall be repeated after a one second interval for all the then remaining unacknowledged blocks.

5.9.4 Receipt of a duplicate block. If a block that has been previously acknowledged is received, the receiver shall assume that the ACK sequence was not received by the transmitter. This block shall be acknowledged by the receiver. The duplicate block shall be discarded.

5.9.5 Excessive block retransmission. If a transmitter transmits a block eight times without receiving an ACK or WBT, the transmitter shall alarm and cancel message transmission by sending a CAN sequence.

5.9.6 Block framing errors. Errors in framing characters or in their expected position shall cause the receiver to ignore the block (see table VIII). Once a frame error has been detected, the receiver shall discard current block accumulation and begin next message block accumulation.

5.9.7 Excessive unexpected characters. The receiver shall consider the receipt of 170 or more contiguous unexpected characters as excessive unexpected characters and shall alarm. When the alarm condition occurs, the protocol shall attempt to re-establish synchronization between systems.

5.10 Mode VI traffic-state. Figures 13 and 14 and tables VI and VII show the functions required to transmit and receive a Mode VI message. The Mode VI message transmission diagram (figure 13) shows the transmission of Mode VI line block groups and the protocol required for validation of the groups. The Mode VI message reception diagram (figure 14) shows the functions required to accept or reject incoming line block groups and the protocol requirements. The specific inputs and outputs are shown in figures 13 and 14. The alarms generated for abnormal conditions are depicted and processed, as shown on the traffic state in figures 13 and 14.

5.11 Character and bit transmission. Transmission of Mode VI characters shall be in accordance with FIPS PUB 17-1; that is, least significant bit first to more significant bit; (see tables I, II, and III) a_1 through a_8 in ascending (consecutive) order.

5.12 Mode VI timing and timeouts. Table IX specifies the minimum Mode VI requirement for timing and time-out conditions and actions to be taken for proper operation.

5.13 Safe message store. A receiver shall positively acknowledge a Mode VI message only after the message has been placed in safe message store, i.e., hard copy, paper tape, magnetic tape, disk, or any temporary storage element protected from loss of data. Safe storage shall be immune to system perturbations for at least 24 hours. The Mode VI system shall place a message into safe storage within one second after receiving the last block of a message.

TABLE VIII. Mode VI block framing errors.

		Frame Characters (FC)		
	CASE #	STX or SOH	SEL or 32 thru N	ETB or ETX
First msg group	1	Not SOH	SEL	N/A
	2	SOH	Not SEL	N/A
	3	Not STX	33-N	N/A
	4	STX	Not 33-N	N/A
Other than first message group	5	Not STX	32-N	N/A
	6	STX	Not 32-N	N/A
Any message group	7	Not first character in block	N/A	N/A
	8	N/A	Not second character in block	N/A
	9	N/A	N/A	Not ETX or ETB
	10	N/A	N/A	ETX but block # is not equal to previously rec'd ETX block
	11	N/A	N/A	ETB but block # is greater than or equal to previously rec'd ETX block
	12	N/A	N/A	Not 83rd character and no EM in block
	13	N/A	N/A	Not 4th thru 83rd character and EM just before FC3

N/A: Not applicable (i.e., FC correct for this position)

N: 47 for Group Size = 16 blocks; 63 for Group Size = 32; 95 for Group Size = 64; 127 for Group Size = 96

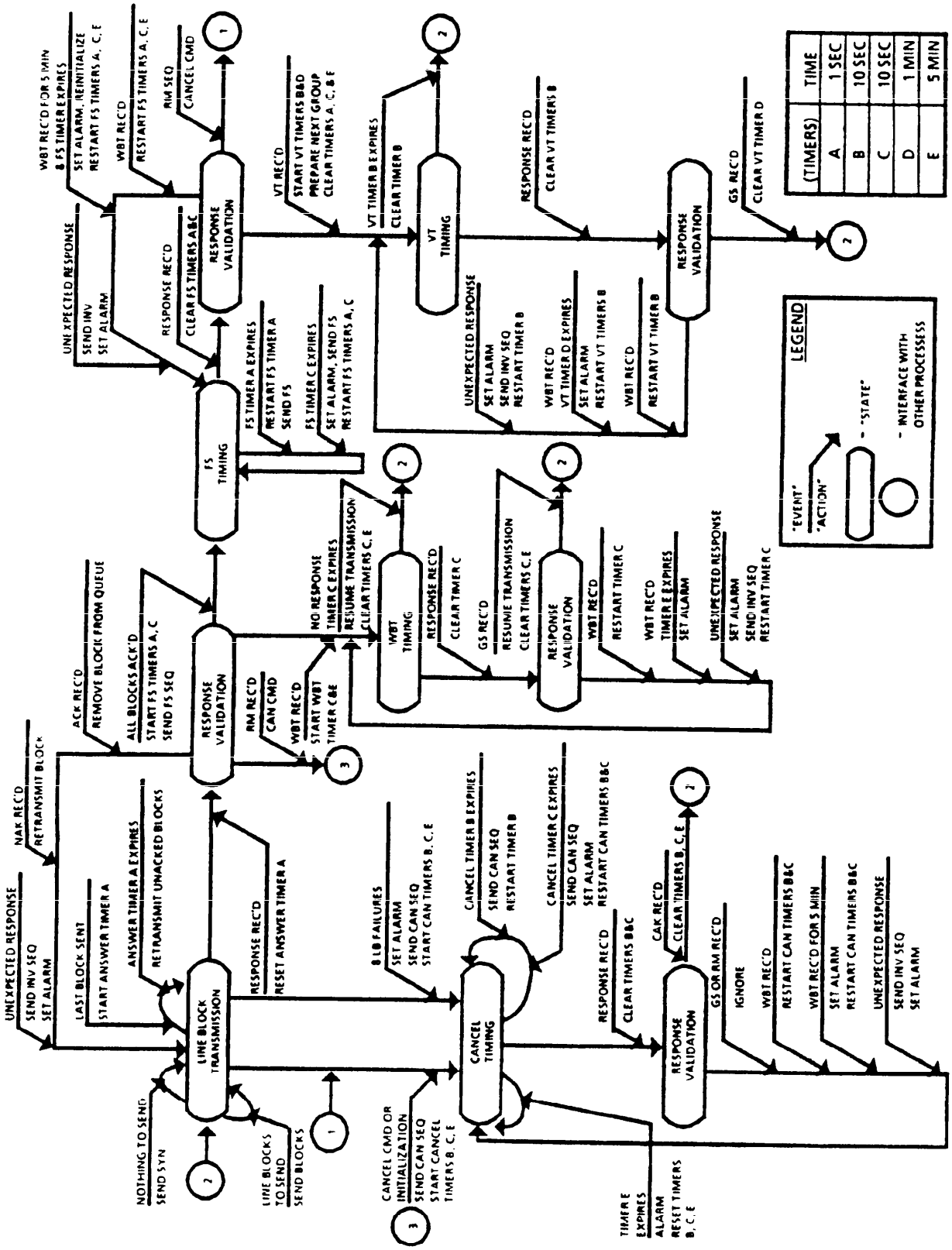


Figure 13. Mode VI message transmission.

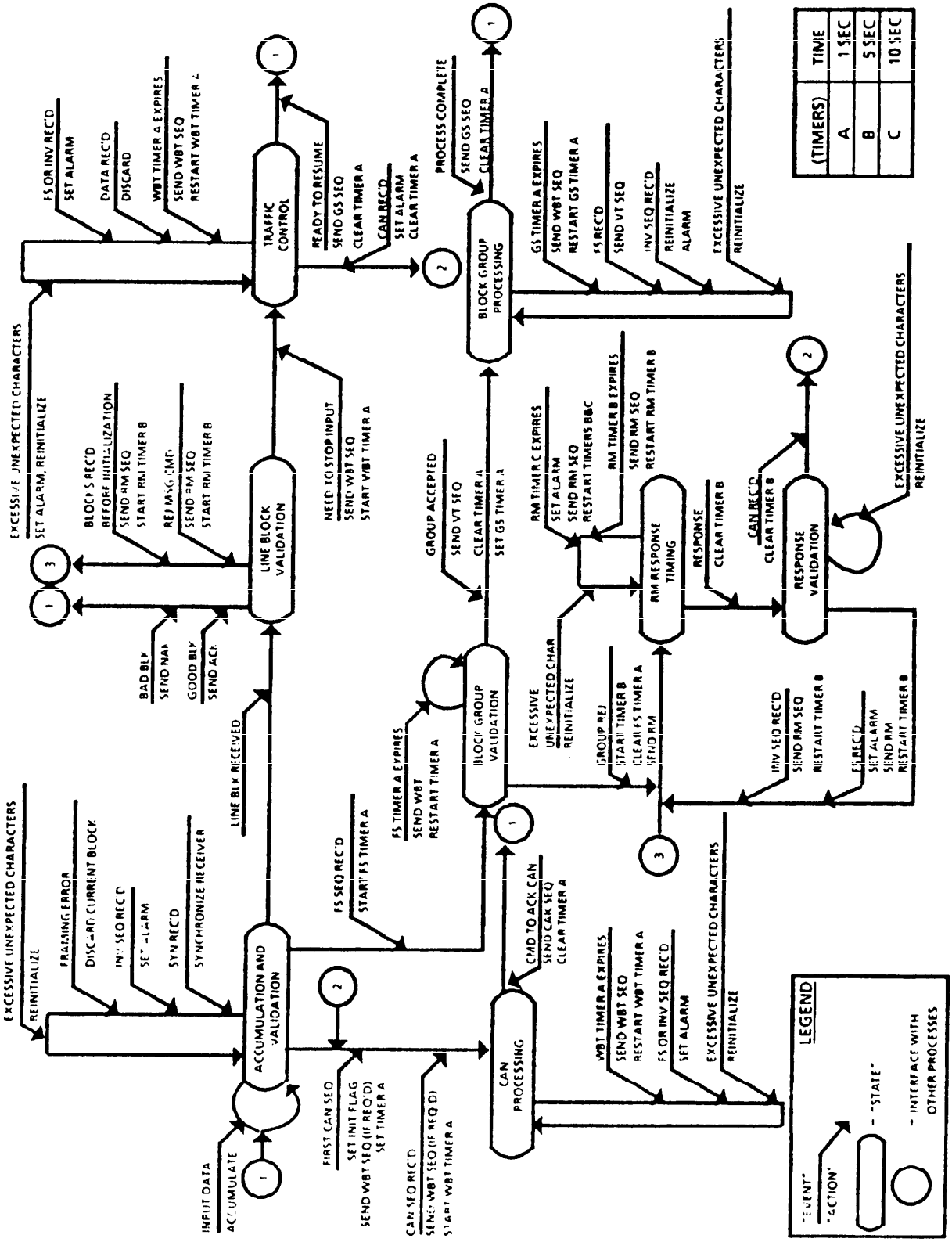


Figure 14. Mode VI message reception.

