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DCA CIRCULAR
370-D175-1*

DEFENSE COMMUNICATIONS AGENCY

AD 877008

DCS AUTODIN INTERFACE AND CONTROL CRITERIA

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DCA CIRCULAR 370-D175-1 — 24 June 1971
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STANDARDS

DCS AUTODIN Interface
and Control Criteria

1. DCA Circular 370-D175-1 is changed as follows:

a. Page 3-2, Select Character B under identification column. Delete the definition and replace with the following new definition:

"Identifies the source transmission tape as being 7-track tape."

b. Page 3-2, Select Character C. Under Identification Column. Delete the definition and replace with the following new definition:

"Identifies the source transmission tape as being 9-track tape."

c. Page 3-5, paragraph 2e(1)(h). Delete this entire entry.

d. Page 3-5, paragraph 2e(2). Terminate the sentence with a period after the word "CONFIDENTIAL". Delete the remainder of the sentence.

e. Page 7-10, paragraph 3f, line 4. Terminate the sentence with a period after the letter "R" and delete the phrase "or M".

f. Page 7-10, paragraph 3g(2), lines 1, 2, and 3. Line 1, delete the word "one" and replace with the word "the". Line 2, delete the phrase "or M". Line 3 add the word "for" between "is" and "unclassified".

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g. Page 7-11, paragraph 3h(3), last line. Delete this line and replace with the following new line:

"It does not contain the security character U."

h. Page 9-2, table 9-1, line 1, Destination LMF. Insert opening and closing parenthesis ( ) around the last "T".

i. Page 9-6, paragraph 6b, last line. Add the following to the end of the parenthetical phrase "; note, however that this equivalence is true only when the ASCII or FIELDATA Code is used to represent ITA #2 information.)"

j. Page 12-9, paragraph 8a, line 5. Correct spelling of "modems".

k. Page 14-16, table 14-6, AUTODIN Code Equivalents, Line-to-line. Under the Extended FIELDATA Column, line 41 (Grave accent). Correct the bit configuration to read "00100101" in lieu of "10100111".

l. Page 14-17, table 14-6, AUTODIN Code Equivalents, Line-to-Line. Under the Extended FIELDATA Column, line 4 (Commercial AT). Correct the bit configuration to read "10100111" in lieu of "00100101".

m. Remove pages xi through xiv and insert enclosed new pages xi through xiv. Remove page 10-1 and insert enclosed new pages 10-1 through 10-15. The changed portions are indicated by number signs (#) in the left margin of the new pages.

2. When the above action has been completed, this change may be filed with the basic publication.

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CHAPTER 10. AUTODIN VARIABLE LENGTH RECORD AND NONSTANDARD CODE MESSAGES

1. Introduction.

a. It is a requirement of AUTODIN to be capable of handling variable length record data as well as fixed length record data. The format of data under most conditions is in 80 character records or blocks and in a standard code. Data in this form is handled easily by the AUTODIN terminals and automatic switching centers since it conforms to the basic concepts of common user record communications. Some user data records do not conform to the 80 character block size and standard character coding. It is, therefore, necessary for the terminal to convert the data records into a block size (80 characters or less) acceptable by AUTODIN, and to designate the data code as nonstandard.

b. This chapter defines the interface and control criteria for variable length records and nonstandard code messages as applied to magnetic tape operation only. The procedures specified in this chapter apply only to terminal using ASCII Mode I operation.[1]

2. LMF Codes. The following language media format (LMF) codes are used for messages with variable length records or nonstandard codes and can only be paired with themselves; i.e., D can only be paired with D, B with B and I with I.

a. LMF B. LMF B identifies the source transmission tape as containing one or more binary stream messages and that the tape is structured or formatted with the header, text, and EOT records for each message on the tape.

b. LMF D. LMF D identifies the source tape as containing one or more data messages in the local or native character coding scheme in variable length records and that the tape is structured or formatted with the header, text. and EOT records for each message on the tape. The characters are translated from the native code to ASCII line code on a one-for-one basis.

---

[1]A small number of Fieldata magnetic tape terminals exist which do not conform to these conventions. These terminals, therefore, cannot exchange binary magnetic tape information with ASCII terminals. Language Media Format (LMF) DD traffic can be exchanged via message switching as long as tape marks are not transmitted. Lack of equivalency between ASCII and Fieldata coded tape marks prohibit exchange of these tape controls.

c. LMF I. LMF I identifies the source tape as containing only one binary stream message and that the tape is nonstructured (formatted without the header and EOT records). The header and EOT records are generated by the terminal from parameters introduced from another source such as a card or paper tape reader, console typewriter, or stored program.

3. Select Codes. Select Characters B and C are used in magnetic tape operation as follows:

a. Select Character B. Identifies the source transmission tape as being 7-track tape.

b. Select Character C. Identifies the source transmission tape as being 9-track tape.

4. Data Records. The data record is defined as a series of contiguous characters recorded on and read from magentic tape as a single unit. Data records are separated by interrecord gaps. The length of data records to be transmitted via AUTODIN may vary according to user requirements. For general transmission of data throughout the system, computerized terminals must have the capability of transmitting records containing a minimum of 18 characters and a maximum of 1200 characters. This restriction is due to characteristics of existing terminal equipment. Subscribers desiring to transmit messages containing record lengths of less than 18 or more than 1200 up to a maximum of 2048 characters must insure that the addressee is capable of receiving such records prior to transmission. The data record, if greater than 80 characters, is formatted into 80 character blocks for transmission by the originating terminal and reformatted by the receiving terminal. The end of a data record is indicated by a special control character, End of Medium (EM). The EM is transmitted after the last character of the record. If the last block of the record contains 80 data characters, the EM is sent in a block by itself following the last data block of the record.

5. Message Length, MSU/CSU.

a. Both MSU and CSU Mode terminals can be used for transmission of messages having variable length records. The message length in the MSU Mode is limited to 500 transmission blocks plus any pilots for a maximum of 550 blocks. The CSU Mode differs in that when it is used with the K select character (CSU-CSU), the number of transmission blocks is r c limited, but transmission time is procedurally limited as specified in JANAP 128. If the CSU Mode is used with the J select character (CSU-MSU), it is also limited to 500 transmission blocks plus pilots, for a maximum of 550 blocks.

b. The following formulae can be used to calculate the number of transmission line blocks (for MSU-MSU and CSU-MSU) and the approximate message transmission time (for CSU-CSU).

(1) Number of transmission line blocks

$$N = \left(\frac{\text{CHARACTERS RECEIVED IN HEADER}}{80} * \right) + 1 \quad + K +$$

$$\sum_{i=1}^{n} \left[\left(\frac{[P\ (\text{CHARACTERS IN iTH RECEIVED})]}{80} ** \right) * + 1 \right] + B$$

WHERE

N = Total line block count

* = Ignore remainder

n = Number of text records (not including tape marks)

B = Number of transmitted tape marks

K = 1 for LMF D

= 3 for LMF B and I

P = 1 for select character B or select character C with LMF D

= 4/3 for select character C and LMF not D

(2) Approximate message transmission time

$$T = \frac{M}{KR}$$

WHERE

T = Approximate transmission time in minutes

M = Total number of characters to be transmitted

K = 6.0 for select character B or select character C with LMF D, continuous mode

= 3.75 for select character B or select character C with LMF D, block-by-block mode

= 4.5 for select character C and LMF not D, continuous mode

= 2.8 for select character C and LMF not D, block-by-block mode

R = Modulation rate in baud

The above formula was derived by reducing the following equation:

$$T = \frac{M \text{ (CHARACTERS)} \times B \left(\frac{\text{BITS}}{\text{CHARACTER}}\right)}{R \left(\frac{\text{BITS}}{\text{SECOND}}\right) \times 60 \left(\frac{\text{SECONDS}}{\text{MINUTE}}\right) E} = \frac{MB}{60\ RE} \quad \text{(MINUTES)}$$

WHERE

B = Number of bits per character on tape

= 24/3 = 8 for select character B and select character C with LMF D

= 32/3 for select character C with LMF not D

E = A transmission efficiency factor to incorporate the effects of framing character times, transmission circuit delay, transmission errors, etc.

= 0.5 for block-by-block mode

= 0.8 for continuous mode

LETTING $\frac{1}{F} = \frac{B}{60E}$, THE EQUATION BECOMES

$$T = \frac{MB}{60RE} = \frac{M}{R} \cdot \frac{B}{60E} = \frac{M}{KR}$$

The values of K are obtained by assigning appropriate values to B and E for the various cases.

6. Magnetic Tape messages. The message originator and addressee may deliver or accept to or from the transmitting terminal structured or nonstructured magnetic tape formats.

a. Structured Format. Tapes uses as input for this format may contain one or more messages. The complete messages, including Headers and End of Transmission (EOT) are written on the tape. A double tape mark is written on the tape after the last message to indicate the end of data to be transmitted. See subparagraph c. below. A structured magnetic tape is identified by LMF pair BB or DD in each message header.

b. Nonstructured Format. Tapes used as input for this format contain one message only, and all data on the magnetic tape is transmitted as data. The message header and EOT are introduced from another source such as card or paper tape reader, console typewriter, or stored program and converted into ASCII for transmission. Additional information such as special information or instruction blocks may also be introduced from the 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. (See subparagraph c below). A nonstructured magnetic tape message is identified by the LMF pair II in the message header. The nonstructured format allows data to be transmitted from tapes which are void of communications Headers and EOT's and allows data to be written on the receiving tape in the same manner. This format is primarily applicable to CSU operation since the message length is not limited, and complete files can be transmitted as they appear on the tape. This format may also be used for message switching operation, however, the 550 block maximum message length including pilots will apply. When nonstructured files are broken into segments by the originator for transmission via the MSU, each segment will be identified; e.g., a tape label or header element, so that files can be reconstructed at the receiving station as necessary.

c. Tape Marks. A tape mark is a special hardware sensitive tape record used optionally in individual applications for "data separator" purposes such as separating label records from data records, separating individual files, or separating groups of records within a particular file. Use of a single tape mark record within AUTODIN continues to be optional, but use of a "double tape mark" or two contiguous tape mark records is standardized for use within the DCS AUTODIN as follows:

(1) 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 a text separator.

(2) In nonstructured format, there is the text of only one message on the tape; the double tape mark indicates the end of the message text.

(3) The double tape mark sequences discussed in paragraphs (1) and (2) above will not be transmitted. Single tape marks, may be transmitted by formatting the DC-3 ASCII control character in a special 6-character block. This block is described in paragraph 8b.

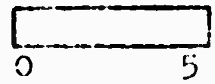
7. Code Translation.

a. LMF DD. The complete message for LMF DD is written on tape in the native code of the user: i.e., BCD, ASCII, EBCDIC, etc.. and is converted by the terminal to ASCII for transmission. Since ASCII is a seven level code, native codes containing more than seven information bits per character must be restricted to the 128 ASCII character set as defined in appendix A. Complete integrity of character sets greater than 128 characters can be maintained only if the information is transmitted as binary text (LMF pair BB).

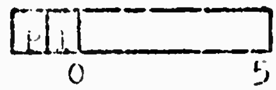
b. LMF BB and II. For LMF BB messages, only the Header and EOT blocks, plus labels or special information preceding binary text, are written in the native code. These portions of the message are translated to ASCII on a character-for-character basis the same as for LMF DD. For LMF II only the text is on tape; Header and EOT records must be introduced from a separate source. Special information may be entered into the same record as the header so that it may be translated to ASCII. Construction of ASCII line characters from binary information is accomplished as follows:

(1) Seven-Track Tape (Select Character B). For Select Character B which identifies seven-track tapes (six bits of binary data plus parity). The terminal will, in preparing the text for transmission, take the six bits of each text character, add a "1" bit to the seventh position, and add a parity bit to the eighth position to create a character with odd parity. This character is accepted as an ASCII character by the system for AUTODIN transmission.

Six-Level Binary Character

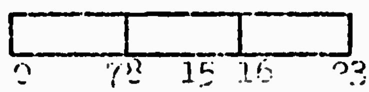


Converted for Transmission

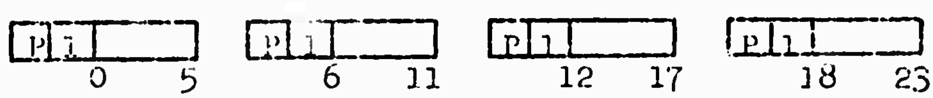


(2) Nine-Track Tape (Select Character C). For Select Character C which identifies nine-track tapes (eight-level binary plus parity) the terminal will segment the 24 bits of each group of three eight-bit characters to four six-bit characters. The six-bit characters are then handled the same as six-bit binary.

Eight-Level Binary Character



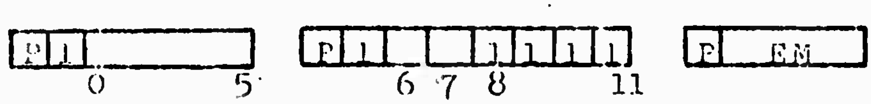
Converted for Transmission



If there are not three eight-level characters on the last character conversion for a record, "1" bits will be inserted to fill the last six-bit character before adding the EM character.

One Eight-Level Binary Character

Converted for Transmission



Two Eight-Level Binary Characters

13

Converted for Transmission

P	1		P	1		P	1	1	1	P	EM
	0	5		6	11		12	15			

8. Description of Transmission Sequence.

a. Header. The message header is always translated to ASCII for the transmission on a character-for-character basis. Select Character B is placed in the second framing character position of the first block of a message originated from seven-track tape. Select Character C is used for nine-track tape. If the last block of the record containing the header contains less than 80 characters an EM is transmitted after the last character of the record and is followed by the framing characters ETB and BP. If the last block of the header record contains 80 characters, the EM is transmitted as a unique line block as follows:

STX	DEL	EM	ETB	BP

b. Text. The begining of binary text is indicated by transmission of the special control character Mode Change (MC). The unique MC line block is as follows:

STX	DEL	MC	EM	ETB	BP

The text blocks are then read from tape and transmitted in 80-character line blocks. For LMF BD messages, the text characters are translated to ASCII just as the Header characters were. For LMF BB and II messages, ASCII line characters are constructed from the binary text as described in paragraph 7b. The ASCII control character DC-3 will be framed as a unique block, and transmitted when a tape mark record is read from non-structured tapes and when a tape mark record is read within the message text on structured tapes. This unique line block will be transmitted as follows:

STX	DEL	DC-3	EM	ETB	BP

The end of binary text is indicated by transmission of the unique MC block.

c. EOT. The last block to be transmitted will be the EOT block. This block is always translated character-for-character to ASCII for transmission.

d. Examples. Figures 10-1 through 10-4 illustrate the relationship between the information contained on tape and the transmitted data.

9. Description of Receive Sequence.

a. Header Record. The first line block(s) may contain pilots, followed by the original Header of the message and special information block which precede the message text. The framing characters of all line blocks are stripped at the receive terminal and do not appear on magnetic tape. The LMF Pair II indicates that the message was originated in a non-structured format and the pilots, Header, and special information blocks should be delivered to a separate device, leaving only the text to be written on tape. The complete message is written on tape for LMF Pairs BB and DD. The Header record received in ASCII characters, is converted to the code of the terminal.

b. Text. The Header record is terminated with an EM character. For LMF DD, message text immediately follows the header record. For LMF BB and II messages, the special MC block will mark the beginning of binary text. The text characters of a DD formatted message are translated to the code of the terminal in the same manner as the Header. The text characters (the binary portion framed by MC blocks) for BB and II messages are converted by a process which is the inverse of that noted in paragraph 7b. The text is written back onto tape in the same variable length records as read originally by the transmitting terminal. The EM character informs the terminal of the end of each data record. A unique DC-3 line block identifies the need for a tape mark. At the end of the last text record of BB and II messages, a Mode Change line block is received by the terminal indicating the end of binary text.

c. EOT. The last block of the message will be the EOT block. This block is received in ASCII and is always converted to the native code of the terminal. For messages with LMF Pair II the EOT record is delivered to a separate device.

d. Cancel Transmission Sequence (CANTRAN). In the event that a message is terminated prior to its normal end (message is cancelled by a received CAN Control character sequence or the circuit is preempted during CSU operation), the canceled message on magnetic tape shall be identified by an 80 column CANTRAN record formatted as follows:

*	CANTRAN	*	NNNN
1 8	9 15	16 76	77 80

10. Resumption of Circuit Switch Transmission Following Interruption. Long circuit switch transmissions are subject to interruption by a number of conditions such as circuit preemption, circuit failure, equipment malfunction, etc. The following procedures have been formaulated to minimize the amount of transmission time lost due to interruptions. These

procedures allow magnetic tapes to be repositioned and transmission to be resumed at or near the point of interruption. Those terminals currently existing in the Government inventory, especially those having only one tape drive may not have this capability. However, this feature should be considered for future terminals having two or more tape drives, or other output devices, and the capability of circuit switch operation.

a. Record Accountability. At the send and receive terminals counts will be maintained of tape records (including tape mark records) transmitted and received. The count will begin at 00000000 for the first text record of each message. The count will be incremented each time an acknowledgment is sent or received for the last line block of a record, and reset at the end of each message.

b. Transmitting Terminal Procedures. The transmitting station may resume transmission after interruption by transmitting the portion of the message which was not previously transmitted, with a special header. The special header will be identical to the original header which was sent prior to interruption, in the precedence, LMF, originating station routing indicator, station serial number and date-time-group fields. The content indicator code (CIC) will consist of numerics which will specify the first four digits (most significant) of the eight-digit record number with which transmission is being resumed; leading zeroes will be used as required to form the CIC field. The record count field of the resumption header will specify the last four digits (least significant) of the record number with which transmission is being resumed. The resumed transmission will normally begin with the record following the last fully acknowledged record of the original transmission. For example, if tape record number 0025 was acknowledged and transmission was interrupted during record 0026, transmission would be resumed at the beginning of record 0026 and the new header would contain 0026 in the record count field. The resumption can begin with a record which was previously acknowledged if the exact point of interruption cannot be determined. It should be noted that the sender must insure that the addressee has the required capability before attempting a resumption.

c. Receiving Terminal Procedures. To effect a successful resumption, the receiving terminal must retain the status of the partially recorded message as to the specific message involved, the last record acknowledged, and the tape position. Upon resumption, the receiving terminal must be capable of properly repositioning the tape by use of the CIC and record count field in the restart header, as required.

d. Unsuccessful Resumptions. Under some conditions, the receive terminal will be unable to accept resumption of a transmission and the message may have to be retransmitted from the beginning. For example, at a terminal having only one receive tape station, it may be necessary to record additional messages on a reel containing a portion of an interrupted message prior to resumption of the interrupted message. (Resumption may be within a few seconds or minutes, or it could be several hours after the interruption). The receive terminal, when unable to immediately accept a resumption, will respond to the header with the Reject Message (RM) control character sequence. (This RM procedure applies only between terminal operating in the CSU mode. It does not apply to the terminal operating with the ASC in the MSU mode.) The receive terminal should also provide notification to the operator of the condition. The operator may be able to manually place the terminal in a condition to accept the resumption, or may initiate a short message containing special instructions to the sender. Upon receipt of an RM indicating an unsuccessful attempt to resume a transmission, the transmitting terminal will provide notification of the condition to the operator. The operator then has the option of initiating another attempt to resume the transmission, restarting the message from the beginning or holding the message for resumption at a later time. The operator should make several attempts to resume the transmission before electing to retransmit the entire message, however the number of attempts should be commensurate with the amount of time that would be saved from resumption versus retransmission.

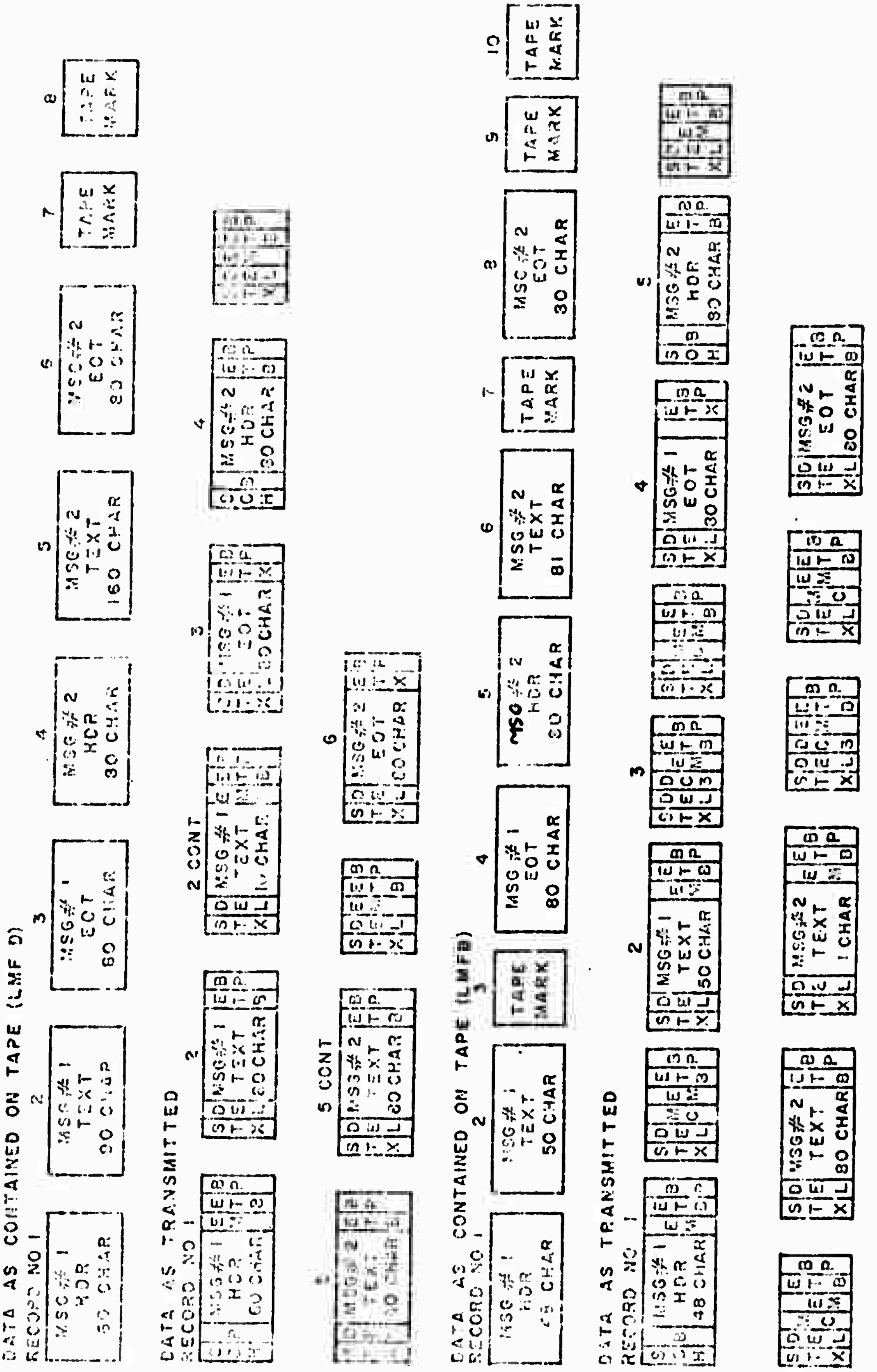


FIGURE 10-1. TYPICAL STRUCTURED FORMAT FOR SEVEN-TRACK TAPE

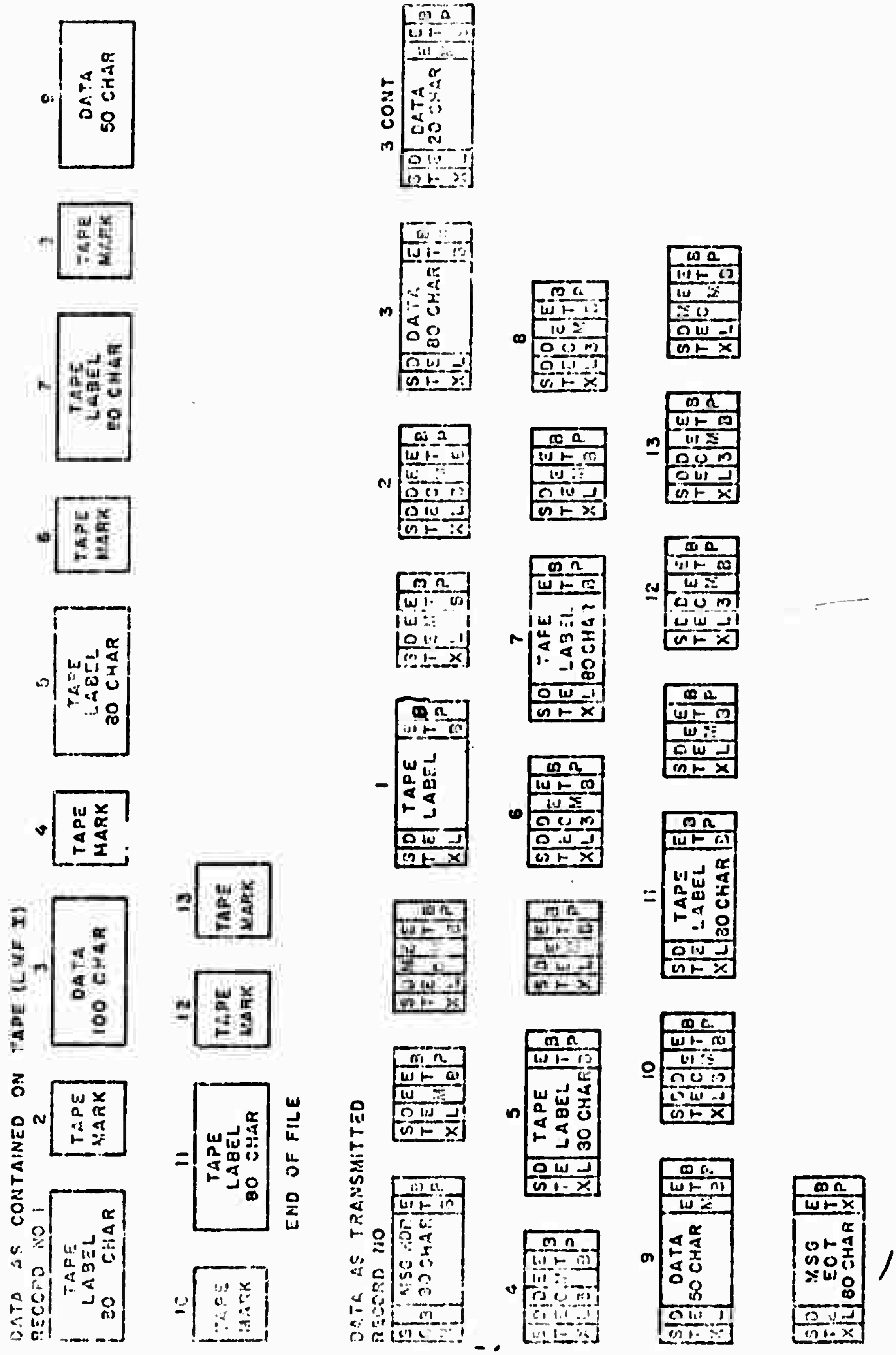


FIGURE 10-2. TYPICAL NONSTRUCTURED FORMAT FOR SEVEN-TRACK TAPE

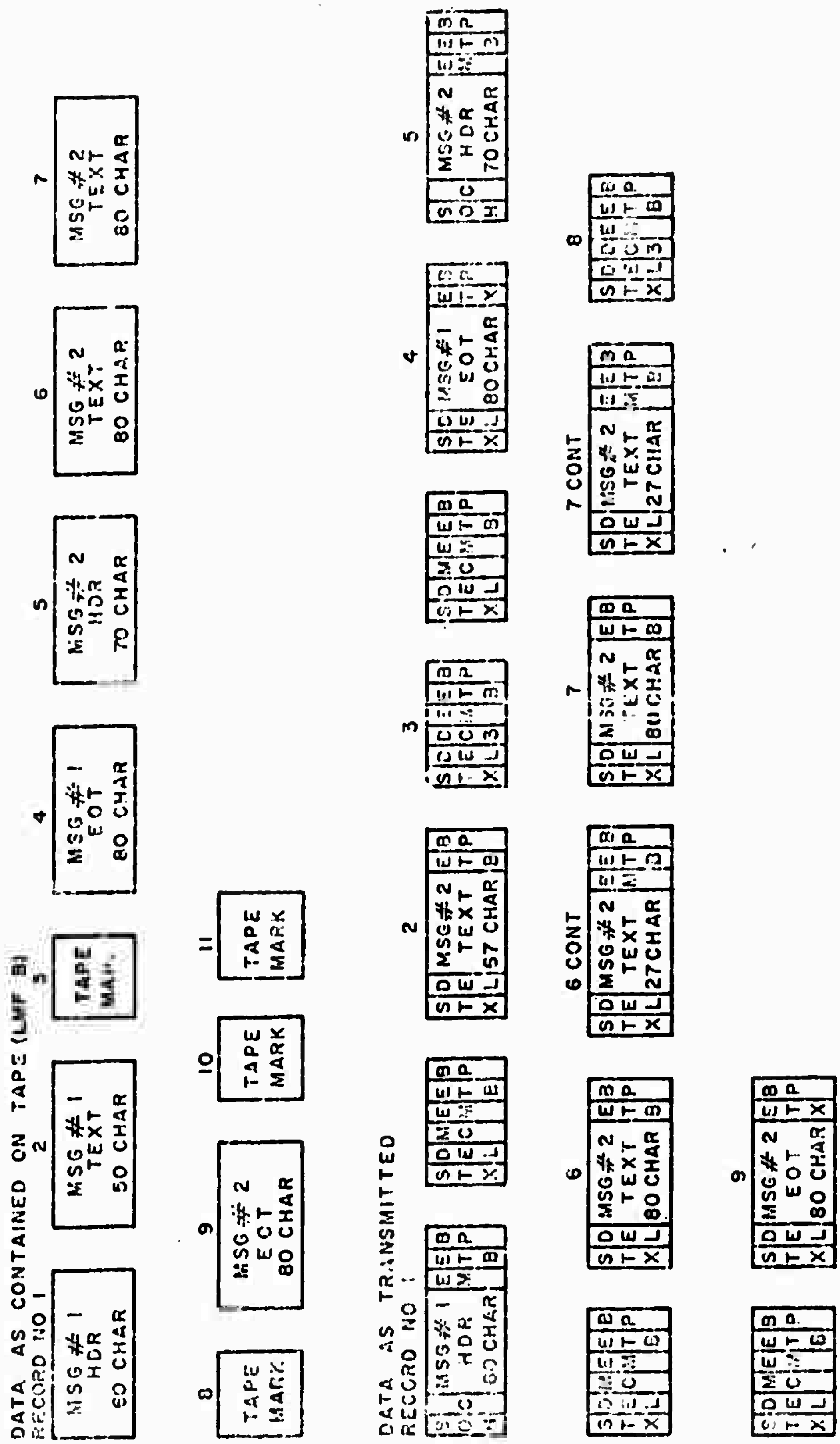


FIGURE 10-3. TYPICAL STRUCTURED FORMAT FOR NINE-TRACK TAPE

20

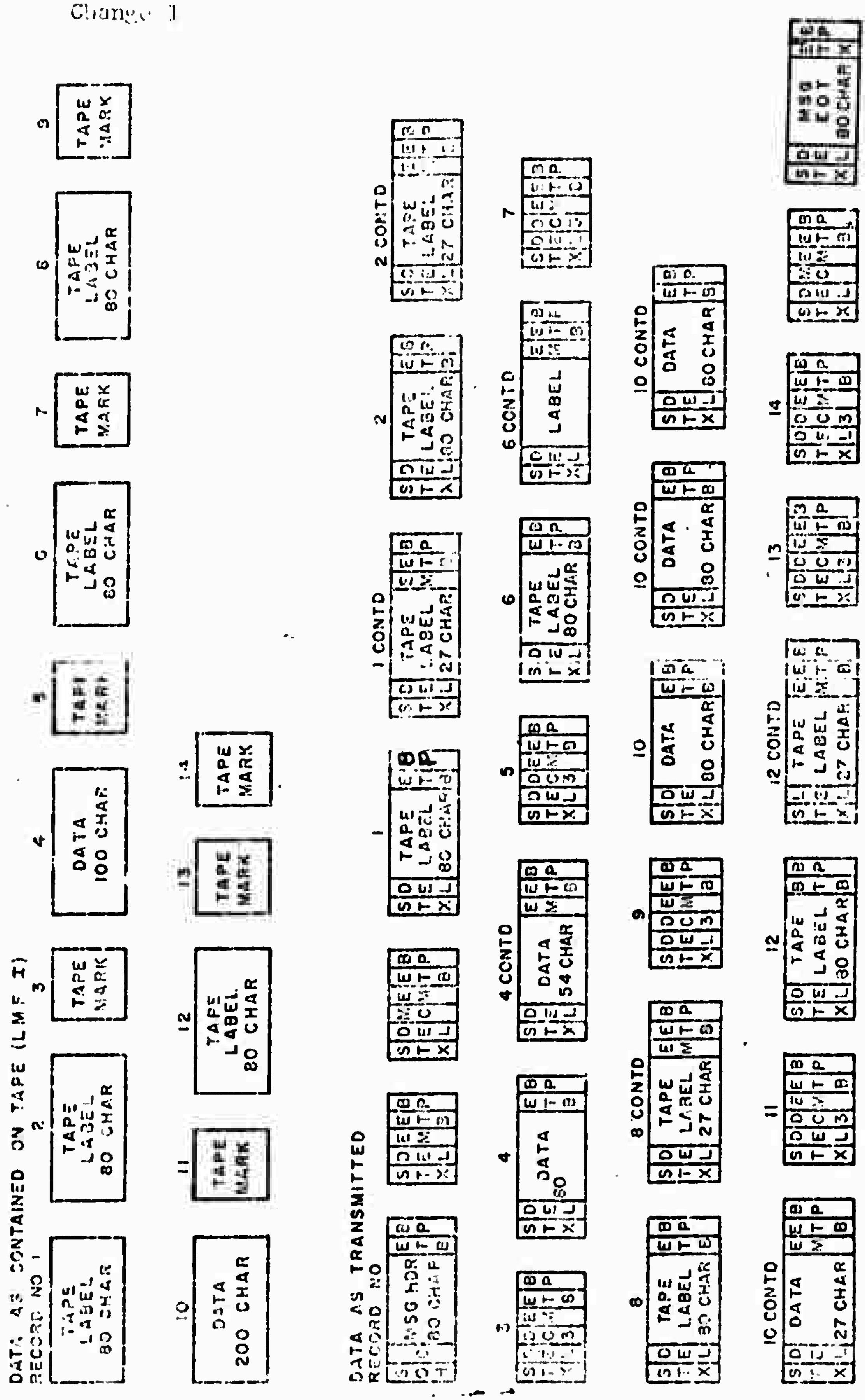


FIGURE 10-4. TYPICAL NONSTRUCTURED FORMAT FOR NINE-TRACK TAPE

21

DEFENSE COMMUNICATIONS AGENCY
WASHINGTON, D. C. 20305

DCA CIRCULAR 370-D175-1 16 June 1972
Change 2

STANDARDS

DCS AUTODIN Interface
and Control Criteria

1. DCA Circular 370-D175-1 is changed as follows:

a. Cover and page 1. Change distribution statement to read:

> Approved for public release;
> distribution unlimited

b. Page xiv. List of Tables. Change column heading "Figure" to read "Table".

c. Page xiv, List of Tables. Under Table 14-5 delete title of table and insert new title "Expanded Character Set Permitted in ASCII (104)".

d. Page xiv, List of Tables. Under Table 14-6 delete words "Line-to-Line" and page "14-15". Insert new words "Machine-to-Line" and page "14-11".

e. Page xiv, List of Tables. Under Table 14-7 delete words "Line-to-Machine" and page "14-19". Insert new words "Line-to-Line" and page "14-15".

f. Page xiv, List of Tables. Add new table listing as follows:

"TABLE		PAGE"
14-8	AUTODIN Code Equivalents Line-to-Machine	14-19

22

OPR: 450
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g. Page 3-11, paragraph 5b. Change the first sentence to read, "MC is a special control character used to mark the beginning and the end of the binary text portion of the message (LMF BB or II)."

h. Page 5-5, paragraph 3j. Between the sixth and seventh sentences insert the following new sentence:

"However, the maximum period that an AUTODIN subscriber may withhold the ACK for a block terminated with ETX-BP shall not exceed 1 second."

i. Page 8-2, paragraph 3c, last sentence. Change sentence to read as follows:

"The Mode Change (MC) block delineated in table 8-5 is also required on trunks to mark the beginning and the end of the binary text portion of a message containing LMB BB or II."

j. Page 8-6, table 8-5. Delete the narrative explanation within the heavy lines and substitute the following:

"Block formats for LMF "B" and "I" messages are the same as those delineated in table 8-3 with the exception of the unique Mode Change blocks which segregate the beginning and the end of the binary text portion of the message. A Mode Change block is formatted as follows:"

k. Page 8-7, table 8-7, b) second block, second character position. Delete "or M".

l. Page 10-3, paragraph 5b(1), second line of the formula. Delete the second asterisk appearing between J and). Delete the asterisk preceding +1.

m. Page 10-6, paragraph 7b. After the colon insert the following parenthetical statement:

"(Note that in the graphic illustrations the leftmost bit is the high order bit.)"

n. Page 10-8, paragraph 8b. Delete the next to the last sentence, beginning with "The ASCII Control Character DC-3..." and insert the following new sentence:

"The ASCII Control Character DC-3 will be framed as a unique block and transmitted when a single tape mark record is read within the message text of either a structured or non-structured tape."

o. Page 10-12, figure 10-1, Data as Transmitted (LMF B), Record No. 1, Row 1, Block 4. Delete the vertical line preceding "ETX" to remove the indication that a framing character should be contained in that position.

p. Page 10-12, figure 10-1, Data as Transmitted (LMF B), Record No. 1, Row 2. Number the second block "6", the third block "6 con.", and the sixth (last) block "8". For block 8 (MSG#2 EOT) correct the third framing character to read "ETX" in lieu of "ETB".

q. Page 10-13, figure 10-2, Data as Transmitted, Row 1. Insert the number "1" after "record no." On Row 3, Data as Transmitted, delete numbered blocks 12 and 13.

r. Page 10-14, figure 10-3, Data as Transmitted, Record No. 1, Row 1, block numbered 2. Correct the message number to read "#1" in lieu of "#2". Add a vertical line preceding "ETB" to create a new framing character position and insert "EM" in this new position.

s. Page 10-15, figure 10-4, Data as Transmitted, Row 2, block numbered 4. Add "CHAR" after the number 80. Row 2, block numbered 6 con., add the word "tape" above the word "Label" and add "27 Char" below "Label".

t. Page 10-15, Table 10-4, Data as Transmitted, Row 4. Delete the blocks numbered 13 and 14.

u. Pages 14-11 through 14-14. Renumber Table to read "Table 14-6".

v. Page 14-14, Remarks. At the end of remark number 1 insert the following parenthetical phrase:

"(Applicable only to those sites equipped with Government-owned DST equipment, AN/FYA-71)"

w. Page 14-14, Remarks, remark number 8. Correct "U.S." to read "U.C."

x. Pages 14-15 through 14-18. Renumber the Table to read "Table 14-7".

y. Pages 14-19 through 14-22. Renumber the Table to read "Table 14-8".

z. Remove the superseded pages and insert the enclosed new pages as indicated below:

REMOVE PAGES	INSERT PAGES
3-1 through 3-6	3-1 through 3-6
8-3, 8-4	8-3, 8-4
	14-10a, 14-10b
1-3	1-3

The changed portions are indicated by number signs (#) in the left margin of the new pages.

FOR THE DIRECTOR:

OFFICIAL:

ARTHUR E. HAYES
Chief, Administrative Division

TODD A. SMITH
Lieutenant Colonel, USAF
Executive Officer

1 Enclosure a/s

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b. Mode II. A duplex asynchronous operation allowing simultaneous two-way operation without automatic error and channel controls. Mode II AUTODIN terminal connectivity to ASC's is discouraged. Subscribers requesting Mode II service must have previously obtained validation for permanent connection to AUTODIN by either Mode I or Mode V access. Requests for Mode II service or tests will be evaluated by DCA on a case-by-case basis. The acceptable number of Mode II subscribers will vary for each AUTODIN ASC depending upon the existing subscriber configuration. This will be a major consideration in any decision affecting requests for Mode II service to meet unusual and emergency needs.

c. Mode III. A duplex synchronous operation with automatic error and channel controls utilizing one-way message transmission with the return direction used exclusively for error control and channel coordination responses. The Mode III channel is reversible on a message basis. Control characters are used in the same manner as for Mode I.

d. Mode IV. A unidirectional asynchronous operation (send only or receive only) without automatic error control. The Mode IV channel is not reversible on a message basis.

e. Mode V. A duplex asynchronous operation allowing independent and simultaneous two-way transmission. Control characters are used to acknowledge receipt of messages, perform limited channel coordination, and display limited information to the operator.

CHAPTER 3. CHANNEL COORDINATION CONTROL CHARACTER DEFINITIONS-SYNCHRONOUS OPERATION

1. Introduction. Control characters are transmitted with even parity. The five subsets of control characters are defined in paragraphs 2 through 6.

2. Communication Framing Characters. Communication framing characters are a subset of control characters whose positional and coding significance serve to delineate the beginning and end of each serial block of data which comprise the transmission of a message. Two of these characters precede the block and two succeed the block. A block consists of 80 text characters together with the associated framing characters for a total of 84 characters.

a. Start of Heading - SOH. SOH is the first framing character of the first block of a message. SOH is an even parity character. It is always followed by the select character. This sequence will not be split by any other character.

b. Select - SEL. The select character is the second framing character of the first block of a message. It is an alphabetic character with even parity. At the transmitting subscriber terminal the select character is determined by the Language Media Format (LMF) Indicator or on the basis of switch settings. Select characters that may be used at the transmitting subscriber terminal are A, B, C, D, E, J, K, M, P, G, and H. The receiving subscriber terminal will process messages and route them to the output device associated with the select character with the exception of a narrative message containing either S or F select character. The S or F select characters will be routed to the specified output device dependent upon subscriber terminal configuration. The ASC program uses the LMF to determine whether to perform message exchange and may change the select character to correspond to the required output format. Select characters that may be used by the ASC are A, B, C, D, E, F, M, P, S, and H.

(1) The select characters will be as follows:

Select Characters	Identification
A	Teletypewriter format and code.
B	Identifies the source transmission tape as being 7 track tape.
C	Identifies the source transmission tape as being 9 track tape.
D	Card format.
E[1]	Data format magnetic tape terminal.
F	Switch card flash or higher precedence messages identification. Activate operator alarm.
G	Identifies the block transmitted in response to ENQ.
H	ASCII paper tape.
J	Circuit switching unit. Select MSU CONUS AUTODIN.
K	Circuit switching unit. Select CSU CONUS AUTODIN.
M	Reserved for future use.
P	Reserved for future use.
S	Switch paper tape flash or higher precedence messages identification--Activate operator alarm.

[1] The AUTODIN program will permit continued use of Select Character E until July 1972 when existing magnetic tape terminals will have been modified to conform to the new procedures defined in Chapter 10.

(2) AUTODIN handling of select characters will be as follows:

(a) Select Characters A, B, C, D, E and H are used by the receiving terminal to route messages to the output device associated with the Select Character. Select Characters J and K are used in circuit switching (CSU) applications.

(b) Select Character F will be inserted by the ASC as the second framing character of the first block of each card message delivered to a Mode I ASCII channel if the header of the message indicates flash or higher precedence. It will not be inserted by any subscriber terminal.

(c) Select Character S will be inserted by the ASC as the second framing character of the first block of each paper tape message delivered to a Mode I ASCII channel if the header of the message indicates flash or higher precedence. SEL-S will not be generated by any terminal.

(d) The ASC will verify that the select character as received from a Mode I ASCII channel is an even parity character, check the select character, ascertain that it is one of a set of assigned select characters and reject the message if the check fails. The ASC will transmit the appropriate select character to the Mode I ASCII terminal.

(e) Select Character G is not defined for use in the leased ASC's. Select Characters M and P are reserved for future use.

(3) The LMF Indicator is placed in the second and third position of the JANAP 128 message header. The first character of the LMF denotes the format of the messages as originated; the second character denotes the preferred output format. LMF's will be as specified in JANAP 128.

(4) The LMF codes authorized for use in AUTODIN are listed below. These codes can only be paired as prescribed in JANAP 128.

LMF	Source Media	Format
A	Paper Tape (teletypewriter ASCII)	Any ASCII Teletypewriter message which is not off-line encrypted.
B	Magnetic Tape, containing one or more structured binary stream messages with variable length records.	Binary text structured message with the header, text, and EOT records for each message on the tape.
C	EAM cards or magnetic tape.	Fixed record length of 80 characters.
D	Magnetic tape containing one or more structured messages in the local or native character coding scheme with variable length records.	Structured messages are recorded in a local or native character coding scheme in variable length records with the header, text, and EOT records for each message on the tape.
F	Paper tape from Mode II and Mode V relays (ITA #2)	Format automatically generated in header, position 2, by ASC. For ASC use only.
G	Paper tape (five level ITA #2)	Indicates message was prepared in modified ACP 127 format.
I	Magnetic tape containing only one non-structured binary stream message with variable length records.	Nonstructured message formatted without the header and EOT records on the tape.

LMF	Source Media	Format
Q	Paper tape, ITA #2, Format converted ACP 127 to JANAP 128	For use only at Mode I subscriber terminals performing format automatic conversion.
R	Paper tape (Teletypewriter ITA #2).	Off-line encrypted text.
S	Magnetic tape or punched card.	Single 80 character record which is a complete date message including header and EOTS.
T	Paper tape (teletypewriter ITA #2).	Any ITA #2 Teletypewriter message which is not off-line encrypted.

c. Start of Text - STX. STX is the first framing character of all blocks except for the first block of a message. STX is an even parity character.

d. Delete - DEL. At a Mode I ASCII subscriber terminal DEL will be placed in the second framing character position of all blocks, with the exception of the first block of a message. This character will have even parity. On input from a tributary, the ASC will change this character to the proper security character.

e. AUTODIN Security - (Switch Action). On input from a tributary, the ASC will add the security character in the second framing character position of all blocks with the exception of the first block of the message. On input from a trunk, the ASC will validate the security character in the header against the security character of the second and all succeeding blocks. This character will be the same character as the security classification indicator in the message header.

(1) The security classification indicators are:

(a) A for SPECAT.

(b) T for Top Secret.

(c) S for Secret.

(d) C for Confidential.

(e) R for Restricted (Not authorized for intra-USA use).

(f) E for EFTO (Encrypted for transmission only).

(g) U for Unclassified.

(h) M reserved for special use.

(2) The ASC will process R and C as CONFIDENTIAL.

(3) At the ASC, the security characters in the header format are checked to assure that the security classification of the message does not exceed the authorized security level of the circuit. The security prosign which was added to the second and all succeeding blocks of a message will be checked before the blocks are transmitted.

(4) If a mismatch occurs as the message is being transmitted, transmission will be halted and canceled (CAN sent) and the message for the destination removed from the system. An appropriate ASC supervisory printout will be issued advising of such action.

(5) An incoming message from a tributary containing a higher security classification than the security classification of the incoming line will be rejected (RM sent) by the ASC. The ASC will automatically send a service message to the tributary and to the traffic service section of the ASC.

(6) On output to a tributary, the ASC will replace the security character in the second framing character position of the second and all succeeding blocks with the even parity DEL character. On output to a trunk, the ASC will not replace the security character.

f. End of Transmission Block - ETB. ETB is the third framing character of all blocks except the last block. It is an even parity character. ETB always appears in the 83rd character position of a block or following EM in those messages where short blocks are permitted.

g. End of Text - ETX. ETX is the third framing character of the last block of a message. ETX is an even parity character and always appears in the 83rd character position of the last block of a message or following EM in those messages where short blocks are permitted.

h. Block Parity - BP. BP is the last framing character of every block in the message. BP always follows ETB or ETX and no other character may be inserted between these characters. BP may be either odd or even parity because it is formed by the binary addition without carry of each of the bits in each row of a block starting with the second framing character, including all text characters, the EM and MC characters if used, and ETX or ETB. Receive control characters are not included in the block parity summation. The synchronous receiving terminal will count the one bits of each received character starting with the second character of each block. When ETX or ETB is detected, the next character will be compared bit for bit with the receiver generated BP character. The two characters must be identical. If they are not, the block is considered to be in error.

TABLE 8-1. MCB FORMAT

Character Position(s) and Item	No. of 8 Bit ASCII Characters	Description
1. Framing Character	1	SOH Framing Character.
2. Select Character	1	Select Character from incoming line.
3. Precedence	1	Precedence Character of original message
4-5. Message Type	2	Original LMF pair if JANAP 128 format. If ACP 127 originated format, LMF pair is "FT". If ACP 127 modified originated format, LMF pair is "GG".
6. Security	1	Security Character appearing in the message header. If the message originated in ACP 127 modified format (LMF GG), the output will have a TCC code represented in the 6 low order bits.
7-10. Content Indicator	4	Content indicator code field of original message header if originated in JANAP 128 format. ZYUW appears in this field in ACP 127 or ACP 127 modified format (LMF pair FT or GG).
11. Space	1	Space Character.

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TABLE 8-1. MCB FORMAT (CON.)

Character Position(s) and Item	No. of 8 Bit ASCII Characters	Description
12-18. Originating Station Routing Indicator (OSRI)[1]	7	The originating station routing indicator appearing in the message header if originated in JANAP 128 format. For messages originated in ACP 127 or ACP 127 modified formats (LMF FT or GG), the home ASC relay designation (R type or Y type) is entered in positions 12-15 for tributary input; for non-ASC relay input the relay routing indicator (R type or Y type) associated with the input channel is entered in positions 12-15. The channel designator (CD) of the input channel is placed in positions 16-18.
19-22. Originating Station Serial Number (OSSN)[1]	4	The originating station serial number appearing in the message header if originated in JANAP 128 format. For messages originated in ACP 127 or ACP 127 modified formats (LMF FT or GG), the input CSN is entered in positions 20-22. Position 19 is always zero unless an error condition exists.
23. Space	1	Space Character.
24-30. Time of File (TOF)[1]	7	The time of file in the message header if originated in JANAP 128 format.

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1 For LMF's FT and GG the OSRI, OSSN, and TOF fields are constructed as defined above; source information for these fields is not taken from format line 3 of the message involved.

TABLE 8-1. MCB FORMAT (CON.)

Character Position(s) and Item	No. of 8 Bit ASCII Characters	Description
24-30. Time of File (TOF)1 (con.)		for messages originated in ACP 127 or ACP 127 modified format (LMF FT or GG) the ASC Julian day is entered in positions 24-26 and the ASC SOM-In Time is entered in positions 27-30.
31-33. Number of Blocks	3	Number of blocks in the message excluding the MCB.
34-40. Start of Header (SOM)-In Time	7	SOM-In Time in Julian date and Zulu time (GMT) at the originating ASC.
41. Type of Routing Indicator (RI) Processing (TRIP)	1	Type of RI processing: N = Normal header processing; contains no collective RI's. C = Normal header processing but contains at least one collective RI. O; P; R = Used by CONUS AUTODIN for internal ASC processing. D' = Deterministic Route Selection directive is contained in the Alternate Route Routing Indicator (ARRI) field.
42. Special Designator Codes (SDC)	1	Special Designator Codes: Space = Ignore S = Automatically generated service message C = Complete CRITIC message P = Partial CRITIC message M = Multiaddressed CRITIC message I = Partial multiaddressed CRITIC message A = Automatic high precedence trunk message

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TABLE 8-1. MCB FORMAT (CON.)

Character Position(s) and Item	No. of 8 Bit ASCII Characters	Description
43-48. Forward Destination Word (FDW)	6	a. In the FDW a fixed bit is assigned to each ASC (bits B1-B6 designate ASC's, bit B7 is set to a binary one, and bit B8 is reserved for parity). b. All unassigned bit (B1-B6) positions are set to binary zero. Assigned FDW bit positions are set to binary one only if a collective RI in the message requires the corresponding center to make local delivery to a tributary or NARC. Messages which do not contain collective RI's will be received with all assigned FDW bits set to binary zero.
49-54. Trace Destination Word (TDW)	6	a. In the TDW a fixed bit is assigned to each ASC (bits B1-B6 designate ASC's, bit B7 is set to a binary one, and bit B8 is reserved for parity). b. The assigned TDW bit positions (B1-B6) are set to a binary one for each of the ASC's through which the received message has been previously switched. The TDW bits collectively designate all the ASC's through which the message has been processed. It is used by the ASC's to trigger an alarm (printout) each time a message is received at a center through which it has previously processed.

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TABLE 8-1. MCB FORMAT (CON.)

Character Position(s) and Item	No. of 8 Bit ASCII Characters	Description
55. Suspected Duplicate Originator (SDO)	1	Suspected Duplicate Originator Assignments: Space = not a susdupe A = Andrews ASC B = Albany ASC C = Clark ASC D = Detrick ASC E = Croughton ASC F = Guam ASC G = Gentile ASC H = Syracuse ASC I = (not assigned) J = Drake ASC K = Korat ASC L = (not assigned) M = McClellan ASC N = Norton ASC O = (not assigned) P = Pirmasens ASC Q = Coltano ASC R = (not assigned) S = Phu Lam ASC T = Tinker ASC U = V = (not assigned) W = Hawaii ASC X = Buckner ASC

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TABLE 8-1. MCB FORMAT (CON.)

Character Position(s) and Item	No. of 8 Bit ASCII Characters	Description
56. Trailing ASC (TASC)[2]	1	See SDO for character coding for TASC. TASC is used in conjunction with SDC code of "A".
57. Successor ASC (SASC)[2]	1	See SDO for character coding for SASC. SASC is used in conjunction with SDC code of "A".
58-62. Alternate Route Routing Indicator (ARRI)	5	a. The ARRI will contain space characters for a normal transmission. b. The second, third, and fourth characters of a relay RI are entered in character positions 58-60. Character positions 61-62 are not used in the CONUS portion of the DCS AUTODIN. In the overseas portion character positions 61-62 may contain spaces or they may indicate a tributary of the relay indicated in character positions 58-60. c. When ARRI contains a nonautomatic relay center (NARC) call letter, the message is intended for delivery to the destination specified by ARRI (one or more collective RI's are contained in the header and all RI's in the received header belong to the NARC destination).

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2 TASC is set at input time; SASC is set at output time.

TABLE 8-1. MCB FORMAT (CON.)

Character Position(s) and Item	No. of 8 Bit ASCII Characters	Description
58-62. Alternate Route Routing Indicator (ARRI) (con.)		d. If ARRI contains a NARC call letter, the ASC routes the message to the ASC serving the NARC. When transmission (within CONUS) of the message is made to the NARC, a collective alternate route pilot is automatically generated by the leased ASC; the addressee portion of the pilot will contain all of the individual RI's, unmodified, and all of the collective RI's replaced with the NARC call letters of the destination. When transmission (within overseas) of the message is made to the NARC, a collective alternate route pilot is automatically generated by government-owned ASC's; the addressee portion of the pilot will contain only the RI (4 characters) of the destination NARC.
63. Originating ASC (OASC)	1	See SDO for character coding for OASC. OASC identifies the ASC directly connected to the input terminal/relay station.
64-68. Service Message Routing Indicator (SMRI)	5	SMRI contains the second through sixth characters of the "Prime RI".
69-71. Input Channel Designator (ICD)	3	Input Channel designator from JANAP 128 asynchronous line. ICD is used in service message generation. ICD is ignored if the field contains all spaces.

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TABLE 8-1. MCB FORMAT (CON.)

Character Position(s) and Item	No. of 8 Bit ASCII Characters	Description
72-79. Trace Message Identifier (TMID)	8	TASC message identification. TMID is used as a unique message identifier by the TASC.
80-82. Input Channel Sequence Number (ICSN)	3	Input channel sequence number from JANAP 128 asychronous line. ICSN is used in service message generation. ICSN is ignored if the field contains all spaces.
83. Framing Character	1	ETB Framing character.
84. Framing Character	1	BP Framing character.

TABLE 8-2. MODE I ASCII TRIBUTARY LINE FORMAT LMF "C", "R", "Q", "T", AND "A" MESSAGES

a) First Block

Framing Control			Framing Control	
Two Characters		80 Characters	Two Characters	
SOH	"SEL" See chapter 3	Format per JANAP 128	ETB	BP

b) Intermediate Blocks

Two Characters		80 Characters	Two Characters	
STX	DEL	Format per JANAP 128	ETB	BP

c) Last Block

Two Characters		80 Characters	Two Characters	
STX	DEL	Format per JANAP 128	ETX	BP

TABLE 8-3. MODE I ASCII TRIBUTARY LINE FORMAT LMF "S" MESSAGES

Framing Control		Data Group	Framing Control	
Two Characters		80 Characters	Two Characters	
SOH	D	Format per JANAP 128	ETX	BP

TABLE 14-5. Expanded Character Set Permitted in ASCII (105)[1]

A	W	i	&
B	X	j	'
C	Y	k	(
D	Z	l	)
E	Ø	m	,
F	1	n	-
G	2	o	.
H	3	p	/
I	4	q	:
J	5	r	;
K	6	s	?
L	7	t	%
M	8	u	*
N	9	v	+
O	a	w	<
P	b	x	=
Q	c	y	>
R	d	z	_
S	e	!	[
T	f	"	@
U	g	#	^
V	h	$	\

[1] Users of this expanded character set are cautioned that not all AUTODIN terminals can accommodate all of the 104 characters. It is the user's responsibility to insure that loss of character integrity is not incurred by attempting to use those additional characters of this table not contained in Table 14-2 in messages addressed to AUTODIN terminals not capable of accommodating the expanded character set.

]

~

`

{

}

¦

BEL[2]

LF[2]

CR[2]

SO[2]

SI[2]

EM[2]

DEL[2]

NUL[2]

DC3[2]

DC4[2]

SPACE[2]

[2] Nonprinting characters.

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22 August 1972

STANDARDS

DCS AUTODIN Interface
and Control Criteria

1. DCA Circular 370-D175-1 is changed as follows:

a. Page xiv, list of tables. Insert new entries as follows:

"Table		Page
8-9	Mode I ASCII Tributary to ASC Line Format LMF "G" Messages	8-9
8-10	Mode I ASCII ASC to Tributary Format LMF "G" Messages	8-10"

b. Page 3-11, paragraph 5a, line 9. Delete the words "and II" and substitute "II, and GG".

c. Page 7-9, paragraph 3d. Delete the first four sentences and substitute: "The disconnect sequence can be initiated either manually or automatically by either the calling or the called terminal. At the calling terminal, the disconnect signal is not automatically initiated until after acknowledgment has been received for the ETX (End of Test) block."

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d. Remove the superseded pages and insert the enclosed new pages as indicated below:

REMOVE PAGES	INSERT PAGES
7-1, 7-2	7-1, 7-2
8-1, 8-2	8-1, 8-2
	8-9, 8-10

The changed portions are indicated by number signs (#) in the left margin of the new pages.

2. When the above action has been completed, this change may be filed with the basic publication.

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CHAPTER 7. AUTODIN CIRCUIT SWITCHING NETWORK OPERATION

\# 1. Introduction. In addition to its Message Switching Unit (MSU) providing store and forward message switching, the Tinker Air Force Base, Oklahoma ASC is equipped with a Circuit Switching Unit (CSU). The CSU provides a capability for real-time message transfer over direct connections between its own subscribers (local tributary operations). It also operates in conjunction with an MSU over interchange trunks when store and forward service is required. Separate interchange trunks for transmission from CSU to MSU and from MSU to CSU are provided. The circuit switching unit of AUTODIN was designed primarily to pass large volume data files from one tributary to another. Although the CSU is capable of passing short messages, greater circuit and system efficiency will be realized with larger volume transmissions. A preemption feature is available for Flash messages; however, it is not recommended for general use. Flash message transmission over the CSU should not be used except when MSU services are not available. The circuit switching network handles digital traffic only. Duplex operation may be used between tributaries within the circuit switching network. The leased AUTODIN circuit network operates with lines that use either FIELDATA Code or the ASCII. This chapter deals only with operation using the ASCII. Although only one CSU is currently being utilized, this chapter as written is also applicable to a network of more than one interconnected CSU.

2. Signals and Preambles. Control and supervisory signalling is accomplished over the information paths for all circuits. The control signalling is in Mode I ASCII and a real-time connection can only be made between terminals that are compatible with regard to speed and type. Control signalling is a modulation rate of 75×2^m, where m is an integer equal to or greater than zero and equal to or less than six. Supervisory signals are either d.c. levels or eight-bit characters conforming to the modulation rate requirement described above for control signals. In the following paragraphs, signals and preambles are described for Mode I ASCII operation. Code compatibility is observed throughout the full sequence of the call; i.e., if an ASCII terminal originates a call, all control and test characters involved in the connection of the call will be in ASCII.

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a. Signals.

(1) Free State. The send and receive legs of a line or trunk are at a steady "1" when the circuit is free. This Free State signal indicates that the line or trunk is in an operable but nonbusy state and is available to initiate or receive a call.

(2) Service Request (SR). When requesting service, the calling party sends successive SYN characters (10010110) to the CSU as a Service Request. This is an indication to the CSU that the calling party desires to initiate a call. The calling party may be a CSU tributary station, a remote CSU on an incoming trunk, or the associated MSU on a MSU to CSU interchange trunk. For an outgoing trunk call, the local CSU acts as a calling party and sends successive SYN characters as a Service Request to the remote CSU before forwarding the CSU preamble. The interface circuitry of the CSU recognizes the first transition of the SYN control signal to initiate an internal Service Request sequence.

(3) Acknowledgment to Service Request (SRA). The signal is a steady "0" placed on the receive leg of a calling line or trunk. It indicates to the calling party that the CSU has honored its request for service, has been connected and synchronized to the calling line or trunk and that the CSU is ready to receive a preamble for establishing a CSU connection.

(4) Alert. The Alert signal is used to alert the local CSU tributary or MSU interchange that it is receiving a call. The Alert signal consists of successive SYN characters generated by the calling CSU tributary or MSU interchange following the Line or MSU Preamble. The Alert signal is received by the called tributary or MSU after the connection is established.

(5) Connection Established. When the called station is connected, it responds to the Alert signal sent from the CSU by sending successive SYN characters. These SYN characters are recognized by the CSU, and later the calling station, as Connection Established. The receipt of the Connection Established signal further indicates that the called line has synchronized on the characters sent by the CSU as an alerting signal and is, therefore, synchronized to the calling line.

CHAPTER 8. TRUNK AND TRIBUTARY BLOCK FORMATS

1. Introduction. Control characters are defined in chapter 3. This chapter delineates trunk and tributary block framing rules by Language Media Format (LMF) Indicator.

2. Tributary Block Formats.

a. Block framing by LMF for messages transmitted by tributaries is shown in the following tables:

LMF	Table
C, R, T, A, Q	8-2
S	8-3
D	8-4
B, I	8-5
G (tributary to ASC)	8-9
G (ASC to tributary)	8-10

b. For LMF's other than G, block formats transmitted between the ASC and tributaries are the same as those shown in tables 8-2 through 8-5. For LMF G block formats transmitted from the tributary to the ASC are as shown in table 8-9 and block formats transmitted from the ASC to the tributary are as shown in table 8-10.

c. Between the ASC and the subscriber terminal, messages will be formatted and transmitted in 80 text character blocks for synchronous operations using LMF's C, R, T, A, Q, and S. For blocks containing less than 80 text characters, fill characters, odd parity ASCII SI, will be inserted to maintain uniform blocks of 80 text characters.

d. Between the tributary and the ASC, for messages having an LMF of G, the SOH block containing the Transmission Identifier (TI) line will be formatted and transmitted as a short block; i.e., a block of 79 or less text characters truncated by the framing control character sequence EM, ETB, BP. Intermediate blocks and the End of Text (ETX) block will contain 80 text characters with fill characters (odd parity ASCII SI characters) inserted as necessary to maintain uniformity.

e. Between the ASC and the tributary for messages having an LMF of G the SOH block will be formatted as a short block in accordance with paragraph 2d. Header blocks containing routing indicators may be truncated by the use of the EM character to delete nonpertinent routing indicators and, at the same time, maintain original message blocking without the use of fill characters in the routing field. Intermediate blocks (except for the ETX block) will contain 80 text characters. The ETX block will be transmitted exactly as received.

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3. <u>Trunk Block Formats</u>.

a. Block framing by LMF for trunk lines is shown in the following tables:

LMF	Table
C, R, T, A, Q	8-6
S	8-7

Messages will be formatted and transmitted in 80 text character blocks; however, for blocks containing less than 80 text characters, fill characters, odd parity ASCII SI, will be inserted to maintain uniform blocks of 80 text characters.

b. Block formats for LMF D messages on trunks are the same as those shown in table 8-6 except that the intermediate blocks may contain EM as delineated in table 8-4, details (b) and (c).

c. Block formats for LMF B and I messages on trunks are the same as those delineated for LMF D messages in paragraph b. above. The Mode Change (MC) block delineated in table 8-5 is also required on trunks to segregate the end of the binary text from the last block of the message for LMF B and I messages.

d. Mode II messages are not divided into blocks on tributary lines. Mode II formats on tributary lines are as prescribed in ACP 127 series and JANAP 128. Mode V messages are not divided into blocks on tributary lines. Mode V tributary lines may use either the JANAP 128 or ACP 127 series paper tape message format. On trunks, however, Mode II and V messages will be divided into blocks as shown in table 8-8.

e. The format of the Message Control Block is shown in table 8-1.

TABLE 8-9. MODE I ASCII TRIBUTARY TO ASC LINE FORMAT
LMF "G" MESSAGES

a) SOH Block containing the Input Transmission Identifier (TI):

Two Characters		79 or less Characters	Three Characters		
SOH	SEL	Input TI C - - - SO - - - SI ΔΔΔΔΔ<<≡ (C - - - = Channel Id[1]; - - - = CSN[2])	EM	ETB	BP

b) Intermediate Blocks:

Two Characters		80 Characters	Two Characters	
STX	DEL	Text Characters	ETB	BP

c) Last Block:

Two Characters		80 Characters	Two Characters	
STX	DEL	Text Characters (Includes filler characters, if any)	ETB	BP

[1]The Channel Identifier (Channel Id) consists of three alphabetic characters.

[2]The Channel Sequence Number (CSN) consists of three numeric characters.

TABLE 8-10. MODE I ASCII ASC TO TRIBUTARY FORMAT LMF "G" MESSAGES

a) SOH Block containing the Output Transmission Identifier (TI):

Two Characters		79 or less Characters	Three Characters		
SOH	SEL	Output TI ZCZC - - - S/O - - - ▼▼▼▼▼<<≡ (- - - = Channel Id[1]; - - - = CSN[2])	EM	ETB	BP

b) Intermediate Blocks:

Two Characters		80 Characters	Two Characters	
STX	DEL	Text Characters	ETB	BP

c) Last Block:

Two Characters		80 Characters	Two Characters	
STX	DEL	Text Characters (Includes filler characters, if any)	ETB	BP

[1]The Channel Identifier (Channel Id) consists of three alphabetic characters.

[2]The Channel Sequence Number (CSN) consists of three numeric characters.

DEFENSE COMMUNICATIONS AGENCY
WASHINGTON, D.C. 20305

DCA CIRCULAR 370-D175-1* 2 October 1970

STANDARDS

DCS AUTODIN Interface
and Control Criteria

1. Purpose. This Circular describes the operational characteristics to be used in the DCS between switching centers and between centers and their tributaries.

2. Applicability. This Circular applies to Headquarters, DCA, the DCS, and to any digital communication system or network desiring to use the DCS.

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CHAPTER 1. INTRODUCTION

1. General. This Circular specifies procedures to be used for the control of data being interchanged between interconnected elements of the DCS AUTODIN. DCS AUTODIN consists of leased Automatic Switching Centers (ASC's) used in the Continental United States (CONUS) and Government-owned ASC's used overseas. These procedures define the block format for messages and rules for transmission and checking which provide the means of detection and orderly correction of errors. Included is an explanation of a technique in which the parity of control characters differs from that of other digital characters. This parity control system is intended to allow a user connected to the DCS AUTODIN the use of any seven-bit information character without interfering with the communication control functions. The DCS AUTODIN is a digital communications network in which both synchronous and asynchronous operation is employed in the exchange of messages. Synchronous operation is employed on trunks between switching centers and on tributary channels when equipped with appropriate terminal equipment. Asynchronous operation is employed only on tributary channels and interchange channels to other teletypewriter networks. For synchronous operation the system will process traffic at modulation rates of 75×2^m baud where m is any positive integer between 0 and 6. Modulation rates defined for current use in the DCS AUTODIN are 2400 and 4800 baud (high-speed service), 600 and 1200 baud (intermediate speed service) and 75, 150, and 300 baud (low speed service). Asynchronous channels will accommodate the low speed service modulation rates (75, 150, and 300 baud).

2. Code and Format. Synchronous operation on trunks between switching centers and on subscriber circuits will use the American Standard Code for Information Interchange (ASCII) as shown in Supplement 1, figure 1. Message formats will be as described in JANAP 128. Asynchronous operation will use ASCII and the ITA #2 code shown in Supplement 1, figure 5. Message formats will be as described in the latest issues of JANAP 128 and ACP 127 and the latest U.S. Supplement thereto.

3. Channel Coordination and Error Control.

a. Synchronous Operation. Channel coordination and error control procedures used in synchronous operation provide for segmenting information into blocks, verification of the accuracy of the received block(s), and acknowledgment of receipt of error free block(s). Receipt of a block containing an error results in retransmission of the block in error. The requirement to transmit the total 128 characters of ASCII in AUTODIN necessitated the development of a control system that is transparent to all characters. The system is character-oriented using positional, coding, and parity criteria for control. All characters will use seven bits for information and an eight bit for parity. Characters are transmitted serially by bit with the low order bit first and the parity bit last. Message characters will have odd parity; control characters will have even parity with the exception of the last character of each block called the Block Parity (BP) character which may have either odd or even parity (chapter 3, paragraph 2h). Characters having even parity, which are not recognized as one of the assigned control codes, will be treated as errors.

b. Asynchronous Operation. Channel coordination and control procedures used in asynchronous operation are based upon segmentation of information to be transmitted into messages. Messages are verified for accuracy at the receiver by the provision of character and control sequence validity checks and start and end-of-message checks. Messages which are correctly received are acknowledged by the receiver while messages which are received incomplete or in error result in requests for retransmission. The control procedures permit the use of the total ASCII and ITA #2 code sets to be transmitted as message characters. The system is character and positionally oriented. Transmission is either in the ASCII or ITA #2 code. Message characters are transmitted contiguously in the native code of the input device. Control sequences, which may be interspersed with message characters, are transmitted in groups of two characters each preceded by a control leader consisting of a timed pause in message transmission. Message and control characters are transmitted serially in a low to high order bit sequence using a one unit start interval and a one unit stop interval. Character validity checks on the ITA #2 transmission code consist of verifying each character for proper start and stop frame bits while for ASCII it includes both a check of the start-stop frame bits and the character parity.

4. Modes of Operation.

a. Mode I. A duplex synchronous operation with automatic error and channel controls allowing independent and simultaneous two-way operation. The terminal (or switching center) responds automatically to control characters by continuing or stopping transmission or displaying action information to the operator.

b. Mode II. A duplex asynchronous operation allowing simultaneous two-way operation without automatic error and channel controls.

c. Mode III. A duplex synchronous operation with automatic error and channel controls utilizing one-way message transmission with the return direction used exclusively for error control and channel coordination responses. The Mode III channel is reversible on a message basis. Control characters are used in the same manner as for Mode I.

d. Mode IV. A unidirectional asynchronous operation (send only or receive only) without automatic error control. The Mode IV channel is not reversible on a message basis.

e. Mode V. A duplex asynchronous operation allowing independent and simultaneous two-way transmission. Control characters are used to acknowledge receipt of messages, perform limited channel coordination, and display limited information to the operator.

CHAPTER 2. DCS-AUTODIN SYNCHRONOUS MESSAGE FORMATTING

General. The maximum message length accepted by the store and forward portion of the system will be 550 blocks. The procedural limitations for message length are defined in JANAP 128. Messages will be segmented for transmission into blocks of 80 characters, exclusive of control characters. In certain message types, blocks of 79 or less characters will be permitted provided the last character of such a block is followed by the special control character End of Medium (EM). Each block will be transmitted, preceded, and followed by framing control characters. The typical message will consist of three parts: the header block or blocks, a variable number of text blocks, and a single (end-of-message) block. Provision is made in JANAP 128 for an exceptional message type which consists of a single block.

CHAPTER 3. CHANNEL COORDINATION CONTROL CHARACTER DEFINITIONS-SYNCHRONOUS OPERATION

1. Introduction. Control characters are transmitted with even parity. The five subsets of control characters are defined in paragraphs 2 through 6.

2. Communication Framing Characters. Communication framing characters are a subset of control characters whose positional and coding significance serve to delineate the beginning and end of each serial block of data which comprise the transmission of a message. Two of these characters precede the block and two succeed the block. A block consists of 80 text characters together with the associated framing characters for a total of 84 characters.

a. Start of Heading - SOH. SOH is the first framing character of the first block of a message. SOH is an even parity character. It is always followed by the select character. This sequence will not be split by any other character.

b. Select - SEL. The select character is the second framing character of the first block of a message. It is an alphabetic character with even parity. At the transmitting subscriber terminal the select character is determined by the Language Media Format (LMF) Indicator or on the basis of switch settings. Select characters that may be used at the transmitting subscriber terminal are A, B, C, D, E, J, K, M, P, G, and H. The receiving subscriber terminal will process messages and route them to the output device associated with the select character with the exception of a narrative message containing either S or F select character. The S or F select characters will be routed to the specified output device dependent upon subscriber terminal configuration. The ASC program uses the LMF to determine whether to perform message exchange and may change the select character to correspond to the required output format. Select characters that may be used by the ASC are A, B, C, D, E, F, M, P, S, and H.

(1) The select characters will be as follows:

Select Characters	Identification
A	Teletypewriter format and code.
B	Binary nonstandard parity magnetic tape.
C	Binary standard parity magnetic tape.
D	Card format.
E	Data format magnetic tape terminal.
F	Switch card flash messages identification. Activate operator alarm.
G	Identifies the block transmitted in response to ENQ.
H	ASCII paper tape.
J	Circuit switching unit. Select MSU CONUS AUTODIN.
K	Circuit switching unit. Select CSU CONUS AUTODIN.
M	Reserved for future use.
P	Reserved for future use.
S	Switch paper tape flash messages identification--Activate operator alarm.

(2) AUTODIN handling of select characters will be as follows:

(a) Select Characters A, B, C, D, E, and H are used by the receiving terminal to route messages to the output device associated with the Select Character. Select Characters J and K are used in circuit switching (CSU) applications.

(b) Select character F will be inserted by the ASC as the second framing character of the first block of each card message delivered to a Mode I ASCII channel if the header of the message indicates precedence Z. It will not be inserted by any subscriber terminal.

(c) Select character S will be inserted by the ASC as the second framing character of the first block of each paper tape message delivered to a Mode I ASCII channel if the header of the message indicates precedence Z. SEL-S will not be generated by any terminal.

(d) The ASC will verify that the select character as received from a Mode I ASCII channel is an even parity character, check the select character, ascertain that it is one of a set of assigned select characters and reject the message if the check fails. The ASC will transmit the appropriate select character to the Mode I ASCII terminal.

(e) Select Character G is not defined for use in the leased ASC's. Select Characters M and P are reserved for future use.

(3) The LMF Indicator is placed in the second and third position of the JANAP 128 message header. The first character of the LMF denotes the format of the messages as originated; the second character denotes the preferred output format. LMF's will be as specified in JANAP 128.

(4) The LMF codes authorized for use in AUTODIN are listed below. These codes can only be paired as prescribed in JANAP 128.

LMF	Source Media	Format
A	Paper Tape (teletypewriter ASCII)	Any ASCII Teletypewriter message which is not off-line encrypted.
B	Magnetic Tape, variable record	Binary text, not to exceed 1200 native characters per record.
C	EAM cards or magnetic tape	Fixed record length of 80 characters.
D	Magnetic Tape, variable record	Alpha numeric tape record not to exceed 1200 native characters per record.
F	Paper tape from Mode II and Mode V relays (ITA #2)	Format automatically generated in header, position 2, by ASC. For ASC use only.
I	Magnetic tape, variable record	Binary text-nonstandard parity. Not to exceed 1200 native characters per record.
Q	Paper tape, ITA #2, Format converted ACP 127 to JANAP 128	For use only at Mode I subscriber terminals performing format automatic conversion.
R	Paper tape (Teletypewriter ITA #2)	Off-line encrypted text
S	Magnetic tape or punched card	Single 80 character record which is a complete date message including header and EOTS.
T	Paper tape (teletypewriter ITA #2)	Any ITA #2 Teletypewriter message which is not off-line encrypted.

c. Start of Text - STX. STX is the first framing character of all blocks except for the first block of a message. STX is an even parity character.

d. Delete - DEL. At a Mode I ASCII subscriber terminal DEL will be placed in the second framing character position of all blocks, with the exception of the first block of a message. This character will have even parity. On input from a tributary, the ASC will change this character to the proper security character.

e. AUTODIN Security - (Switch Action). On input from a tributary, the ASC will add the security character in the second framing character position of all blocks with the exception of the first block of the message. On input from a trunk, the ASC will validate the security character in the header against the security character of the second and all succeeding blocks. This character will be the same character as the security classification indicator in the message header.

(1) The security classification indicators are:

(a) A for SPECAT.

(b) T for Top Secret.

(c) S for Secret.

(d) C for Confidential.

(e) R for Restricted (Not authorized for intra-USA use).

(f) E for EFTO (Encrypted for transmission only).

(g) U for Unclassified.

(h) M for Unclassified (Special Handling).

(2) The ASC will process R and C as CONFIDENTIAL and U and M as UNCLASSIFIED.

(3) At the ASC, the security characters in the header format are checked to assure that the security classification of the message does not exceed the authorized security level of the circuit. The security prosign which was added to the second and all succeeding blocks of a message will be checked before the blocks are transmitted. If a mismatch occurs between the security classification of a message and the authorized security level of a circuit, the message will be automatically delivered to a

security alternate if one has been designated. If no security alternate has been designated, the message will be removed from the system and the originator advised.

(4) If a mismatch occurs as the message is being transmitted, transmission will be halted and cancelled (CAN sent) and the message for the destination removed from the system. At the Government-owned ASC's, the header is transmitted to the traffic service section, and at the leased ASC's, a traffic printout is issued to a local monitor printer indicating an error.

(5) An incoming message from a tributary containing a higher security classification than the security classification of the incoming line will be rejected (RM sent) by the ASC. The ASC will automatically send a service message to the tributary and to the traffic service section of the ASC.

(6) On output to a tributary, the ASC will replace the security character in the second framing character position of the second and all succeeding blocks with the even parity DEL character. On output to a trunk, the ASC will not replace the security character.

f. <u>End of Transmission Block - ETB</u>. ETB is the third framing character of all blocks except the last block. It is an even parity character. ETB always appears in the 83rd character position of a block or following EM in those messages where short blocks are permitted.

g. <u>End of Text - ETX</u>. ETX is the third framing character of the last block of a message. ETX is an even parity character and always appears in the 83rd character position of the last block of a message or following EM in those messages where short blocks are permitted.

h. <u>Block Parity - BP</u>. BP is the last framing character of every block in the message. BP always follows ETB or ETX and no other character may be inserted between these characters. BP may be either odd or even parity because it is formed by the binary addition without carry of each of the bits in each row of a block starting with the second framing character, including all text characters, the EM and MC characters if used, and ETX or ETB. Receive control characters are not included in the block parity summation. The synchronous receiving terminal will count the one bits of each received character starting with the second character of each block. When ETX or ETB is detected, the next character will be compared bit for bit with the receiver generated BP character. The two characters must be identical. If they are not, the block is considered to be in error.

i. CONUS AUTODIN Framing Characters. The following cross-referenced control characters will be used as framing characters on the respective lines and within the leased ASC.

ASCII	FIELDATA	INTERNAL
EM	EDB	EDB
STX	SOLB	SOLB
ETB	EOLB	EOLB
ETX	EOM	EOM
BP	BP	
	SOM-H & SOM-L	SOM-H & SOM-L
SOH		SOM-L
DEL	i (ignore)	i (ignore)

3. Receive Control Characters. Receive control characters are a subset of control characters which are sent by a receiving station when requested to do so by the transmitting station. They are answers or responses to transmission of blocks or control sequences received at the receiving location. These characters are ACK 1, ACK 2, NAK, RM, and WBT. All the Receive Control Characters are transmitted in identical contiguous pairs, each character having even parity. They may be interspersed anywhere in the bit stream except between two adjacent framing characters, and they are not added to the block parity sum nor are they counted in establishing the positional criteria for ETB or ETX.

a. Requests for Answers.

(1) The requests for an answer are:

(a) ETX-BP or ETB-BP if the rest of the block is in proper format with the proper framing characters.

(b) The REP sequence.

(c) The CAN sequence.

(d) The ENQ sequence.

(2) When a request for an answer is received, the receiver will respond with an answer which is inserted in the transmitting side within three character times at the modulation rate of the line. This does not mean that the transmitter will receive the answer in three character times from the time it requests an answer. There are line delay variables to add to the overall time.

b. Acknowledge Number One - ACK 1. ACK 1 is sent by the ASC or subscriber terminal to signal the transmitter that a block has been received correctly. It and the other answer characters are sent only when requested by the transmitter. ACK 1 is the answer to the first block received after power on, or after a message has been canceled, or after a connection has been established in CONUS AUTODIN CSU operation. Thereafter, ACK 1 is used alternately with ACK 2 to indicate correctly received blocks.

c. Acknowledge Number Two - ACK 2. ACK 2 is sent by the ASC or subscriber terminal in acknowledgment of every correct block received after a block which was answered with ACK 1. The sequence of alternate ACK 1 and ACK 2 is not interrupted between messages; i.e., if the answer to the last block of a message was ACK 1, the answer to the first block of the following message will be ACK 2. ACK 2 is the proper answer to a CAN sequence.

d. Negative Acknowledge - NAK. NAK is sent by the ASC or a subscriber terminal when an error has been detected during the receipt of a properly framed block. It is sent when an answer is requested, not at the time of detection of the error. Upon receipt of NAK the transmitter will repeat the complete block for which the NAK applies.

e Reject Your Message - RM. RM is sent as a response to a properly framed block to inform the transmitter that there is a defect in the message that cannot be corrected by retransmission of the block. Upon receipt of RM, the transmitter will cause the message to be canceled. RM may be sent only by the ASC's, and computer interface subscriber terminals. Computer interface subscriber terminals are permitted to send RM only automatically and only after receipt of the BP character or a REP character which follows a power up condition, a momentary loss of power, or a return from self-test. Subscribers with Digital Subscriber Terminal Equipment (DSTE) are not required to send RM.

f. Wait Before Transmitting - WBT. WBT is sent by the ASC or a subscriber terminal as response to a properly framed block to inform the transmitter that it can no longer accept blocks. While WBT is being received, the transmitting station can send only control characters or SYN characters except in continuous operation as noted in chapter 5.

4. Transmit Control Characters. Transmit control characters are a subset of control characters which are sent by the transmitting station to direct the receiving station to take some action. These characters are REP, CAN, and ENQ. They are transmitted in identical contiguous pairs, each character having even parity. Transmit control characters may be transmitted only between blocks in block-by-block operation. In continuous operation, transmit control characters may be sent between blocks and also after the 82nd character position. See chapter 5 for definitions of block-by-block and continuous operation.

a. Reply - REP. REP is sent by the transmitting station to direct the receiver to send its last response or its current updated response; i.e., ACK 1, ACK 2, NAK, RM, or WBT. Each transmitting station will be equipped with a variable timer hereafter referred to as the answer timer. When the BP character of a block is transmitted, the answer timer will be started.

(1) REP will be sent when the answer timer expires if:

(a) ACK 1, ACK 2, NAK, or RM has not been received.

(b) WBT has been received.

(c) No answer has been received.

(2) The timer will be restarted each time REP is sent. At such time as ACK 1, ACK 2, NAK, or RM is received, the timer will be stopped.

(3) The time to which the answer timer is set is the maximum allowable time which the transmitter should wait for an answer before requesting the answer. The precise time is a variable and is a function of the line modulation rate, the length of the line, delays in the modems and different carrier section propagation times. The round trip delay time is determined by adding the transmitting and receiving line delays to the reaction time of the receiver. The maximum response time of the receiver is fixed at the time required to send three characters at the operating line modulation rate. Thus the answer timer setting is determined by adding up the maximum expected line delays to the maximum receiver response time plus a safety factor. This timer setting is based on block-by-block operation.