Table IX. Mode VI timing and time-outs.

FUNCTION	CAUSE	ACTION
WBT	WBT received.	Send only SYN.
	No WBT received for 10 sec.	Restart data transmission.
	5 min of WBT reception.	Alarm.
WBT	WBT transmission.	Send WBT sequence every second.
	For 1 sec no data or CC can be processed.	Send WBT sequence.
	Ready to receive data.	Send GS sequence.
FS	FS transmission.	
	ACKs received for all blocks.	Send FS sequence.
	1 sec no VT or WBT.	Send FS sequence.
	10 sec no VT or WBT.	Alarm and send FS sequence.
FS	FS received.	Send VT sequence.
	For 1 sec unable to send VT.	Send WBT. Send WBT every second until VT is sent.
VT	VT transmission.	
	For 1 sec unable to send GS.	Send WBT sequence.
VT	VT received.	
	1 min of WBT reception.	Alarm.
	10 sec of no VT.	Restart data transmission.
BLOCKS	1 sec after transmission of all blocks.	Transmit all blocks not ACK'd.
	All blocks transmitted at least 8 times and all blocks not ACK'd.	Alarm and send RM.

Table IX. Mode VI timing and time-outs - Continued.

FUNCTION	CAUSE	ACTION
RM	RM transmitted.	
	5 sec.	Send RM, accept only WBT or CAN.
	10 sec.	Send RM and Alarm.
RM	RM received.	Send CAN.
CAN	CAN transmitted.	
	5 sec and no response.	Send CAN.
	10 sec and no response.	Send CAN and Alarm.
CAN	CAN received.	Send CAK.
	CAN received. Unable to send CAK in one sec.	Send WBT. Send WBT every second until CAK is sent.
GS	GS transmitted.	Send GS after transmission of VT when ready to accept data.
		Transmission of GS sequence eliminates WBT sequence.
GS	GS received.	Transmitter continues sending data.

5.14 Mode VI throughput calculation. The following equation shall be used to calculate the theoretical time to transmit a Mode VI message and the assumptions used to generate the equation:

a. No errors are generated or detected.

b. All blocks of a message except for the last block have an equal number of bits.

c. All responses are given in ten character times.

d. Where:

t	=	time, in seconds, to transmit a Mode VI message
G	=	number of block groups required to transmit the message
B	=	number of bits in a block group except for the last block group
L	=	number of bits in last block group
Rt	=	round trip time in seconds
R	=	data rate in bps
608	=	(10 ch to process last block + 4 ch ACK seq + 10 ch to process ACK + 12 ch to process FS + 20 VT ch + 20 GS ch) x 8 bit/ch
S	=	One second to place message in safe message storage

then:

$$t = [(G-1)(2\,Rt + (B + 608)/R) + (2\,Rt + (L + 608)/R) + S] \text{ seconds}$$

5.14.1 Example. The following example illustrates the calculation of the time needed to transmit a 6900-character message in Mode VI. Using the equation from 5.14 and using a block group of 16, Rt = 0 and R = 2400 bps, the following equation is derived:

$$t = [(G-1)(2\,Rt + (B + 608)/R) + (2\,Rt + (L + 608)/R) + S] \text{ second}$$

where:

G = 6
Rt = 0
B = [16 blocks/group (90ch/blockx8 bits/ch)] = 11520 bits/group
L = [6 blocks/group (90 ch/block x 8 bit/ch)
+ 1 block/group (25 ch/block x 8 bits/block)] = 4520 bit/group
S = 1 second

then:

$t = [(6-1)(2\,Rt + (11520 + 608)/R) + (2\,Rt + (4520 + 608)/R) + s]$
$t = (5)(2\,Rt + 12128/R) + (2\,Rt + (5128)/R) + S]$
$t = [10\,Rt + (61640/R) + (2\,Rt + (5128)/R) + 1]$
$t = [12\,Rt + (66768/R) + 1]$
$t = [12\,(0) + (66768/2400) + 1] =$
$t = 28.40$ seconds

5.15 Tabulation transmission times. Table X lists the transmission time for a 6900 character message for various block groups. (96, 64, 32, and 16) and Rt (0, 0.5, and 1).

5.16 Mode VI transmission efficiency. The transmission efficiency for a Mode VI error-free message shall be at least 95%. The following equation shall be used to calculate the transmission efficiency of a Mode VI message.

Where:

E = Mode VI message efficiency in percent (%)
t = Calculated theoretical time, in seconds, to transmit a Mode VI message
tac = Measured time, in seconds, to transmit a Mode VI message

then:

$$E(\%) = (t/tac) \times 100$$

Table X. Mode VI transmission - time in seconds

Data Rate (bps)	MODE VI TRANSMISSION TIME IN SECONDS 6900 CHARACTER MESSAGE											
	GROUP SIZE 96 Blocks			GROUP SIZE 64 Blocks			GROUP SIZE 32 Blocks			GROUP SIZE 16 Blocks		
	Rt 1 (sec)	Rt 0.5	Rt 0	Rt 1 (sec)	Rt 0.5	Rt 0	Rt 1 (sec)	Rt 0.5	Rt 0	Rt 1 (sec)	Rt 0.5	Rt 0
16000	6.93	5.93	4.93	8.97	6.97	4.97	11.00	8.00	5.00	17.12	11.12	5.12
9600	9.54	8.54	7.54	11.61	9.61	7.61	13.67	10.67	7.67	19.86	13.86	7.86
8000	10.85	9.85	8.85	12.93	10.93	8.93	15.00	12.00	9.00	21.23	15.23	9.23
4800	16.08	15.08	14.08	18.21	16.21	14.21	20.34	17.34	14.34	26.72	20.72	14.72
4000	18.70	17.70	16.70	20.85	18.85	16.85	23.00	20.00	17.00	29.46	23.46	17.46
2400	29.16	28.16	27.16	31.42	29.42	27.42	33.67	30.67	27.67	40.43	34.43	28.43
2000	34.39	33.39	32.39	36.70	34.70	32.70	39.00	36.00	33.00	45.91	39.91	33.91
1200	55.32	54.32	53.32	57.83	55.83	53.83	60.33	57.33	54.33	67.85	61.85	55.85

6. NOTES

6.1 Key word listing. The following key words and phrases apply to MIL-STD-188-174:

Automatic repeat-request
Block parity
Channel control procedures
Eight-bit code
Error detection
Line block
Message block
Message protocol
Mode VI

APPENDIX A

DEPARTMENT OF DEFENSE DIRECTIVE 4640.11
21 DECEMBER 1987
SUBJECT: MANDATORY USE OF MILITARY TELECOMMUNICATIONS STANDARDS IN THE MIL-STD-188 SERIES

This appendix contains information related to MIL-STD-188-174. Appendix A is a mandatory part of this standard.

APPENDIX A

Department of Defense
DIRECTIVE

December 21, 1987
NUMBER 4640.11

USD(A)

SUBJECT: Mandatory Use of Military Telecommunications Standards in the MIL-STD-188 Series

References: (a) DoD Directive 5137.1, "Assistant Secretary of Defense (Command, Control, Communications, and Intelligence)," April 2, 1985
(b) DoD Directive 4120.3, "Defense Standardization and Specification Program," February 10, 1979
(c) DoD 4120.3-M, "Defense Standardization and Specification Program Policies, Procedures and Instructions," August 1978, authorized by DoD Directive 4120.3, February 10, 1979
(d) through (l), see enclosure 1

A. PURPOSE

This Directive establishes policy governing the application and use of the MIL-STD-188-100, -200, and -300 series of telecommunications standards; prescribes procedures; and assigns responsibilities.

B. APPLICABILITY AND SCOPE

1. This Directive applies to the Office of the Secretary of Defense (OSD), the Military Departments, the Organization of the Joint Chiefs of Staff (OJCS), the Unified and Specified Commands, and the Defense Agencies (hereafter referred to collectively as "DoD Components").

2. Its provisions cover the development and application of military telecommunications standards, specifically, the following:

a. MIL-STD-188-100 series, containing standards common to long-haul and tactical communications.

b. MIL-STD-188-200 series, containing standards exclusive to tactical telecommunications.

c. MIL-STD-188-300 series, containing standards exclusive to long-haul telecommunications.

C. POLICY

It is DoD policy that the interoperability and performance standards in the MIL-STD-188 series that are required for interoperability and compatibility of DoD telecommunications equipment and systems are mandatory for use for all inter- and intra-DoD Component systems and equipment.

APPENDIX A

D. RESPONSIBILITIES

1. The Assistant Secretary of Defense (Command, Control, Communications, and Intelligence) (ASD(C^{3}I)) shall interact with affected DoD Components under DoD Directive 5137.1 (reference (a)).

2. The Assistant Secretary of Defense for Production and Logistics (ASD(P&L)) is responsible for Defense Standardization and Specification Program (DSSP) policy, administration, and guidance.

3. The Director, Standardization and Data Management (SDM), Office of the Deputy Assistant Secretary of Defense (Production Support) (ODASD(PS)), manages and administers the DSSP and establishes policy, program guidance, and controls under DoD Directive 4120.3 (reference (b)).

4. The Director, Defense Standardization Program Office (DSPO), Defense Product Standards Office (DPSO), Defense Data Management Office (DDMO), ODASD(PS), shall assist the Director, SDM, in managing and administering the DoD communications standardization program for developing and establishing DSSP policies, program guidance, and controls.

5. The Heads of DoD Components shall:

a. Comply with this Directive, so that:

(1) Developers of the MIL-STD-188 series ensure that each standard is not only essential but of uniformly high quality, clear and concise as to application suitable for use in acquisition packages and, to the maximum extent possible, compatible with existing or proposed national and international (both Government and non-Government) telecommunications standards.

(2) Users of these standards cite in their procurement specifications only those standards essential to the proper functioning of the device or system over its projected lifetime.

b. Ensure the application of the MIL-STD-188 series in their organic acquisition specifications.

c. Be responsible for policing and enforcing the use of the MIL-STD-188 series standards within the DoD Component.

d. Support the development, revision, and use of the MIL-STD-188 series documents and, when necessary, provide personnel and funding resources.

e. Incorporate in each activity's internal review process a method for ensuring that the telecommunications standards are referenced to the extent necessary in acquisition documents.

f. Be the granting authority for waivers and deviations for intra-DoD Component systems and equipment, and shall forward any consideration of and granting of waivers and deviations to the standardization office responsible for the maintenance of the MIL-STD-188 series standard concerned.