(4) For continuous mode operation this timer setting may expire within the block following the one for which the answer is outstanding. In this case, the first REP should not be sent until the 80th data character or EM for this block has been sent. Once sent it is repeated thereafter at intervals as defined above.

(5) Typical answer timer settings used are 3 seconds for 75 to 600 baud circuits and one-quarter to one-half second for 1200 and 2400 baud circuits.

(6) If REP is sent three times without a reply from the receiver, an alarm will be activated.

b. Cancel - CAN. CAN is sent by a transmitting station to direct the receiver to cancel or discard the message currently being received. Between messages it serves as a means of synchronizing the ACK sequence.

(1) The CAN sequence may be initiated manually or automatically by an uncorrectable error condition at the transmitter or by the receipt of RM as the response to a block.

(2) CAN must never be transmitted within the text portion of a block nor when the answer to a block is outstanding. If the response to a block is WBT, CAN must not be sent until ACK 1, ACK 2, NAK, or RM has been substituted for WBT by the receiver. CAN must be acknowledged with ACK 2. When CAN is sent, the answer timer will be started and if

ACK 2 has not been received when the timer expires, CAN will be sent again. If the response to CAN is WBT, CAN will continue to be sent each time the timer expires.

(3) If CAN is sent three times without a reply from the receiver, an alarm will be activated and the CAN sequence will continue to be sent at predetermined intervals. If a CAN/WBT sequence continues for approximately 5 minutes, the ASC program will initiate a printout.

c. Enquiry - ENQ. ENQ is sent by the Government-owned ASC's to request that an AUTOVON connected subscriber terminal identify itself. The answer to ENQ is defined in chapter 6. This control character is not used in leased ASC's.

5. Special Control Characters. Special control characters are a subset of control characters which perform the following functions:

a. End of Medium - EM. EM is a special control character which marks the end of text in a block containing 79 characters or less. EM will have even parity and will be included in the block parity check. EM must immediately follow the last text character of a block containing 79 or less text characters. EM will be followed by one of the communication framing character sequences, ETB-BP or ETX-BP (see chapter 5, Continuous Mode for an exception). EM is permitted in messages containing SEL-G or an LMF of BB, DD, and II. The Common Control Unit at the subscriber terminal will have the capability to insert the EM character in messages containing select characters other than B, C, E, and G, but this capability is reserved for future use.

b. Mode Change - MC. MC is a special control character used to mark the end of the binary text portion of the message (LMF BB or II). (See chapter 10).

c. Suspected Invalid Message - INV. INV is sent by the ASC or a subscriber terminal when an unsolicited answer is received. INV will be transmitted as dual character sequence in response to each ACK 1, ACK 2, NAK, RM, or WBT sequence received when an answer is not expected by the transmitter. An alarm will be activated when the INV control character sequence is transmitted or received. INV may be interspersed anywhere in the bit stream except between two adjacent framing characters or between adjacent characters of a two-character control sequence.

6. Synchronous Idle - SYN. SYN is used with synchronous operation to enable character synchronization of the bit stream between the transmitter and the receiver. SYN is an even parity character which is transmitted continuously whenever the transmitter cannot or should not transmit data. In circuit Switch Operation, SYN is also used as a Service Request. See chapter 7.

CHAPTER 4. DIGITAL SYNCHRONIZATION

1. Character Frame. Synchronous Idle (SYN) is an even parity control character used to establish and maintain digital synchronization when no other characters are being exchanged. In a nonframed, nondata state the terminal and ASC shift the received bit until the eight-bit configuration assigned to the SYN character is detected. After the first SYN character is detected, the next three characters are looked at for the same SYN configuration. If the following three characters have the same configuration, the terminal or ASC is considered to be in character frame and traffic may be exchanged. If the following three characters are not SYN characters, then the above process is resumed. When a receiver is in character frame, it will remain in this state until the out of frame criteria is recognized.

2. Loss of Character Frame. The receiver will consider itself out of frame and start the reframing procedure when it fails to detect four consecutive SYN characters or a REP or CAN sequence within a time delay equal to the answer timer setting. The time delay will start when the block parity character is received or when the receiver is ignoring characters waiting for a REP or CAN. The time delay will be stopped; i.e., not allowed to expire, when the expected SOH or STX character is received. The time delay will be restarted whenever four consecutive SYN characters or a REP or CAN sequence is received.

CHAPTER 5. BLOCK-BY-BLOCK AND CONTINUOUS OPERATION

1. Introduction. The synchronous channel coordination procedures described herein are divided into two parts. The first part describes block-by-block operation and the second part, the procedures used in continuous operation. Continuous operation is designed primarily for high reliability circuits over which the percentage of block retransmissions is relatively low. In continuous operation, transmission of a second block can start prior to receipt of the proper ACK for the first block, thereby saving the turn-around time between blocks. Greater circuit efficiency is realized on highly reliable lines. Block-by-block operation is more efficient on less reliable lines. Since a greater proportion of retransmissions is required on these lines, subsequent line blocks are not transmitted until the previous line block has been properly acknowledged. The greater the time delays associated with the transmission path, the less efficient block-by-block operation becomes. The narrative description is complemented by the flow charts shown in figures 5-1 through 5-12. Dynamic examples demonstrating simultaneous transmission and channel coordination are illustrated in figures 5-15 through 5-18. Figures 5-13 and 5-14 illustrate the CONUS AUTODIN CSU operation. Details of CSU operation are given in chapter 7.

2. Introduction to Block-by-Block Operation. Block-by-block operation is the synchronous, duplex, transmission and reception of blocks of 84 (or less) characters wherein after a block is sent, no further blocks are transmitted until an answer is received. Synchronizing control characters are sent until the proper acknowledgment is received, at which time the next block is transmitted. If a NAK sequence is received, the same block will be retransmitted; however, if no answer is received, then, after a preselected time has expired, the REP sequence is sent. The answer to the REP sequence will determine the next operation. If the proper ACK is received, the next block will be transmitted. However, if the wrong ACK is received, the block will be retransmitted. Figures 5-15 and 5-16 are dynamic examples of block-by-block channel coordination. Blocks will be framed as described in chapter 3. Transmit control characters and receive control characters may not be sent between the start of block character and the second position character or between the end of block character and the block parity character. Synchronizing control characters may not be sent between the start of block position and the block parity position.

3. <u>Analysis of Block-by-Block Receive</u>. Before message reception starts, the receiver must establish and maintain synchronization with the transmitter. Bit synchronization and character synchronization (frame) must take place as specified in chapter 4. Once character frame has been established, loss of character frame will be suspected when the receiver times out and fails to detect SYN. After these synchronizing processes take place, the receiver is ready to accept messages. All discussion hereafter will assume that synchronization and character frame have taken place unless stated otherwise.

a. After the receiver is in character frame and is ready to receive messages, it is receiving SYN characters or control characters. This is the nondata state or condition. When receiving the text characters of a block, the receiver is said to be in the data state or condition. Thus, the time between reception of blocks is the receive nondata condition and the time during which a block is being received and accepted is the receive data condition in the block-by-block operation.

b. If no answers are expected and an answer is received, then a transmission of an invalid message is indicated and the INV sequence is returned for each such return control sequence.

c. The flow charts, figures 5-1 to 5-6 indicate how characters are processed from the receive side of the line. Where it is necessary for the receive side to send a character, a flag will be set and the character will be sent by the transmitter. The receive flow charts have been divided into five groups which are:

(1) The start of block framing character position (figure 5-1).

(2) Second character position (figure 5-2).

(3) Text character position (figure 5-3).

(4) End of block framing character position (figure 5-4).

(5) Block parity position (figure 5-5).

d. In the start of block position the receiver accepts synchronizing characters, receive control characters, transmit control characters, the INV character, or the proper SOH or STX character. Between messages, the only acceptable character which can make the transition from the nondata to the data state for the receiver is SOH. After having received a SOH character in the first block, the receiver looks for a STX character in the first block position in each succeeding block until either the End of Text (ETX) character or a CAN sequence has been received and acknowledged. Refer to figure 5-1. Message integrity is maintained by requiring that the end of block framing character sequence accepted last is ETB-BP. If this requirement is met, STX is accepted, and the second framing character is expected.

e. The acceptable characters in the second framing position are even parity Select (SEL) characters, Security (SEC) characters, or the Delete (DEL) character. If the second character is not even parity, the receiver will ignore the block and wait for the REP or CAN sequence. In the Government-owned ASC's, the second framing character will be additionally checked to determine that it is one of the acceptable set. If the second character is not one of the acceptable set, the receiver will ignore the block and wait for the REP or CAN sequence. In the leased ASC's, the second framing character will be additionally checked to determine that it is neither SYN, nor one of the framing characters (SOH, STX, ETB, ETX), nor one of the transmit or receive control characters. If the receiver determines the character to be one of these characters, the block is ignored and the receiver waits for the REP or CAN sequence.

f. After receiving a valid SOH, the next framing character must be the SEL character. The tributary will detect an error immediately if the select character is part of the select character set but the terminal has not been assigned that particular select character. In this case the tributary will set the NAK flag. For multiple block messages, the ASC's will, after the block has been acknowledged, check the select character against the acceptable select characters for that channel. For single block messages, the ASC's will, prior to the block being acknowledged, check the select character against the acceptable select characters for the channel. If a mismatch occurs, the ASC's will set the RM flag causing the transmit section to send the RM sequence.

g. The second framing character of all except the first block of a message may be either DEL or a security character. If the ASC is receiving a message from a terminal, the second character is a DEL. Message traffic after having been processed by an ASC will have a security character placed in the second framing character position. The ASC will validate the DEL and SEC character in the same manner as it does the SEL character. If a mismatch occurs, the ASC will set the RM flag causing the transmit section to send the RM sequence. If this character is accepted, the receiver will move to the text character position.

h. In the text character position, only odd parity data characters, even parity receive control characters, and even parity special control characters are allowed. The receive control characters and the special control character INV must be double character sequences.

(1) The NAK flag will be set, if a double character sequence is broken, or if an even parity transmit control character is received, or if an even parity data character is received. When the NAK flag is set, it will not be used to update the response until after receipt of block parity for that block.

(2) If a framing control character or a synchronizing character is received in the text character position, the receiver will ignore the block, go to the waiting state, and wait for the REP or CAN sequence.

(3) Reception of data characters will be continued until the receiver reaches the end of block framing position. The receiver is in the end of block framing position when 80 text characters, or 79 or less text characters and the even parity EM character is received. It should be noted that in the channel coordination procedures the even parity MC and EM characters are treated as text characters.

i. In the end of block framing position, the only characters accepted are receive control characters, INV, ETB, or ETX. Any other character received in the 83rd character position will cause the receiver to ignore the block and wait for the REP or CAN sequence. All characters received, other than control characters, will be ignored until the REP or CAN is received.

j. The BP position of the receive block is established when ETB or ETX is accepted. The next character is BP. This character is compared with the locally generated block parity (BP) framing character. If they do not compare the NAK flag is set. If they do compare and the NAK flag has not been previously set, the proper ACK flag is set and the receiver returns to the start of block framing of the next block. Whenever the block accepted is determined to be the last block of a message (block is terminated with framing control characters ETX-BP) the ACK for this block is withheld until a good transfer of the block to I/O is confirmed. If the NAK flag is set, the receiver returns to the start of block framing position of the same block which will be retransmitted. Following the BP, the receiver can reject the message if required. (See chapter 3, paragraph 3e.)

NOTE: If the received BP compares with the generated BP, and the NAK Flag has not been set previously, the block is accepted. When the block is accepted, it must be answered. If the receiver cannot accept any additional blocks at this time, it may halt the distant transmitter by answering the received block with the WBT sequence. If this delay in ability to accept another block continues, then the next sequence expected to be received is the REP sequence. See figure 5-1. Upon receiving the REP sequence, the receiver will answer with the WBT sequence, and this will continue until the receiver is able to accept another block. When the receiver is ready to accept blocks again, it answers the received REP sequence with the acknowledgment for the last accepted block.

4. Analysis of Block-by-Block Transmit. The transmitter is in the nondata state when it is not sending any part of a block and is sending SYN or control characters. The transmit data state is entered when SOH or STX is sent and exists until BP of the block being transmitted is sent. Flow diagrams 5-7 through 5-12 indicate how characters are processed on the transmit side of the line. The transmit side also sends receive control characters for the receive side and intersperses these control characters properly in the text portion of the block.

a. The transmit flow charts have been divided into six groups which are:

(1) Start of block position (figure 5-7).

(2) Second character position (figure 5-8).

(3) Text position (figure 5-9).

(4) End of block position (figure 5-10).

(5) Transmit answer routine (figure 5-11).

(6) Transmit control (figure 5-12).

b. In the start of block position the transmitter checks to see if the INV character, any receive control characters, or any transmit control characters are to be sent. If there are, these double character sequences will be sent contiguously. The start of block character; i.e., SOH or STX, will be sent if there is a block to send; otherwise, the synchronizing control characters will be sent. If the start of block character is sent, the transmitter will move to the second character position.

c. The character to be sent in the second framing position of the first block is the SEL character. Both the tributary and the ASC send the SEL character in the second position after the SOH character. Only the SEL character may be sent at this time. The character to be sent in the second framing position of the second and all succeeding blocks differs between ASC and tributaries. The tributary inserts DEL in this position. The ASC inserts DEL when transmitting to a terminal but transmits the security character on output to a trunk.

d. After transmitting the start of block character and the second character, the transmitter is now the text position. In this position, receive control characters, text characters, or special control characters may be sent. Only text, MC, and EM characters are used to count to the next position. After transmitting 80 text characters or 79 or less text characters and EM character, the transmitter is ready to send the end of block framing character. (If in continuous operation and the transmitter has not received a correct acknowledgment for the previous block, then the transmitter sends synchronizing characters.)

e. In the end of block framing position, the transmitter checks to see if any answer flags are set and if set, it will send the answer. If there is no answer to be sent, the end of block framing character is sent (ETB or ETX) followed by the block parity character. At this time the transmitter starts sending synchronizing characters and starts timing for an answer. (In the continuous mode the transmitter starts sending the next block, if there is one; otherwise, synchronizing characters are sent.)

f. Flow chart figure 5-12 is followed when waiting for the answer to the previous block or the answer to a transmitted CAN sequence. If any receive or transmit control characters are to be sent, they are sent at this time. If there are no answers to be sent and the answer time has not expired, synchronizing characters will be sent. When the answer timer expires, the proper transmit control character will be sent. If the CAN sequence or the last block is acknowledged, the transmitter will send the start of block character of the next block.

g. It should be noted that after the ETX-BP sequence has been sent in the block-by-block operation, the message cannot be canceled by the transmitter if the expected ACK sequence has been received. If the last block of a message has been acknowledged with the expected ACK sequence, the CAN sequence can be sent but it will not cancel the message. The answer to the CAN sequence sent after the last block of a message has been acknowledged will be the ACK 2 sequence. This acknowledgment merely serves as an ACK reset, requiring the receiver to respond to the next block transmitted with the ACK 1 sequence. In synchronous operation, the ACK's are alternated first ACK 1 and then ACK 2 for alternate blocks. The receiver sends alternate ACK's and the transmitter expects alternate ACK's as answers for transmitted blocks. When the transmitter sends the CAN sequence, the receiver answers with the ACK 2 sequence; the next ACK sequence sent by the receiver as an answer for a block will be the ACK 1 sequence. The transmitter will expect the ACK 1 sequence as the answer for the first block sent after sending the CAN sequence. The RM sequence may be sent by the ASC in response to the last block of a message and in this case, the CAN sequence sent after receipt of the RM sequence will cancel the message. If WBT is received as an answer to the CAN sequence, the CAN sequence will be repeated at REP time intervals until WBT is no longer received and the ACK 2 sequence is received.

h. The CAN sequence timing is identical to the REP sequence timing procedure. A REP sequence will be sent when an answer for the block is not received in the allowable response time. Each REP sequence will be repeated by the terminal up to three times if no reply is received. If no answer is received after the REP sequence has been sent three times, a no reply alarm is activated and the terminal will continue to send the REP sequence at the proper intervals. The ASC will alarm after three REP sequences have been sent and will continue to send REP sequences at the proper intervals. Refer to figure 5-12. If the previous ACK sequence is received in response to a transmitted block or in answer to a REP sequence, the block will be retransmitted.

5. <u>Continuous Operation - Receive</u>. In continuous operation, as in block-by-block operation, character frame must be established before data reception can begin (see chapter 4). Data reception once begun is continuous; i.e., the SOH/STX character of a block under normal conditions will be contiguous to the block parity character of the previous block. The proper block framing character is STX after detection of SOH and periodically for each block until ETX is detected. Figure 5-17 gives a dynamic example of continuous operation channel coordination.

a. In the start of block position, continuous operation is the same as block-by-block operation, with the exception of the case where the preceding block was in error. In this case, if the last received block is to be acknowledged with NAK, the receiver will ignore a valid SOH or STX character if received immediately after the BP character of the errored block and return to the start of block framing character position. See figure 5-1.

b. The reception of the second framing character is the same for both continuous and block-by-block operation. See figure 5-2.

c. Reception of data characters in continuous operation is the same as in block-by-block operation. See figure 5-3.

d. In the end of block framing position the acceptable characters are ETB, ETX, SYN, receive control characters, or transmit control characters. The situation of receiving SYN or transmit control character sequences, before receiving the end of block framing character, is encountered when the transmitting station has not received an answer for the previous block. Special control character INV is also acceptable at the end of block framing time. See figure 5-4.

e. The reception of the BP is identical for both continuous operation and block-by-block operation.

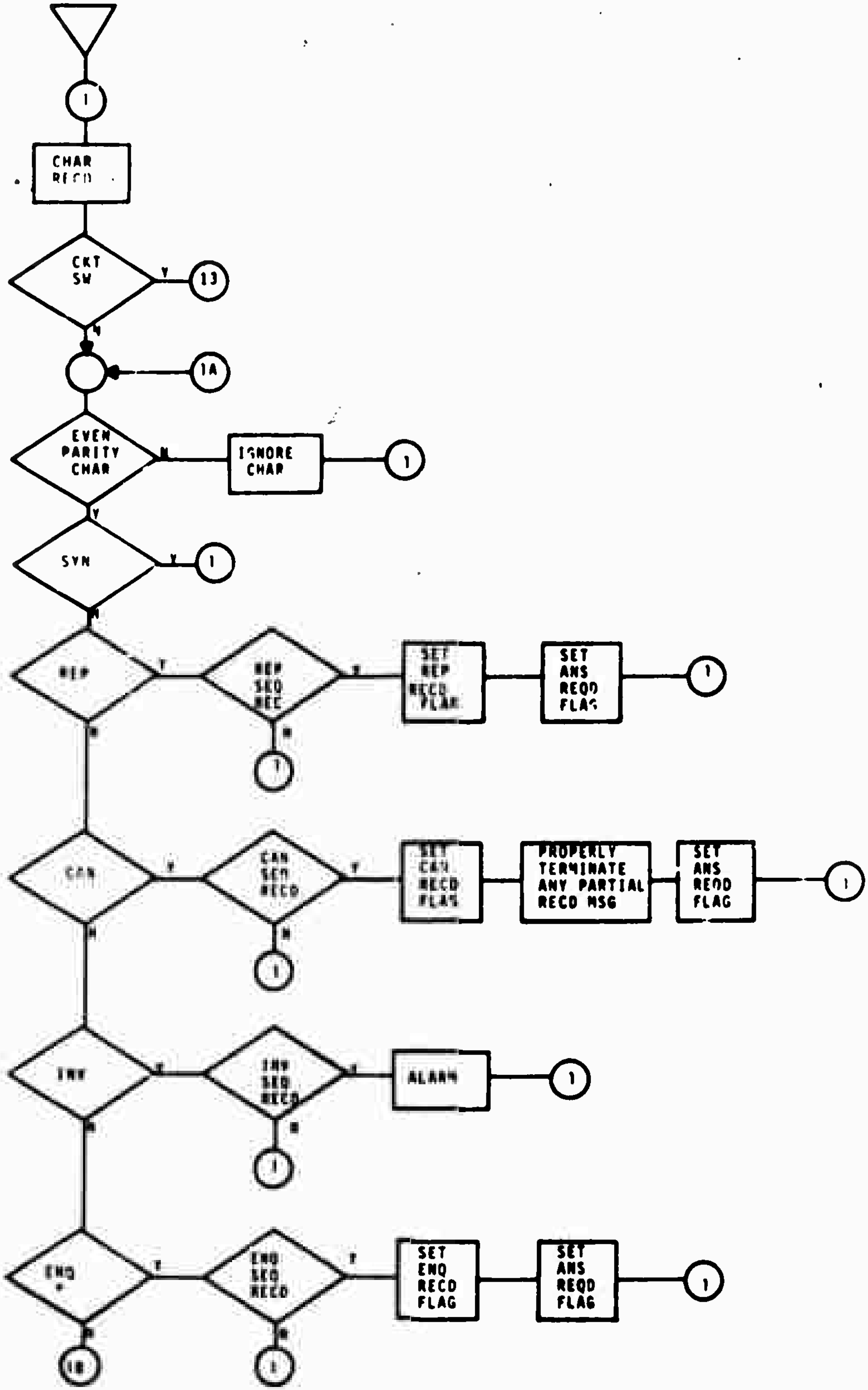
6. <u>Continuous Operation - Transmit</u>. The start of block position and the second framing position for Continuous Operation - Transmit are identical to Block-by-Block Operation - Transmit.

a. In continuous operation, when the end of block framing sequence is sent, timing is started for an answer and the next block is transmitted. Refer to figure 5-10. When the

82nd character or EM character of this block is sent and an answer for the previous block has not been received, SYN characters will be transmitted until the answer timer expires. See figures 5-9 and 5-12. If the answer is received and it is the proper ACK sequence, the block is terminated with end of block framing sequence ETB-BP or ETX-BP. If WBT is received or the answer timer expires before the 82nd character or EM character is transmitted, the transmitter will wait until the 82nd character or EM character is sent before sending the REP sequence.

b. Normally the expected answer timer would expire before the last data character of the following block is sent. The transmitter waits until the last data character is transmitted before transmitting the REP sequence for the answer to the previous block. Figure 5-18 gives a dynamic example of the difference between block-by-block operation and continuous operation.

7. Difference Between the Tributary and ASC Procedures. The differences between the tributary and ASC procedures are in receiving and transmitting the second character of the block and in the fact that the tributary device cannot send the RM sequence, except as noted in chapter 3, paragraph 3e. This is noted in figures 5-2 and 5-8 for the second character position and in figures 5-5 and 5-12 for the transmit RM sequence. In CSU operation the terminal inserts J or K in the second character position of the header block. See chapter 7 for details.



* AUTOVON TERMINAL ONLY

FIGURE 5-1. RECEIVE START OF BLOCK POSITION

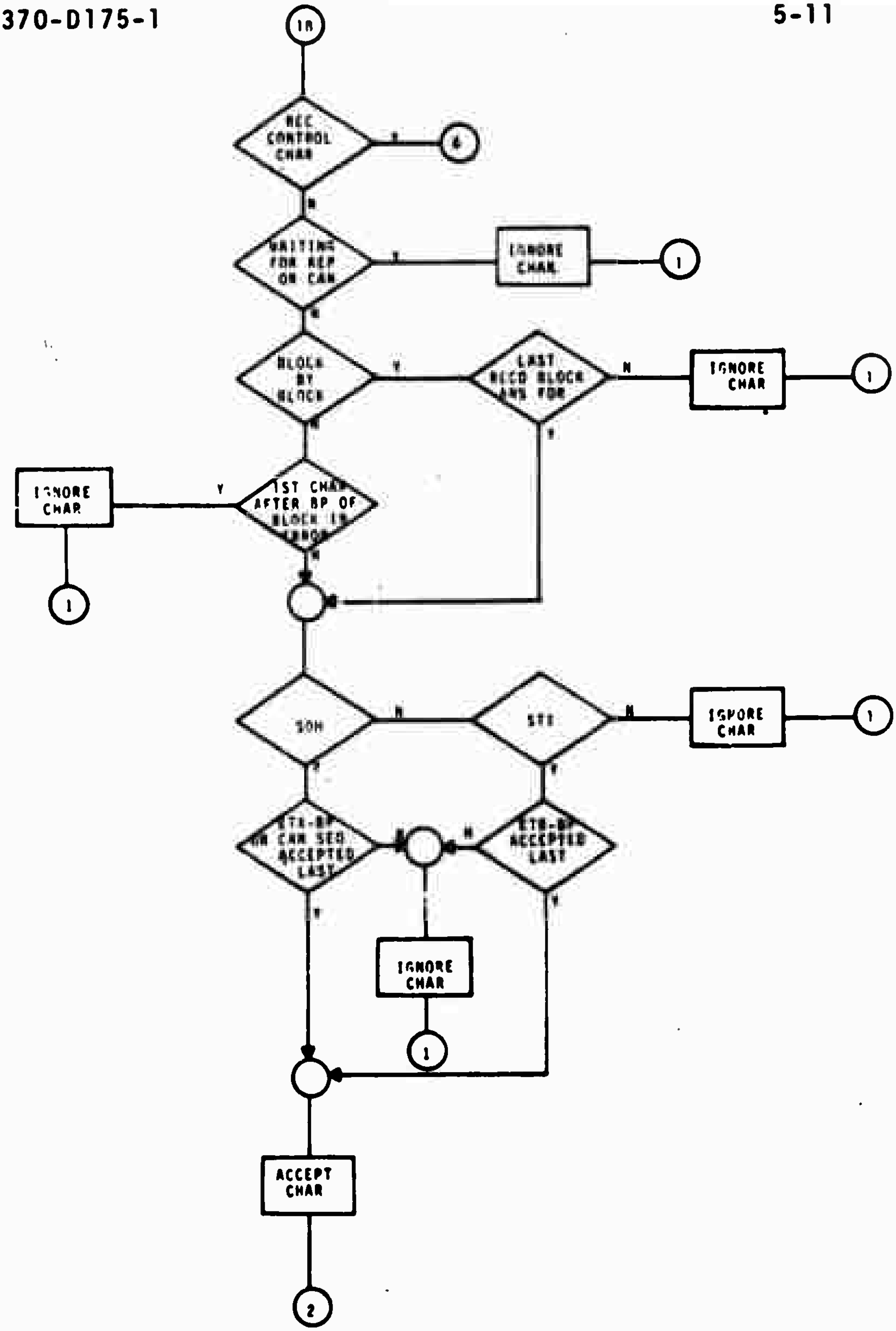
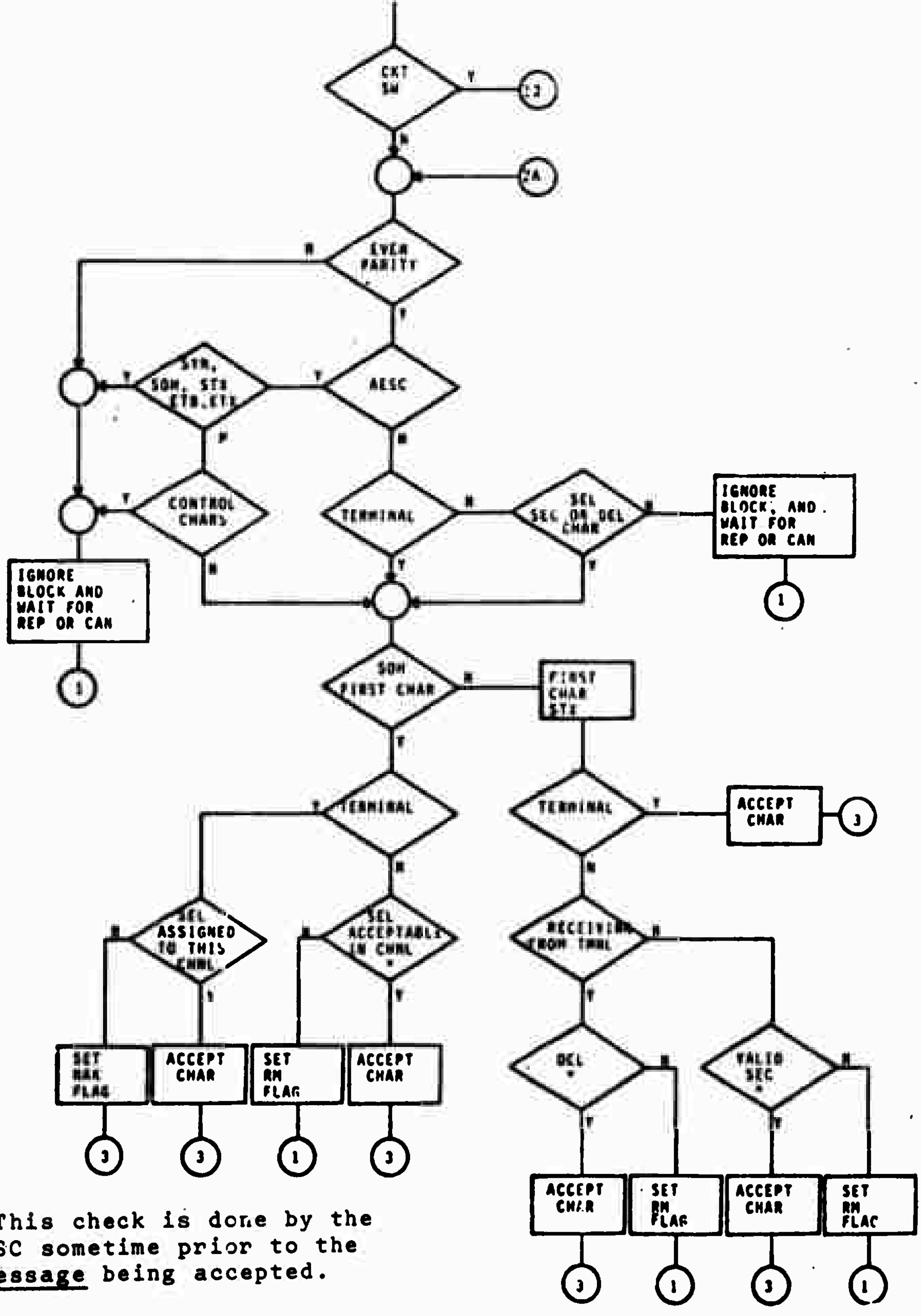


FIGURE 5-1a. RECEIVE START OF BLOCK POSITION



*This check is done by the ASC sometime prior to the Message being accepted.

FIGURE 5-2. RECEIVE SECOND FRAMING POSITION

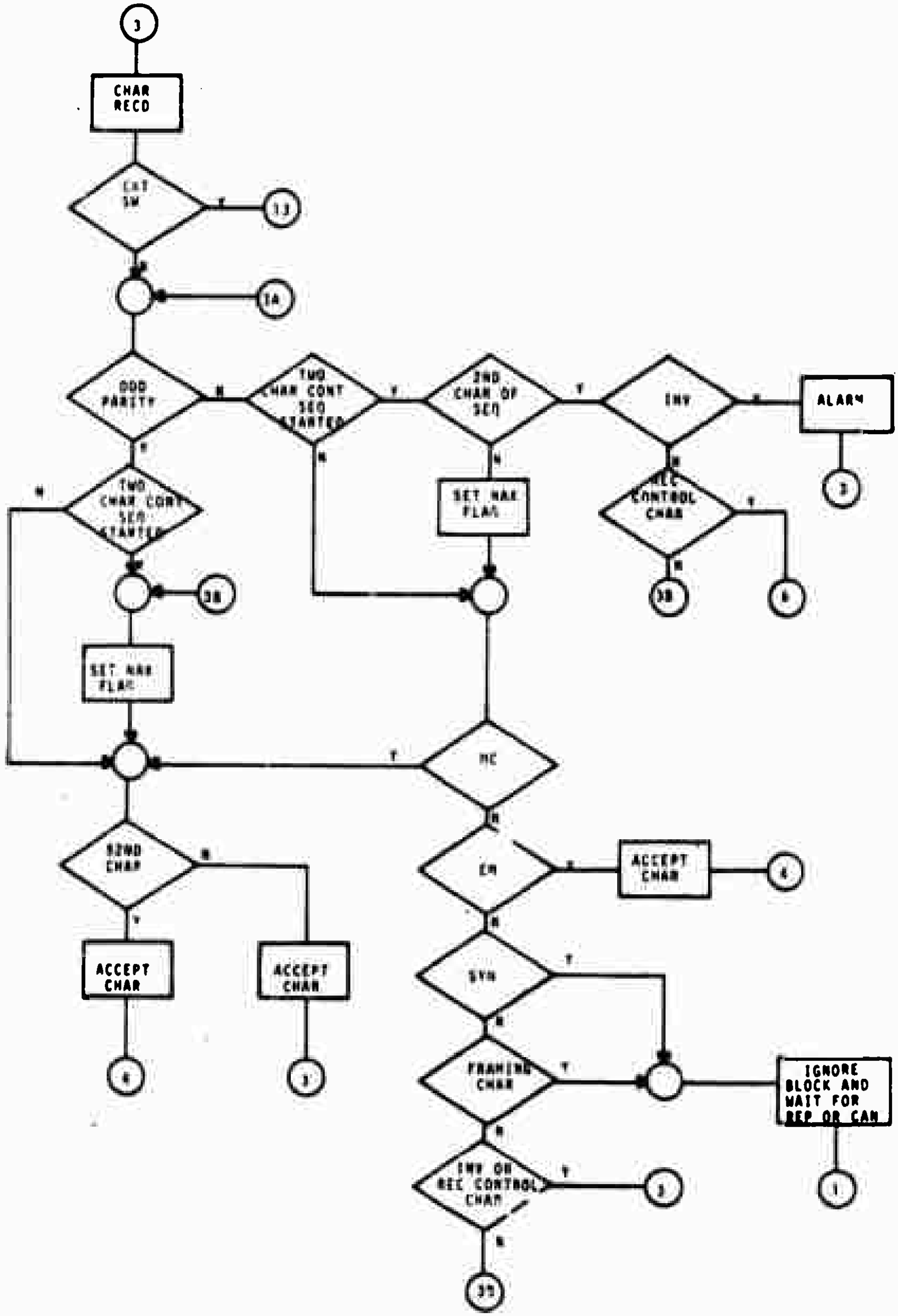


FIGURE 5-3. RECEIVE DATA POSITION

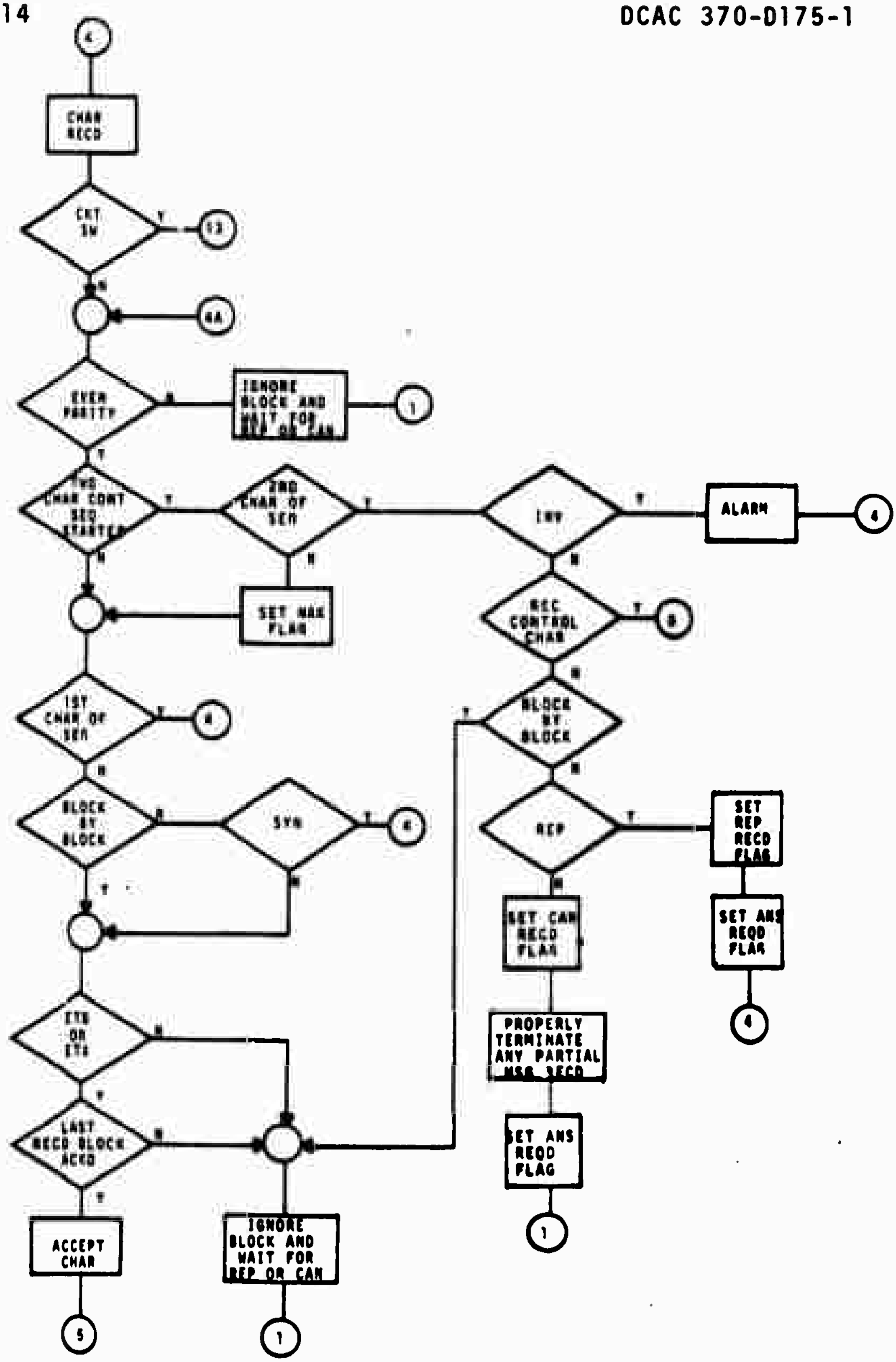
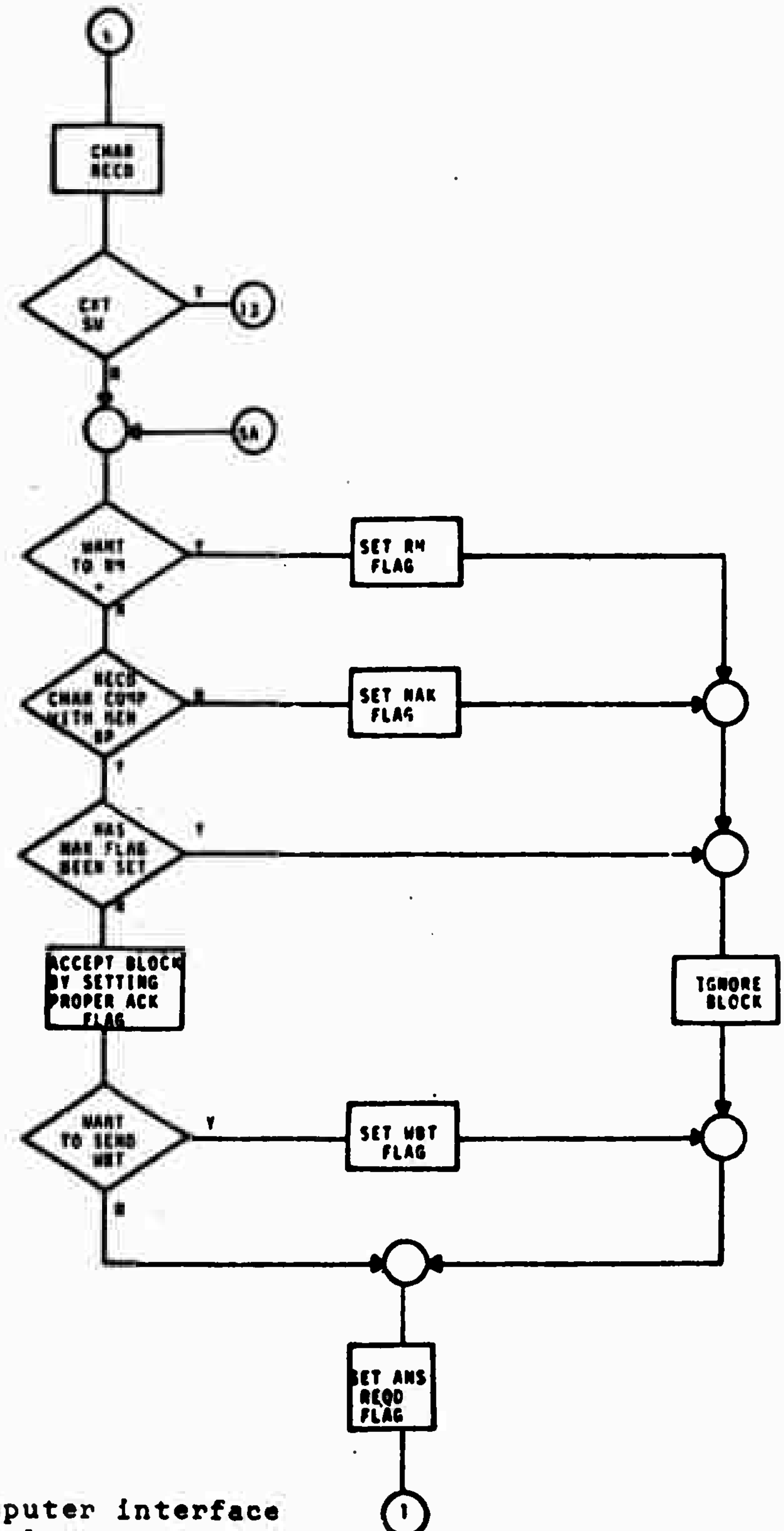


FIGURE 5-4. RECEIVE END OF BLOCK FRAMING POSITION



*ASC and computer interface terminals only.

FIGURE 5-5. RECEIVE BLOCK PARITY POSITION

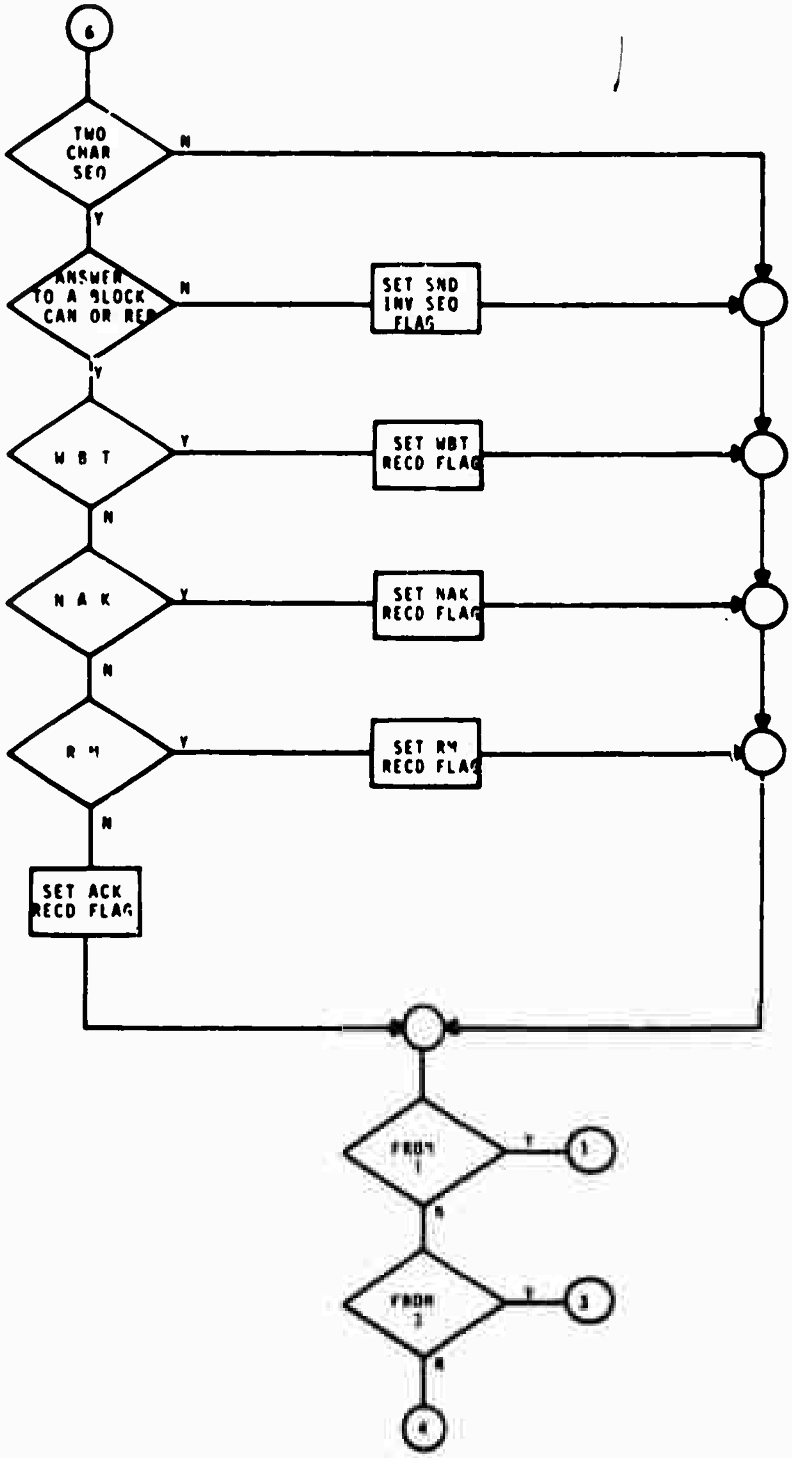


FIGURE 5-6. RECEIVE CONTROL SEQUENCE

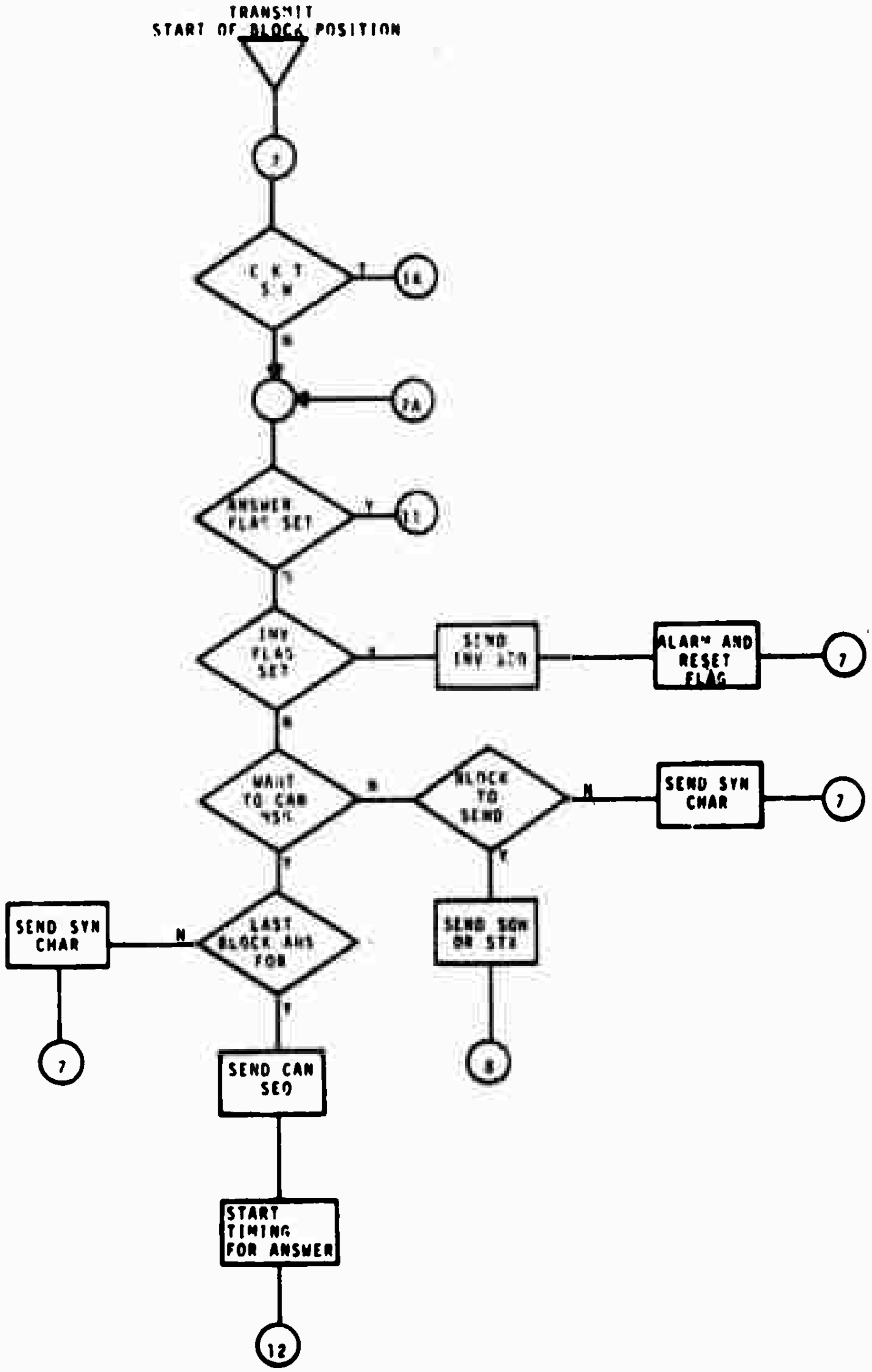


FIGURE 5-7. TRANSMIT START OF BLOCK POSITION

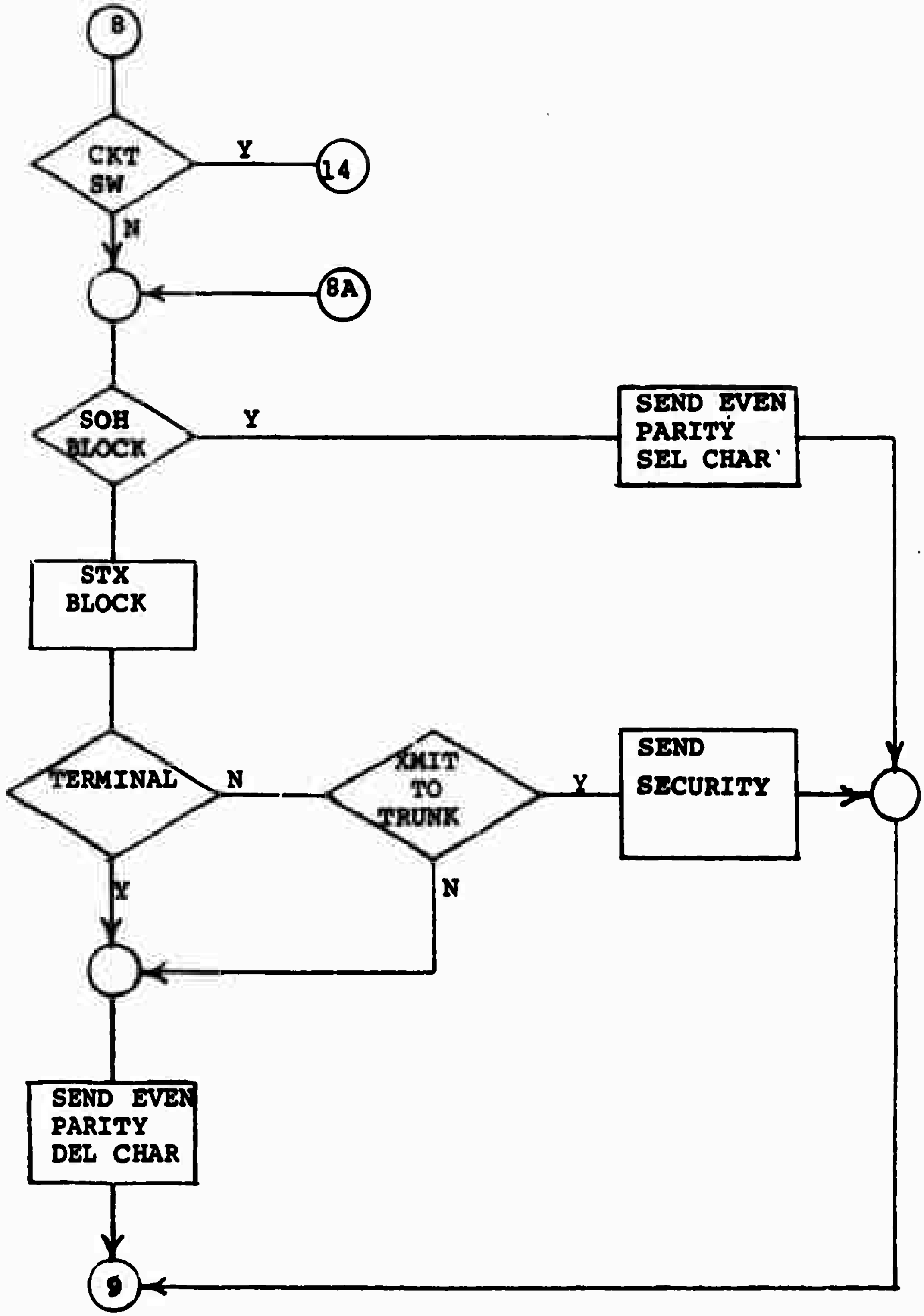


FIGURE 5-8. TRANSMIT SECOND FRAMING POSITION

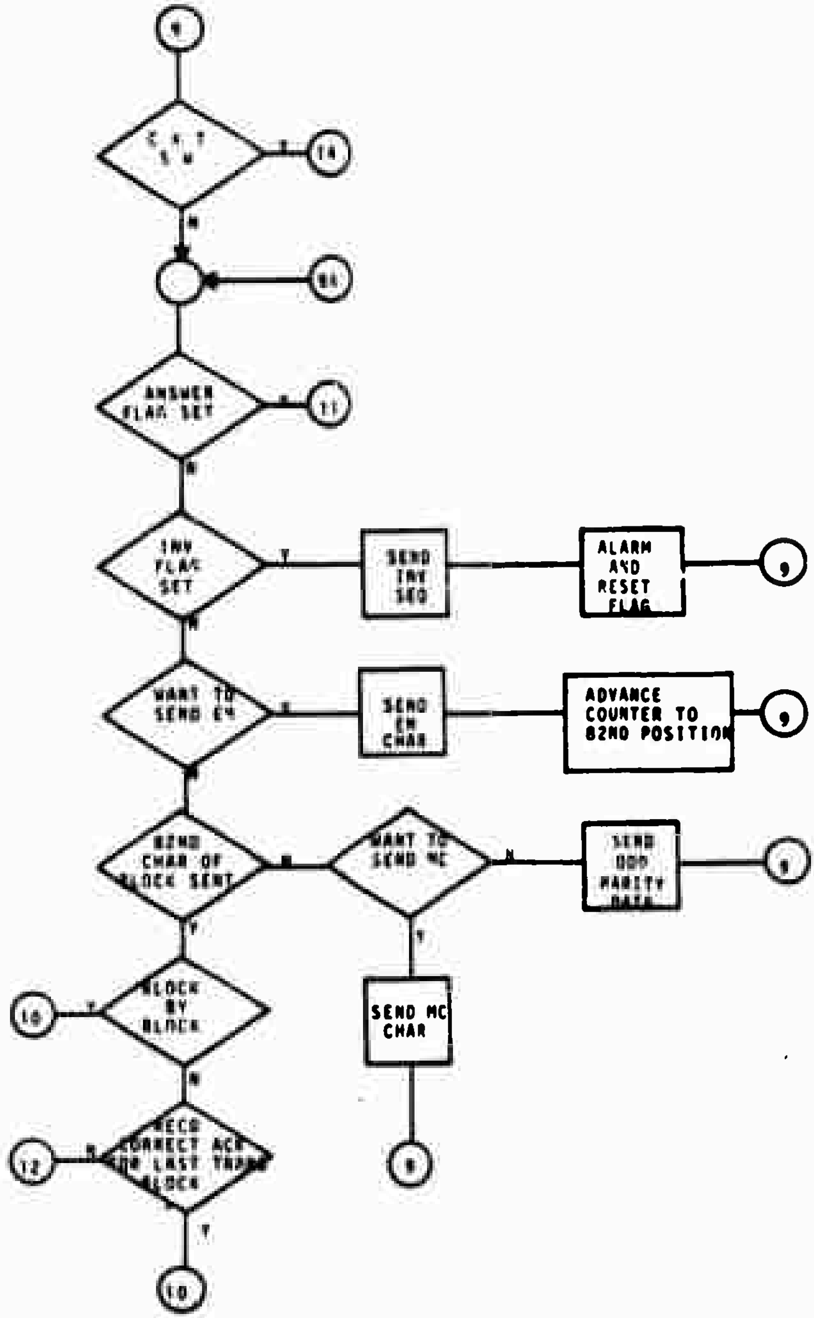


FIGURE 5-9. TRANSMIT DATA POSITION

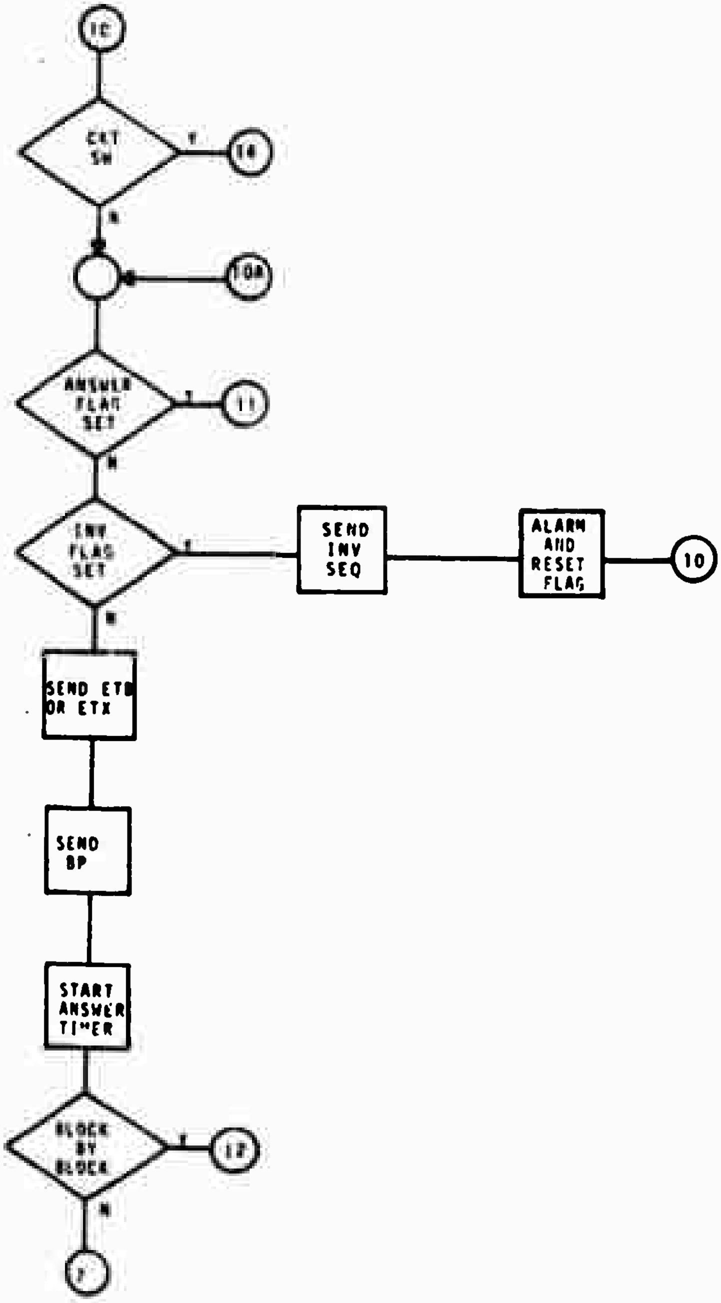


FIGURE 5-10. TRANSMIT END OF BLOCK FRAMING POSITION

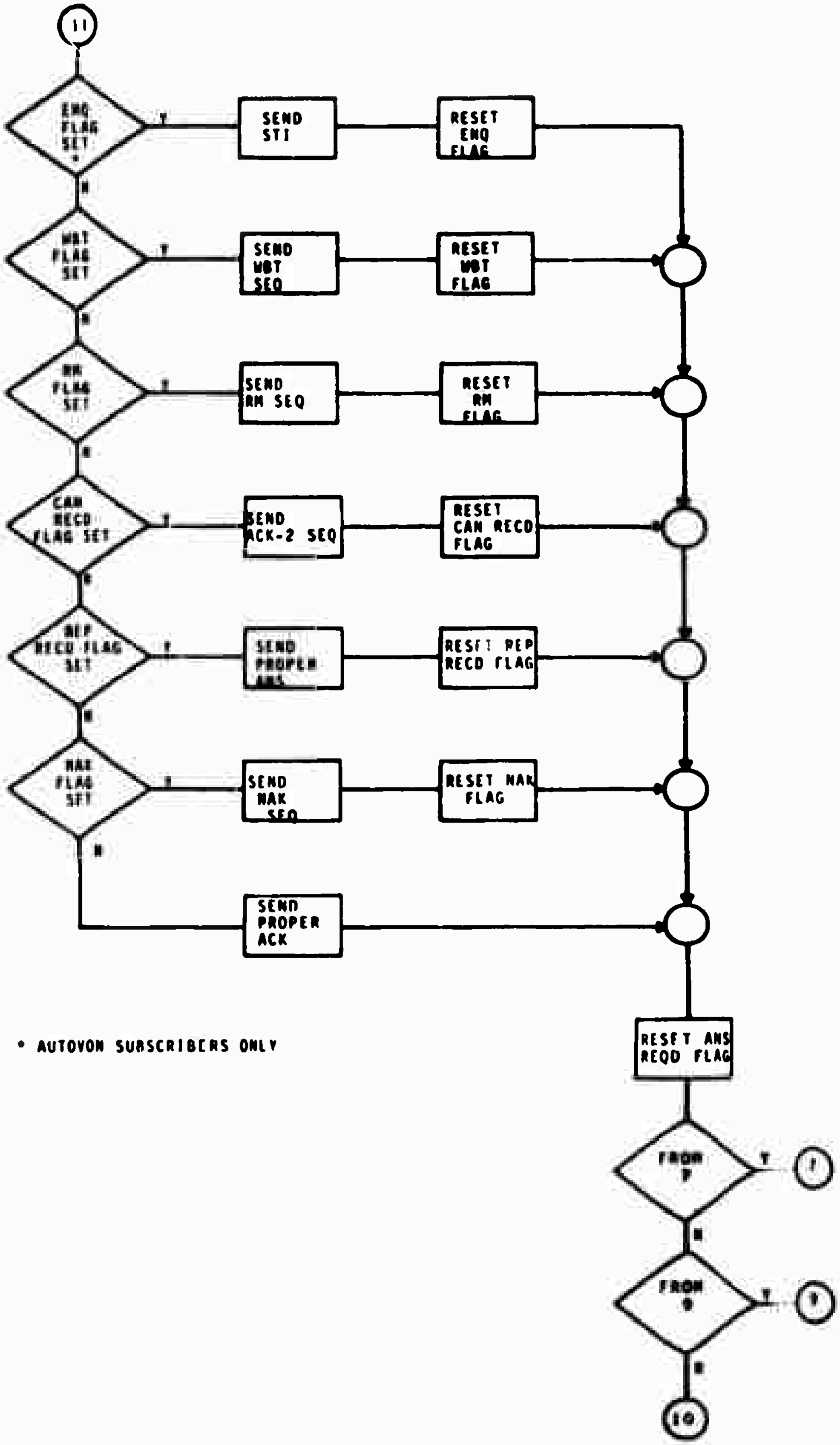


FIGURE 5-11, TRANSMIT ANSWER ROUTINE

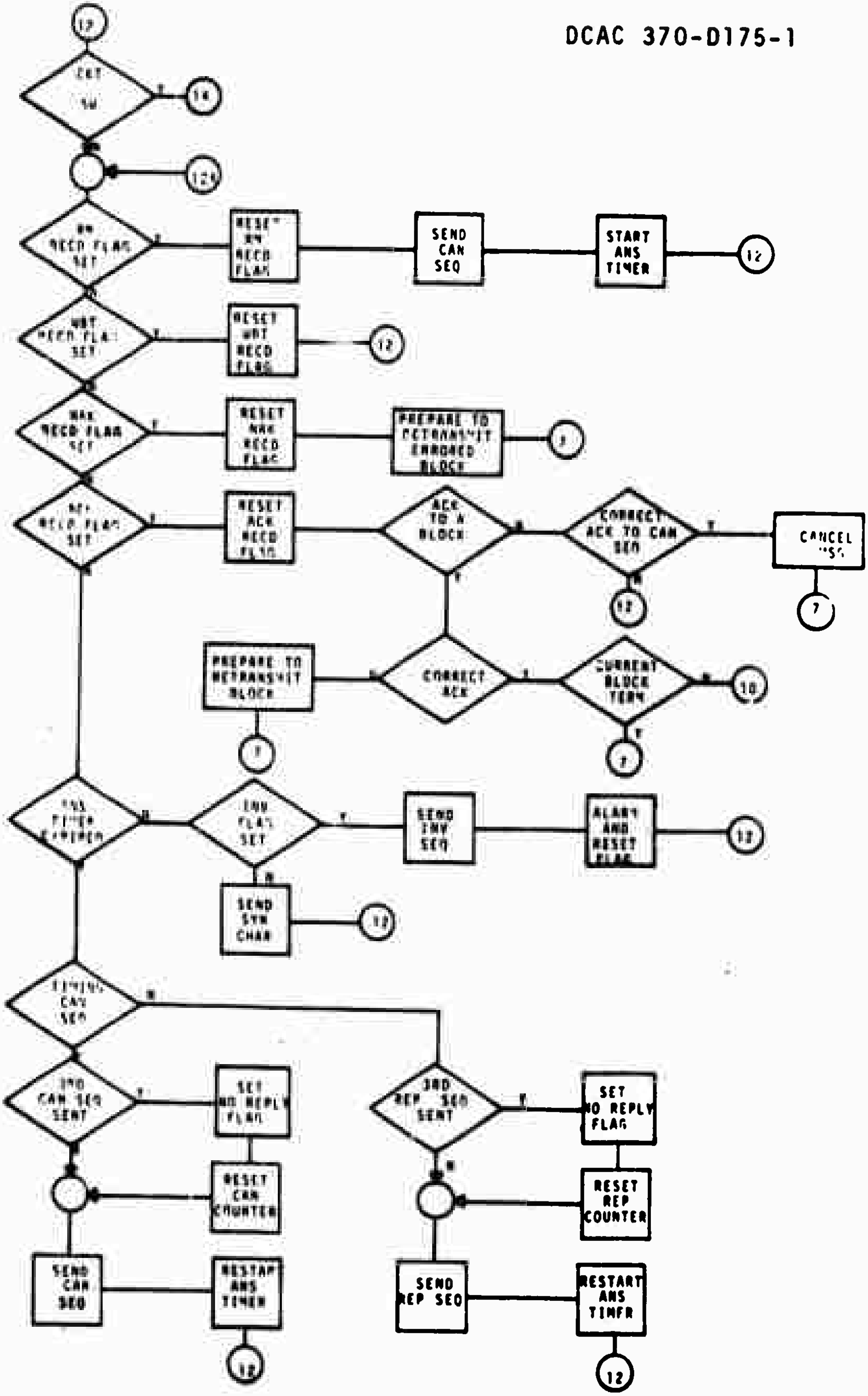


FIGURE 5-12. TRANSMIT CONTROL

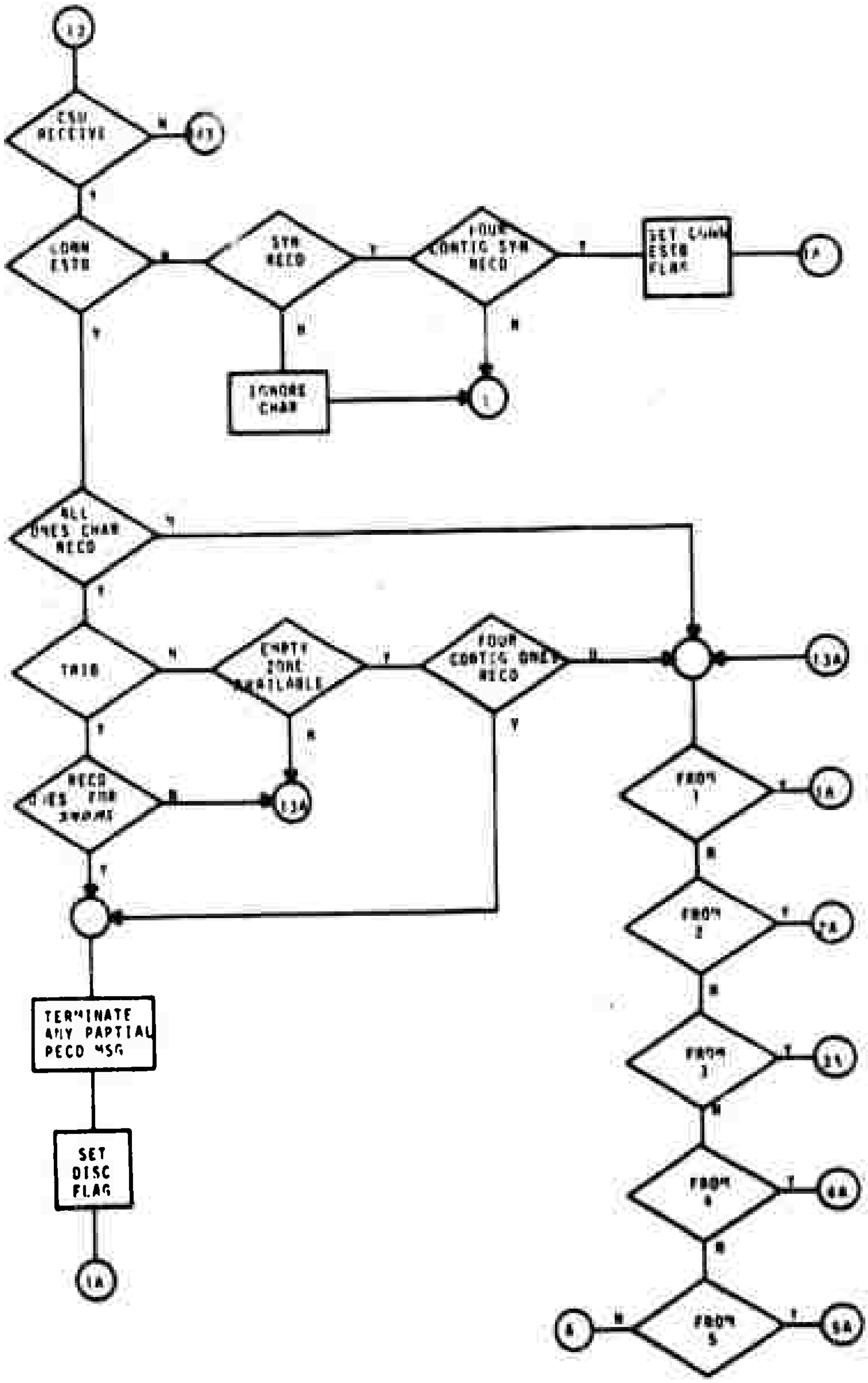
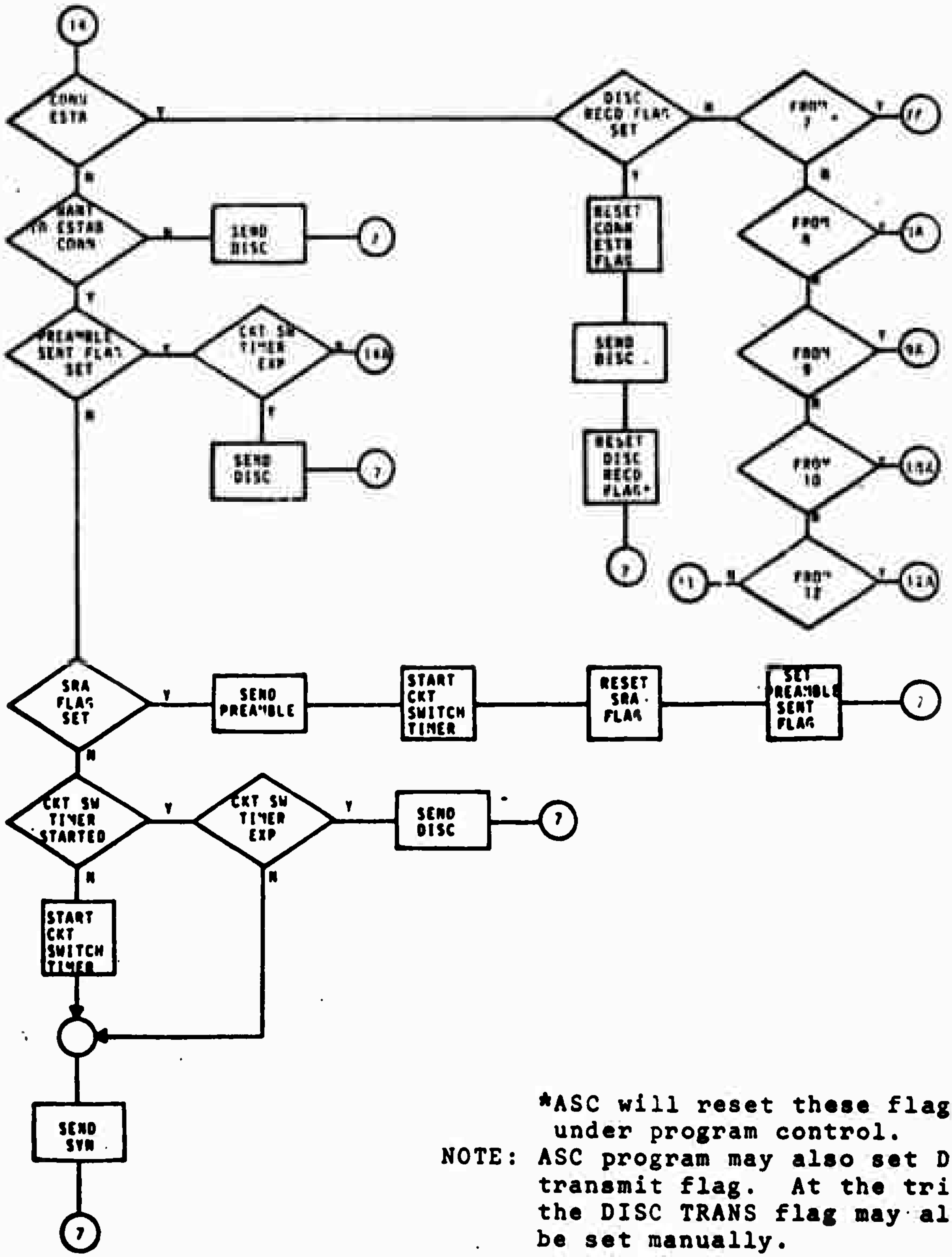


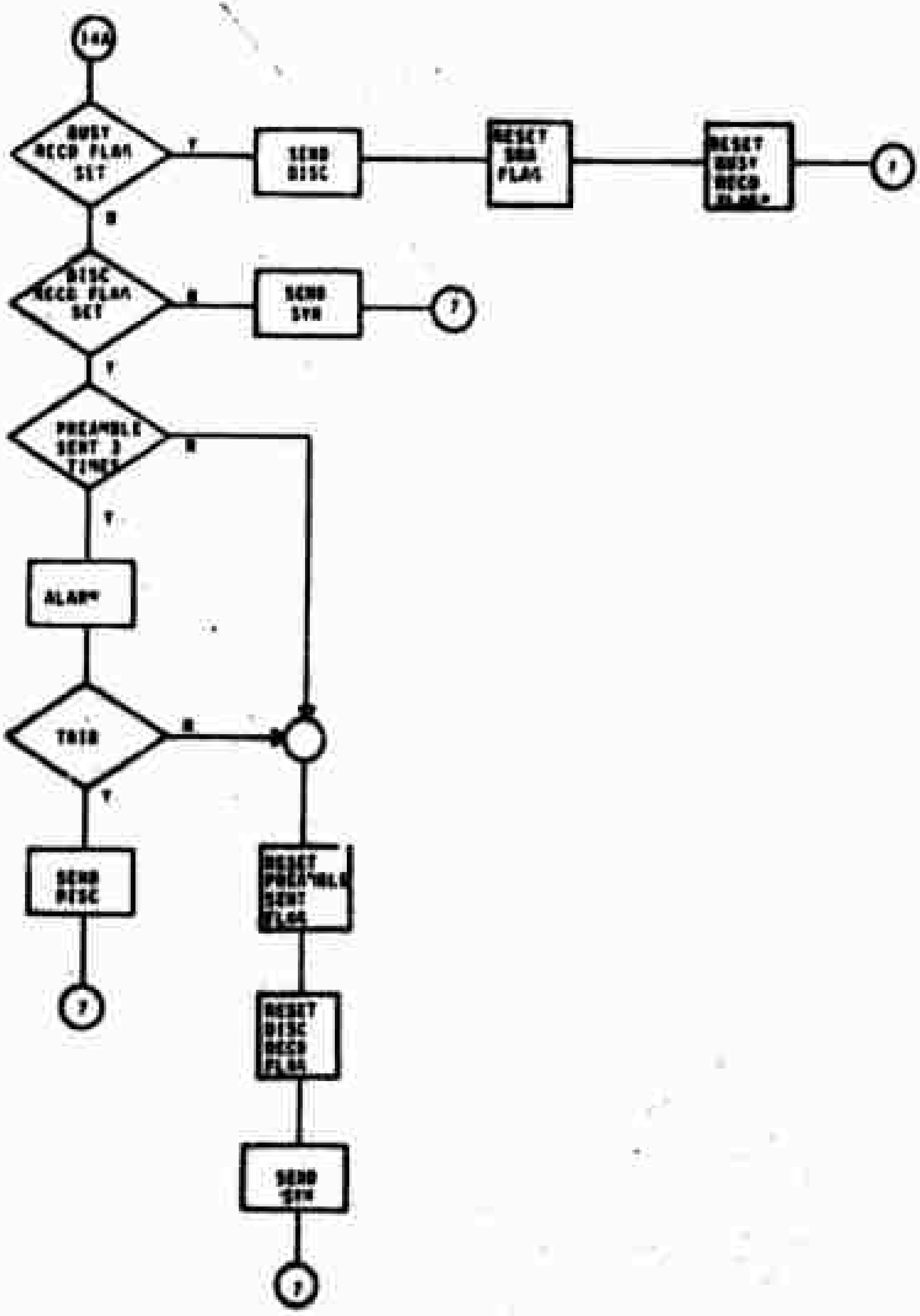
FIGURE 5-13. CIRCUIT SWITCH RECEIVE



*ASC will reset these flags under program control.

NOTE: ASC program may also set DISC transmit flag. At the trib the DISC TRANS flag may also be set manually.

FIGURE 5-14 :H TRANSMIT



*ASC will reset these flags under program control.

NOTE: ASC program may also set DISC TRANSMIT flag. At the trib the DISC TRANS flag may also be set manually.