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g. Ensure that their standardization offices forward waivers and deviations for intra-DoD Component systems and equipment to the Defense Communications Agency (DCA) and the Joint Tactical Command, Control, and Communications Agency (JTC^{3}A).

6. Director, Defense Communications Agency, and Director, Joint Tactical Command, Control, and Communication Agency, as the lead activities for the MIL-STD-188 series of standards, shall be the granting authorities for waivers and deviations for inter-DoD Component systems and equipment and shall review intra-DoD waivers and deviations granted by DoD Components.

E. PROCEDURES

1. DSSP. Under DoD Directive 4120.3 and DoD 4120.3-M (references (b) and (c)), the objectives of the DSSP are to improve the operational readiness of the DoD Components and ensure the cost-effectiveness of systems and equipment. The SDM is responsible for administering and managing the DSSP, which provides a uniform series of specifications, standards, and related documents. Under the DSSP, DoD Components develop military specifications and standards related to equipment acquisitions, including telecommunications equipment.

2. Tailoring of Military Standards. It is neither cost- nor mission-effective to impose military standards on all systems and equipment specifications blindly without consideration and review of each individual case. The applicability and relevance of the standard to the intended use of the equipment must be considered. DoD Directive 5000.43 (reference (d)) outlines DoD policies for the selection and tailoring of specifications used for acquisition. To prevent the misapplication of standards, the Department of Defense classifies most military standards as "approved for use," rather than "mandatory for use."

3. Application of Standards in System Acquisition. The required telecommunications standards selected from the MIL-STD-188 series shall be included, as appropriate, in defense acquisition documents (e.g., Statements of Work (SOWs), etc.). This direction is in addition to the authority and procedures contained in references (b), (c), (d) and DoD Directive 5000.1 and DoD Instruction 5000.2 (references (e) and (f)). DoD Directive 4630.5 (reference (g)), DoD Directive 5105.19 (reference (h)), and DoD Directive 5154.28 (reference (i)) highlight the development and application of interoperability and compatibility standards in the areas of tactical long-haul telecommunications.

4. Interoperability and Standardization

a. As stated in DoD Directives 2010.6, 2010.7, and 3100.4 (references (j) through (l)), the United States shall maximize the utility and effectiveness of allied telecommunications resources through equipment interoperability and standardization.

b. The MIL-STD-188 series addresses telecommunications design parameters, influences the functional integrity of telecommunications systems and their ability to interoperate efficiently with other functionally similar Government and commercial systems, and shall be mandatory for use within the Department of Defense.

APPENDIX A

F. EFFECTIVE DATE AND IMPLEMENTATION

This Directive is effective immediately. Forward one copy of implementing documents to the Assistant Secretary of Defense (Command, Control, Communications, and Intelligence) within 120 days.

William H. Taft, IV
Deputy Secretary of Defense

Enclosure - 1
References

APPENDIX A

REFERENCES, continued

(d) DoD Directive 5000.43, "Acquisition Streamlining," January 15, 1986
(e) DoD Directive 5000.1, "Major and Non-Major Defense Acquisition Programs," September 1, 1987
(f) DoD Instruction 5000.2, "Defense Acquisition Program Procedures," September 1, 1987
(g) DoD Directive 4630.5, "Compatibility and Interoperability of Tactical Command and Control, Communications, and Intelligence Systems," October 9, 1985
(h) DoD Directive 5105.19, "Defense Communications Agency (DCA)," August 10, 1978
(i) DoD Directive 5154.28, "Joint Tactical Command, Control, and Communications Agency (JTC^{3}A)," July 5, 1984
(j) DoD Directive 2010.6, "Standardization and Interoperability of Weapons Systems and Equipment within the North Atlantic Treaty Organization," March 5, 1980
(k) DoD Directive 2010.7, "Policy on Rationalization of NATO and NATO Member Telecommunications Facilities," July 6, 1981
(l) DoD Directive 3100.4, "Harmonization of Qualitative Requirements for Defense Equipment of the United States and Its Allies," September 27, 1963

APPENDIX B

LIST OF ABBREVIATIONS AND ACRONYMS USED IN MIL-STD-188-174

This appendix contains general information in support of MIL-STD-188-174. Appendix B is a nonmandatory part of this document.

ACK	Positive acknowledgment
ANSI	American National Standards Institute
ARQ	Automatic repeat-request
ASCII	American Standard Code for Information Interchange
AUTODIN	Automatic Digital Network
BCD	Binary Coded Decimal
BER	Bit error ratio
BN	Block number
BP	Block parity
BPS	Bits Per Second
CAK	Cancel acknowledgement
CAN	Cancel message
CC	Control character
CH	Character
CKT	Circuit
CMD	Command
DCA	Defense Communications Agency
DCAC	DCA circular
DCS	Defense Communications System
DO	Design objective
DoD	Department of Defense
DODISS	DoD Index of Specifications and Standards
EBCDIC	Extended Binary Coded Decimal Interchange Code
EM	End of medium - framing character
EOT	End of transmission
ETB	End of transmission block
ETX	End of text
FC	Framing character
FS	File separator

shall be accepted and acknowledged within and between messages. A between

APPENDIX B

GS	Group separator
IA No. 2	International Alphabet Number 2
INV	Invalid
JCS	Joint Chiefs of Staff
JSC	Joint Steering Committee
JTCO	Joint Tactical Communications Office
LB	Line block
MC	Mode change
min	Minute
MSG	Message
MSU	Message switching unit
NAK	Negative acknowledgment
NMCS	National Military Command System
RCC	Receive Control Character
RCVR	Receiver
REP	Reply
RM	Reject message
RT	Retransmit message
sec	Second
SEL	Select character
SOH	Start of header
STX	Start of text
SYN	Idle Line Synchronization
SYNC	Synchronization
TCC	Transmit control character
VT	Vertical Tabulation
WBT	Wait Before Transmitting
XMTR	Transmitter

APPENDIX C

DATA CONVERSION TECHNIQUES FOR SYSTEMS USING NONSTANDARD CODES

This appendix contains information in support of MIL-STD-188-174. Appendix C is a nonmandatory part of this document.

10. GENERAL

10.1 Scope. This appendix defines techniques that may be used to transmit data using Mode VI procotols by systems that use nonstandard information interchange codes. The general requirements of section 40 are mandatory; however, the specific requirements in section 50 may be used.

10.2 Application. The requirements presented in section 50 may be used as guides in developing information interchange techniques among systems that use nonstandard codes.

10.3 Application guidance. This appendix contains information and techniques that have been successfully used to transmit and receive seven- and nine-track nonstandard magnetic tape data. These techniques may be used to satisfy similar nonstandard transmission requirements. This appendix shall be tailored to suit unique requirements.

20. APPLICABLE DOCUMENTS

20.1 Government documents.

20.1.1 DCA

DCAC 370-D175-1	DCS AUTODIN Interface and Control Criteria

30. DEFINITIONS

Not applicable.

40. GENERAL REQUIREMENTS

40.1 Minimum criteria. Any system or terminal that transmits information using Mode VI protocols shall conform to the following minimum criteria.

a. The smallest data element shall be the octet defined in section 4 of MIL-STD-188-174.

b. The octets within the data portion of each block shall contain an odd number of one bits.

c. Framing characters and control characters shall be the character set defined in section 4 of MIL-STD-188-174.

d. The special block defined as mode change shall be used to define the beginning and end of nonstandard coded data.

40.2 User responsibility. When using nonstandard codes in switched systems such as the Automatic Digital Network (AUTODIN), the user has the following responsibilities:

a. The user shall conform to the basic data element formats of the system.

b. The user shall ensure, when using nonstandard codes, that the intended recipient has the capability to decipher, decode, or otherwise reconstruct the nonstandard coded data.

50 SPECIFIC METHODOLOGY

50.1 Introduction. The guidance in this section describes a methodology for seven and nine track magnetic tape conversion which has been successfully employed in AUTODIN (DCAC 370-D175-1). The methodology may be used to develop new methodologies.

50.2 Magnetic tape messages. This section contains the interface and control criteria for variable-length data records and nonstandard code messages as applied to seven and nine-track magnetic tape operation. It applies to terminals receiving and transmitting structured and nonstructured magnetic tape formatted messages. A magnetic tape message is a series of contiguous characters recorded on and read as a single unit from magnetic tape. Messages are separated by interrecord gaps. The length of messages is variable. Whenever a magnetic tape message is greater than 80 characters, the message is formatted into 80-character blocks for retransmission by the transmitter and it is reformatted by the receiver. The end of a magnetic tape message is indicated by an EM control character. The EM control character is transmitted after the last character of the message. If the last block of the message contains 80 data characters, the EM control character is sent in a block by itself, following the last block of the message (see figures 10, 16, 18, 20, 22, and 24).

50.2.1 Structured format. Structured formatted tape messages contain a header and end of transmission (EOT) character. A double tape mark is written on the tape after the last message to indicate the end of data to be transmitted.

50.2.2 Nonstructured format. The nonstructured formatted magnetic tape contains data with no header or trailer information. The message header and EOT of nonstructured formatted data are introduced from another source. Additional information may be introduced from a separate source. After header transmission, the text is read from magnetic tape. The message text on magnetic tape is terminated by a double tape mark. The nonstructured format allows data to be transmitted from tapes that are void of communications headers and EOTs and allows data to be written on the receiving tape in the same manner.

50.2.3 Tape marks. A tape mark is used as a "data separator" for separating label records from data records, separating individual files, or separating groups of records within a particular file. Double tape marks are used as follows:

a. On tapes containing one or more structured format messages, a double tape mark indicates that no more messages are contained on the tape. Double tape mark sequences are not permitted as text separators.

b. In nonstructured format, in which there is the text of only one message on the tape, double tape marks shall indicate the end of message text.

c. The double tape mark sequence (a and b above) shall not be transmitted. Single tape marks shall be transmitted by formatting the DC3 character in a special six character block (see figure 12).

50.2.3.1 Record mark (DC3) block. This block shall consist of six characters: STX, BN, DC3, EM, ETB and BP. DC3 shall have an even number of logical 1 bits and shall be a Mode VI data character. This block shall be transmitted when a single tape mark is read within the message text (see figure 12).

50.2.4 Code translation

50.2.4.1 Seven track tape (SEL character B). A seven-track tape message consists of seven bits per track, six bits of binary data, plus one parity bit (see table XI). The terminal, which is used in preparing the seven-track magnetic tape data for transmission, converts the magnetic tape seven bits to the eight-bit Mode VI data characters as shown in table XI.

50.2.4.2 Nine track tape (SEL character C). Nine track tape text characters consist of nine bits: eight bits of binary data plus one parity bit. The terminal converts the nine track tape text data into Mode VI block data characters as follows (see figure 15):

a. Convert the nine bits of text of the magnetic tape data into eight bits by removing the parity bit.

b. Segment the magnetic tape message into groups of three text characters (24 bits).

c. Convert the 24-bit groups into four six-bit groups.

d. Convert the six bits of each group into the Mode VI data character in the same manner as the six data bits of seven-track tape are converted.

NOTE: If there are not three eight-bit characters on the last character conversion for a record, 1 bit shall be inserted to fill the last six bit character before adding the EM character (see figure 15).

50.2.5 Transmission sequences. Figures 16 through 25 illustrate the manner in which different magnetic tape messages (records) are converted into blocks and transmitted.

50.2.5.1 Header. Data characters, as defined in section 4 of this standard, are used to transmit the header. Select character B is used for seven-track tape and Select character C is used for nine-track tape. If the last block of the record that contains the header contains fewer than 80 characters, then an EM control character is transmitted after the last character of the record (see figures 6 and 7). The EM is followed by the framing characters ETB and BP. If the last block of the header record contains 80 characters, then the EM control character is transmitted in a special short block (see figures 10 and 18).

Table XI. Conversion from seven-track tape to Mode VI data (block) character.

Seven-Track Magnetic Tape BITS								Mode VI Block Character BITS							
b_7	b_6	b_5	b_4	b_3	b_2	b_1		a_8	a_7	a_6	a_5	a_4	a_3	a_2	a_1
P	0	0	0	0	0	0		0	1	0	0	0	0	0	0
P	0	0	0	0	0	1		1	1	0	0	0	0	0	1
P	0	0	0	0	1	0		1	1	0	0	0	0	1	0
P	0	0	0	0	1	1		0	1	0	0	0	0	1	1
P	0	0	0	1	0	0		1	1	0	0	0	1	0	0
P	0	0	0	1	0	1		0	1	0	0	0	1	0	1
P	0	0	0	1	1	0		0	1	0	0	0	1	1	0
P	0	0	0	1	1	1		1	1	0	0	0	1	1	1
P	0	0	1	0	0	0		1	1	0	0	1	0	0	0
P	0	0	1	0	0	1		0	1	0	0	1	0	0	1
P	0	0	1	0	1	0		0	1	0	0	1	0	1	0
P	0	0	1	0	1	1		1	1	0	0	1	0	1	1
P	0	0	1	1	0	0		0	1	0	0	1	1	0	0
P	0	0	1	1	0	1		1	1	0	0	1	1	0	1
P	0	0	1	1	1	0		1	1	0	0	1	1	1	0
P	0	0	1	1	1	1		0	1	0	0	1	1	1	1
P	0	1	0	0	0	0		1	1	0	1	0	0	0	0
P	0	1	0	0	0	1		0	1	0	1	0	0	0	1
P	0	1	0	0	1	0		0	1	0	1	0	0	1	0
P	0	1	0	0	1	1		1	1	0	1	0	0	1	1
P	0	1	0	1	0	0		1	1	0	1	0	1	0	0
P	0	1	0	1	0	1		0	1	0	1	0	1	0	1
P	0	1	0	1	1	0		1	1	0	1	0	1	1	0
P	0	1	0	1	1	1		0	1	0	1	0	1	1	1
P	0	1	1	0	0	0		0	1	0	1	1	0	0	0
P	0	1	1	0	0	1		1	1	0	1	1	0	0	1
P	0	1	1	0	1	0		1	1	0	1	1	0	1	0
P	0	1	1	0	1	1		0	1	0	1	1	0	1	1
P	0	1	1	1	0	0		1	1	0	1	1	1	0	0
P	0	1	1	1	0	1		0	1	0	1	1	1	0	1
P	0	1	1	1	1	0		0	1	0	1	1	1	1	0
P	0	1	1	1	1	1		1	1	0	1	1	1	1	1

Table XI. Conversion from seven-track tape to Mode VI data (block) character - Continued.

Seven-Track Magnetic Tape								Mode VI Block Character							
BITS								BITS							
b_7	b_6	b_5	b_4	b_3	b_2	b_1		a_8	a_7	a_6	a_5	a_4	a_3	a_2	a_1
P	1	0	0	0	0	0		1	1	1	0	0	0	0	0
P	1	0	0	0	0	1		0	1	1	0	0	0	0	1
P	1	0	0	0	1	0		0	1	1	0	0	0	1	0
P	1	0	0	0	1	1		1	1	1	0	0	0	1	1
P	1	0	0	1	0	0		0	1	1	0	0	1	0	0
P	1	0	0	1	0	1		1	1	1	0	0	1	0	1
P	1	0	0	1	1	0		1	1	1	0	0	1	1	0
P	1	0	0	1	1	1		0	1	1	0	0	1	1	1
P	1	0	1	0	0	0		0	1	1	0	1	0	0	0
P	1	0	1	0	0	1		1	1	1	0	1	0	0	1
P	1	0	1	0	1	0		1	1	1	0	1	0	1	0
P	1	0	1	0	1	1		0	1	1	0	1	0	1	1
P	1	0	1	1	0	0		1	1	1	0	1	1	0	0
P	1	0	1	1	0	1		0	1	1	0	1	1	0	1
P	1	0	1	1	1	0		0	1	1	0	1	1	1	0
P	1	0	1	1	1	1		1	1	1	0	1	1	1	1
P	1	1	0	0	0	0		0	1	1	1	0	0	0	0
P	1	1	0	0	0	1		1	1	1	1	0	0	0	1
P	1	1	0	0	1	0		1	1	1	1	0	0	1	0
P	1	1	0	0	1	1		0	1	1	1	0	0	1	1
P	1	1	0	1	0	0		1	1	1	1	0	1	0	0
P	1	1	0	1	0	1		0	1	1	1	0	1	0	1
P	1	1	0	1	1	0		0	1	1	1	0	1	1	0
P	1	1	0	1	1	1		1	1	1	1	0	1	1	1
P	1	1	1	0	0	0		1	1	1	1	1	0	0	0
P	1	1	1	0	0	1		0	1	1	1	1	0	0	1
P	1	1	1	0	1	0		0	1	1	1	1	0	1	0
P	1	1	1	0	1	1		1	1	1	1	1	0	1	1
P	1	1	1	1	0	0		0	1	1	1	1	1	0	0
P	1	1	1	1	0	1		1	1	1	1	1	1	0	1
P	1	1	1	1	1	0		1	1	1	1	1	1	1	0
P	1	1	1	1	1	1		0	1	1	1	1	1	1	1

NOTE: b_7 of seven-track tape is the magnetic tape character parity bit.
a_7 of the Mode VI character is always a logical 1 bit.