FIGURE 5-14a. CIRCUIT SWITCH TRANSMIT

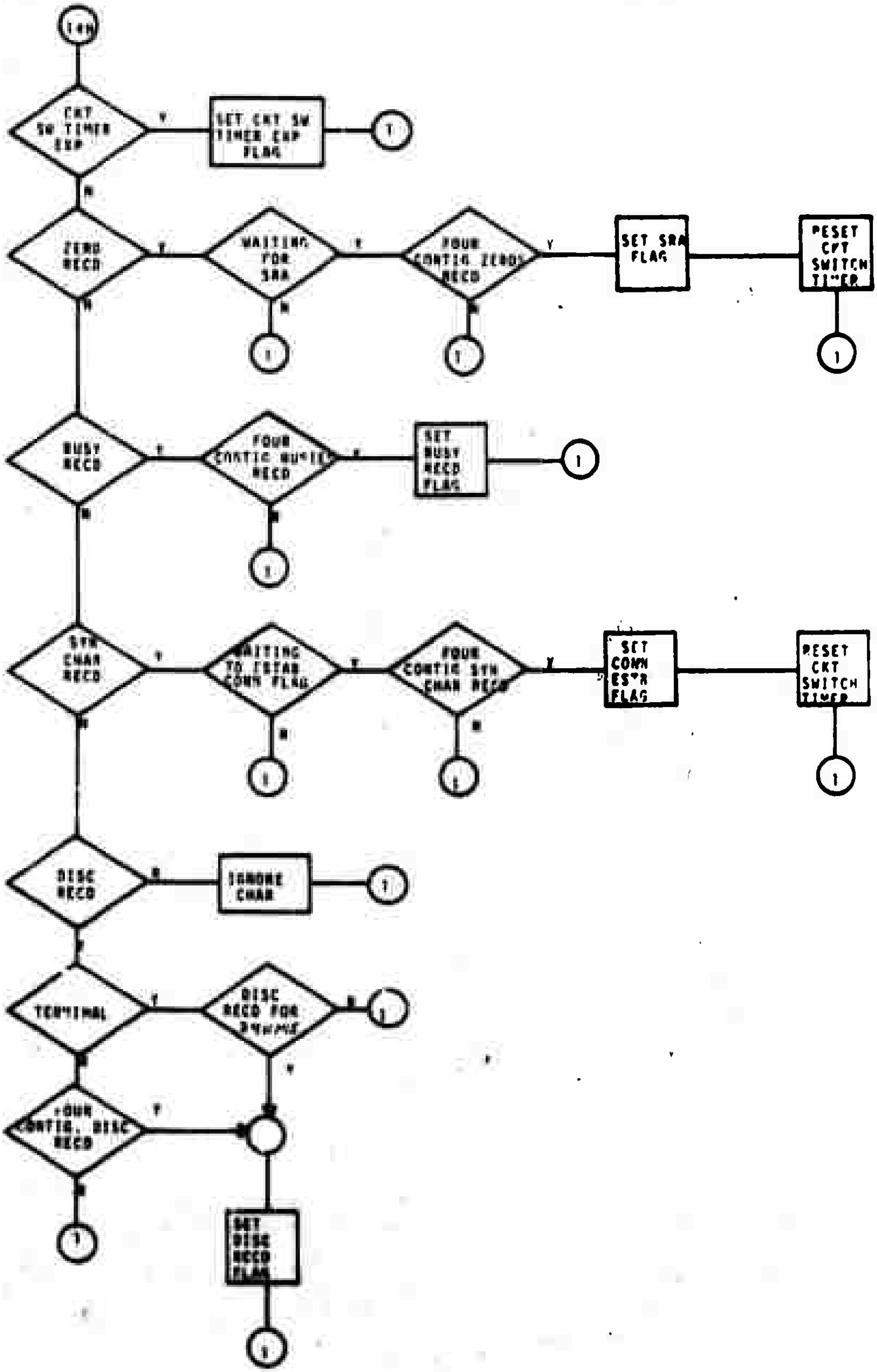


FIGURE 5-14b. CIRCUIT SWITCH TRANSMIT

SOH - START OF HEADING
SEL - SELECT CHARACTER
ETB - END TRANSMISSION BLOCK
DEL - DELETE CHARACTER
STX - START OF TEXT
ACK1 }
ACK2 } ACKNOWLEDGE
REP - REPLY
WBT - WAIT BEFORE TRANSMIT
BP - BLOCK PARITY

*NOTE:
MESSAGES TRANSMITTED BETWEEN SWITCH AND TRIBUTARY WILL CONTAIN DEL AS A SECOND FRAMING CHARACTER IN ALL BLOCKS EXCEPT HEADER BLOCK. MESSAGES TRANSMITTED BETWEEN SWITCHES WILL CONTAIN THE SECURITY CHARACTER

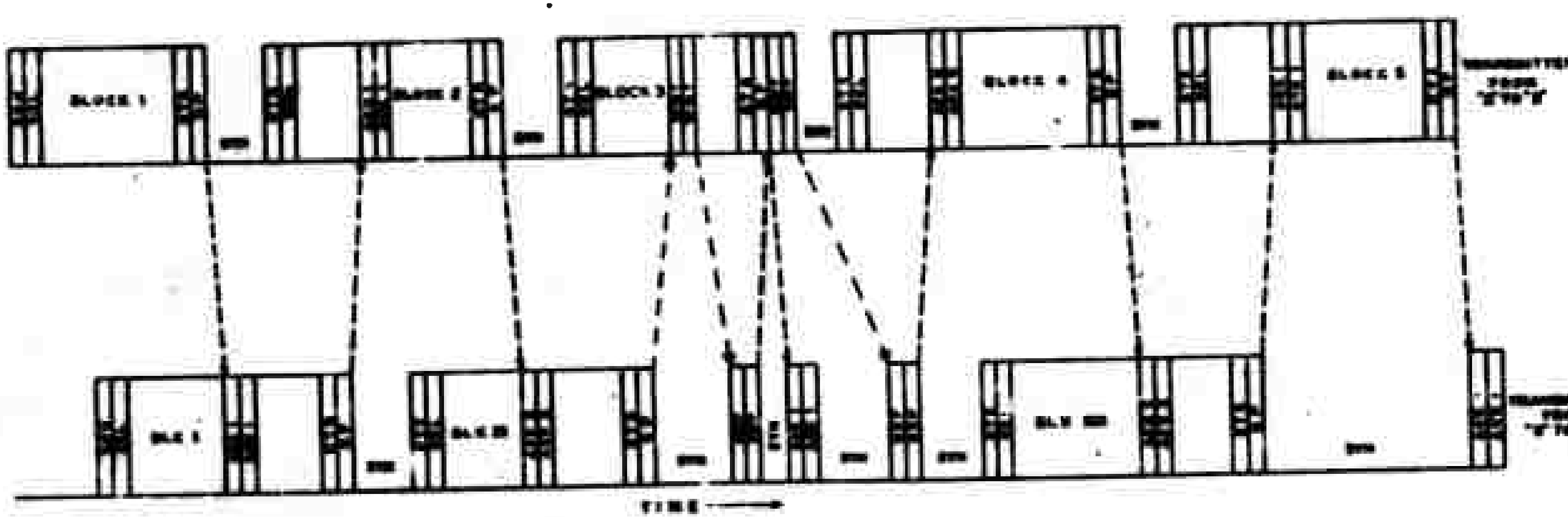


FIGURE 5-15. BLOCK-BY-BLOCK OPERATION-DUPLEX

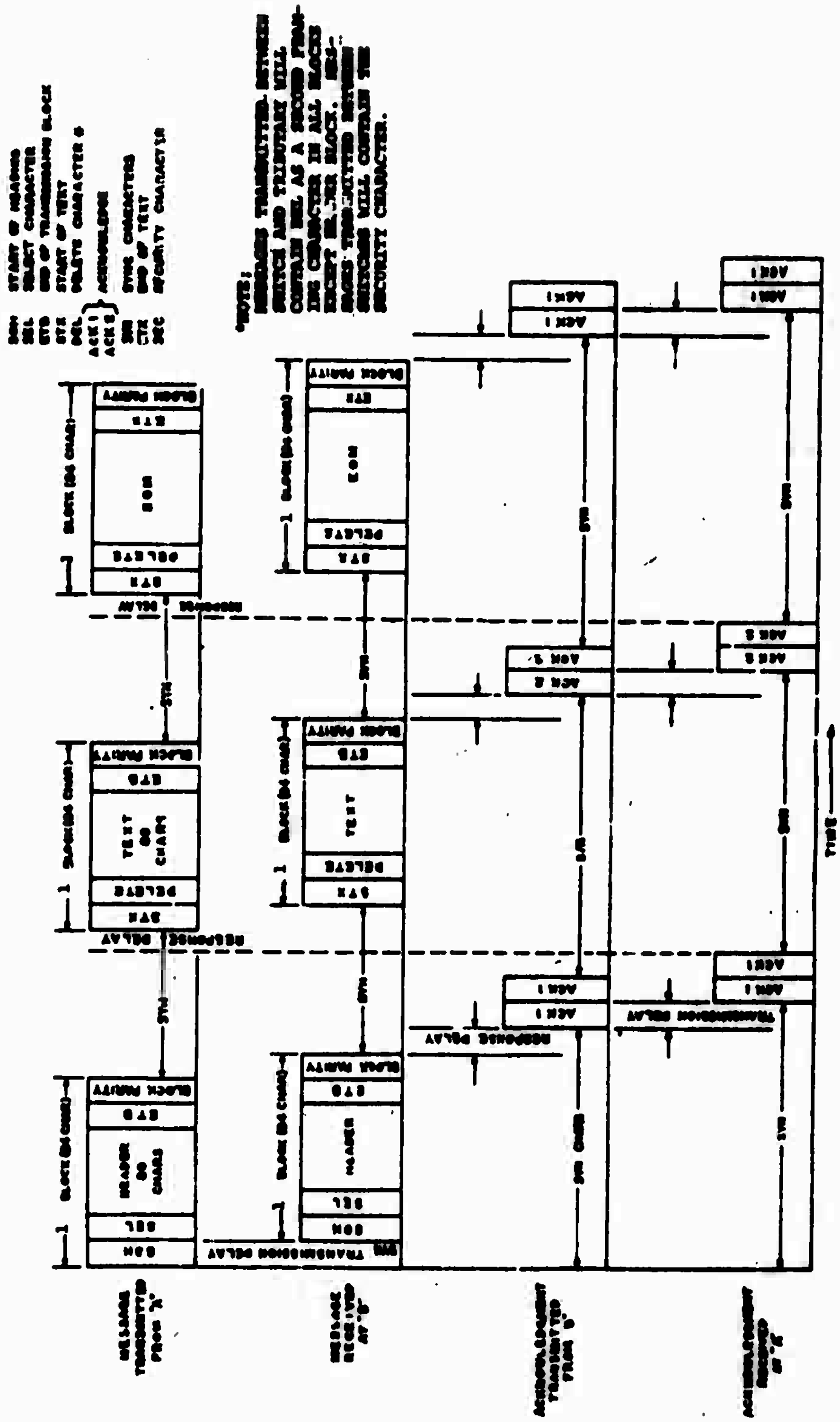


FIGURE 5-16. BLOCK-BY-BLOCK OPERATION - ONE DIRECTION

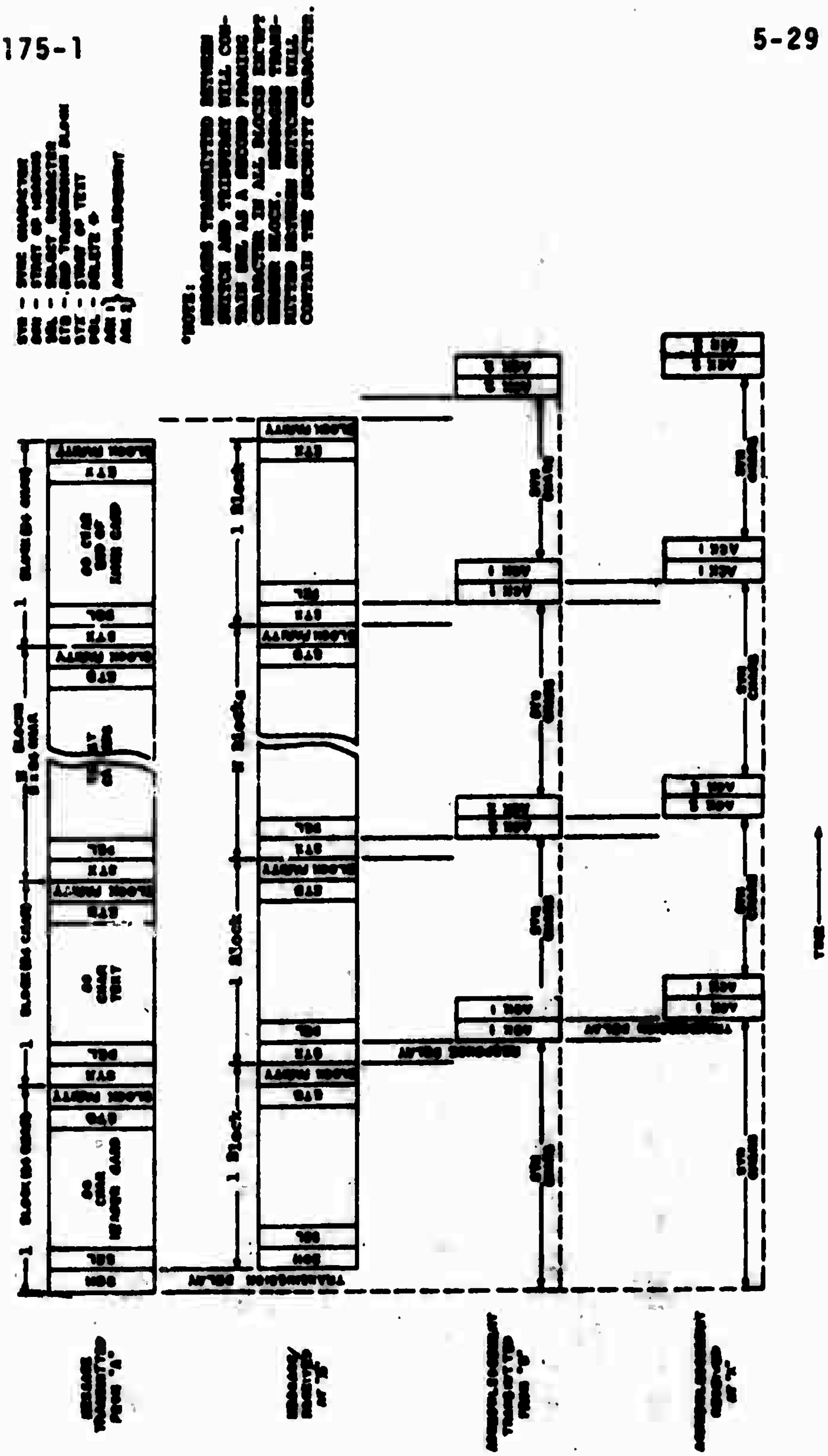


FIGURE 5-17. CONTINUOUS OPERATION - ONE DIRECTION

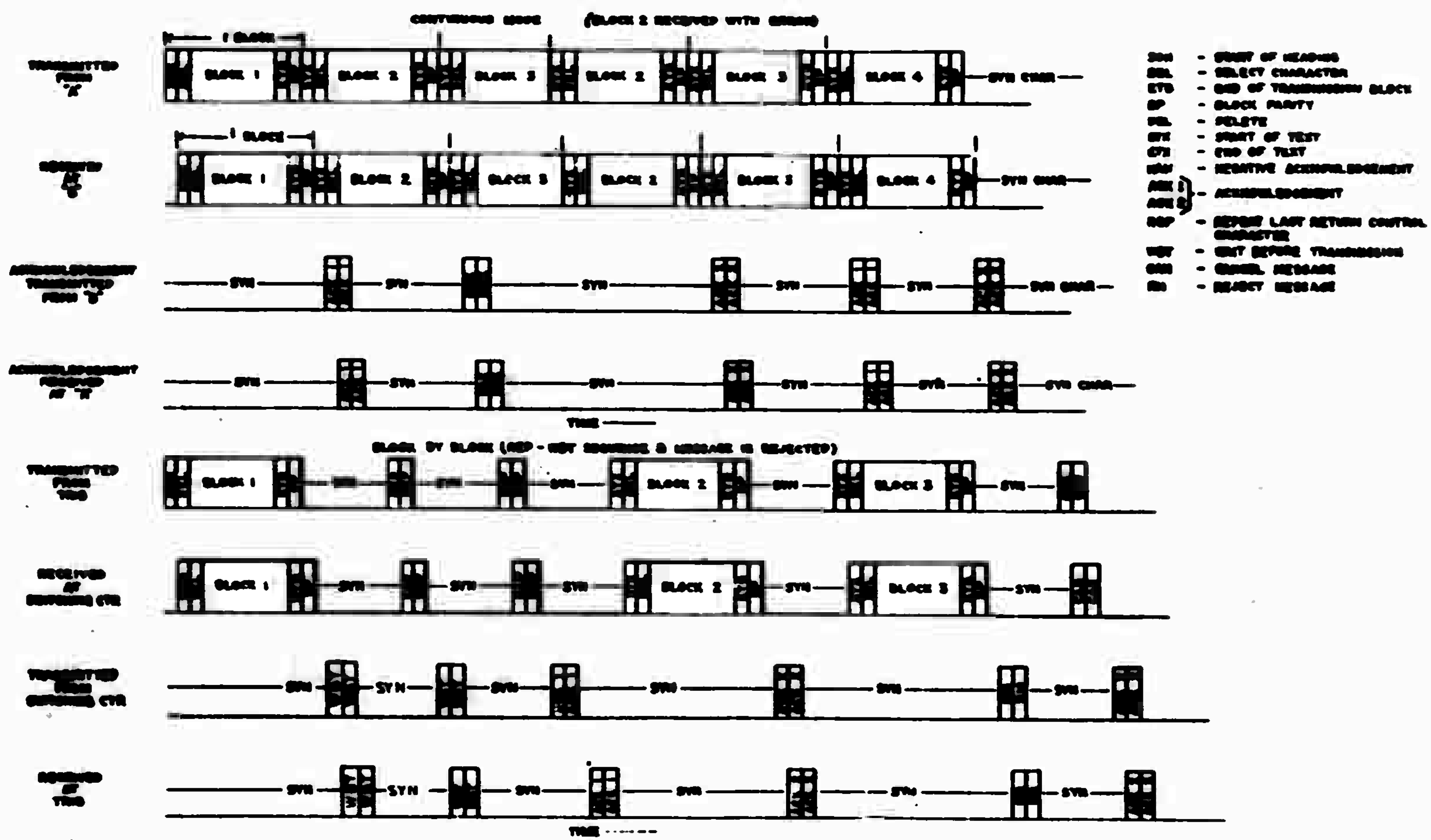


FIGURE 5-18. BLOCK-BY-BLOCK AND CONTINUOUS OPERATION

CHAPTER 6. OPERATION WITH AUTOVON CONNECTED SUBSCRIBER TERMINALS

1. General. This service is available at Government-owned ASC's. However, terminal equipment for this service has not been developed. A circuit between the ASC and the AUTOVON subscriber terminal must be established through the AUTOVON switching center prior to message transmission. This is automatically accomplished at the ASC by converting the digital AUTODIN routing indicator to the AUTOVON analog tones and automatically "dialing" (keying) a telephone type connection. At the subscriber terminal a connection to the desired ASC is established manually by the tributary operator using Dual Tone Multifrequency (DTMF) signalling to key the ASC address to the AUTOVON switching center. Upon each initial "callup" ACK synchronization must be established between calling and called station prior to message transmission. When the ASC has a message to be transmitted to an AUTOVON subscriber terminal, the AUTOVON subscriber terminal must be positively identified as the terminal for which the message is intended prior to transmission of the message. Message transmission from the subscriber terminal to the ASC does not require that the ASC be identified by use of the ENQ procedure. Message transmission over a duplex circuit established through AUTOVON will be restricted to transmission in one direction with the other side of the circuit being used for return control character sequences and the terminal identification information. Once the connection and identification is established, synchronous channel coordination procedures are utilized. The circuit established through AUTOVON by the ASC will be disconnected upon completion of each message.

2. ASC Actions. Upon establishing a circuit to an AUTOVON connected subscriber terminal, the ASC will establish positive identification of that terminal prior to transmission of message traffic. This is done to ensure that messages are not transmitted to terminals other than the one for which the message is destined. Positive identification of the AUTOVON connected terminals is established as follows:

a. After the circuit is established through the AUTOVON, the ASC and the subscriber terminal establish character synchronization.

b. When character synchronization is established, the ASC must then establish ACK synchronization with the called subscriber terminal. The ASC automatically establishes ACK synchronization by transmitting CAN after a delay of four to seven SYN characters. The four to seven character delay ensures that the terminal has achieved character synchronization before the ASC transmits CAN. The AUTOVON connected subscriber terminal recognizes CAN and answers with ACK 2. Receipt of the expected answer (ACK 2) at the ASC establishes ACK synchronization between the ASC and the subscriber terminal.

c. When ACK synchronization has been established, the ENQ control character sequence is transmitted to the AUTOVON connected tributary.

d. The AUTOVON connected subscriber terminal recognizes ENQ and responds with the AUTODIN Subscriber Tributary Identifier. The AUTODIN Subscriber Tributary Identifier (STI) will consist of the ACP 117 AUTODIN routing indicator assigned to the terminal in block format for transmission, as outlined in chapters 2 and 3. The STI block will require an answer in accordance with the procedures specified in chapter 5. The select framing control character G placed in the second framing position in the STI will indicate to the ASC that this is the response to the ENQ control character sequence. The following is a graphic presentation of the STI block.

S O H	G	ACP 117 AUTODIN Routing Indicator	E M	E T X	B P
(1)	(2)		(3)	(4)	(5)

(1) First framing character --- Start of Header.
(2) Second framing character --- (Select Character G). Indicates that the block is an answer to ENQ.
(3) Special control character --- End of Medium (EM)
(4) Third framing character --- End of Text.
(5) Fourth framing character --- Block Parity.

e. The ASC will acknowledge with the correct ACK sequence for the received Subscriber Tributary Identifier and then compare the AUTODIN routing indicator as contained in the STI with the routing indicator marked in the ASC as accessed via this particular AUTOVON connection. If the two routing indicators agree, positive identification of the subscriber terminal is considered established and the ASC then sends the message. If positive identification is not established, the ASC causes the circuit to be disconnected and a new attempt to deliver the message is initiated. The ASC will make a total of three successive attempts to deliver a message and if unsuccessful after a third attempt, the ASC will return that message to the queue. The ASC will maintain First In and First Out (FIFO) service by placing the undelivered message at the head of the queue but first trying to send the next message in the queue for a different destination. Periodic attempts will be made by the ASC to deliver the message until the ASC alarm and printout occurs which indicates that a message has been retained within the ASC beyond specified time limits. The maximum allowable time limits for retention of any message within the ASC before audible and visual alarms and printout are:

FLASH-----------------------------------30 seconds.
IMMEDIATE-------------------------------5 minutes.
PRIORITY--------------------------------30 minutes.
ROUTINE---------------------------------1 hour.

f. The ASC will disconnect the circuit established through AUTOVON upon completion of each message and receipt of the acknowledgment for that message.

g. If the ASC does not receive an answer to ENQ within the time specified by the answer timer (chapter 3, par. 4a) the circuit will be disconnected. If two further attempts at establishing tributary identification fail, the ASC will initiate a printout of this fact.

3. Subscriber Terminal Actions. When the AUTOVON connected subscriber terminal establishes a circuit through AUTOVON to an AUTODIN ASC the subscriber terminal and the ASC establish character synchronization. After character synchronization has been established, the subscriber terminal must then establish ACK synchronization with the ASC. This is accomplished manually at the subscriber terminal by the operator depressing the CAN switch prior to attempting to

send message traffic to the ASC. The ASC recognizes CAN and answers with ACK 2. Receipt of the expected answer (ACK 2) by the subscriber terminal establishes ACK synchronization with the ASC and the subscriber terminal can then send messages to the ASC. Upon completion of the transmission which may consist of one or more messages, the subscriber terminal will disconnect the circuit established through AUTOVON to the ASC in the following manner: Upon receipt of an acknowledgment for a completed message and if no other message characters are transmitted within 15 seconds of the receipt of the acknowledgment for the last message, the circuit established through AUTOVON to an ASC will be disconnected automatically. Receipt of an acknowledgment from the ASC for the STI transmitted in response to the ENQ control character sequence will not activate the disconnect timer at the subscriber terminal.

CHAPTER 7. AUTODIN CIRCUIT SWITCHING NETWORK OPERATION

1. Introduction. Each of the leased Automatic Switching Centers (ASC's) has a Message Switching Unit (MSU) providing store and forward message switching and a Circuit Switching Unit (CSU) providing the capability for real-time message transfer. The CSU provides direct connections between its own subscribers (local tributary operation) and between any CSU terminal connected through any other CSU (tandem trunk operations). It also operates in conjunction with an MSU over interchange trunks when store and forward service is required. Separate interchange trunks for transmission from CSU to MSU and from MSU to CSU are provided. The circuit switching unit of AUTODIN was designed primarily to pass large volume data files from one tributary to another. Although the CSU is capable of passing short messages, greater circuit and system efficiency will be realized with larger volume transmissions. A preemption feature is available for flash messages; however, it is not recommended for general use. Flash message transmission over the CSU should not be used except when MSU services are not available. The circuit switching network handles digital traffic only. Duplex operation may be used between tributaries within the circuit switching network. The leased AUTODIN circuit switching network operates with lines and trunks that use either FIELDATA Code or the ASCII. The chapter deals only with operation using the ASCII.

2. Signals and Preambles. Control and supervisory signalling is accomplished over the information paths for all circuits. The control signalling is in Mode I ASCII and a real-time connection can only be made between terminals that are compatible with regard to speed and type. Control signalling is a modulation rate of 75×2^m, where m is an integer equal to or greater than zero and equal to or less than six. Supervisory signals are either d.c. levels or eight bit characters conforming to the modulation rate requirement described above for control signals. In the following paragraphs, signals and preambles are described for Mode I ASCII operation. Code compatibility is observed throughout the full sequence of the call; i.e., if an ASCII terminal originates a call, all control and text characters involved in the connection of the call will be in ASCII.

a. Signals.

(1) Free State. The send and receive legs of a line or trunk are at a steady "1" when the circuit is free. This Free State signal indicates that the line or trunk is in an operable but nonbusy state and is available to initiate or receive a call.

(2) Service Request (SR). When requesting service, the calling party sends successive SYN characters (10010110) to the CSU as a Service Request. This is an indication to the CSU that the calling party desires to initiate a call. The calling party may be a CSU tributary station, a remote CSU on an incoming trunk, or the associated MSU on a MSU to CSU interchange trunk. For an outgoing trunk call, the local CSU acts as a calling party and sends successive SYN characters as a Service Request to the remote CSU before forwarding the CSU preamble. The interface circuitry of the CSU recognizes the first transition of the SYN control signal to initiate an internal Service Request sequence.

(3) Acknowledgment to Service Request (SRA). The signal is a steady "0" placed on the receive leg of a calling line or trunk. It indicates to the calling party that the CSU has honored its request for service, has been connected and synchronized to the calling line or trunk and that the CSU is ready to receive a preamble for establishing a CSU connection.

(4) Alert. The Alert signal is used to alert the local CSU tributary or MSU interchange that it is receiving a call. The Alert signal consists of successive SYN characters generated by the calling CSU tributary or MSU interchange following the Line or MSU Preamble. The Alert signal is received by the called tributary or MSU after the connection is established.

(5) Connection Established. When the called station is connected, it responds to the Alert signal sent from the CSU by sending successive SYN characters. These SYN characters are recognized by the CSU, and later the calling station, as Connection Established. The receipt of the Connection Established signal further indicates that the called line has synchronized on the characters sent by the CSU as an alerting signal and is, therefore, synchronized to the calling line.

(6) Disconnect. The presence of steady "1" for at least 390 milliseconds on the receive leg from a calling or called line or trunk is recognized by the CSU as a signal that the connection is to be disconnected.

(7) Busy. Should the call not be completed due to a busy condition, the CSU returns the Busy Signal continuously to the calling station until the station disconnects or until the CSU times out. The Busy Signal consists of alternate ones and zeroes at line modulation rates. The signal will be sent to the calling line for 2 to 4 seconds. If the calling station does not disconnect on the Busy Signal, the CSU will time out and will initiate an internal disconnect sequence.

(8) Preemption. Preemption signals are the same supervisory and control signals described in items (4) and (6). When a preemption is performed, the preempted connection is broken down, and the new one set up. The line being called on the preemption receives an alerting signal as per item (4). The other end of the preempte connection is disconnected by the CSU and receives a steady "1" (disconnect signal) from the CSU.

b. Preambles. There are three types of preambles which are used by the CSU to establish different types of connections: Line preamble, MSU preamble, CSU preamble. The formats of various preambles are illustrated in tables 7-1, 7-2, and 7-3.

(1) Line Preamble. When a subscriber terminal receives the acknowledgment of Service Request signal from the CSU, it starts to send the line preamble of the message. The contents of a Line preamble are the same as those contained in the first block of the message (header) as specified in JANAP 128, except that the second framing character is always J or K. However, the CSU only acts upon the applicable portion of the preamble up to the end of routing sentinel or the first space following the first destination routing indicator. The CSU may recognize certain additional characters in the preamble upon which it takes no action.

(2) MSU Preamble. The MSU preamble is generated by the MSU program. It is sent to the CSU for establishing a CSU connection when the MSU initiates a MSU to CSU call. The preamble begins with the Start of Heading character (SOH) followed by the select character K. It ends with EM (End of Medium), ETX (End of Text), and BP (Block Parity) Characters.

(3) CSU Preamble. The CSU preamble consists of 15 characters. All characters of the CSU preamble are as extracted from the line or MSU preamble except the type-speed character which is generated within the CSU. The information required to generate the type-speed character is available within the CSU, as class of service information, on a line-by-line basis. The CSU preamble is temporarily stored in the CSU and is used to establish a local connection or in the case of a trunk call, is sent to the distant CSU. The distant CSU will use the information contained in the CSU preamble to establish a local connection to a tributary station or a tandem connection to another CSU. In the latter case, the same CSU preamble is stored in the distant CSU and will be sent to the next CSU in tandem until the terminating CSU is reached. The terminating CSU will establish the last link connection of a trunk call to the called station.

c. Contents of Preambles. The following elements which are contained in the preambles as delineated in tables 7-1, 7-2, and 7-3 are utilized by the CSU to perform various functions:

(1) Start of Heading (SOH) Character. This character indicates the start of the message heading (preamble).

(2) Select (SEL) Character. This character indicates whether message switching or circuit switching service is required. SEL J (letter J even parity) indicates that message switching service is required; SEL K (letter K even parity) indicates that circuit switching service is required.

(3) Precedence Character. This character indicates the priority of the message being processed. The CSU recognizes that high priority characters are Z or Y, low priority characters are O, P, R, or M. The CSU determines from the precedence character whether the message priority is high or low.

(4) Language and Media Format (LMF). In general, the CSU ignores the two LMF characters contained in the Line and MSU preambles. However, if the first character of the LMF is S (single card message), the CSU will accept only messages which contain a U or M security character.

(5) Security Character. This character indicates the security classification of the message, and is used by the CSU to check for security compatibility. The CSU recognizes five security levels of seven classifications; i.e., T, S, C, or R, E, and U, or M. The criteria for handling security levels are described in paragraph 3g.

(6) Start of Redundant Security Sentinel. This sentinel consists of one hyphen immediately preceding the four redundant security characters in the Line and MSU preambles. It is not contained in the CSU preamble.

(7) Redundant Security Characters. There are four redundant security characters identical to the first security character for all preambles except the Line preamble for a single card message. The CSU will always insert five U characters into security character positions of the CSU preamble if the out-going trunk message is a single card which contains either U or M security classification. In all cases, if the five security characters are not identical, the message will be rejected.

(8) Start of Routing (SOR) Sentinel. This sentinel consists of two hyphens immediately preceding the destination routing indicators in the Line and MSU preambles. The SOR sentinel is not contained in the CSU preamble.

(9) Destination Routing Indicator (RI). The destination routing indicator is the address of the called station. It always consists of seven characters. The CSU tributaries will be addressed by means of seven character routing indicators. The first character must be R and the second character U. The third and fourth characters denote the switching center to which the tributary is connected, and the last three characters denote the called station. If a message is addressed to a non-CSU terminal, to more than one terminal, or to a CSU terminal which can not receive the message due to a code or speed mismatch, MSU service must be selected by use of the CSU-MSU selection switch at the sending terminal prior to transmission of the message. Failure to select MSU service will result in an automatic disconnect by the CSU.

(10) End of Routing Sentinel. The end of routing sentinel is a period. It immediately follows the destination

routing indicator for a single address message. If a space appears in this position, the message is considered to be of a multiple address type and will be routed by the CSU only if MSU service has been selected.

d. Control Signal Checks. The following major checks are performed within the CSU:

(1) Parity Checks -- Start of Heading (SOH) and select (SEL) characters are even parity. All others are odd.

(2) Start of Routing Sentinel starts between 12th and 61st characters.

(3) Type, Speed, and Security compatibility.

(4) CSU-MSU automatic selection checks.

(5) Invalid precedence characters.

(6) Invalid security classification.

e. Signalling Rate.

(1) Signalling Rate. SYN characters and preambles are received from a line at the modulation rate assigned to that line. However, the CSU preamble and SYN characters transmitted between the CSU's are at the modulation rate of the trunk involved in the call.

(2) Signal Synchronization. At the start of a call, it is necessary for the CSU to be synchronized with the digital stream from the calling line. SYN characters are used for bit synchronization. Three consecutive SYN characters must be received by the CSU control circuits after connection to the calling line is established in order for the CSU to determine that the call is from an ASCII line or trunk. Bit synchronization is taking place while the operating code is being determined. The first character of a preamble, Start of Heading (SOH) character, is used for character framing and synchronization and also for recognition of the beginning of the preamble.

3. Signalling, Control, and Supervision Within the Circuit Switched Network (Tributaries and Trunks).

a. Normal Operating Conditions -- Circuit Established -- Tributary to Tributary.

(1) In the nonbusy state the CSU and its subscriber terminals exchange steady Free State signals. When a CSU terminal has a message for transmission, it sends a Service Request (SR) to the CSU. The CSU recognizes the SR and responds with the Acknowledgment of Service Request (SRA) signal. This signal is a single transition to a steady zero on the CSU send leg.

(2) The calling terminal recognizes the SRA, stops transmitting SR characters and sends the line preamble. After the preamble is transmitted, the calling terminal sends Alert characters to the CSU and ultimately to the called terminal.

(3) The CSU sends an Alert signal to the called terminal when a connection between the CSU and called terminal is established. These Alert characters are in phase with those from the calling line. The called station must respond to the Alert signal sent from the CSU by sending a Connection Established signal.

(4) The Connection Established signals sent by the called terminal are in phase with the Alert characters from the calling line. The Connection Established signals are recognized by the CSU and later by the calling station as a Connection Established acknowledgment.

(5) Upon receiving the Connection Established acknowledgment from the called terminal, the CSU completes the final connection between the calling and called terminals. The calling terminal receives the Connection Established signals from the called terminal and then transmits the message. The header block of the message is identical to the line preamble previously sent except that the second framing character now contains the appropriate SEL character.

b. Normal Operating Conditions -- Circuit Established -- Tributary to Trunk (Outgoing Trunk Call).

(1) The initial operating sequence on a trunk call is the same as for a tributary call, up to and including the transmission of the line preamble. After the preamble is transmitted, the calling terminal sends Alert characters to the CSU and ultimately to the called terminal.

(2) After decoding the CSU preamble which is derived from the line preamble, the CSU determines that the message is intended for a remote CSU tributary. The CSU selects a trunk of the appropriate speed and sends the SR signal to the remote CSU. The remote CSU recognizes the SR and responds with the SRA signal. Upon receipt of the SRA, the originating CSU transmits the CSU preamble to the remote CSU. After the preamble is sent, the originating CSU sends Alert characters to the remote CSU and makes a final connection between the calling tributary and the outgoing trunk to the remote CSU.

(3) At this time, the calling tributary is sending Alert characters through the originating CSU to the remote CSU and the remote CSU is returning a steady "0" through the originating CSU to the calling tributary. The originating CSU is then only monitoring the circuit through it for a possible disconnect signal.

(4) The remote CSU sends an Alert signal to the called terminal. These Alert characters are in phase with those from the remote calling terminal. When the called station is connected, it responds to the Alert characters sent from the CSU by sending the Connection Established signal.

(5) The Connection Established signals sent by the remote called terminal are in phase with Alert characters from the originating calling terminal.

(6) Upon receiving the Connection Established signal from the called terminal, the remote CSU completes the final connection between the called terminal and the incoming trunk which is connected to the calling trunk via the originating CSU. The calling terminal receives the Connection Established signal from the remote called terminal and starts to transmit the header block of the message. The header block is identical to the line preamble

sent previously except that the second framing character now contains the appropriate SEL character for the message. The rest of the message follows the header block.

c. Channel Coordination. Once a connection is established between the calling and the called terminals, the CSU furnishes the transmission paths for use by the terminals. During the transmission of messages between the CSU terminals, synchronous channel coordination procedures for transmitting blocks and receiving control characters are observed. All message flow and signalling is under the control of the connected terminal equipments and the CSU only monitors the individual lines for a disconnect condition.

d. Disconnect. The disconnect sequence can be initiated either automatically or manually depending upon the setting of the Auto-Man Disc switch at the calling terminal. It can be initiated by either the calling or called terminal. In the automatic position the calling terminal sends the Disconnect signal automatically after acknowledgment has been received for the ETX (End of Text). If the Auto-Man Disc switch is in manual position, the calling terminal will not send the Disconnect signal until the disconnect switch is operated. When the CSU detects a disconnect signal on the send leg of any line or trunk, it initiates an internal disconnect sequence which causes the line or trunk involved to be disconnected. The CSU then transmits a steady Disconnect or Free State signal to both lines or trunks that were involved in that connection.

e. Busy Line or Trunk Conditions.

(1) When a called terminal is busy or the primary route and alternate route trunks are busy, the CSU will return a Busy signal to the calling terminal. The calling terminal recognizes the Busy signal and responds with the Disconnect signal to the CSU.

(2) The CSU recognizes the Disconnect signal and releases its circuits which causes the Disconnect signal to be returned to the calling terminal. If the CSU times out before the calling terminal sends its disconnect request, an internal disconnect sequence will be initiated.

f. Preemption. The CSU has the capability of recognizing the precedence of calls. High priority characters are Z or Y, and low priority characters are O, P, R, or M. The CSU determines from the precedence character whether the priority is high or low. Upon recognizing a call of high priority for a terminal that is engaged with low priority traffic, the high priority call will preempt the established connection. When the CSU recognizes the need for preemption of a busy line or trunk, the circuit is seized and the Disconnect signal is automatically sent and followed by an Alert signal to the called terminal. The CSU then connects the calling station with the high precedence traffic to the particular preempted terminal for which the message is intended.

g. Security.

(1) Security information is required to enable the CSU to verify that the security classification of a message is lower than or equal to that of the calling and called parties. All types of preambles except the line preamble for single card messages, contain five identical security characters. After the security characters are stored, the CSU checks to see that they are identical. When the CSU detects a preamble which contains a security classification higher than the authorized security classification of either the calling or called terminal, no CSU connection will be made and the calling terminal will be disconnected.

(2) Each single card message contains only one unclassified security character U or M and the CSU checks to see that the character is unclassified. For trunk calls of single card messages the CSU injects five U security characters into the five security storage positions in a CSU preamble which is to be sent to a distant CSU.

h. Abnormal Conditions -- CSU Message Rejection. The CSU rejects an invalid preamble by transmitting a disconnect signal to the calling terminal and resetting its logic to normal. Major criteria for preamble rejection are:

(1) Wrong input or output parity.

(2) Invalid precedence characters.

(3) Invalid security characters.

Any preamble, except a line preamble for a single card message, will be rejected if it does not contain five identical security characters indicating a security classification lower than or equal to that of both the calling and called parties. A line preamble for single card messages will be rejected if they do not contain either the U or M security character.

(4) Routing indicator consisting of other than alphabetic character.

(5) No start of routing signal within the required number of characters.

(6) Unassigned CSU line or trunk routing indicator in preambles containing SEL K. Single address messages will be rejected if preamble contains the select character K and the routing indicator does not specify a local CSU terminal or one of the CSU's in the network. If the message is addressed to a remote CSU, the call will be routed to the remote CSU over an available trunk, the CSU preamble sent to the remote CSU, and the routing process will be repeated at the remote CSU.

(7) Multiple address messages with preambles containing SEL K. Routing indicators in multiple address messages are separated by a space character. If the CSU recognizes a space at the end of the first routing indicator in a preamble containing the select character K, it will reject the message.

(8) Collective routing indicator in SEL K preambles. If the CSU recognizes the third and fourth characters of the routing indicator as CR (collective routing), and the preamble contains the select character K, the message will be rejected.

(9) System (Nation or Service) Character other than U or H in SEL K preambles. When a system character (the letter following the first character of a routing indicator) is other than U or H the message will be rejected if the preamble contains the select character K.

(10) Speed or type mismatch for SEL K messages. The CSU checks the speed and type matching on all calls terminating at a CSU tributary station. The speed and type of the called station must be identical to those of the calling station if the preamble contains the select character K. If a speed or type mismatch is detected, the message will be rejected.

(11) Preamble time out -- No preamble received within 2 to 4 seconds after transmission of SRA signal.

(12) No connection established from called line or trunk within 2 to 4 seconds after transmission of alert signal.

(13) CSU common control trouble time out.

4. Signalling, Control, and Supervision Between CSU and MSU (Interchange Trunks). The signalling, control, and supervision between the CSU and the MSU are identical to the signalling, control, and supervision between a terminal and the CSU as described in paragraph 3.

5. CSU Timing Requirements.

a. Service Request (SR). When a connection has been made between a CSU and the calling party, three SYN characters must have been recognized by the CSU before an acknowledgment is generated.

b. Acknowledgment of Service Request (SRA). The CSU generates SRA to the calling party and will time out if SOH is not received in 2 to 4 seconds. This sequence is the same for tributary, trunk, and MSU calls.

c. Alert. The CSU generates SYN characters as the Alert signal and will maintain the characters until an acknowledgment (CE) is received. An acknowledgment must be received in 2 to 4 seconds or the CSU will time out. This sequence is the same for tributary, trunk, and MSU calls.

d. Connection Established (CE). The CSU must recognize SYN characters from the called party as an acknowledgment (CE) to the Alert signal previously generated. For the CSU to tributary and CSU to MSU call, seven "1's" must be recognized by the CSU.

e. Busy. The CSU generates a Busy signal and must receive a Disconnect signal in 2 to 4 seconds or a timeout signal must be initiated.

f. Circuit Switch Terminal Timer. At the transmitting terminal, a timer is started when a SR or a preamble is sent.

If the proper response to the SR or preamble is not received within 2 to 4 seconds, the timer will expire causing the terminal to send the disconnect signal.

g. Disconnect. The Disconnect signal sent to the CSU must be maintained for a minimum of 390 milliseconds. When a transmitting terminal generates a Disconnect, it must wait until a Disconnect is received before sending SYN characters.

TABLE 7-1. LINE PREAMBLE FORMAT

Positions	Preamble Element	Size	Remarks
1	Framing character	1 character	SOH framing character
2	Framing character	1 character	SEL character J or K
3	Precedence	1 character	As appropriate
4	Language and Media Format	1 character	S for single card message
5	Language and Media Format	1 character	
6	Security classification	1 character	As appropriate
7-10	Content indicators	4 characters	
11	Separator	1 character	Space
12-18	Originator	7 characters	
19-22	Station serial number	4 characters	
23	Separator	1 character	Space
24-26	Julian date	3 characters	
27-30	Time filed	4 characters	
31	Separator	1 character	Space
32-35	Record count	4 characters	
36	Start of redundant security sentinel	1 character	Hypher (not provided for single card messages)
37-40	Security classification redundancy	4 characters	All identical to the security character in position 6 (not provided for single card messages)
41-[illegible]	Start of routing sentinel	2 characters	Two hyphens
43-49	Addressee	7 characters	Destination routing indicator
50	End of routing sentinel	1 character	Period. (Space for multiple address messages)
51-[illegible]			Spaces for unused positions
83	Framing character	1 character	ETB framing character character
84	Framing character	1 character	Block parity character (BP)

TABLE 7-2. TRUNK PREAMBLE FORMAT

Positions	Preamble Element	Size	Remarks
1	Framing character	1 character	SOH framing character
2	Framing character	1 character	SEL character K
3	Precedence	1 character	As appropriate
4	Type and speed	1 character	Supplied by originating CSU
5	Security classification	1 character	U for single card messages
6-9	Security classification redundancy	4 characters	All identical to the security character in position 5
10-14	Addressee	5 characters	3rd, 4th, 5th, 6th and 7th characters of destination routing indicators
15	End of routing sentinel	1 character	Period

TABLE 7-3. MSU PREAMBLE FORMAT

Positions	Preamble Element	Size	Remarks
1	Framing character	1 character	SOH framing character
2	Framing character	1 character	SEL character K
3	Precedence	1 character	As appropriate
4	Language and Media Format	1 character	S for single card messages
5	Language and Media Format	1 character	
6	Security classification	1 character	As appropriate
7-10	Content indicator	4 characters	Used for reserved space of CSU address storage function
11	Start of redundant security sentinel	1 character	Hyphen
12-15	Security classification redundancy	4 characters	All identical to the security character in position 6
16-17	Start of routing sentinel	2 characters	Two hyphens
18-24	Addressee	7 characters	The first two characters of the destination routing indicator must be RU
25	End of routing sentinel	1 character	Period
26	End of medium signal	1 character	EM character
27	Framing character	1 character	ETX framing character
28	Framing character	1 character	BP character

CHAPTER 8. TRUNK AND TRIBUTARY BLOCK FORMATS

1. Introduction. Control characters are defined in chapter 3. This chapter delineates trunk and tributary block framing rules by Language Media Format (LMF) Indicator.

2. Tributary Block Formats.

a. Block framing by LMF for messages transmitted by tributaries is shown in the following tables:

LMF	Table
C, R, T, A, Q	8-2
S	8-3
D	8-4
B, I	8-5

b. Block formats transmitted from the ASC to tributaries are the same as those shown in table 8-2 through 8-5.

c. Between the ASC and the subscriber terminal, messages will be formated and transmitted in 80 text character blocks for synchronous operations using LMF's C, R, T, A, Q and S. For blocks containing less than 80 text characters, fill characters, odd parity ASCII SI, will be inserted to maintain uniform blocks of 80 text characters.

3. Trunk Block Formats.

a. Block framing by LMF for trunk lines is shown in the following tables:

LMF	Table
C, R, T, A, Q	8-6
S	8-7

Messages will be formatted and transmitted in 80 text character blocks; however, for blocks containing less than 80 text characters, fill characters, odd parity ASCII SI, will be inserted to maintain uniform blocks of 80 text characters.

b. Block formats for LMF D messages on trunks are the same as those shown in table 8-6 except that the intermediate blocks may contain EM as delineated in table 8-4, detail (b) and (c).

c. Block formats for LMF B and I messages on trunks are the same as those delineated for LMF D messages in paragraph b. above. The Mode Change (MC) block delineated in table 8-5 is also required on trunks to segregate the end of the binary text from the last block of the message for LMF B and I messages.

d. Mode II messages are not divided into blocks on tributary lines. Mode II formats on tributary lines are as prescribed in ACP 127 series and JANAP 128. Mode V messages are not divided into blocks on tributary lines. Mode V tributary lines may use either the JANAP 128 or ACP 127 series paper tape message format. On trunks, however, Mode II and V messages will be divided into blocks as shown in table 8-8.

e. The format of the Message Control Block is shown in table 8-1.