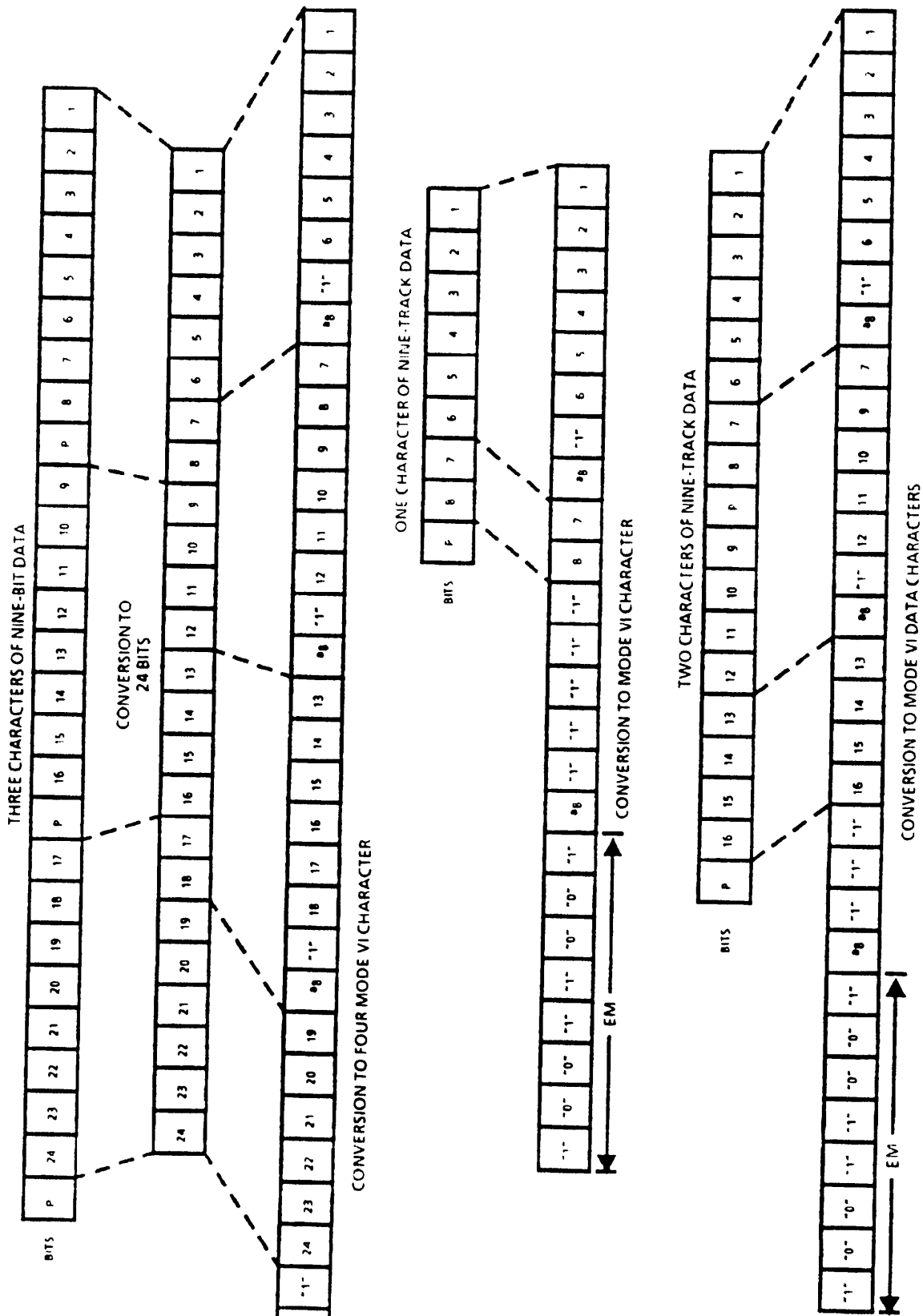
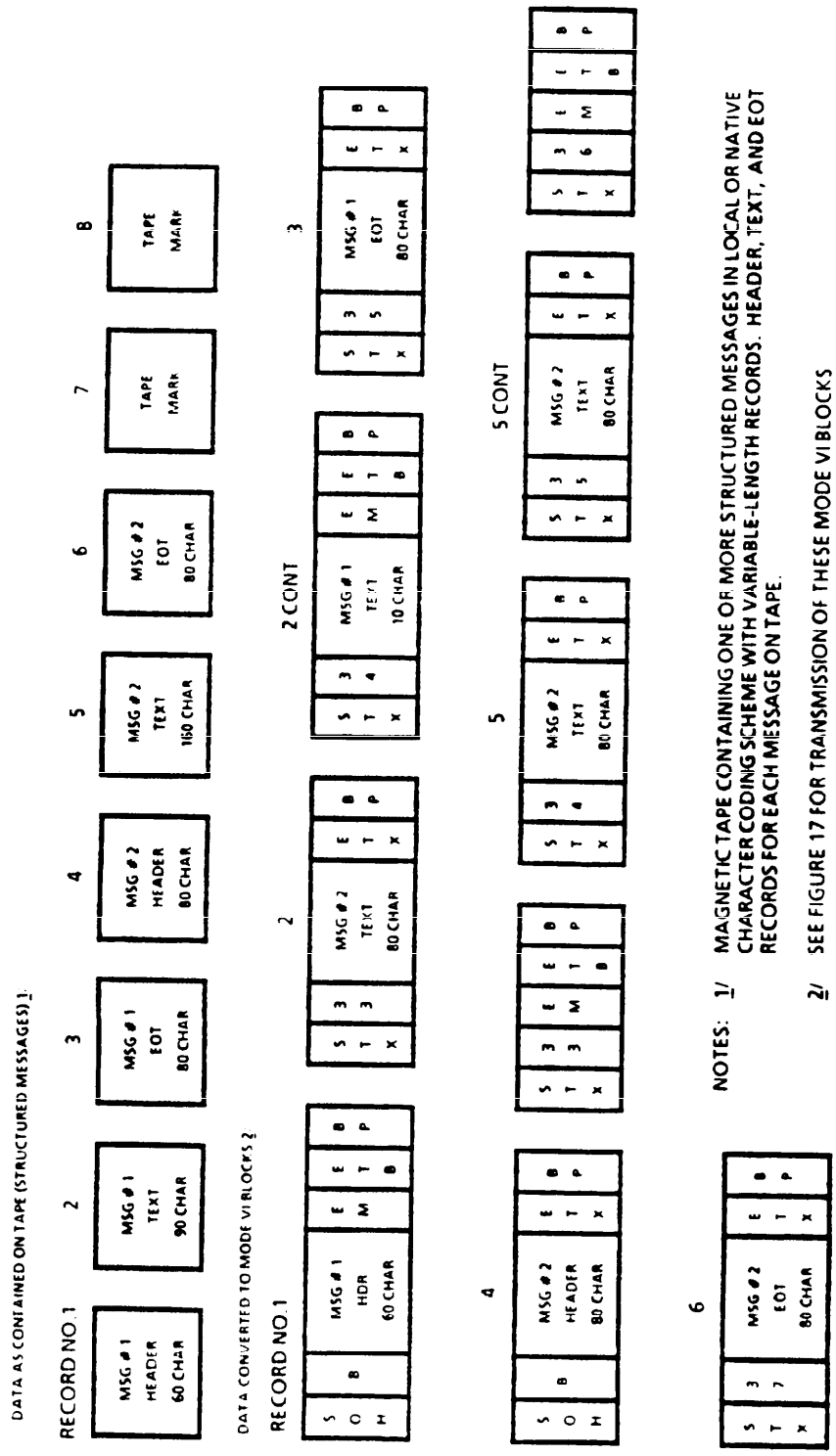


Figure 15. Conversion of nine-track tape to Mode VI text characters.



NOTES: 1/ MAGNETIC TAPE CONTAINING ONE OR MORE STRUCTURED MESSAGES IN LOCAL OR NATIVE CHARACTER CODING SCHEME WITH VARIABLE-LENGTH RECORDS. HEADER, TEXT, AND EOT RECORDS FOR EACH MESSAGE ON TAPE.

2/ SEE FIGURE 17 FOR TRANSMISSION OF THESE MODE VI BLOCKS

Figure 16. Typical structured format for seven-track tape.

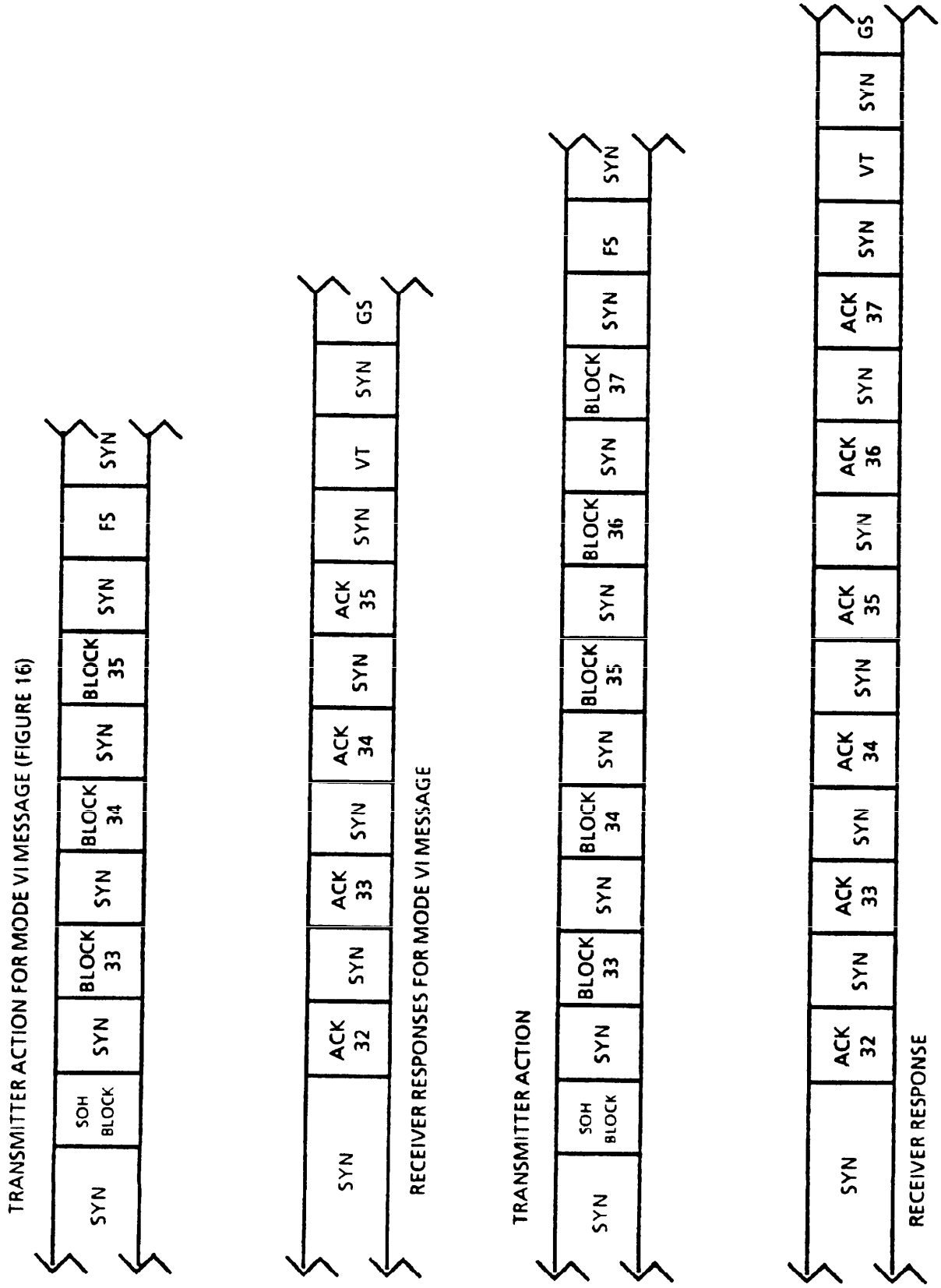
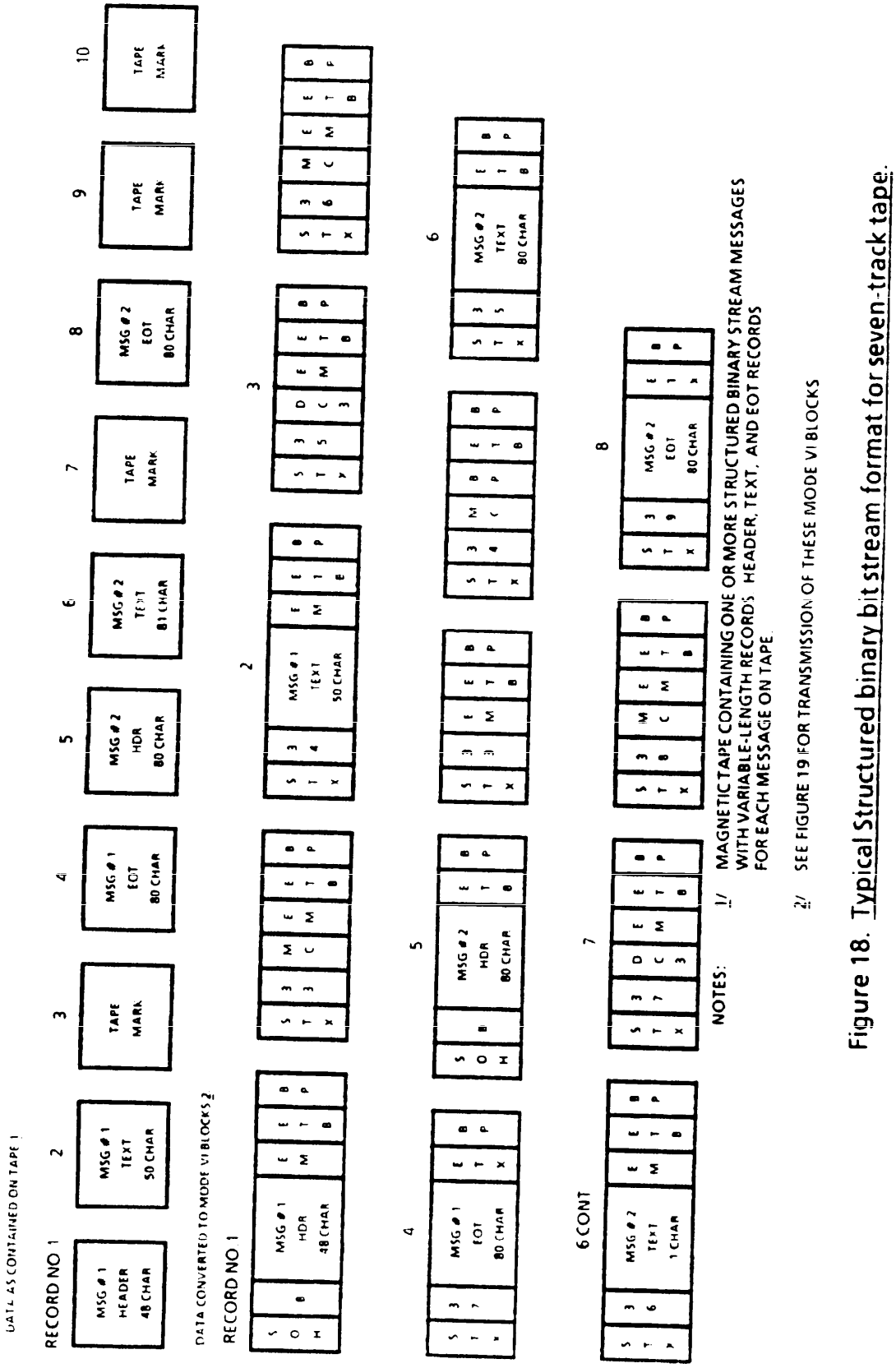


Figure 17. Typical Mode VI transmission structured format actions/reactions.



NOTES: 1/ MAGNETIC TAPE CONTAINING ONE OR MORE STRUCTURED BINARY STREAM MESSAGES WITH VARIABLE-LENGTH RECORDS: HEADER, TEXT, AND EOT RECORDS FOR EACH MESSAGE ON TAPE.

2/ SEE FIGURE 19 FOR TRANSMISSION OF THESE MODE VI BLOCKS

Figure 18. Typical Structured binary bit stream format for seven-track tape.

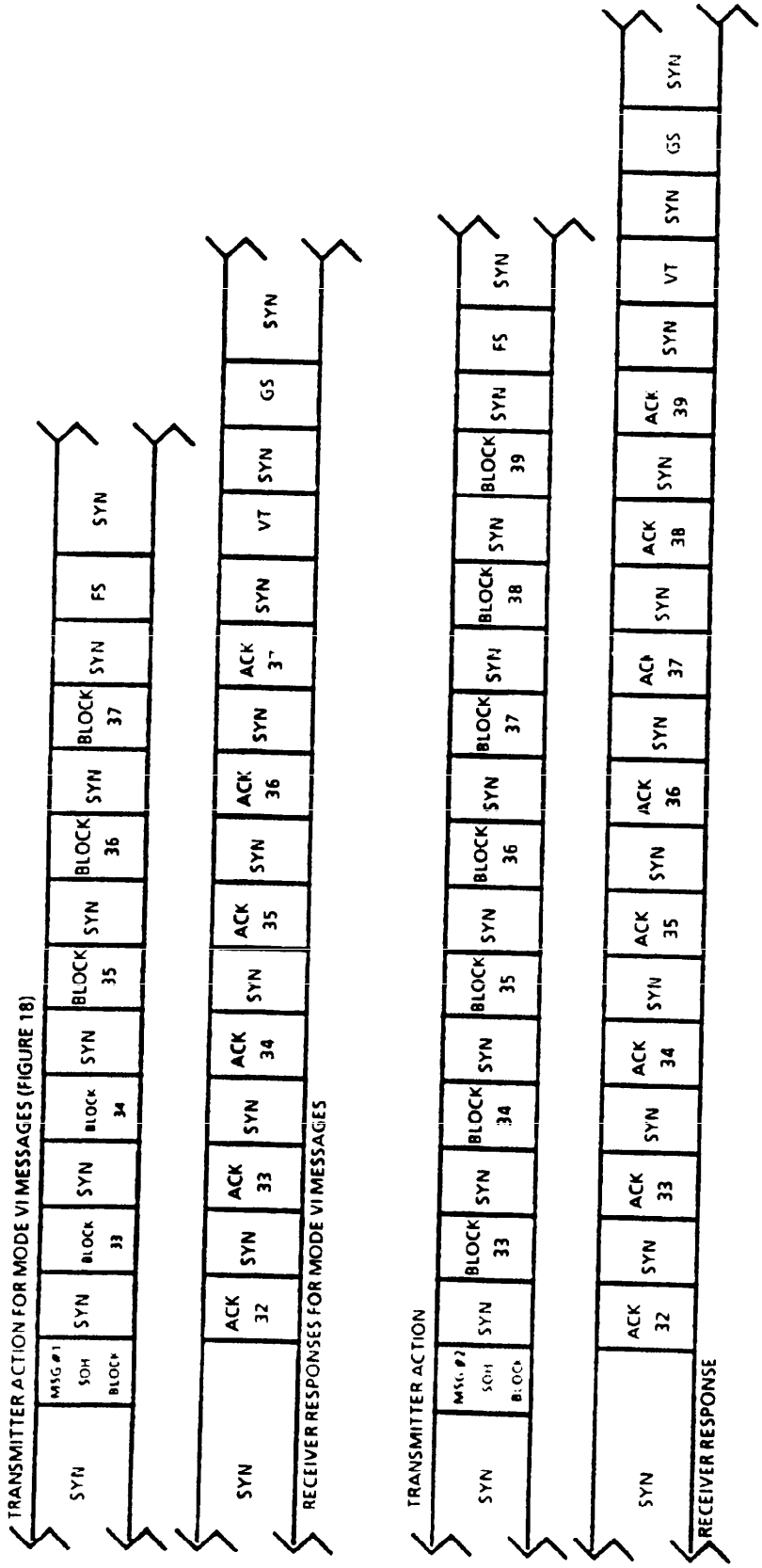


Figure 19. Mode VI transmission structured binary bit stream format action/reaction.

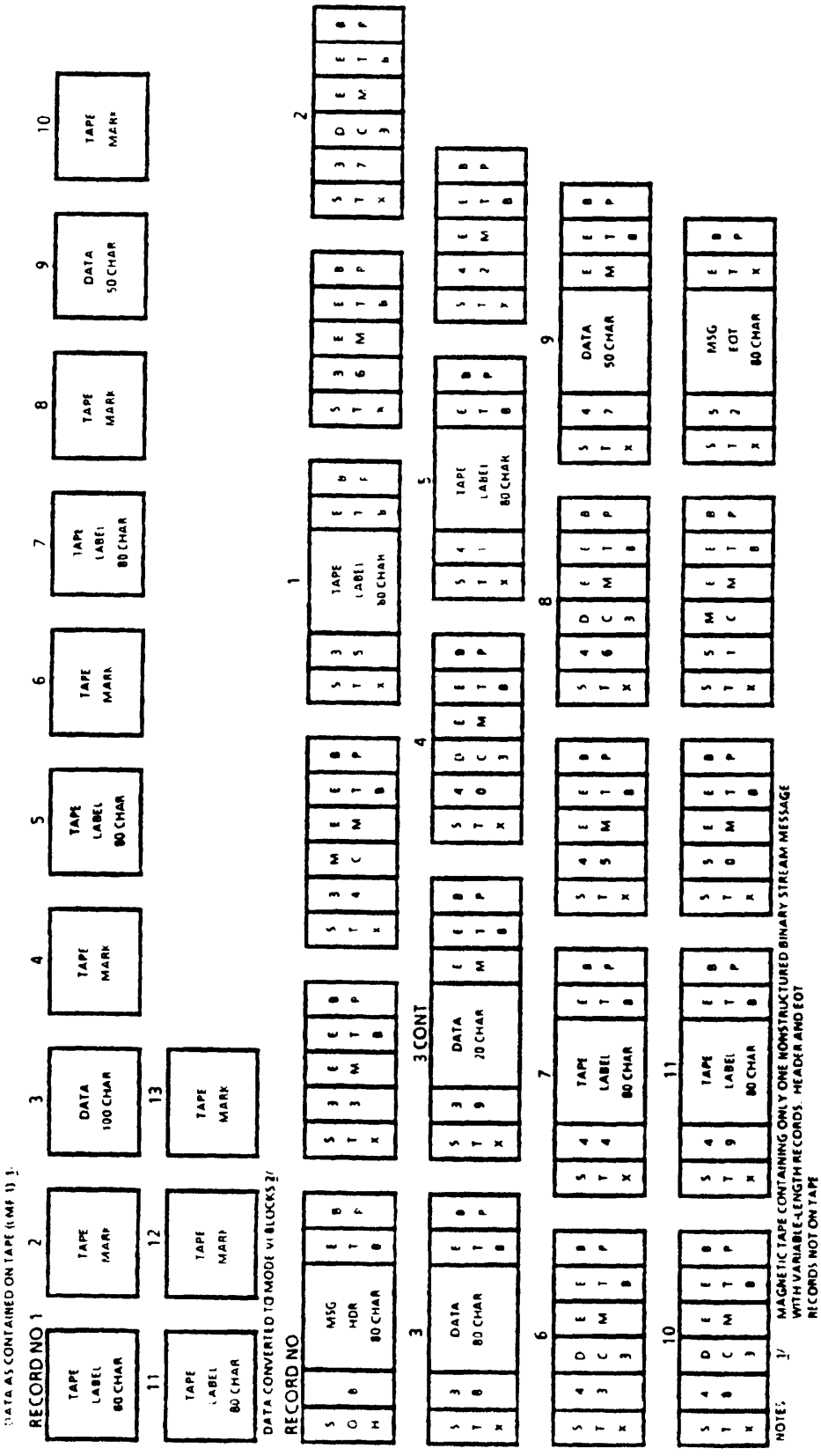


Figure 20. Nonstructured format for seven-track tape.