TABLE 8-1. MCB FORMAT

Character Position and Item	Size (all 8 bit ASCII characters)	Description
1. Framing character	1 character	SOH framing character.
2. Select character	1 character	Select character from original message. (A if OMTN format).
3. Precedence	1 character	Precedence of original message.
4. Message type designator	1 character	First LMF of original message (F if OMTN format).
5. Message type designator	1 character	Second LMF of original message (T if OMTN format).
6. Security	1 character	Security of original message.
7-10. Content indicator	4 characters	Content indicator code field of original message.
11. Space	1 character	Space.
12-18. Originating station routing indicator	7 characters	Originating station routing indicator, taken from original message if data format, or generated if from OMTN format.
19-22. Origination station serial number	4 characters	Originating station serial number, taken from original message if data format, or generated if from OMTN format.
23. Space	1 character	Space.
24-30. Date-Time	7 characters	Date-time group from original message, or SOH-Julian date and ZULU time if OMTN format.
31-33. Number of blocks	3 characters	In-block count (excluding MCB).
34-40. SOH-IN time	7 characters	SOH-IN Julian date and ZULU time at originating ASC.
41. Type of RI processing	1 character	Set to N if header contains only individual RIs and set to C if header contains one or more collective RIs.
42. Automatically generated service message	1 character	Not set or checked by leased ASCs. Set to S by Government owned ASCs if automatically generated service message is sent.
43-48. Forward destination word	6 characters	a. Forward destination word - fixed bit assigned each ASC. (Bits B1-B6 designate ASCs. Bit B7 is set to binary one. Bit B8 is reserved for parity). b. All unassigned bit (B1-B6) positions are set to binary zero. Each of the assigned FDW bit positions are set to binary one only if a collective RI is the message requires the corresponding center to make local delivery to a tributary or NARC. Messages which do not contain collective RIs will be received with all assigned FDW bits set to zero.
49-54. Trace destination word	6 characters	a. Trace destination word - fixed bit assigned each ASC. (Bits B1-B6 designate ASCs. Bit B7 is set to binary one. Bit B8 is reserved for parity). b. The assigned TDW bits (B1-B6) are set to binary one for each of the ASCs through which the received message has been previously switched. The TDW bits collectively designate all the centers through which the message has been processed. It is used by the ASCs to trigger an alarm (printout) each time a message is received at a center through which it has been previously processed.
55-57. Suspected duplicate originator	3 characters	3 spaces if non-suspected duplicate message or ASC call letters of center originating suspected duplicate.
58-60. Alternate route routing indicator	3 characters	a. Normally three spaces. NARC call letters (2nd, 3rd, and 4th characters of alternate routed destination, if destination is addressed by a collective RI. b. When ARRI contains a NARC call letter, the message is intended for delivery to the destination specified by ARRI (one or more collective RIs are contained in the header and all routing indicators in the received header belong to the NARC destination). c. If ARRI contains a NARC call letter, the ASC routes the message to the ASC serving the NARC. When transmission (CONUS) of the message is made to the NARC, a collective alternate route pilot is automatically generated by the leased ASCs; the addressee portion of the pilot will contain all of the individual RIs, unmodified, and all of the collective RIs replaced with the NARC call letters of the destination. When transmission (Overseas) of the message is made to the NARC, a collective alternate pilot is automatically generated by the Government owned ASCs; the addressee portion of the pilot will contain only the RI (four characters) of the destination NARC.
61-79. Trace input message identifier	19 characters	Used as a message identifier at leased ASCs. When transmitted from leased ASCs, the field will contain numerics. When transmitted from a Government owned ASC to a leased ASC, the field will be numerics and the limit of each digit is from 0 through 7. At the Government owned ASCs the field is used for internal functions.
80-82. Reserved	3 characters	Reserved for internal use.
83. Framing character	1 character	ETB framing character.
84. Framing character	1 character	BP framing character.

TABLE 8-2. MODE I ASCII TRIBUTARY LINE FORMAT LMF "C", "R", "Q", "T", AND "A" MESSAGES

a) First Block

Framing Control			Framing Control	
Two Characters		80 Characters	Two Characters	
SOH	"SEL" See chapter 3	Format per JANAP 128	ETB	BP

b) Intermediate Blocks

Two Characters		80 Characters	Two Characters	
STX	DEL	Format per JANAP 128	ETB	BP

c) Last Block

Two Characters		80 Characters	Two Characters	
STX	DEL	Format per JANAP 128	ETX	BP

TABLE 8-3. MODE I ASCII TRIBUTARY LINE FORMAT LMF "S" MESSAGES

Framing Control		Data Group	Framing Control	
Two Characters		80 Characters	Two Characters	
SOH	D	Format per JANAP 128	ETX	BP

TABLE 8-4. MODE I ASCII TRIBUTARY LINE FORMAT LMF "D" MESSAGES

Block formats for LMF "D" type messages are the same as those shown in figure 8-1 except that the first block and intermediate blocks may contain less than 80 characters. The end of each record on magnetic tape will cause the terminal to generate an EM character as follows:

a) If number of header characters in first block is 79 or less:

Two Characters		79 or less		Two Characters	
SOH	SEL	Header Characters	EM	ETB	BP

b) If number of data characters in intermediate blocks is 79 or less:

Two Characters		79 or less		Two Characters	
STX	DEL	Message Characters	EM	ETB	BP

c) If the number of characters in the tape record, header, or text is divisible by 80, an intermediate block of five characters is generated as follows:

STX	DEL	EM	ETB	BP

TABLE 8-5. MODE I ASCII TRIBUTARY LINE FORMAT LMF "B" MESSAGES

Block formats for LMF "B" and "I" messages are the same as those delineated in figure 8-3. One additional block of six characters is required to segregate the end of the binary text from the last block of the message. The format of this block is as follows:

STX	DEL	MC	EM	ETB	BP

TABLE 8-6. TRUNK FORMAT LMF "C", "R", "T", "Q", AND "A" MESSAGES

a) First Block

See paragraph 3e (MCB)

Two Characters		MCB	Two Characters	
SOH	SEL	(Character Positions 3 through 82)	ETB	BP

SEL: Derived from original message

b) Intermediate Blocks

Two Characters		80 Characters	Two Characters	
STX	SEC	Format per JANAP 128	ETB	BP

SEC: Security classification of message (even parity character)

c) Last Block

Two Characters		80 Characters	Two Characters	
STX	SEC	Format per JANAP 128	ETX	BP

TABLE 8-7. TRUNK FORMAT LMF "S" MESSAGES

a) First Block

See paragraph 3e

Two Characters		MCB	Two Characters	
SOH	D	(Character positions 3 through 82)	ETB	BP

b) Second Block

Two Characters		80 Characters	Two Characters	
STX	U or M	Format per JANAP 128	ETX	BP

TABLE 8-8. TRUNK FORMAT MODE II AND MODE V MESSAGES
LMF, "R," "T," AND "A."

a) First Block

See paragraph 3e (MCB)

Two Characters		MCB	Two Characters	
SOH	SEL	(Character Position 3 through 82)	ETB	BP

SEL: Generated at originating AESC/ADMS

b) Intermediate Blocks

Two Characters		80 Characters	Two Characters	
STX	SEC	Allowable Formats Per Paragraph 3d	ETB	BP

SEC: Security classification of message (even parity character)

c) Last Block

Two Characters		Characters		Two Characters	
STX	SEC	Allowable Formats Per Paragraph 3d	*	ETX	BP

Characters: 79 or less; Characters plus filler (*): 80

* Filler characters are: letters for an ITA #2 line and Shift In (SI) for an ASCII line.

CHAPTER 9. MESSAGE EXCHANGE REQUIREMENTS

1. Introduction. This chapter prescribes the allowable message exchanges between the different input/output media and the conversions and manipulations which must be effected to make such exchanges possible. Table 9-1 identifies permissible and nonpermissible message exchanges. Table 9-2 lists the required actions that must be performed for each allowable exchange. Paragraphs 3 through 10 are detailed explanations of how each of the required actions is accomplished.

2. General.

a. The basis for the type of message exchange performed is the two-character LMF field. The first of these characters indicates the format of the incoming message. The second of these characters is the preferred output format. This preference may be overridden if the output format is different from that preferred, and if this alternate type of exchange is allowable. In the event of forced message exchange, such as delivery of a CC message to a tape-only terminal, the second LMF character is not changed to reflect output format; however, the select character will be changed to reflect the proper message format and code of the receiving terminal. Select (SEL) characters are not discussed in any of the procedures. In all cases, the proper SEL character pertinent to the output medium must be inserted as the second framing character of the first line block of each message. When the LMF format field requires a prohibited type of message exchange for a destination, the message will not be delivered to that destination and the destination Routing Indicator (RI) is treated as an invalid RI.

b. As a normal relay function, the ASC always performs the following on all output messages:

(1) RI segregation.

(2) A message header format line one, transmission Identification (TI), is generated on output on asynchronous circuits.

TABLE 9-1. COMPATIBLE LMF COMBINATIONS

		DESTINATION LMF						
		B	D	I	C	A	T	T
SOURCE LMF	B	1						
	D		1					
	I			1				
	S				1	3	3	
	C				1	2	2	2
	A				2	1	2	2
	T				2	2	1	2
	R						1	2
	Q				3	3	1	2
	F				3	3	2	1

NOTES: (T) designates output to ACP 127 format

LMF BB and II traffic cannot be exchanged between an ASCII and a Fieldata terminal.

The numbers within the table have the following meanings:

1 - Compatible exchange, no format or code conversions required.
2 - Compatible exchange, format or code conversions is required.
3 - LMF combination is not valid. Forced message exchange rules of paragraph 2a. apply.
Blank - Prohibited exchange.

TABLE 9-2 MESSAGE EXCHANGE REQUIREMENTS

	SOURCE LMP		S	C				A				T				R		J				F				B	D	I
	DESTINATION LMP*		C	C	A	T	(T)	C	A	T	(T)	C	A	T	(T)	T	(T)	C	A	T	(T)	C	A	T	(T)	B	D	I
	REQUIRED ACTION	PARA**																										
	No actions required except as noted in Paragraph 2b and 3.	2b, 3	X	X					X					X		X				X					X	X	X	X
HEADER	Delete case shift functions	6										X	X					X	X									
HEADER	Insert case shift functions	6				X				X																		
HEADER	Insert "NNNN" in record count field	4						X				X						X										
HEADER	Delete input card record count field	-			X	X																						
HEADER	Generate JANAP 128 Header (Format line 2)	4																				X	X	X				
HEADER	Delete ACP 127 format line 2 (precedence and routing)	-																				X	X	X				
HEADER	Generate ACP 127 format line 2 (precedence and routing)	-					X				X				X		X				X							
HEADER	Delete JANAP 128 Header (Format line 2)	-					X				X				X		X				X							
HEADER	Generate ACP 127 format line 3 ("DE" line)	-					X				X				X		X											
TEXT	Convert each card to a TTY line	5			X	X	X																					
TEXT	Insert necessary carriage control functions	6			X	X	X																					
TEXT	Convert each TTY line to a card	7						X				X						X				X						
TEXT	Delete TTY carriage control functions	6						X				X						X				X						
TEXT	Convert source SO and SI character to space	-								X	X																	
TEXT	Compress out source ASCII Delete character	-						X		X	X																	
TEXT	Insert necessary case shift functions	6				X	X			X	X																	
TEXT	Delete case shift functions	6										X	X					X	X			X	X					
EOM	Convert EOT to a TTY EOM sequence	8			X	X	X																					
EOM	Delete TTY EOM sequence, generate EOT card	9						X				X						X				X						
EOM	Fill EOM block with filler characters after the last "N"	10			X	X	X			X	X		X						X				X					

*Destination LMP refers to effective output LMP; (T) refers to ACP 127 output format.

**These paragraphs contain more detailed descriptions of the required actions.

c. LMF's B, D, and I can only be paired with themselves; LMF BB and II traffic cannot be exchanged between an ASCII and a Fieldata terminal.

d. Message input processing performs code conversion when necessary, and adds a Message Control Block (MCB) to each message for network transmission. Speed, code, and format conversion, when required, are performed on output processing to the addressee, and the Message Control Block is deleted.

e. Message exchange requirements are based on the format, code, and transmission mode of the message. Allowable message formats are defined in the latest issues of JANAP 128 and ACP 127 and the latest US Supp. thereto. For detailed format information, see these reference documents.

f. Modes of operation applicable to message exchange are Mode I, II, III, IV, and V. (See chapter 1.) Permissible line codes are Fieldata (CONUS only), ASCII, and ITA #2.

3. Routing Line Segregation. Perform routing line segregation to delete nonpertinent routing indicators so that a subscriber terminal or ASC will receive, in the heading, only the single address or collective routing indicators to which they have delivery responsibility.

a. This deletion is accomplished on transmission over a trunk by replacing the routing indicator by:

(1) A space, if the originating LMF is S,C,B,D, or I.

(2) A shift in character, if the originating LMF is T,R,F,Q, or A.

b. This deletion is accomplished on delivery to a terminal by:

(1) Replacing the routing indicator by an equivalent sequence of spaces, if the LMF pair is SC,CC,BB,DD, or II.

(2) Rebuilding the routing indicator portion of the message header for all other LMF pairs, by repacking, or left-justifying the routing indicators and end of routing sentinel. In certain cases, to maintain message blocking, fill characters may appear after the end of routing sentinel.

4. Generation of JANAP 128 Header. The JANAP 128 header will be constructed using the header elements contained in the MCB (as shown in table 8-1 of chapter 8) and the input routing field. On ACP 127 input, the MCB will contain LMF "FT"; therefore, the output LMF will be "FT," regardless of actual output format. For card output, the record count field of the header will contain the letters "MTMS."

5. Conversion of Cards to Teletypewriter Lines.

a. JANAP 128 Output. Each input card is converted to one line of printable teletypewriter characters; each generated teletypewriter line is terminated with a CR-CR-LF sequence. Trailing spaces in the input card; i.e., blank portion of right-hand of card, are deleted on output transmission. (See paragraph 6 for case shift function for ITA #2 output.)

b. ACP 127 Output. Each input card is converted to a single line of printable teletypewriter characters; trailing space characters; i.e., blank portion on right-hand end of card, are deleted on output transmission. Case shift functions are inserted if necessary, but they are not counted as printable characters. (See paragraph 6.) Each generated teletypewriter line is terminated with a CR-CR-LF sequence. In the event the input card contains more than 69 printable characters, the card will be converted to two teletypewriter lines. The first line will contain the first 69 printable characters and the second line will contain the remainder of printable characters. In generating the first 69-character line, words are not broken indiscriminately between teletypewriter lines (except in the remote possibility that no space appears between the 11th and 70th characters of the card). The first output line will contain the characters from card column 1 up to and including the last nonspace character preceding card column 70; the second output line will contain the remaining printable characters (excluding trailing spaces) in the input card.

6. Teletypewriter Carriage Control and Case Shift Functions.

a. Carriage Control Functions. Carriage Control Functions are defined as carriage return (CR) and line feed (LF).

b. Case Shift Functions. Case Shift Functions are defined as letters (LTRS) and figures (FIGS). Case shift functions apply to ITA #2 code only. (ITA #2 LTRS and FIGS are equivalent to the ASCII characters shift-in and shift-out and to the Fieldata characters lower case and upper case.)

c. Removal of carriage control and case shift functions is accomplished by message compression; i.e., the functions are deleted and the characters on either side of the function become contiguous.

7. Conversion of TTY Lines to Cards. The teletypewriter line consisting of the information between two CR-CR-LF sequences is used to format a block when converting to card format. In the event of the teletype line exceeding 80 printable characters; e.g., because of operator error or garbling of CR, LF sequence, a new block is formatted for the excess characters. Case shift and carriage control are deleted on output processing. When the teletype line contains less than 80 characters between the CR-CR-LF sequences, the remainder of the card block will be filled with spaces.

8. Conversion of EOT Card to TTY EOMS. Delete the entire EOT card and generate the teletypewriter sequence of 2CR-8LF-4N.

9. Conversion of TTY EOMS to EOT Card. Delete the TTY EOM sequence and generate an EOT card as specified in JANAP 128. Insert the characters "MTMS" in the record count field of the EOT card.

10. Fill the EOM Block with Filler Characters After the Last "N." The remainder of the EOM (last line block) will be filled with a sequence of filler characters. Filler characters are defined as letters functions when the message is to be transmitted over Fieldata or ITA #2 lines and shift-in (SI) characters when the message is to be transmitted over an ASCII line. Depending on where in the line block the last N of the EOM sequence falls, the number of filler characters inserted will vary from 0 to 79 in government-owned ASC's and from 1 to 80 in government-leased ASC's.

CHAPTER 10. AUTODIN VARIABLE LENGTH RECORD AND NONSTANDARD CODE MESSAGES

This chapter is being rewritten to incorporate proposed new concepts and procedures; the revised chapter will be published subsequent to MCEB approval of the new concepts and procedures. Chapter 8 illustrates current magnetic tape block formats.

CHAPTER 11. ASYNCHRONOUS CHANNEL COORDINATION PROCEDURE

1. General. This chapter specifies Mode V channel coordination and error control procedures to be used between DCS AUTODIN switching centers and subscriber terminals. Mode V operation is employed on tributary channels between switching centers and appropriately equipped terminals to provide the following capabilities at the transmitter and receiver:

a. Transmitter. The transmitter must be capable of:

(1) Receiving a positive acknowledgment for each transmitted message accepted by the receiver.

(2) Receive transmit instructions for each transmitted message not accepted by the receiver.

(3) Detecting most forms of transmission, crytographic, and equipment failures associated with the transmission loop.

(4) Canceling a message transmission prior to its termination.

b. Receiver. The receiver must be capable of:

(1) Controlling the rate of data reception by starting and stopping the transmitter on command from the receiver.

(2) Requesting retransmission of incoming messages that are not acceptable.

2. Codes. Mode V operation on channels between ASC's and appropriately equipped subscriber terminals will use either ITA #2 American version, or ASCII as the line code. A given subscriber terminal will operate in only one of the above codes.

a. When using ASCII (see figure A-1), transmission will be a serial 10 or 11 unit start-stop code consisting of:

(1) A single unit start interval.

(2) An 8-unit interval wherein the bits are transmitted in low to high order bit sequence with the parity bit last.

(3) A one or two unit stop interval.

b. When using ITA #2 (see figure A-5), transmission will be a serial 7 or 8 unit start-stop code consisting of:

(1) A single unit start interval.

(2) A 5-unit interval wherein the bits are transmitted in low to high order bit sequence.

(3) A one- or two-unit stop interval.

3. Speed. Mode V ITA #2 subscriber terminals will operate at modulation rates of 45.45, 74.2, and 75 baud. ASCII subscriber terminals may operate at modulation rates of 75, 150, and 300 baud respectively. Currently government-owned ASC's do not provide a 300 baud asynchronous capability.

4. Message Format. Messages will be prepared for transmission over controlled teletypewriter channels as specified in ACP 127 (C) and US Supp (A)-1 thereto and JANAP 128. A mode V ASCII subscriber channel will process messages only in the format specified in JANAP 128. The Mode V ITA #2 subscriber channel will process messages in formats specified in JANAP 128 or ACP 127 series. However, a given ITA #2 channel is authorized to use only one of these formats as specified in these documents. All messages are preceded by a Start of Message Sequence (SOMS) and terminated with an End of Message Sequence (EOMS) as described in chapter 9.

5. Operations. The Mode V channel coordination technique provides for two types of operation, standard and emergency.

a. Standard Operation.

(1) The standard operation will be used exclusively except under conditions outlined for the Emergency operation. The standard operation requires the use of both the transmit and receive channels to transmit or receive messages. While sending a message, the receive channel is monitored for return control sequences and while receiving a message, the transmit side of the channel is used to transmit return control characters.

(2) The subscriber terminal can send and receive messages simultaneously; consequently, both sides of the duplex channel may be used for the exchange of control character sequences as well as message characters. Return control character sequences are interspersed with message characters as required. Whenever it becomes necessary to acknowledge receipt of an inbound message, the outbound message is interrupted for the time period required to send the return control character sequence. Control sequences which are interspersed with the message characters are not delivered to the receiving device.

b. Emergency Operation.

(1) The emergency operation is used only when equipment or transmission facilities prevent operation of the terminal or switching center in the standard operation.

(2) In the emergency operation, the Mode V control functions are bypassed and the use of the Mode V control sequences is omitted, thus requiring the operational capabilities of only that portion of the equipment which is used to send or receive a message. If the logic associated with Mode V control, for example, is inoperative, the channel can be operated duplex but in an uncontrolled mode. If only one side of the channel is operational due to equipment, cryptographic, or facility failures, the channel can be operated uncontrolled in a one-way-send or a one-way-receive mode, depending upon the direction of the side which did not fail.

(3) The speed and format used in the emergency operation must be the same as that used on the channel in the standard operation.

(4) Conversion from the standard operation to the emergency operation, or the converse, must be established manually by coordinated action at both ends of the channel. Changing the type of operation at the switching center is accomplished by a standard channel change routine and at the subscriber terminal by the operation of a switch.

6. Encryption Capabilities. Standard government-furnished encryption equipment may be employed on channels operated with Mode V control. The Mode V channels using the ITA #2 may use either asynchronous or synchronous encryption equipment, while the Mode V ASCII operated channels may use only synchronous.

7. Mode V Channel Coordination.

a. General.

(1) The Mode V asynchronous channel coordination procedures are a derivative of the Mode I synchronous control procedures. Many of the communications control characters used in the synchronous procedures are functionally present in the asynchronous procedure. Like the synchronous procedures, Mode V provides positive control between the transmitter and receiver. Operation is analogous to the block-by-block operation in Mode I except that the unit of transmission in Mode V is a message instead of a block. Messages are framed at the beginning and end with Start of Message Sequences and End of Message Sequences as defined in ACP 127 series and JANAP 128. Messages are transmitted message by message. Once the EOMS has been sent, transmission of message data is halted until a control sequence acknowledging the message or requesting a retransmission of the message is received from the receiving station. Upon receiving an acknowledgment, the next message is transmitted. If a retransmission of the message is requested, the message is repeated. At any point during message reception, the receiving station has the ability to stop transmission by initiating a control sequence requesting such action. Once the transmitter has recognized a request to stop transmission, it remains in a stopped condition until authorized to proceed by the receiver.

(2) The control system is interlocked by a set of transmit and receive control signals. Each transmit control sequence requires a valid response from the receiver. Should no response be received in reply to a transmit control sequence, it or a substitute transmit control sequence is repeated until a response is received or three consecutive transmissions of the control sequence have occurred.

b. Control Leader.

(1) A special signalling technique is used which permits the subscriber connected to the DCS AUTODIN to use all of the ITA #2 or ASCII characters without interfering with the communication control functions. Control character sequences are preceded by a pause in transmission, a marking condition on the line, to flag or inform the receiver that a two-character control sequence will follow. This pause will only appear on the line while a message is being transmitted if a return control sequence is to be transmitted.

(2) However, should a pause fortuitously occur due to the lack of message characters to send, the transmitter will insert a two-character dummy control sequence immediately prior to the transmission of the next message character (see START transmit control character). The control leader is specified in terms of the following three time intervals:

(a) Send Detect. This interval is detected at the transmitter when the line has been held in a marking condition equal to the Send Detect time as specified below. When the transmitter detects a Send Detect interval, it will continue in the marking condition as specified by the Send Generate time.

(b) Send Generate. This interval is detected at the transmitter when the line has been held in a marking condition equal to the Send Generate time specified below. When this interval has been detected, transmission of message characters will not be resumed until a two-character control sequence has been sent.

(c) Receive Detect. This interval is detected at the receiver when a marking line condition has been received equal to the Receive Detect time specified below. When this interval has been recognized, the receiver prevents the transfer of characters to the receive device until two contiguous control characters have been received.

(3) The Send Detect, Send Generate, and Receive Detect intervals are specified below in terms of milliseconds timed from the end of the last character transmitted or received. Separate intervals are specified for ITA #2 and ASCII channels and are applicable for the modulation rates specified for Mode V.

	ITA #2		ASCII	
	From and including	To and including	From and including	To and including
Send Detect	10	50	10	25
Send Generate	620	1000	400	750
Receive Detect	170	480	75	370
Send Generate Government-owned ASC's	200	667	286	1000
Receive Detect Government-owned ASC's	150	500	215	750

(4) Tolerances on the detect and generate timers will be such as to ensure that they fall within the above ranges of time.

(5) The government-owned ASC times are based on the ASC being set to recognize the control leader in three character times and send a control leader of four character times. The ITA #2 is based on a 7½ interval code and ASCII on a 10½ interval code.

c. Control Character Sequences. Control character sequences are designated either as transmit or receive control characters.

(1) Receive Control Characters. Receive control characters are a subset of control characters which are sent by the receiving station when requested to do so by the transmitting station. They are responses or answers to transmission of messages or transmit control sequences. These characters are transmitted in contiguous pairs following the control leader. They may be interspersed anywhere in the bit stream between characters and are excluded from the bit stream delivered to the receiving device. The receive control characters are ACK 1, ACK 2, STOP, and RT.

(a) Acknowledgment Number One - ACK 1. ACK 1 is sent by the ASC or subscriber terminal to signal the transmitter that a message has been received correctly. It and the other answer characters are sent only when requested by the transmitter. ACK 1 is sent as the acknowledgment to the first and each alternate message received correctly. It is sent in response to receiving the EOMS or the transmit control sequence REP, if the most current received message requires the ACK 1 response and the receiver is ready to receive more message characters.

(b) Acknowledgment Number Two - ACK 2. ACK 2 is sent by the ASC or subscriber terminal in acknowledgment of every correct message received after a message acknowledged with ACK 1. It is also the proper answer to a CAN sequence.

(c) Stop-STOP.

1. STOP is sent by the ASC as an answer to REP or EOMS and by the subscriber terminal as an answer to REP to indicate that transmission of message data should not proceed beyond the current position.

2. It is also initiated by the receiver without solicitation by the transmitter as a command instructing the transmitting station to stop message transmission. When initiated as a command, it is repeated periodically at intervals equal to the STOP timer interval until a REP control sequence is received.

3. It is also transmitted by the ASC without starting the STOP timer when the per line message storage area has been filled to either near-full or almost-full.

(d) Retransmit Message - RT.

1. RT is sent by the ASC or subscriber terminal as an answer to an EOMS or REP to inform the transmitter that the message received is in error and must be corrected by retransmission. Upon receipt of RT the transmitter will cancel the message by transmitting a CAN sequence.

2. When an RT condition occurs prior to receiving the EOMS, the receiver initiates a STOP control sequence each time the STOP timer expires until the REP control sequence is received. When REP is received the RT response is transmitted.

(2) Transmit Control Characters. Transmit control characters are a subset of control characters which are sent by a transmitting station to direct the receiving station to take some action. They are transmitted in identical contiguous pairs preceded by a control leader. The transmit control sequences are START, REP, CAN, and ENQ.

(a) Start - START. START is sent by the ASC or subscriber terminal under the following conditions:

1. Prior to the first message character if the receiver is in the marking condition due to a pause in transmission between messages and a receive control sequence does not have to be sent.

2. As a dummy control sequence while a message is being transmitted if a fortuitously generated control leader has been generated due to the lack of a message character to transmit or a pause in transmission resulting from the receipt of the STOP sequence. The START sequence is sent immediately prior to the transmission of the next message character. START is not transmitted for the above conditions if one of the receive control sequences is to be sent.

(b) Reply - REP. REP is sent by the transmitting station to direct the receiver to send its last response (ACK 1, ACK 2, STOP, or RT) or its current updated response. If a response is not received within a preset time interval determined by the REP timer setting (paragraph 7d), the REP sequence is repeated.

(c) Cancel - CAN. The CAN sequence may be initiated either manually or automatically, and it must be acknowledged with ACK 2.

1. The CAN sequence may be transmitted as follows:

a. Generated automatically to cancel a message for which an RT or the wrong ACK was received.

b. Sent by the transmitter, prior to the transmission of EOMS, to direct the receiver to cancel the message.

c. Sent between messages to achieve ACK synchronization between the transmitter and receiver.

2. Once sent the CAN sequence is repeated each time the REP timer expires if no answer is received, or if STOP is received.

3. The CAN sequence cannot be sent if an outstanding response to an EOM is expected from the receiver. Under this condition, CAN cannot be sent until an acceptable reply, other than STOP, has been received.

(d) Enquiry - ENQ. ENQ is sent by the ASC to request that an AUTOVON connected subscriber terminal identify itself. The answer to ENQ is the assigned ACP 117 AUTODIN routing indicator of the station. This transmit control sequence is not used in CONUS AUTODIN.

(3) Control Character Assignment. The characters assigned for Mode V control sequences are specified for Mode V ITA #2 and Mode V ASCII as follows:

Control Sequence	Mode V ITA #2 Characters	Mode V ASCII Characters
ACK 1	Z	ACK 1
ACK 2	L	ACK 2
STOP	A	STOP
RT	S	RM
START	I	START
REP	R	REP
CAN	D	CAN
ENQ	W	ENQ

d. Reply Timer. Each transmitting station is equipped with a timer referred to as the REP timer which is started each time a REP, CAN, or ENQ transmit control sequence or an EOMS is transmitted. If an ACK 1, ACK 2, or RT reply is not received before the timer expires, the control sequence is repeated or a REP is transmitted. For the case of ENQ see paragraph 9b. The typical setting of the REP timer shall fall within the range of 2 to 4 seconds.

e. Repeat Counter. Each transmitting station is equipped with a counter which is incremented by one each time a transmitted REP, ENQ, or CAN sequence is not answered within the REP timer interval, and reset upon receiving a valid receive control sequence. When the counter has accumulated a count of three, an alarm is activated. This alarm is reset manually. At the subscriber terminal the transmit routine is halted after three unsuccessful attempts and reinitiated only after the alarm (designated Three Repeat in the flow charts) is manually released. At the ASC, an equivalent alarm is activated after three unsuccessful attempts; however, the transmit routine continues to repeat the REP or CAN control sequence. See paragraph 9b. for special procedures at the ASC regarding no reply or a wrong reply to ENQ.

f. STOP Timer. This timer is associated only with the receive channel.

(1) At the subscriber terminal, the STOP timer operates as follows:

(a) The timer is started each time a STOP control sequence is generated as command to halt transmission.

(b) If no answer is received and the timer expires, the STOP sequence is reinitiated and the STOP timer is restarted.

(c) If a REP or CAN control sequence is received, the STOP timer is reset but not restarted.

(d) The typical interval to be used for the STOP timer will be within a range of 2 to 8 seconds.

(2) At the ASC the interval of this timer is identical to the setting of the REP timer and it is started only if STOP is generated due to an RT condition.

8. Mode V Operation. The Mode V transmit and receive procedures are described below in two parts. The ASC transmit and receive operation is described first, followed with the subscriber terminal description. Functions common to both are included in the switching center portion of the description. The text refers to the applicable sections of the Mode V flow charts (figures 11-1 through 11-16) for further amplification of the procedures. The procedures outlined in these charts

are to be followed except for qualifications contained in the text. The flow charts indicate functions which must be performed; they are not intended to prescribe the method of implementation. Procedures unique to the ASC or the subscriber terminal are identified in the flow charts by an A or T respectively in the action boxes, or by a branch to a terminal or switching center routine.

a. ASC Transmit Operation - Non-AUTOVON Channel.

(1) Initial Startup Procedure.

(a) The ASC startup procedure for a non-AUTOVON channel sets the transmit side of the Mode V channel into the same state as that assumed after having sent a message and having received the proper acknowledgment (intermessage state) and conditions the channel to transmit the CAN control sequence. This is indicated in figure 11-1 by the setting of CAN flag via Startup/Power On and the exit to (1) on the chart. All transmit flags other than CAN are reset such that when the transmitter enters the procedure at (1) , it will cause the Transmit Control Character (TCC) to Send to be set the first time through the loop, and an exit to (9) (figure 11-9) on the second time through (1) (assuming that Receive Control Character (RCC) to Send has not been set by the receive side of the channel). In following the procedure on figure 11-9 the CAN sequence is generated and the transmitter set to time for a response from the receiver. While the REP timer is running the procedure loops from (1) on figure 11-1 through the Reply to CAN routine on figure 11-6 until a valid response is received (STOP or ACK 2) or the REP timer expires. Note that while the transmitter is in this loop, it can be interrupted to send a receive control sequence if the RCC to Send condition is present.

(b) If the response to CAN is ACK 2, the procedure is completed, and the transmitter and receiver are respectively set to expect and reply with ACK 2 until the end of the next transmitted message resets the ACK alternators to ACK 1. The transmitter is now ready to send a message or enter another routine specified in figure 11-1.

(c) If the response to CAN is STOP, the procedure continues until the REP timer has expired at which time CAN is transmitted again. The transmission of CAN and reception of STOP will continue until an ACK 2 or no response is received.

(d) If no response is received to CAN while the REP timer is running, the 3 RPT counter is incremented by one and the CAN sequence repeated. No reply to CAN after the third transmission is a three repeat (3 RPT) condition and sets an alarm to notify the ASC operator of a possible trouble condition in the facility, cryptographic equipment, terminal equipment, or the ASC. While the alarm is activated, the transmission of the CAN sequence continues until it is answered or is manually halted.

(2) Intermessage Transmit Procedures. While the transmitter is in the intermessage state, it is ready to transmit return control characters whenever called upon to do so by the receive side. When this is required, the RCC to Send condition is present (figure 11-1), and the transmitter enters the RCC transmit routine (figure 11-5). If the channel has been in a marking condition in excess of the Send Generate interval, then the Send Generate Flag will be set and the appropriate receive control sequence is sent immediately. If the proper length control leader has not been sent, the control sequence is delayed until the Send Generate Flag is set. Also, if it should be required to send a CAN transmit control sequence due to the CAN Flag being set, the transmit routine will enter the cancel routine (figures 11-1, 11-9, 11-6) as described before. Since the CAN sequence, in this case, was sent while a message is not being transmitted, it serves the function of only resetting the receive and transmit ACK alternators to ACK 2.

(3) Transmitting a Message.

(a) When the ASC determines that a message is to be transmitted (figure 11-1) it follows the transmit routine described on figures 11-1 and 11-2. The Send Generate Flag will normally be set at this time due to a pause in transmission between messages, and consequently, the START control sequence will be sent ahead of the first message character as shown in figure 11-2.

(b) Transmission proceeds from this point uninterrupted until the End of Message is sensed unless an RCC to Send is set by the receiver, a STOP is received, a CAN sequence is to be generated, or no message characters are available.

(c) If the transmitter runs out of message characters to send, a control leader is generated automatically, and the receiver at the distant end is shut off or blinded to subsequent characters until a control sequence is received. When message characters become available to the transmitter, a START control sequence is generated (figure 11-2) and transmission of message characters is resumed. Note that if an RCC is to be sent at the same time that message characters become available, the transmission of the RCC sequence takes precedence over the START and removes the necessity of having to send the START sequence.

(d) If a STOP sequence is received as indicated by the STOP received flag being set in figure 11-1, the transmit routine halts transmission and enters the REP routine, periodically sending REP until an ACK 1, ACK 2, or RT is received or until a 3 RPT condition occurs. During the time the first message following a startup procedure is being transmitted, the correct ACK to this REP is ACK 2. If the expected ACK is received in response to REP, the transmitter may resume sending as per figures 11-1 and 11-2. However, if the incorrect ACK or RT is received, the CAN flag is set (figure 11-7) and the CAN routine is entered. If a 3 RPT condition occurs, the ASC operator is notified via an alarm and the REP transmit routine is continued.

(e) If the CAN sequence is generated prior to complete transmission of the message, the TCC routine is entered to generate the CAN control sequence (figure 11-9). Then the reply to CAN routine (figure 11-6) is entered to await a response to the CAN; while the response is being timed, the transmitter is halted. When the response (ACK 2) is received for the CAN sequence, the ASC returns the cancelled message to the queue for retransmission and sends a standard CANTRAN sequence to the terminal.

(f) If an RCC sequence is to be sent as a response from the receiver, transmission is halted for the length of time required to generate a control leader followed by the two-character RCC sequence as per figure 11-5.

(g) After the End of Message sequence is sent (EOM framing character detected in CONUS AUTODIN) the transmitter is halted, the transmit ACK alternator is complemented (set to ACK 1 for example for the first message after start up), and the reply timer is started per figure 11-2. If STOP is received as the response or if the timer expires (figure 11-8), the transmitter enters the REP routine as previously described (figures 11-1 and 11-7). Should the correct ACK response be received (ACK 1 in case cited), the transmitter considers the message completed and returns to the intermessage state. However, if the wrong ACK or RT is received, the CAN routine is followed as previously described. At the ASC the RT received flag is set whenever the wrong ACK or RT is received to inform the ASC program that the message is to be retransmitted. The program in turn sets the CAN flag to cause the message to be cancelled. Note, since CAN is transmitted prior to receiving the correct ACK to the EOM, the message will be returned to the queue for retransmission and a CANTRANS sequence will be generated.

b. Subscriber Terminal Transmit Operation - Non-AUTOVON Channel.

(1) Initial Startup Procedure. The startup procedures described for the ASC apply to the terminal except for the action following a 3 RPT alarm. The terminal halts transmission of the CAN sequence following a 3 RPT alarm until the condition is released by operation of the Start Send Control (figure 11-3). When this control is operated, the CAN procedure is repeated three more times unless the ACK 2 is received.

(2) Intermessage Transmit Procedures. The terminal, while in the intermessage state, performs in the same manner as described for the ASC except for the variation previously mentioned for the 3 RPT alarm. In addition, it performs specific tests on the tape reader as shown in figure 11-3. The tests shown here are representative of the type of tests

that may be required to control a tape reader and do not necessarily constitute the complete set of tests required. If the RPT message and 3 RPT alarms are not set, the Start Send switch is operated, the Tight Tape, Tape Out, and Reader Stop switches are not operated, and the tape reader is sensing an intermessage character, the reader is stepped a character at a time until the first message character is read or one of the other conditions occur. When the reader has sensed the first message character (other than letter, blank, line feed, carriage return, space, or N) the transmitter is set in a condition to send the message.

(3) Transmitting a Message. Transmission of a message from a non-AUTOVON subscriber terminal proceeds as shown in figures 11-1, 11-2, 11-3, and 11-4 in a manner similar to that described for the ASC except for the following situations:

(a) Subscriber terminals equipped with an Automatic Numbering Machine initiate transmission from it prior to sending message characters from the tape reader. This procedure is shown in figure 11-4. The Automatic Numbering Machine generates the SOM, a unique three-character channel designator, the three-digit channel sequence number and the machine functions carriage return and line feed. The only variable field in the sequence transmitted to a channel is the channel sequence number which is normally increased by one for each message transmitted. However, the message following a cancelled message will contain the sequence number (not updated by one) of the cancelled message per figure 11-4. When the last character of the SOM line has been transmitted (line feed) the rest of the message is transmitted from the tape reader.

(b) If the terminal is not equipped with an Automatic Numbering Machine, the SOM line as well as the rest of the message is transmitted from the tape. In this case, the message numbers must be transmitted in sequence. The message following the cancelled message should contain the same sequence number as that assigned to the cancelled message in order for it to be accepted. This procedure allows a message which was rejected due to transient errors to be repeated without changing the sequence number. If a message has to be transmitted out of sequence to the ASC, it will be rejected due to a sequence number error the first time it is transmitted and accepted the second time provided that the number as received at the ASC on the second transmission is equal to the number received for the first transmission.

(c) When transmitting the message from the tape, the terminal operation is subject to the same conditions as the ASC as shown on figures 11-1 and 11-2. Conditions unique to the terminal are shown on figure 11-3.

(d) If the Tight Tape, Tape Out, or Reader Stop switches are set, transmission halts. An alarm is operated if a tape out condition has occurred to call for operator attention. If the tape out condition is due to torn tape and the transmit monitor indicates that the transmission has been garbled, the message can be cancelled by manually initiating a CAN sequence. When the CAN sequence is acknowledged with ACK 2, the RPT message flag is set.

(e) If the RPT message flag is set due either to manually cancelling the message or automatically cancelling the message because of receiving an RT or wrong ACK response, tape must be repositioned in the reader and the Start Send switch operated before another message transmission can be initiated. The terminal need not generate the CANTRANS when operating with the ASC as the CAN sequence itself will notify the ASC to cancel the message.

(f) If a 3 RPT condition occurs while a message is being sent, transmission is halted until the Start Send switch is operated and the control sequence causing the 3 RPT condition; e.g., REP, has been sent and properly acknowledged. If the 3 RPT is due to no response to a CAN, transmission cannot be restarted until the CAN is acknowledged and the repeat message procedures previously described have been completed.

c. ASC Receive Operation - Non-AUTOVON Channel.

(1) Initial Startup Procedure. The ASC startup procedure sets the receive side of the channel in the inter-message state, stores an RT response which will be used to request a retransmission of the first message received, and blinds the receive device to subsequent characters until a two-character control sequence is received. This is indicated in figure 11-10 by entering the receive routine from Startup Power On, setting the RT flag and going to (10A)

(2) Intermessage Receive Procedures.

(a) When two contiguous characters are received as indicated by the flow from (10A) to (14) in figure 11-10 the control sequence is decoded per figure 11-14.

(b) If an RCC sequence STOP, ACK 1, ACK 2, or RT is received, the transmit side of the channel is informed via the setting of the appropriate flag.

(c) If CAN is received, the RT flag set by the start up routine is reset, the receive ACK alternator is reset to respond with ACK 2 and the RCC to Send Condition is set requesting the transmit side to generate an RCC sequence. Since the Stop and RT flags are not set, the ACK 2 control sequence will be sent as the reply (figure 11-5).

(d) If REP is received, the RCC to Send condition is set and an RT control sequence is sent per figure 11-5. If the condition is a valid REP condition, the transmission of the RT sequence results in the reception of the CAN sequence and the initiation of procedures described in the paragraph above.

(e) The ASC receive routine monitors for the completion of the SOM sequence (ZCZC) as indicated on figure 11-10. The ASC receiver remains in a blinded state such that no characters are stored. When the SOM sequence is detected, the receiver is enabled to store subsequent message characters. For channels using the ITA #2 code, these characters are processed as lower case characters until a figure character is received.

(3) Intramessage Receive Procedures.

(a) When the SOM sequence has been detected at the ASC, the receiver is placed in the intramessage state entering the routine at (11) of figure 11-11. The receiver will process all received characters as message characters, validating them for proper frame (marking stop interval) and for odd parity if an ASCII operated channel, and deliver them to the storage medium unless a pause in transmission is detected equal to the Receive Detect interval or an overflow situation in the per line storage occurs. When a pause is detected, the next two characters received are not delivered to the receiver.