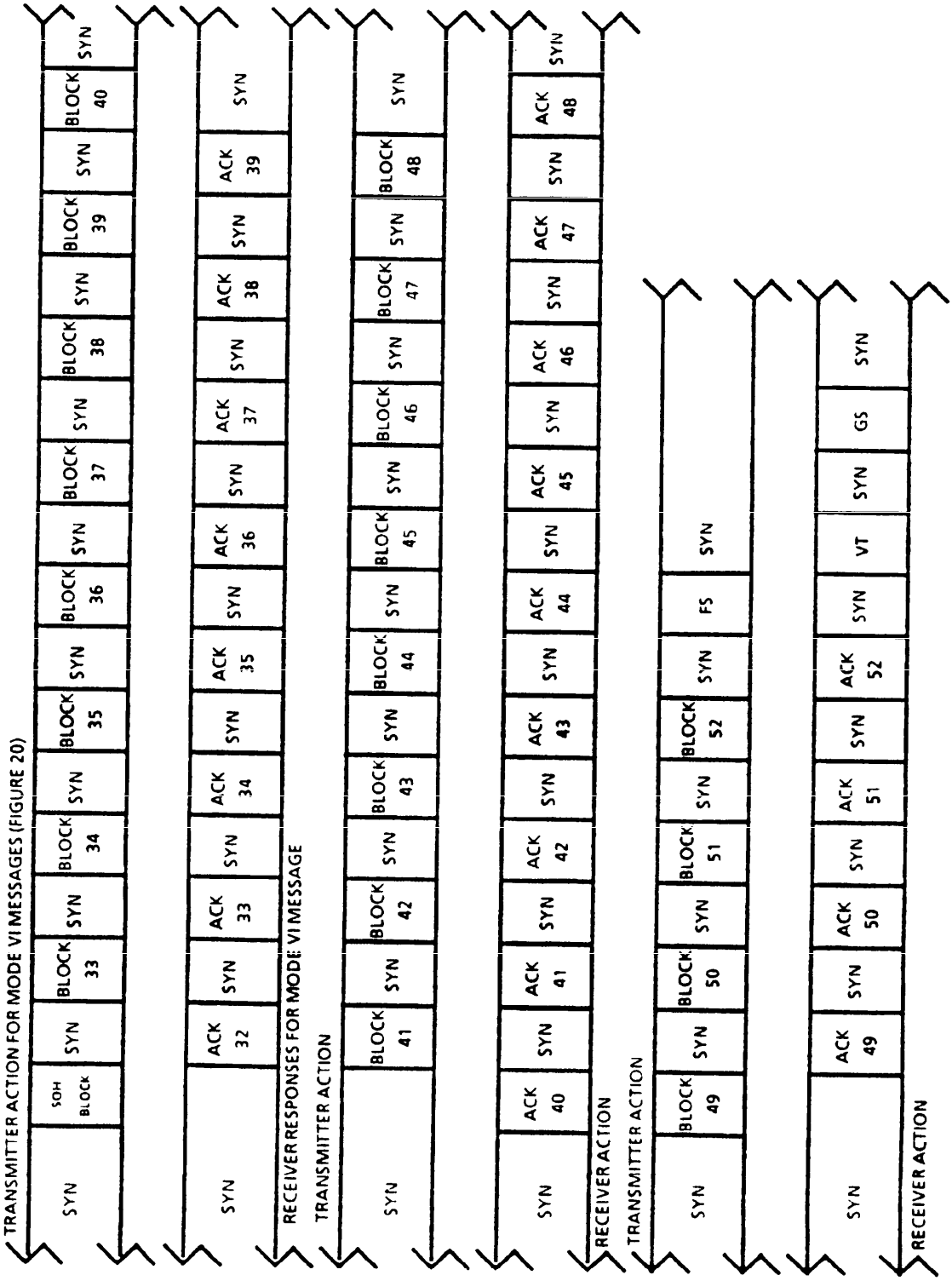
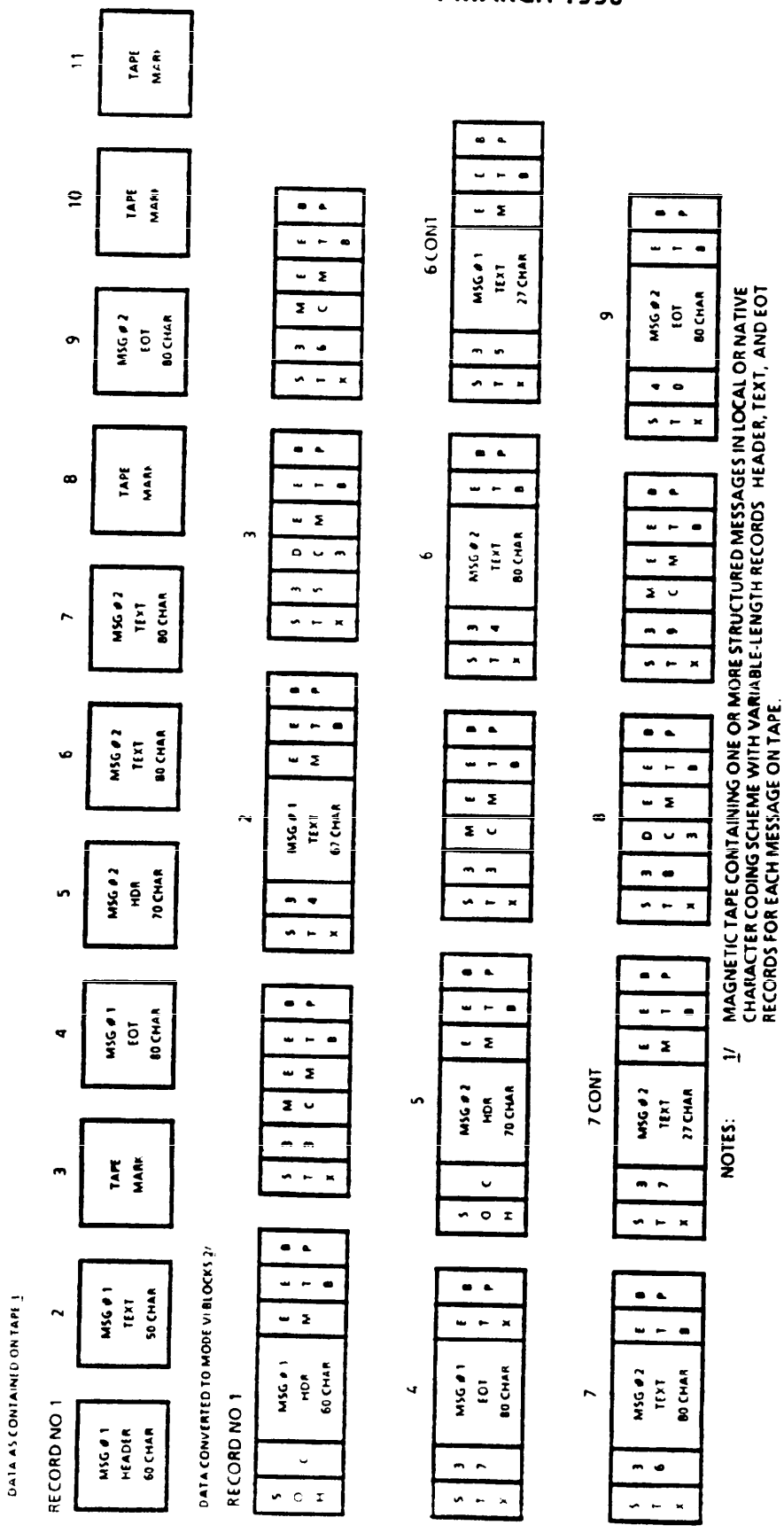


Figure 21. Mode VI transmission nonstructured format action/reaction.



NOTES: 1/ MAGNETIC TAPE CONTAINING ONE OR MORE STRUCTURED MESSAGES IN LOCAL OR NATIVE CHARACTER CODING SCHEME WITH VARIABLE-LENGTH RECORDS' HEADER, TEXT, AND EOT RECORDS FOR EACH MESSAGE ON TAPE.

2/ SEE FIGURE 23 FOR TRANSMISSION OF THESE MODE VI BLOCKS

Figure 22. Structured format for nine-track tape.

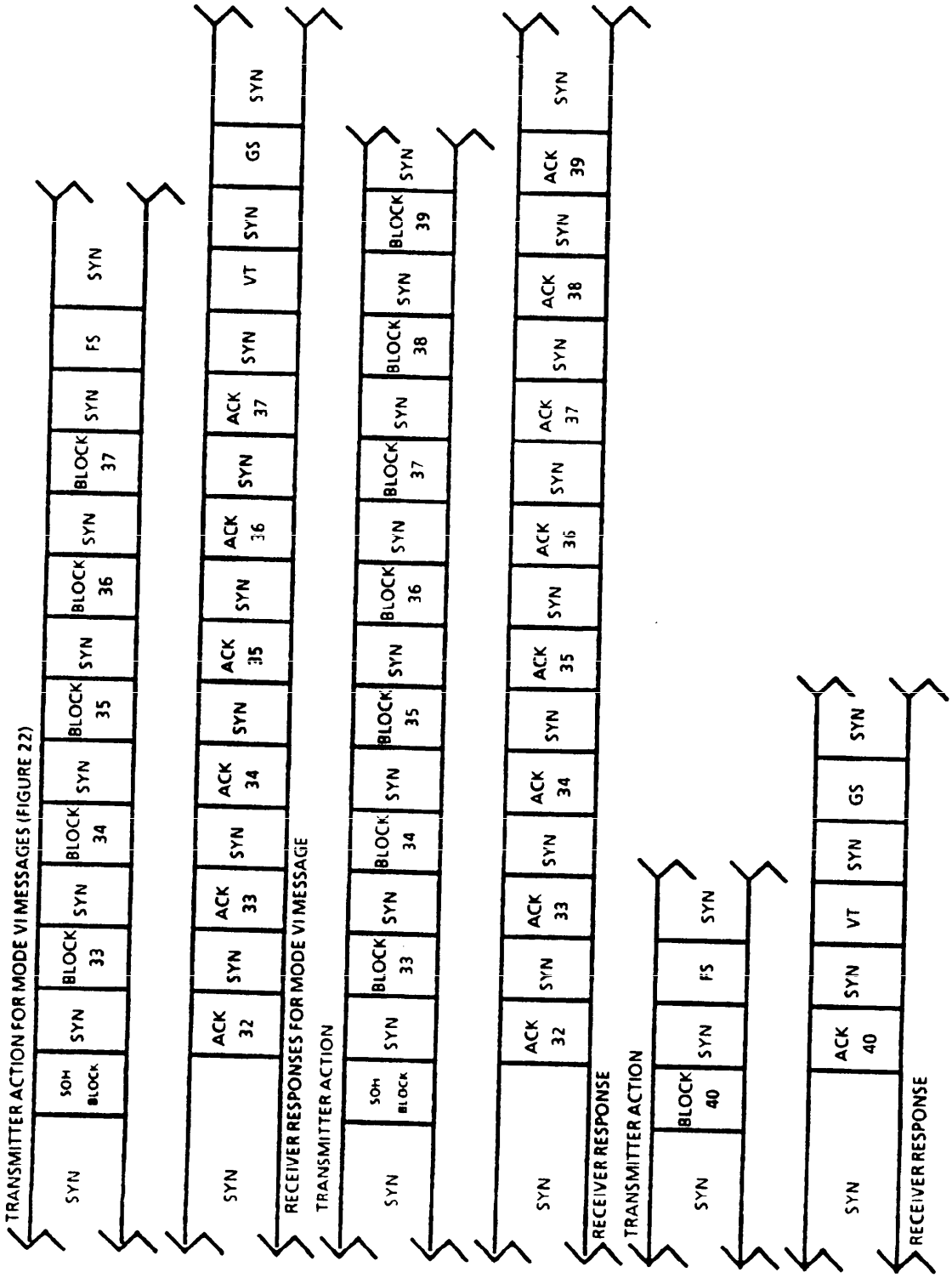
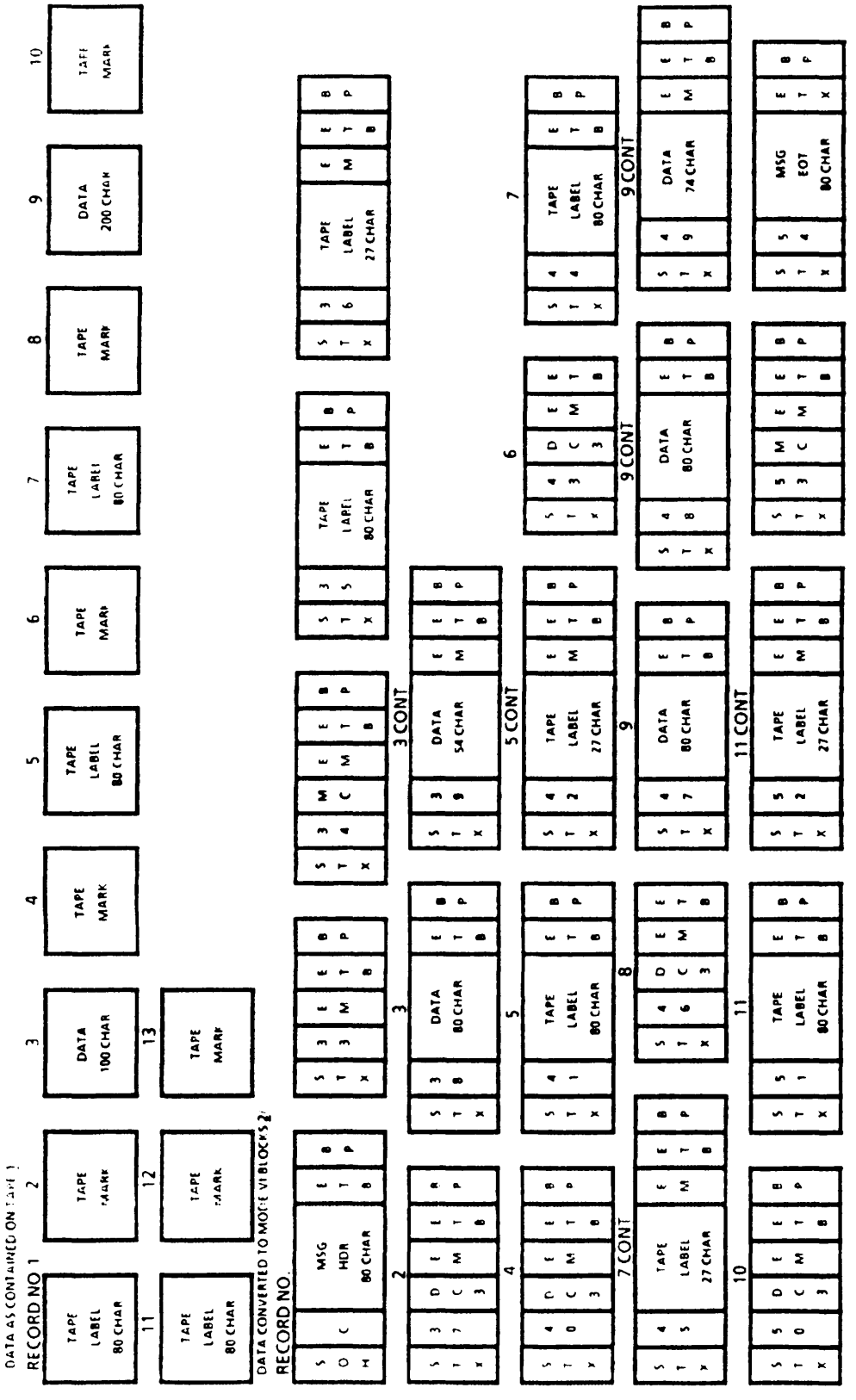


Figure 23. Mode VI transmission nonstructured format action/reaction.



NOTE 1/ MAGNETIC TAPE CONTAINING ONLY ONE NONSTRUCTURED BINARY STREAM MESSAGE WITH VARIABLE LENGTH RECORDS. HEADER AND EOT NOT ON TAPE

2/ SEE FIGURE 25 FOR TRANSMISSION OF THESE MODE VI BLOCKS.

Figure 24. Nonstructured format for nine-track tape.

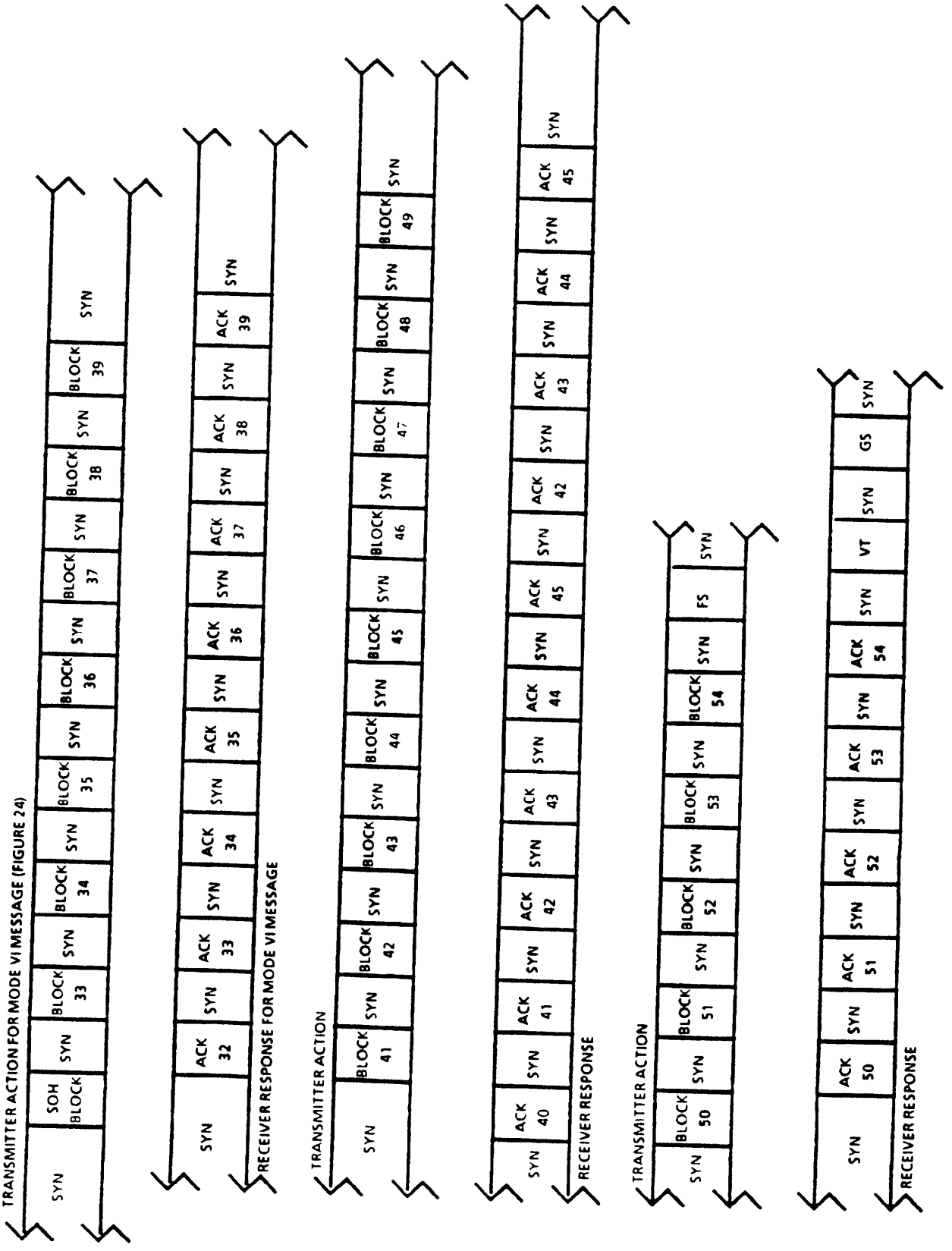


Figure 25. Mode VI transmission nonstructured format action/reaction.

CONCLUDING MATERIAL

Custodians:

Army - SC
Navy - EC
Air Force - 90
DCA - DC
NSA - NS

Preparing Activity:

JTC3A - JT
(Projects TCTS - 1160)

Review Activities:

Army - CR, AC
Navy - MC, TD, OM
Air Force - 02, 17
NSA
DCA
DODECAC

User Activities:

Army - CR
Navy - NC
Air Force - 13
DCA
NSA

Civilian Agency Coordinating Activities:

NCS - TS

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions – Reverse Side)

1. DOCUMENT NUMBER	2. DOCUMENT TITLE
MIL-STD-188-174	Interoperability Standards for Information and Record Traffic Exchange, Mode VI

3a. NAME OF SUBMITTING ORGANIZATION

b. ADDRESS *(Street, City, State, ZIP Code)*

4. TYPE OF ORGANIZATION *(Mark one)*

- ☐ VENDOR
- ☐ USER
- ☐ MANUFACTURER
- ☐ OTHER *(Specify)*: _____

5. PROBLEM AREAS

a. Paragraph Number and Wording:

b. Recommended Wording:

c. Reason/Rationale for Recommendation:

6. REMARKS

7a. NAME OF SUBMITTER *(Last, First, MI)* – Optional	b. WORK TELEPHONE NUMBER *(Include Area Code)* – Optional
c. MAILING ADDRESS *(Street, City, State, ZIP Code)* – Optional	8. DATE OF SUBMISSION *(YYMMDD)*

DD FORM 82 MAR 1426

PREVIOUS EDITION IS OBSOLETE.