(b) If the per line storage is approaching a near-full condition, the receiver will want to stop the transmitter. This will result in the setting of the Stop flag and RCC to Send as shown in figure 11-11 while the receiver continues to store incoming characters. The setting of the Stop flag and RCC to Send results in the transmission of the STOP channel sequence to the remote terminal. Shortly thereafter, the remote transmitter should stop and send the REP control sequence which resets the STOP timer and calls for the generation of a response from the receiver as shown in figure 11-15.

(c) When the STOP condition has been removed, the receiver will remove the STOP response by resetting the Stop flag (figure 11-11) and reply to the next REP sequence with the current ACK response (ACK 2 within the first message following a startup procedure).

(d) The ASC will transmit STOP once more when the per line storage has been filled to a second threshold level of almost full.

(e) If the RT flag is set due to an overflow situation or some other condition, such as an invalid header or sequence number, the receiver will set both the RT and Stop flags and RCC to Send and start the STOP timer as shown in figure 11-11. This will cause STOP to be sent to the remote terminal and REP to be received shortly thereafter. When REP is received, RT is sent in reply. Should the transmitting terminal not stop in response to the STOP control sequence, the sequence is generated again due to the STOP timer running out as shown at the top of figure 11-11.

(f) If a pause interval equal to Receive Detect has been recognized, the receiver is blinded and set to expect a control sequence. When two contiguous characters without an intervening pause have been detected as shown in figure 11-12, the sequence is validated as shown in figure 11-15. If the sequence is a RCC sequence (STOP, ACK 1, ACK 2, or RT) the appropriate flag is set for the transmit logic and the blind is removed on the receiver. The blind is also removed if REP, START, or an invalid sequence is received. If REP is received, the transmitter will send the current applicable response.

(g) If CAN is received, the receive ACK alternator is set to ACK 2 as the appropriate ACK response to CAN, the RCC to Send is set, and the RT flag and STOP timer reset. The message fragment received at the ASC is terminated with a designator indicating that it is to be discarded and the routine exits to the End of Message receive routine in figure 11-13 which is followed until the CAN sequence is acknowledged by ACK 2.

(h) If a character is determined to be in error, it is converted to a unique character (OWD in the CONUS ASC) and the message rejected (RT sent) unless the channel has been selected by the ASC operator to override the RT response as shown in figure 11-11.

(i) When the correct end of message sequence (line feed NNNN) is detected or a CAN sequence is received, the routine exits to figure 11-13. If the channel is set to respond with STOP in response to the EOM or if the receiver wants to hold the transmitter stopped, the STOP flag is set and the ACK response withheld until the STOP condition is removed. STOP is sent in response to REP until the STOP condition is removed.

(j) While in the end of message routine, the ASC is set to ignore all characters except those which are part of a valid control sequence. Control sequences received at this time are processed by the receiver in the same manner as those received while in the intermessage state except that the operation returns to the EOM receive routine in figure 11-13.

d. Subscriber Terminal Receive Operation - Non-AUTOVON Channel.

(1) Initial Startup Procedures. The initial startup procedures for the receive side of the terminal are identical to those described for the ASC.

(2) Intermessage Receive Procedures.

(a) While the terminal is in the intermessage state, it operates in a manner similar to the ASC except for the method of detecting a start of message, controlling the receiver, and detecting RT situations.

(b) The first two contiguous characters following a startup procedure or a pause are examined for a valid control sequence. See figure 11-14. If the received sequence is STOP, ACK 1, ACK 2, RT, or START the same action is followed as described for the ASC except that the blind on the receiver is removed to allow subsequent incoming characters to be recorded on the receiver. This procedure is followed to permit feed out characters following an EOM to be recorded in tape. If the control sequence is CAN or REP, the procedure delineated for the ASC is followed and the receiver remains blinded to subsequent characters.

(c) If characters are received following a control sequence received in error, they are not delivered to the receiver and the RT flag is set to cause the next message to receive the RT response.

(3) <u>Receiving a Message</u>. The procedures for receiving a message at a terminal correspond to those described for the ASC with the following exceptions:

(a) Upon detection of an invalid character (character frame error, or invalid ASC II character parity) the invalid character is delivered to the receive device without code conversion (see figure 11-11).

(b) Control sequences received in error or REP received within the message while the RT response is not inhibited do not remove the blind on the receiving device. This same condition will also cause an RT response to be sent for the message if a character is detected after the control sequence and before a pause is received (see figure 11-15).

(c) Characters received following an EOM and prior to message acknowledgment, will be delivered to the receive device if the previously received control seouence was valid and was not a CAN or REP.

(d) Message acknowledgment is withheld until a REP is received from the ASC.

e. Example of Mode V Operation. A dynamic example of message transmission utilizing the Mode V channel coordination procedures is shown in figure 11-17 for a message being transmitted in one direction. Figure 11-18 illustrates duplex message transmission utilizing the Mode V channel coordination procedures.

9. Operation with AUTOVON Connected Subscriber Terminals.

a. General. Mode V operation for AUTOVON connected subscriber terminals differs from the previously described operation with directly connected ASC subscriber terminals in that:

(1) A circuit between the ASC and the AUTOVON subscriber terminal must be established through the AUTOVON switching center prior to message transmission.

(2) The AUTOVON subscriber terminal must be positively identified as the terminal for which the message is intended.

(3) ACK synchronization between the ASC and the subscriber terminal must be established.

(4) Message transmission over the duplex circuit established through AUTOVON will be restricted to one direction with the other side of the circuit being used for return control character sequences.

(5) Release of the connection through AUTOVON preemption while a message is being transmitted must be recognized as a repeat message condition.

b. ASC Actions.

(1) Upon establishing a circuit to an AUTOVON connected subscriber terminal, the ASC will establish ACK synchronization with the subscriber terminal. The ASC establishes ACK synchronization automatically by transmitting the CAN control character sequence to the subscriber terminal. The subscriber terminal recognizes CAN and answers with the ACK 2 control character sequence. Receipt of the expected answer (ACK 2) at the ASC establishes ACK synchronization between the ASC and the subscriber terminal. The subscriber terminal is now set to respond with ACK 1 to the first EOM received from the ASC and the ASC is set to expect ACK 1 for the first EOM to be transmitted.

(2) When ACK synchronization has been established, the ASC then must establish positive identification of the AUTOVON connected subscriber terminal prior to transmission of message traffic. This procedure prevents transmission of messages to terminals other than the one for which the message is destined. Positive identification of the AUTOVON connected subscriber terminal is established as follows:

(a) The ASC transmits the ENQ control character sequence to the subscriber terminal and then times for a response. If no response is received within 4 seconds, the circuit is disconnected.

(b) The ASC will make three successive call attempts to elicit a response to ENQ. If the ASC is unsuccessful after the third attempt, the message will be returned to the queue and a printout will be delivered to the station supervisory position.

(c) The ASC will maintain First-In-First-Out (FIFO) service by placing the undelivered message at the head of the queue but first trying to send the next message in queue for a different destination. If manual intervention or corrective action is not taken immediately, the ASC will continue to make periodic attempts to deliver the message until the ASC alarm and printout occurs which indicates that a message has been retained within the ASC beyond specified time limits.

(d) If the subscriber terminal recognizes ENQ, it will respond with its assigned AUTODIN routing indicator formatted as follows, VZCZC (RI) CRCRLF.

(e) The ASC then compares the received routing indicator with the RI marked in the ASC as accessed via this particular AUTOVON connection. If the two routing indicators agree, positive identification of the terminal is considered established and the ASC then sends the message. If positive identification is not established, the ASC causes the circuit to be disconnected and after a second timeout period, a new attempt to deliver the message is initiated.

(f) The ASC will make a total of three successive attempts to deliver the message. If the ASC is unsuccessful in delivering the message after the third attempt, that message will be returned to the queue.

(g) The ASC will maintain FIFO Service by placing the undelivered message at the head of the queue, but first trying to send the next message in queue for a different destination. The ASC will make periodic attempts to deliver the message until the ASC alarm and printout occurs which indicates that a message has been retained within the ASC beyond the ASC specified time limits.

(3) Upon receipt of the correct ACK control character sequence for the EOM of the message transmitted, the ASC will cause the circuit established through AUTOVON to be disconnected.

c. Subscriber Terminal Actions. When the AUTOVON connected subscriber terminal establishes a circuit through AUTOVON to an AUTODIN ASC, the subscriber terminal must establish ACK synchronization with the ASC before attempting to transmit message traffic. This is accomplished manually at the subscriber terminal by the operator depressing the CAN button. The ASC recognizes CAN and answers with ACK 2. Receipt of the expected answer (ACK 2) by the subscriber terminal establishes ACK synchronization with the ASC as outlined in paragraph 9b, and message transmission may now be initiated. Upon completion of the transmission which may consist of one or more messages, receipt of the correct ACK for the last EOM transmitted, and no transmission of message characters for 15 seconds, plus or minus 10 percent, after receipt of the last ACK, the circuit will be disconnected automatically. The disconnect feature will cause a control lead potential of six volts to change to zero and cause an AUTODIN/AUTOVON interface unit to go to the on-hook condition.

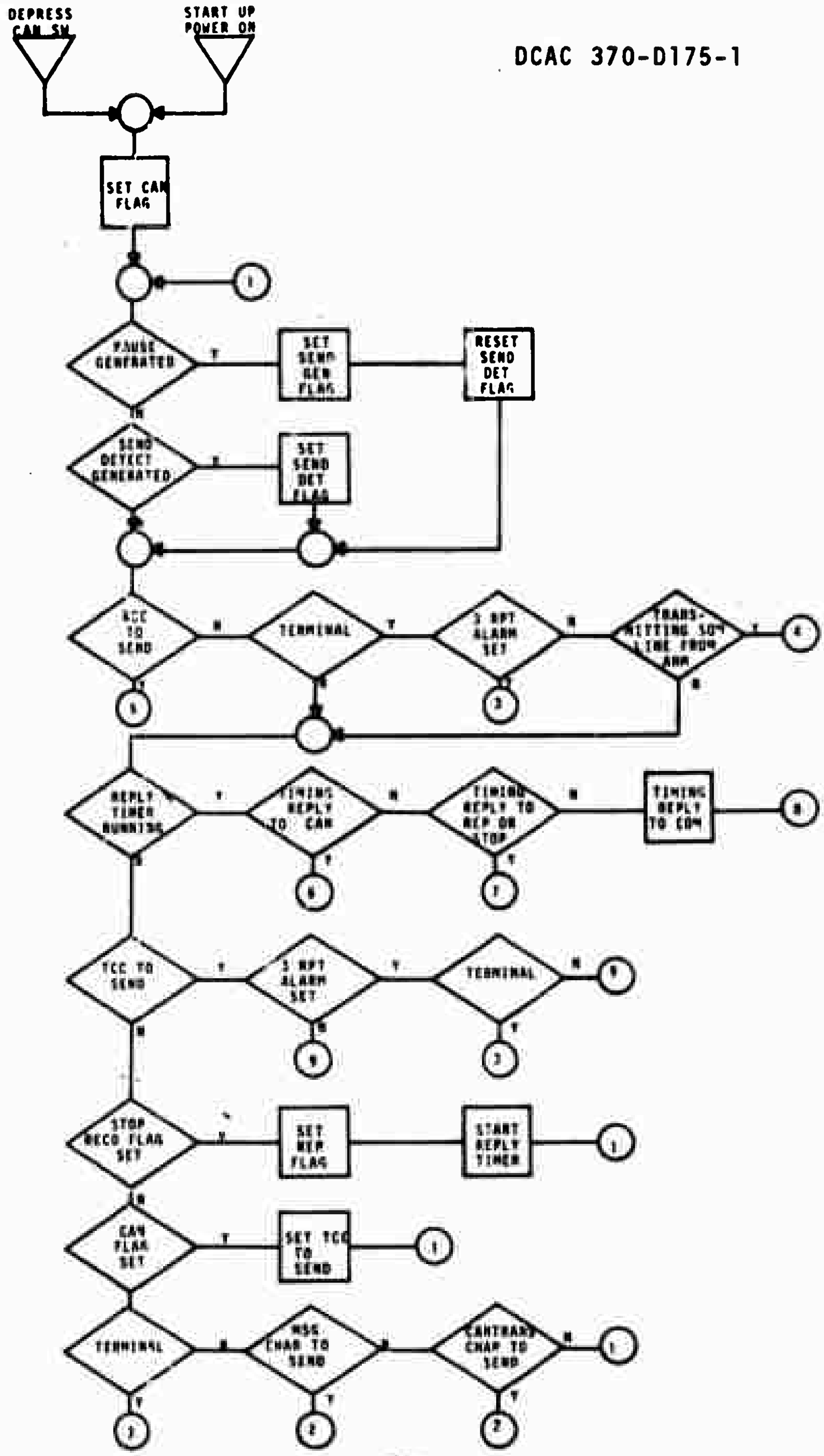
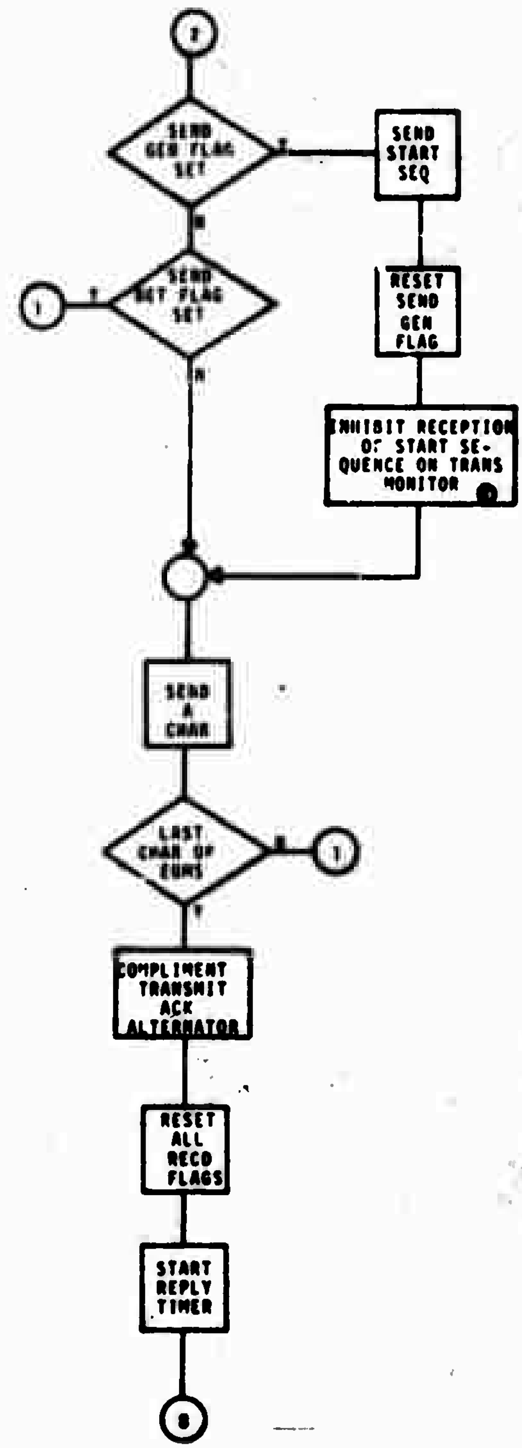


FIGURE 11-1. TRANSMIT ROUTINE - COMMON



(T) TERMINAL ONLY

FIGURE 11-2. TRANSMIT ROUTINE - INTRAMESSAGE

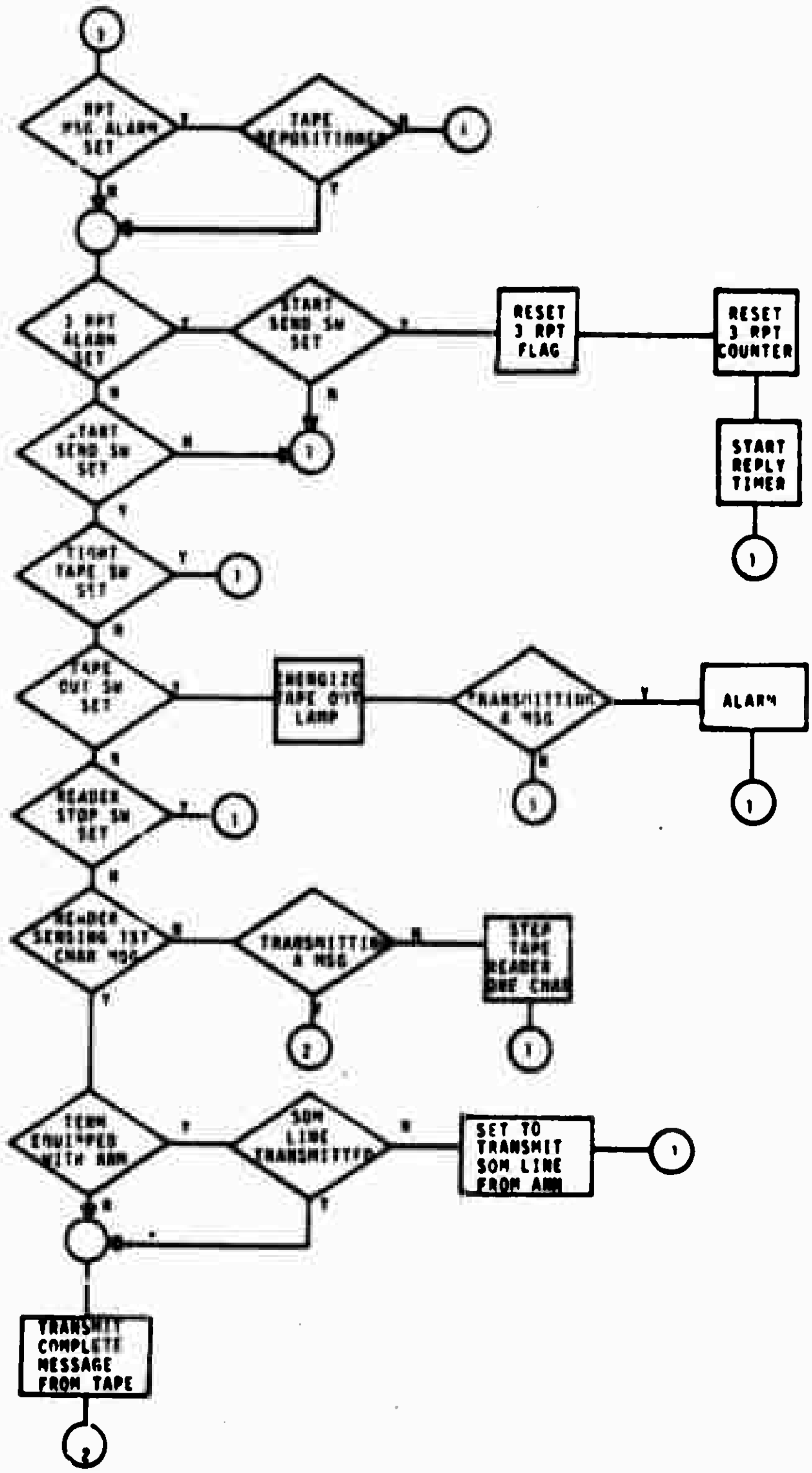


FIGURE 11-3. TRANSMIT ROUTINE - TERMINAL

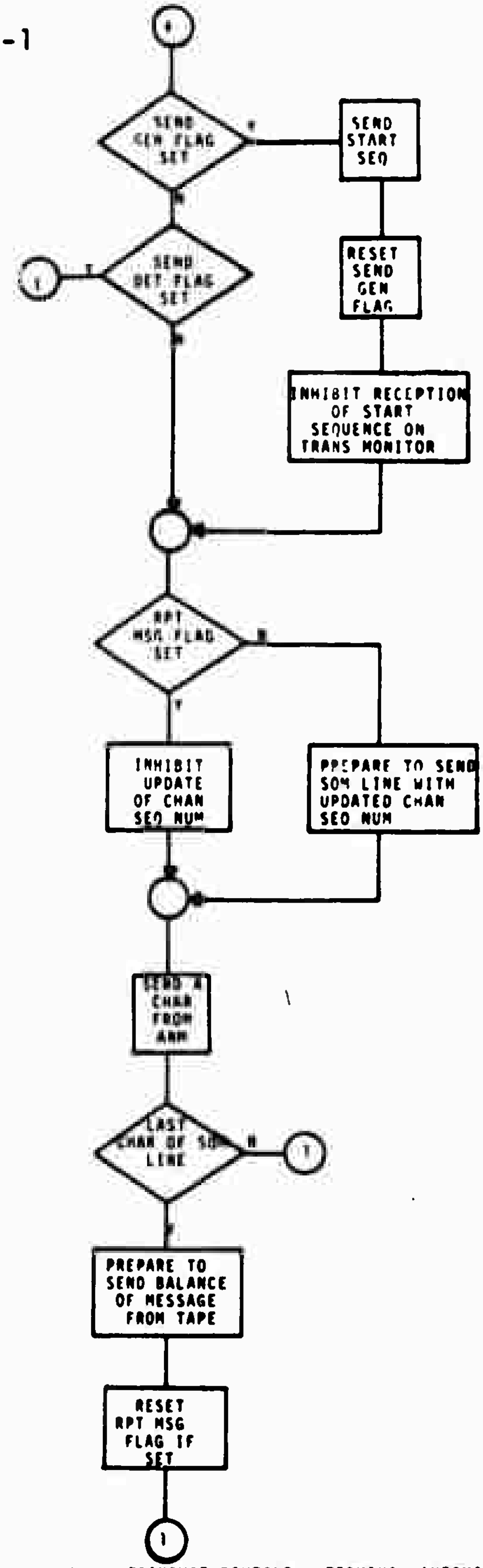
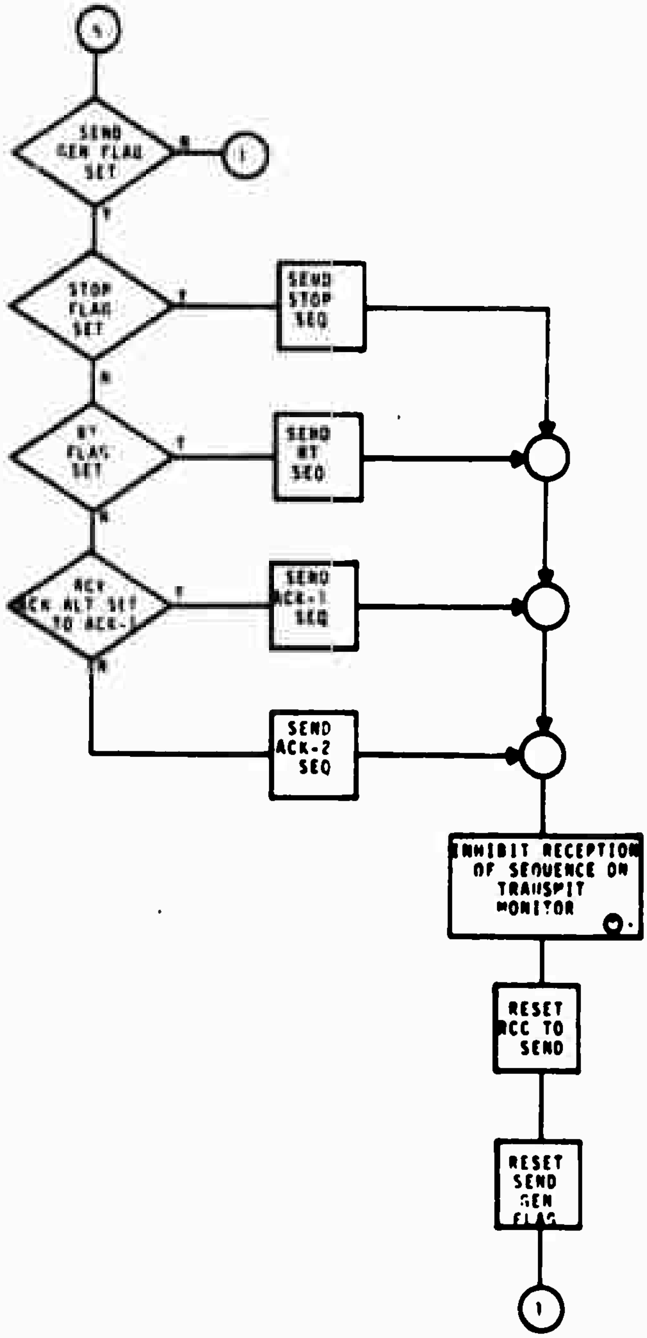


FIGURE 11-4. TRANSMIT ROUTINE - TERMINAL AUTOMATIC NUMBERING ROUTINE



Ⓣ TERMINAL ONLY

FIGURE 11-5. TRANSMIT ROUTINE - SENDING A RCC SEQUENCE

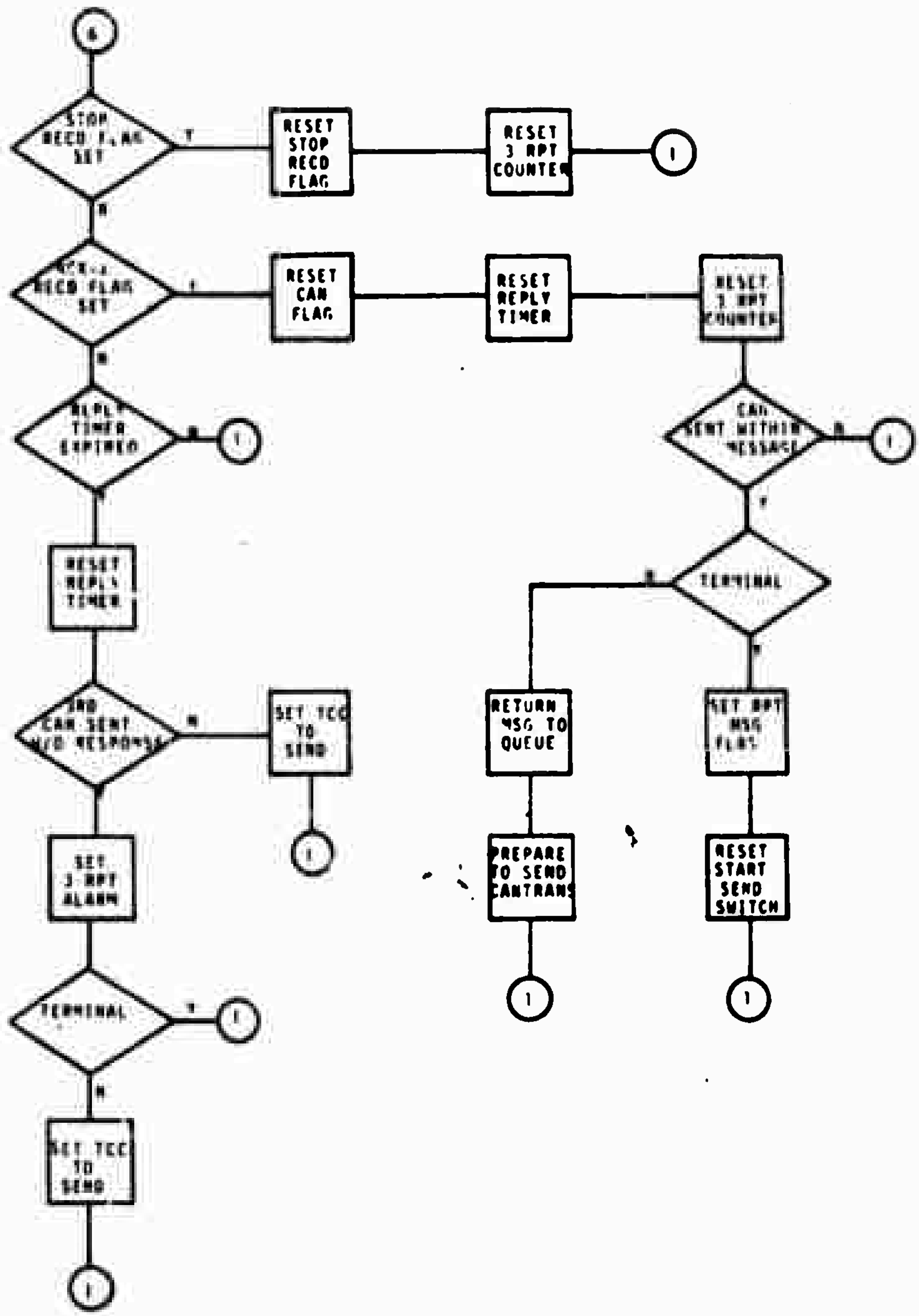


FIGURE 11-6. TRANSMIT ROUTINE - REPLY TO CAN

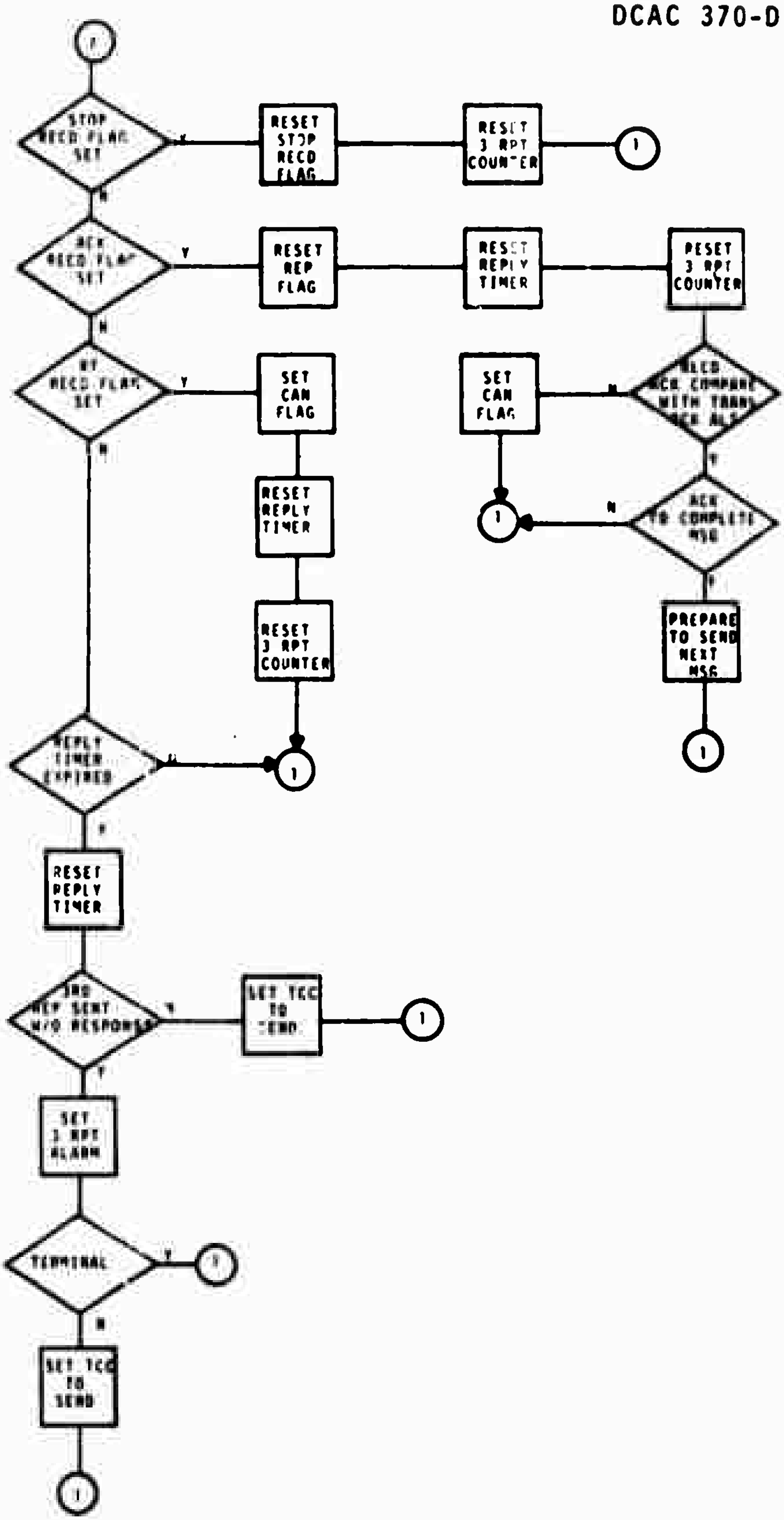


FIGURE 11-7. TRANSMIT ROUTINE - REPLY TO REP

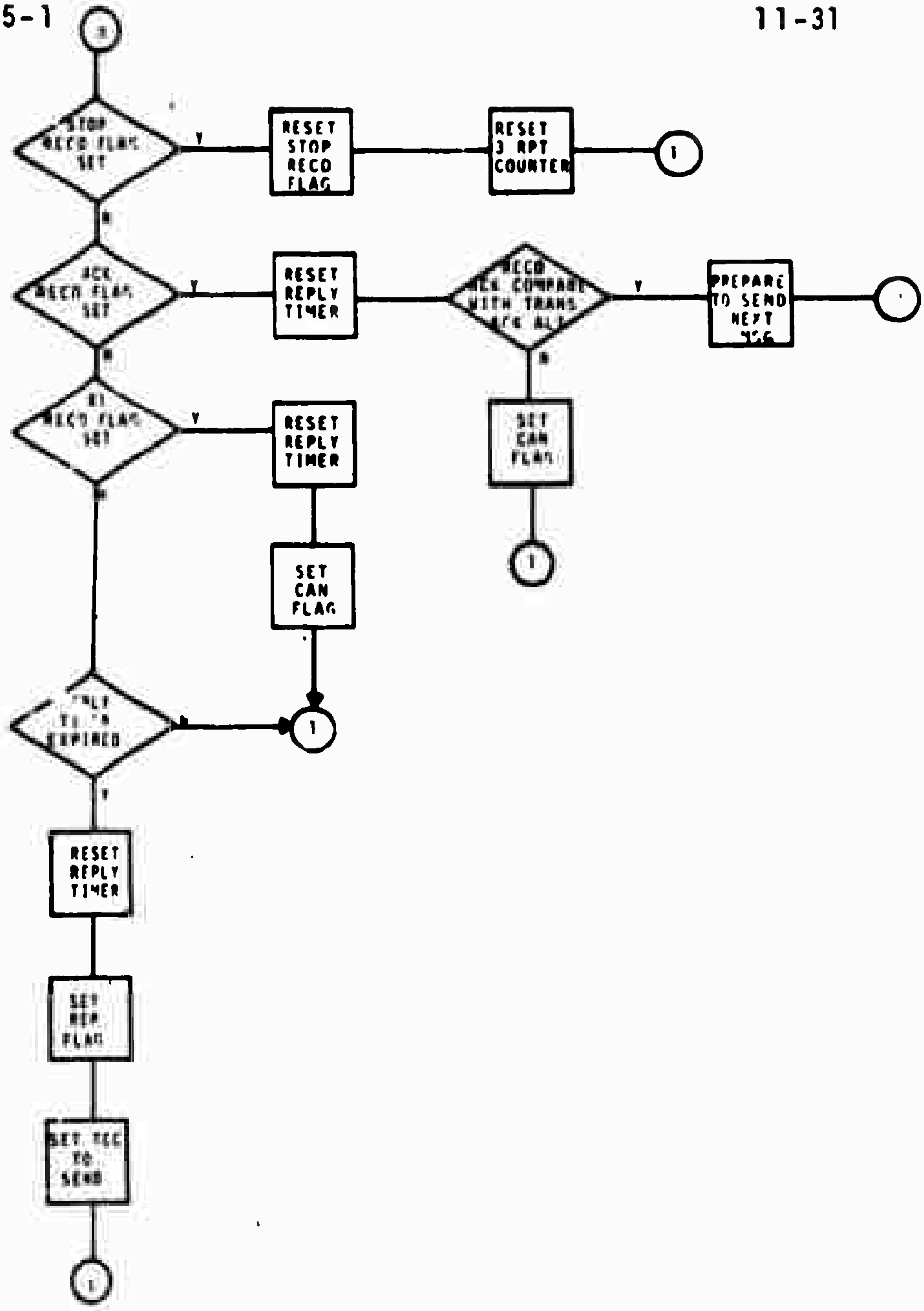


FIGURE 11-8. TRANSMIT ROUTINE - REPLY TO EOM

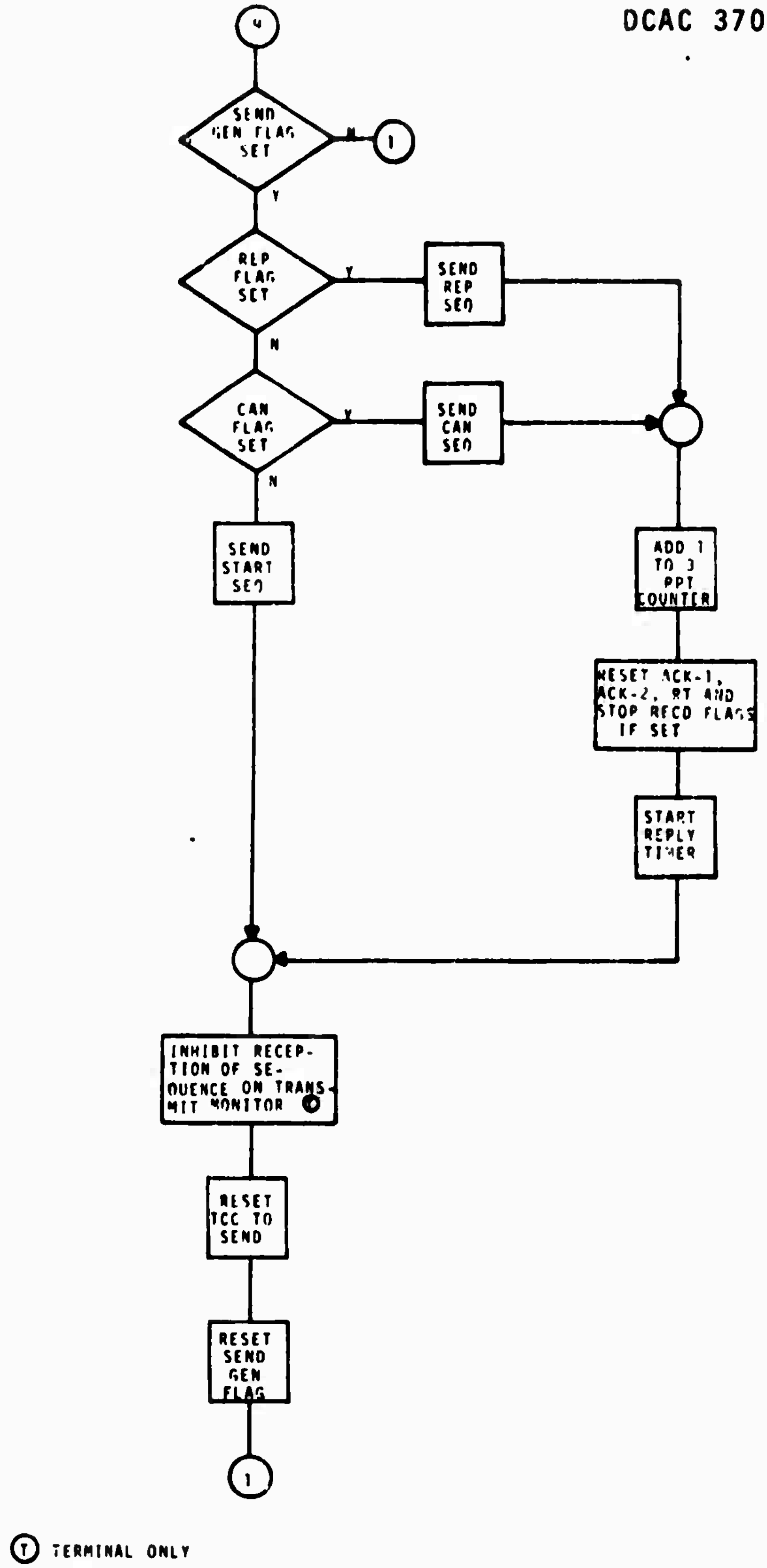


FIGURE 11-9. TRANSMIT ROUTINE - SENDING A TCC SEQUENCE

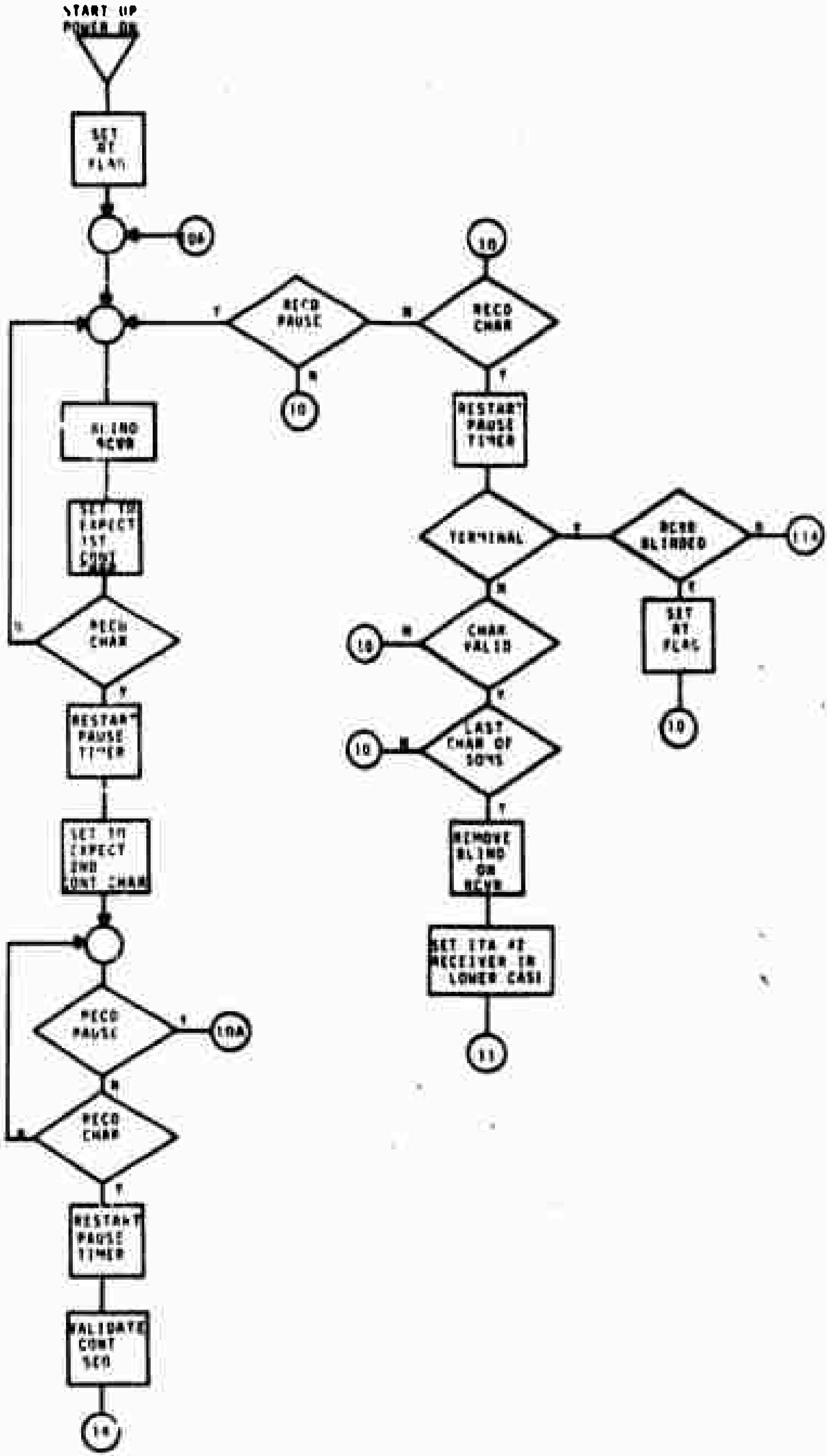


FIGURE 11-10. RECEIVE ROUTINE - INTERMESSAGE

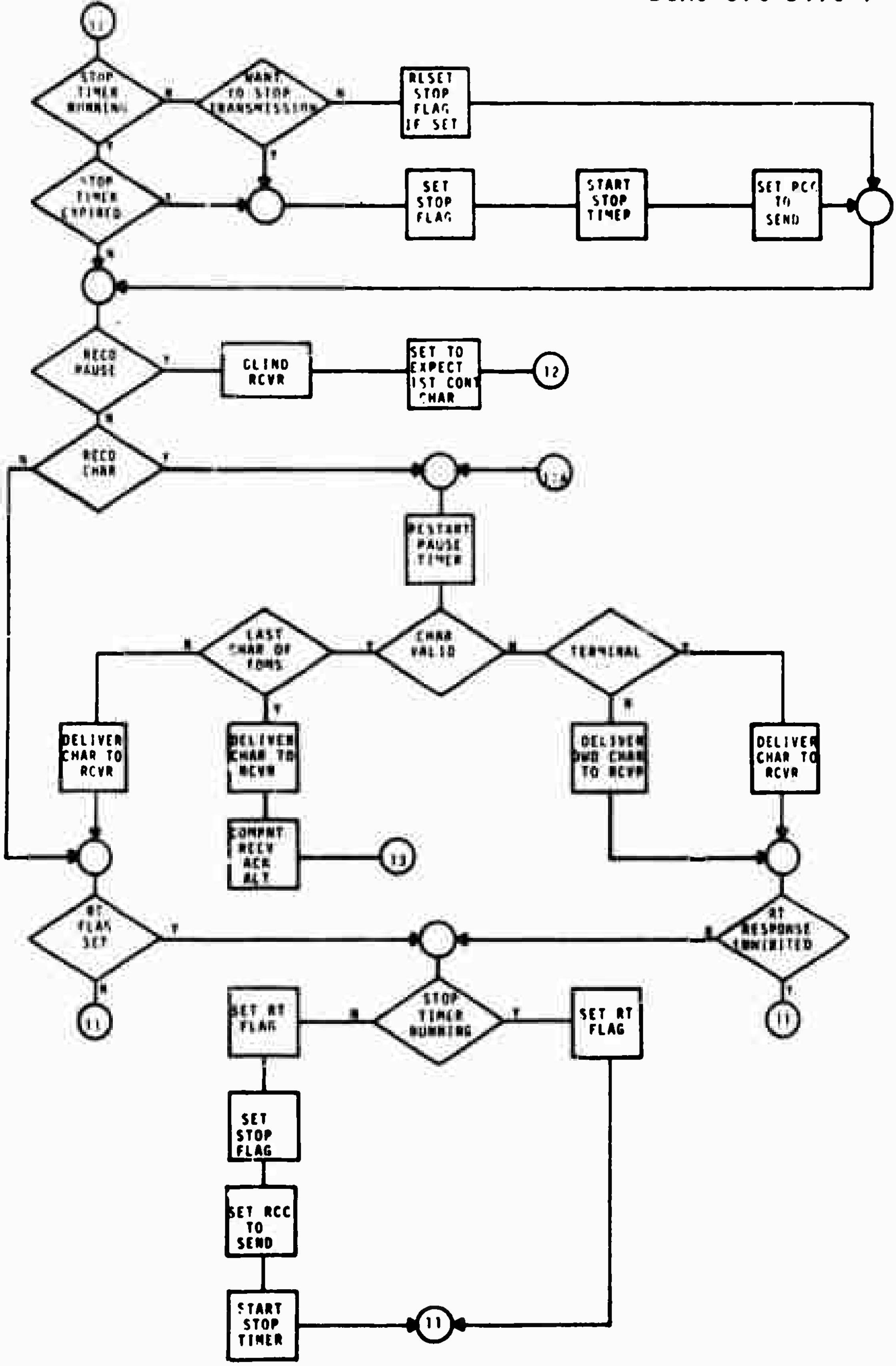


FIGURE 11-11. RECEIVE ROUTINE - INTRAMESSAGE

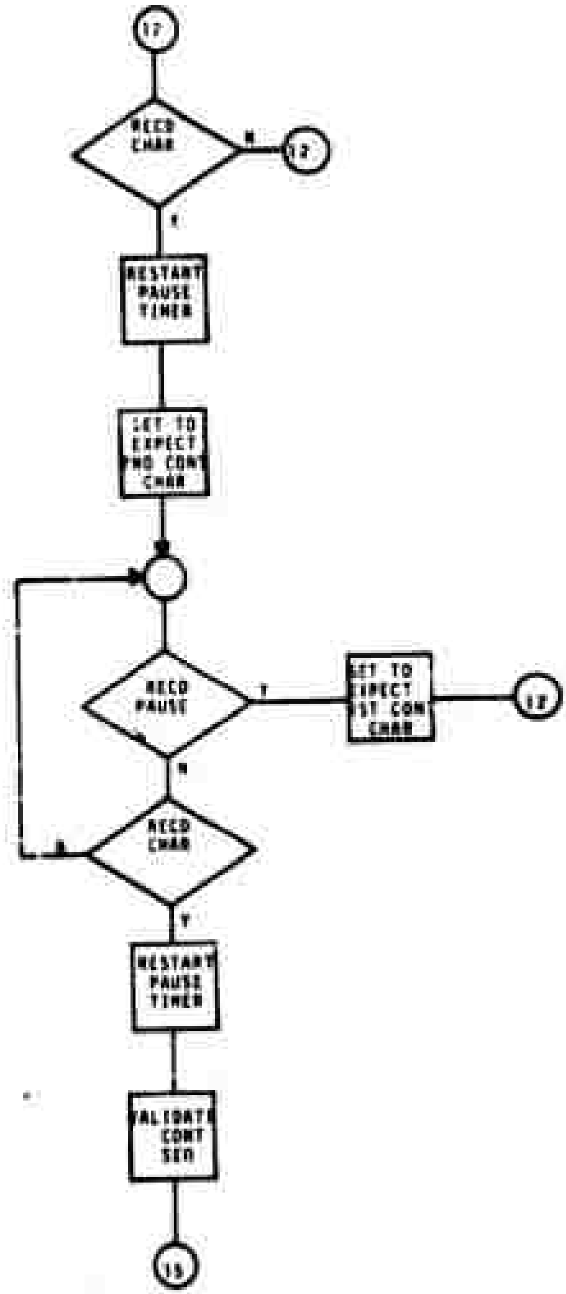


FIGURE 11-12. RECEIVE ROUTINE - INTRAMESSAGE - CONTINUED

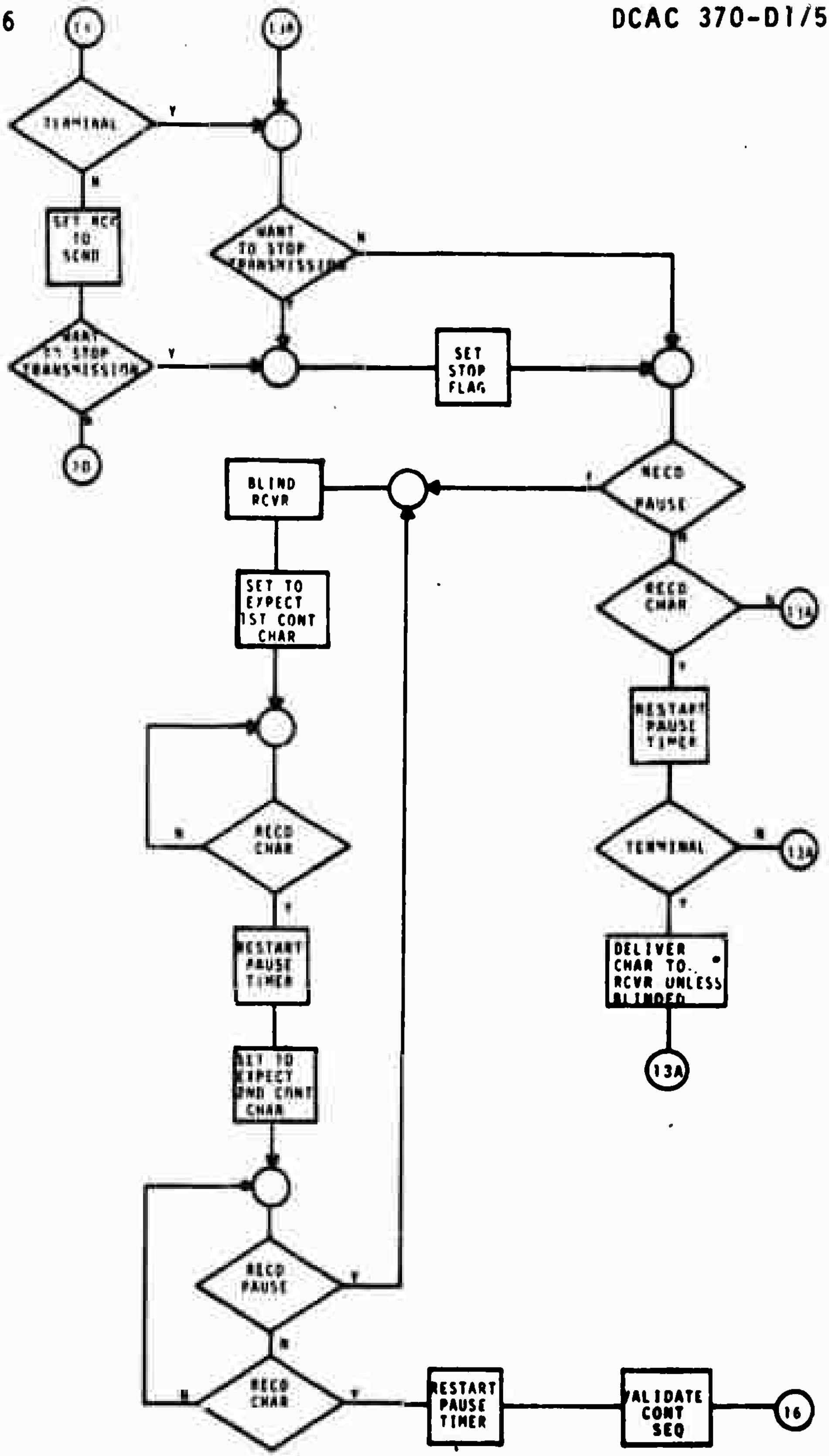
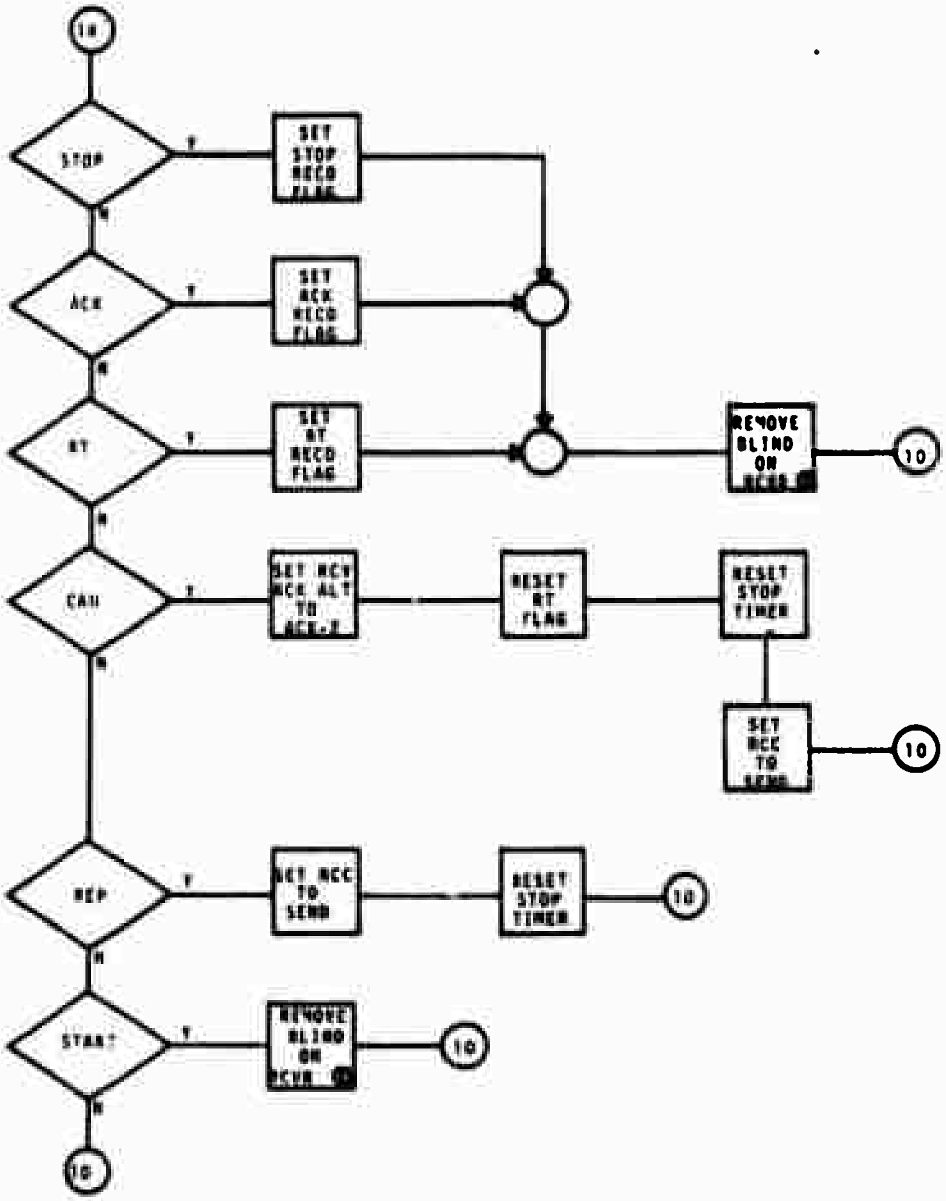
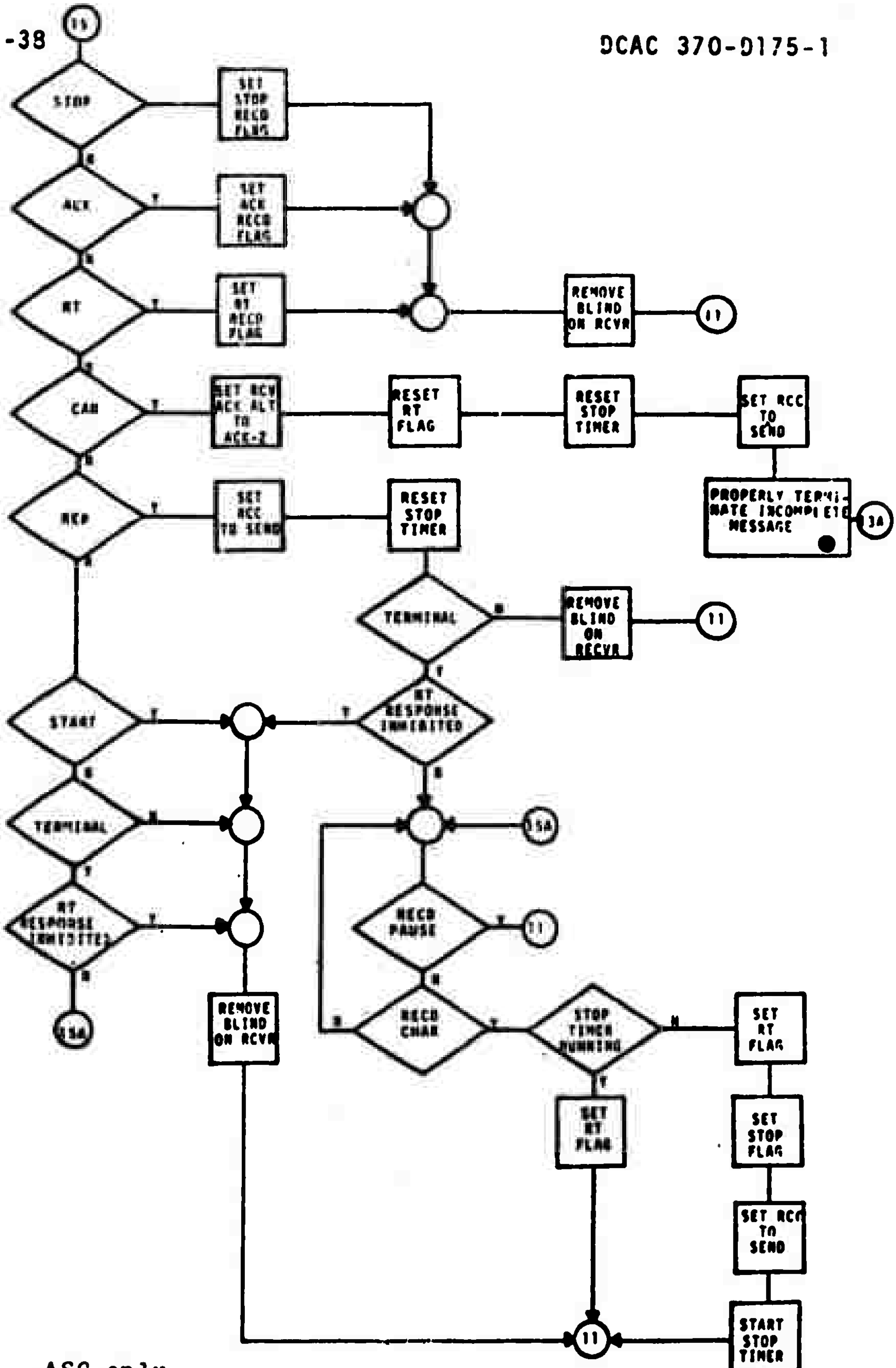


FIGURE 11-13. RECEIVE ROUTINE - END OF MESSAGE



(T) TERMINALS ONLY

FIGURE 11-14. RECEIVE ROUTINE - INTERMESSAGE CONTROL SEQUENCE



Ⓐ ASC only.

FIGURE 11-15. RECEIVE ROUTINE - INTRAMESSAGE CONTROL SEQUENCE

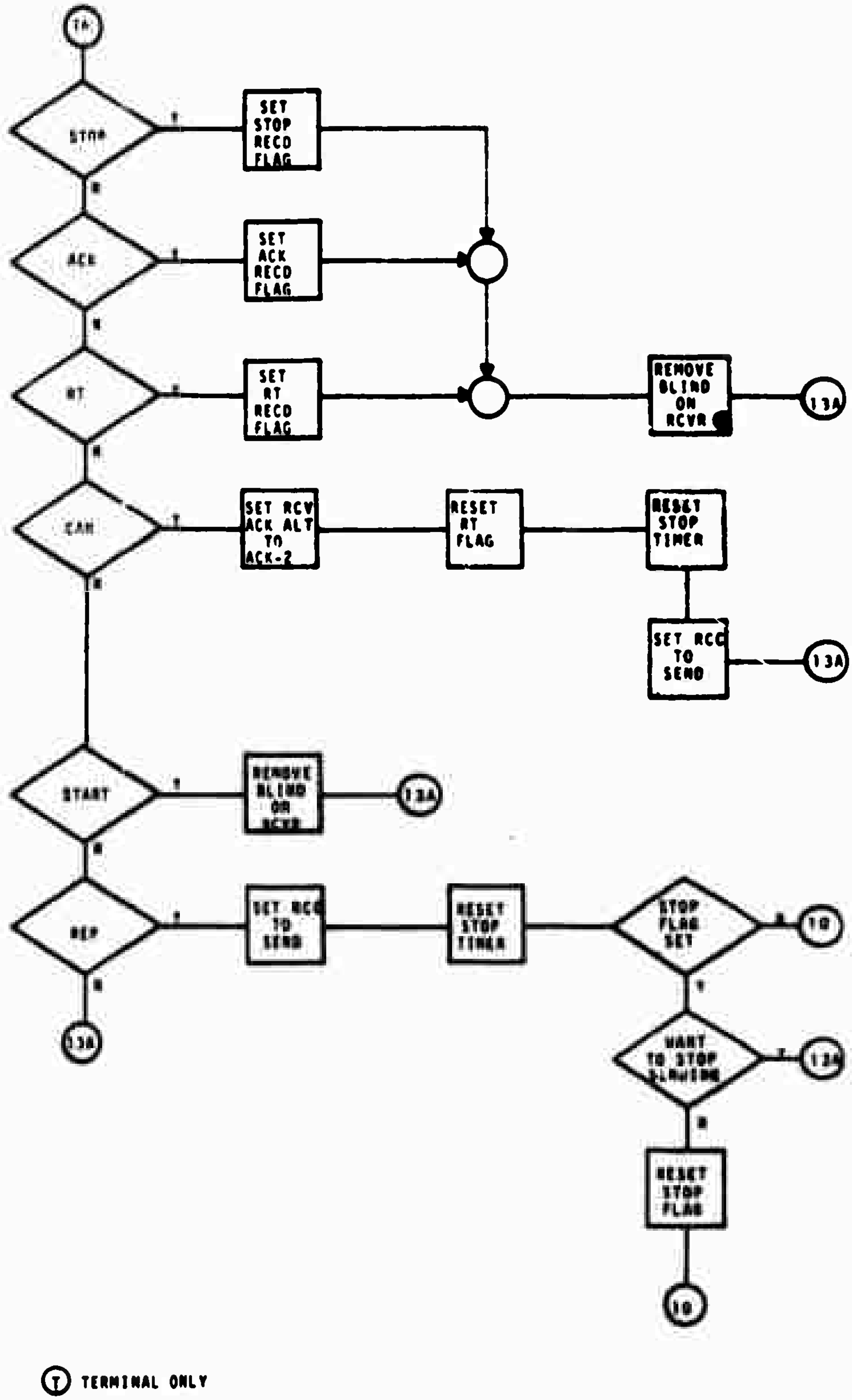
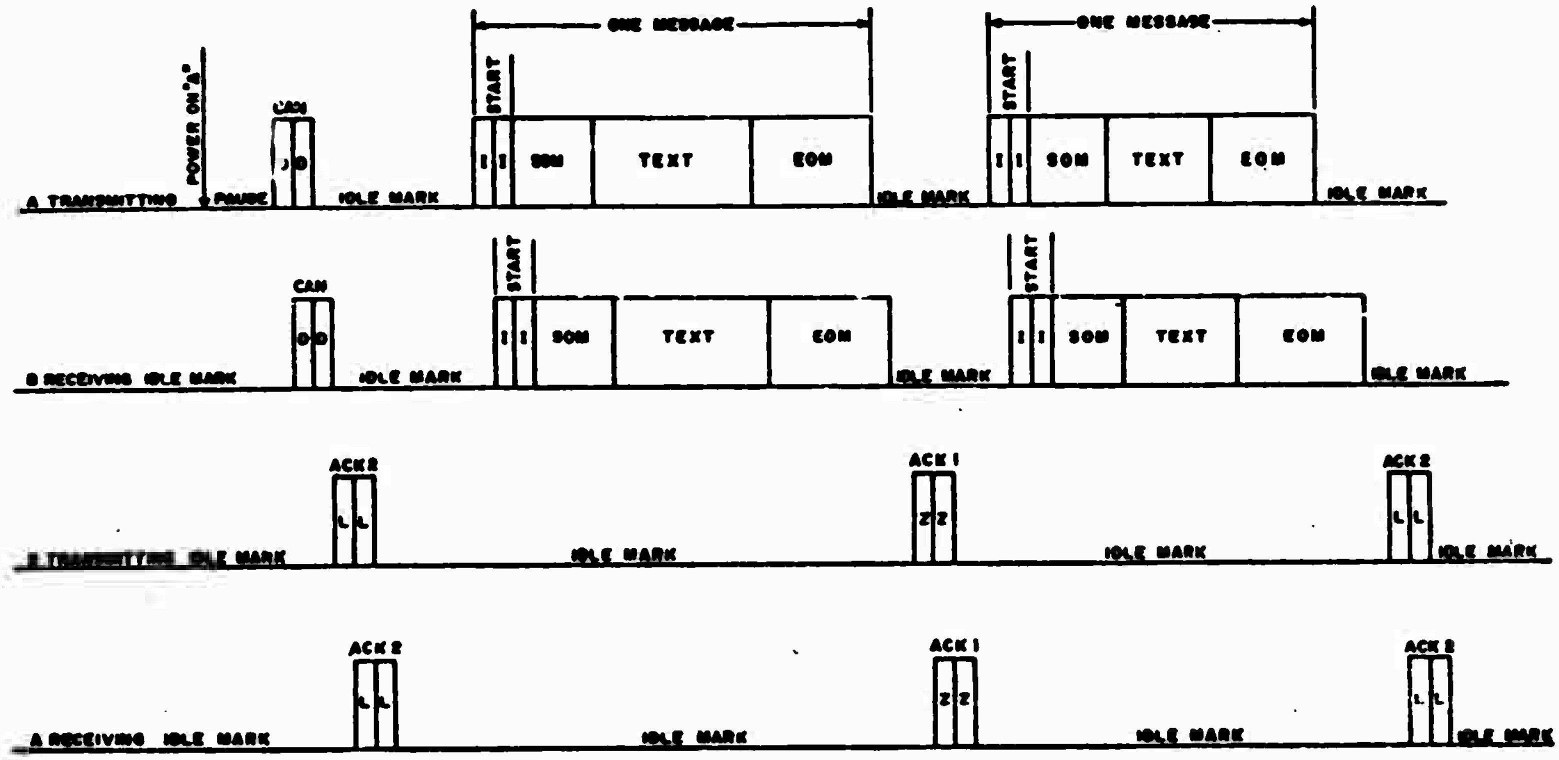


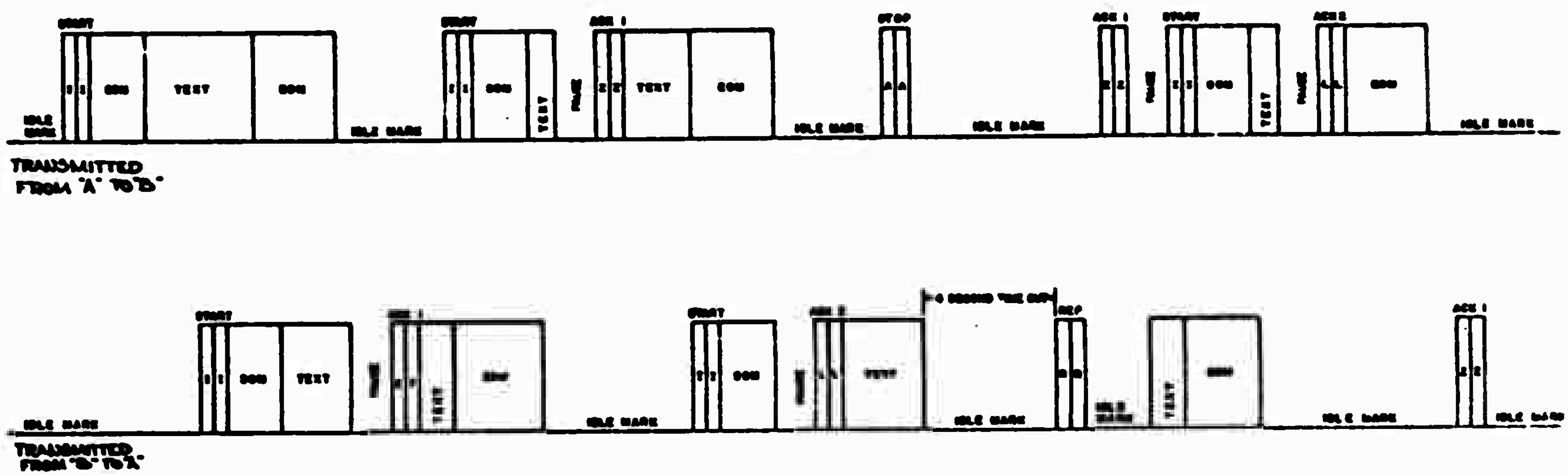
FIGURE 11-16. RECEIVE ROUTINE - END OF MESSAGE CONTROL SEQUENCE



NOTES

Pause = A Steady Mark Transmitted for a specific period of time.
SOM = Start of Message Sequence
EOM = End of message sequence
"A" = Subscribers Terminal
"B" = ASC

FIGURE 11-17. TYPICAL TELETYPEWRITER MESSAGE TRANSMITTED ON DIRECTION MODE V



NOTES

Pause = A steady mark transmitted for a specific period of time
SOM = Start of Message Sequence
EOM = End of Message Sequence
"A" = Subscriber terminal
"B" = ASC

For simplicity the REP-ACK sequence as described on page 11-31 and illustrated in the flow charts has been omitted.

FIGURE 11-18. TYPICAL TELETYPEWRITER DUPLEX OPERATION

CHAPTER 12. TRANSMISSION CRITERIA

1. Introduction. Certain transmission factors should be considered during the various stages of planning, implementation and operation of digital systems to insure the compatibility of interconnected transmission facilities. These factors include the various methods of accessing digital subscribers and deriving digital channels; interface characteristics; application of DCS Technical Schedules; and procedures for requesting telecommunications service. Since no single DCS publication addresses all of these factors, a compendium covering AUTODIN transmission systems and interfaces has been assembled and provided herewith. These criteria are equally applicable to both AUTODIN and peripheral data systems which could use AUTODIN Oriented transmission facilities.

2. Techniques for Deriving Multiple Digital Channels from a Voice Channel. Multiplexing is a method of deriving several digital channels from one voice channel. Frequency Division Multiplexing (FDM) and Time Division Multiplexing (TDM) are the most common techniques in use today.

a. The FDM Technique. The Frequency Division Multiplexer consists of a subcarrier generator for each digital channel, this subcarrier being amplitude, frequency or phase modulated by the digital stream. Insignificant sidebands of each sub-channel are filtered and the outputs of all channels bussed together. This common bus is connected to the input to the telephone channel. The output of the telephone channel is connected to filters which select the frequency components intended for each digital subchannel and reject all other components. The output of each filter is connected to an automatic signal leveling circuit and the output of this circuit connects to an amplitude, frequency, or phase detector. This detector converts the analog signal back into the original digital form.

(1) Although Voice Frequency Carrier Telegraph (VFCT) systems using the FDM technique with Frequency ShiftKeyed (FSK) subcarriers are commonly used throughout the DCS as 16-channel systems, collocation of all channels is not required. Although the usual case is to procure a 16-channel equipment and install it at a given location, individual channels may be located miles apart and interconnected by telephone type channels which are bridged together at suitable points to construct a network capable of providing digital service on an analog basis

to widely dispersed transmission points. This bridging technique has been incorporated into the transmission design of the AUTODIN. A network capable of supplying digital service to all of its digital subscribers was developed. These subscribers operate at speeds of 75 through 2400 BPS. It was determined that 1200 and 2400 BPS subscribers required a full voice channel for interconnection. Subscribers operating at 75, 150, 300, and 600 BPS presented a challenge. These subscribers in most cases were noncollocated and the distances between them were great. Existing transmission networks were not designed to operate at these rates. A transmission concept based upon FDM-FSK techniques was developed with service provided on a bridging basis to conserve voice channels. Special 75, 150, 300, 600, and 1200 BPS modems were procured for this program. The 75 BPS modem was designated single channel modem (SCM). The other modems were designated "Low Speed Modems" (LSM). Telephone type bridges and amplifiers were procured to serve at network junction points because these equipments were readily available and had already been selected for use in the AUTOVON program.

(2) The bridging method is used universally in the DCS to provide data service to noncollocated subscribers at rates through 600 BPS. Figure 12-1 shows a typical network. Standard modem frequencies shown in figures 12-2 and 12-3 must be allocated to insure a compatible system. The circuit engineer must specify circuit transmission levels. Such engineering is rather complex and transmission levels at all interface points require precise adjustment to the level specified. Paragraph 10 prescribes the method for deriving modem and bridge transmission levels. Although this is a function of the circuit engineer, it is included in this document as background data to illustrate the complexity of determining proper interface levels.

b. The TDM Technique. Digital channels may also be derived from higher-speed digital channels by compressing the time required to transmit the intelligence and restoring this time on the receiving end to its original state. The compressed channel is combined with other compressed channels to form a composite bit stream which permits the transmission of information from several digital channels over a single higher speed digital channel. This process is Time Division Multiplexing.

(1) This technique has been used for many years in digital computers and digital communications end terminals. Teletypewriters employ this technique. Since DCS transmission facilities are primarily analog telephone type facilities, digital to analog conversion is required between the output of a Time Division Multiplexer and the input to a telephone channel. The reverse process is required between the output of the telephone channel and the input to the Time Division Multiplexer. Since modulation rate conversion is accomplished within this multiplexer, precise timing is required throughout the Multiplexer and Demultiplexer for all functions to operate synchronously.

(2) The development of extensive data networks using TDM technique is complicated by the requirement for exact system timing. Precise clocks do not exist on a worldwide basis. However, the technique is very useful where multiple digital subscribers are collocated. The development of such systems under these conditions makes good sense since more efficient use is made of the transmission facility than in the FDM case. Although the trend is to develop TDM transmission systems on a worldwide basis, this subject is not a topic of discussion for this document.

3. Techniques for Deriving Single Digital Channels from Multiple Lower Speed Digital Channels. In the TDM technique described above, it is apparent that such multiplexers accept several low speed data inputs and provide one higher speed output. These equipments are designated parallel to serial converters. The demultiplexer accepts one higher speed input and provides several lower speed outputs. If the reverse logic is applied and the input to the demultiplexer is connected to the output of a data terminal, then the output of the demultiplexer may be connected to several lower speed digital transmission circuits. The outputs of these lower speed circuits are then connected to the inputs of the multiplexer and the output of the multiplexer connected to the data terminal. This configuration allows the transmission of higher speed data over several lower speed digital circuits.

a. This technique is often used when interfacing high frequency radio systems. The high frequency radio media will not support serial data transmission at speeds above 75 BPS; however, it will support several 75 BPS channels. Therefore, the TDM technique described above is used to derive multiple digital channels which are converted to FDM analog signals and transmitted over the HF radio system.

b. These techniques are employed in the design of the HF radio modem in use in the AUTODIN program which accepts and delivers digital signals at 1200 or 2400 BPS. Also, Serial-Parallel and Parallel-Serial digital converters are used in conjunction with VFCT equipments to derive 150 and 300 BPS data service over the HF system.

4. Methods of Access. The methods by which digital subscribers at the various standard modulation rates access DCS transmission facilities are specified in the subparagraphs below. Rates above 2400 BPS are recognized herein although they are not in actual use within the DCS at present. All modems discussed will be located in the same building with the digital terminals (subscriber terminal or ASC) in order to limit the lengths of cable between the devices over which the low level data and clock signals pass. All modems are intended for use over wire, microwave, tropospheric scatter, and communication satellite systems with the exception of the HF modem which has been specifically designed for use over high frequency radio systems. The latter modem, in the dual 1200 configuration, is also used over satellite systems in the Overseas AUTODIN. The low speed multiplexed configuration and the 1200 through 2400 BPS modems require full voice channels in accordance with the appropriate DCS Technical Schedules. With the exception of the multiplexed configuration, access between digital terminals may be via the AUTOVON on a circuit switched basis. This includes connections between: AUTOVON subscribers with compatible digital terminals; ASC's and AUTOVON subscribers with compatible digital terminals and two ASC's. The methods of access for the various bit rates follow:

a. 45 Through 75 BPS Access Methods.

(1) Voice frequency carrier telegraph systems which are interconnected at analog and digital interfaces in such a manner that single telegraph loop circuits are provided at the digital terminal interfaces. This is a standard DCS service.

(2) DC telegraph loop circuits between digital terminals via government-owned cable plant.

(3) Leased commercial DC telegraph loop circuits between digital terminals.

(4) Single Channel Modems (SCM's) providing a single DC telegraph loop circuit between digital terminals. These modems are normally frequency division multiplexed with other SCM's and with Low Speed Modems to more fully utilize the voice channel.

(5) Hybrid systems composed of leased facilities, VFCT systems and SCM's as described above.

b. <u>150-Through 600-BPS Access Methods</u>.

(1) Low Speed Modems (LSM's) providing 150, 300, or 600 BPS service between digital terminals. The modems are normally frequency division multiplexed with other LSM's and SCM's to more fully utilize the voice channel. This is the standard method of deriving circuits of these bit rates in the DCS.

(2) Serial-Parallel and Parallel-Serial Converters provide 150 or 300 BPS service between digital terminals by converting the serial data stream from the terminal to two or four parallel 75 BPS VFCT channels, respectively, for transmission between terminal locations and then reconverting to the serial stream for delivery at the distant terminal. The normal application of this system is for transmission via VFCT systems on high frequency radio facilities.

c. <u>1200 and 2400 BPS Access Methods</u>.

(1) Low Speed Modems providing 1200 BPS service between digical terminals. This is a standard DCS service.

(2) Medium Speed Modems providing 2400 BPS service between digital terminals. This is a standard DCS service.

(3) HF Modems arranged to provide one 2400 BPS channel or two 1200 BPS channels between digital terminals. The modems also have a capability to provide one 1200 BPS channel utilizing in-band frequency diversity technique which may be used under degraded media conditions. The normal configurations are one 2400 BPS channel via high frequency radio facilities and, because of transmission path delay contraints, two 1200 BPS channels via communications satellite facilities. The constraint in the latter case applies in the AUTODIN where the ARQ error correction system limits the amount of delay which can be accepted and still maintain continuous data transmission.

d. <u>4800 Through 9600 BPS Access Methods</u>.

(1) Modems providing 4800 BPS service between digital terminals. These modems may also have the capability of providing two 2400 BPS channels or four 1200 BPS channels in lieu of a single 4800 BPS channel. The multiple channel configurations will have applications in the AUTODIN on long submarine cable circuits or satellite circuits where transmission delay becomes a constraint. DCS Technical Schedules have not been developed for 4800 BPS circuits; however, tests performed thus far indicate circuits meeting published 2400 BPS criteria will be adequate for 4800 BPS service. This is a proposed DCS standard service.

(2) Modems providing 9600 BPS service between dedicated digital terminals. This service is not applicable to the AUTODIN which is limited to a maximum speed of 4800 BPS. DCS Technical Schedules have not been developed for this speed. This is an anticipated future DCS standard service.

5. <u>Application of the DCS Technical Schedules</u>. DCAC 310-130-1, <u>Processing Telecommunications Service Requests</u>, itemizes the various services offered by the DCS, describes circuit transmission parameters required for each service item and specifies procedures to be followed by subscribers when requesting service. Such procedures must be followed in all cases. The following factors should be considered by potential DCS subscribers to insure satisfactory service:

a. The circuit parameters specify end-to-end frequency response, envelope delay distortion, net loss variation, change in audio frequency, phase jitter, noise, impulse noise, single tone interference, harmonic distortion, impedance, longitudinal balance, telegraph distortion and composite data level requirements. A DCS subscriber should view these parameters as minimum (or maximum) levels of service degradation at which corrective action will be taken by cognizant DCS personnel. A circuit which fails to meet the specified parameters should not be activated until the problem is corrected.

b. The DCS Technical Schedules apply to all DCS-leased and DCS government-furnished circuits. All major U.S. commercial carriers have agreed to provide service that will equal or exceed the parameters specified by the DCS Technical Schedules, although commercial service designators are different from the DCS designators.

c. Since the circuit engineers lay out circuits to meet subscriber service requirements, it is important that TSR's be carefully prepared and include all pertinent information. DCAC 310-130-1 does not specify such circuit design details as signal power level since facility net losses are not uniform throughout the DCS and this information must be developed by the circuit engineer. The subscriber should indicate the transmission equipment that he intends to connect to the circuit as well as special transmission equipment or service (transfer keys, signalling lights, or control leads) that may be required.

6. AUTOVON Interface Considerations.

a. The parameters for the interface of AUTODIN with AUTOVON are defined in DCAC 370-V175-6, AUTOVON System Interface Criteria, Chapter XI, Interface With Other Systems. The AUTOVON transmission facilities available for use by AUTODIN are:

(1) Trunking between ASC's on either an off-hook basis or a dual-tone multifrequency (DTMF) dial-up basis.

(2) Intermittent message exchange between an ASC and AUTODIN tributaries homed on AUTOVON.

(3) Alternate voice-data service to the AUTODIN tributaries homed on AUTOVON.

b. The AUTOVON access line will consist of the AUTOVON four-wire line circuit, appropriate signalling and transmission facilities, the telephone line terminating unit, and the four-wire telephone or equivalent. The four-wire line circuit provides access from the subscriber to the AUTOVON switch. The AUTODIN line terminating unit will also perform the same functions as the AUTOVON line adapter circuit. Subscriber signalling is detailed in the above-referenced document.

c. The operation of the AUTODIN subscriber terminal over an AUTOVON circuit is described in chapter 6 of this Circular. A circuit between the ASC and the AUTOVON subscriber terminal must be established through the AUTOVON switching center prior to message transmission. After establishing a circuit to an AUTOVON connected subscriber terminal, the ASC will establish positive identification of that terminal to insure that messages are not transmitted to terminals other than the one for which the message is destined.

d. The DCS Technical Schedules describing the services available in AUTOVON are specified by DCAC 310-130-1, Processing of Telecommunications Service Requests.

e. DCAC 310-130-1 should be consulted to determine circuit characteristics. Other transmission criteria for AUTOVON access lines from four-wire subscribers and other switching systems are specified in DCAC 370-V175-6, Chapter IV, Transmission Criteria. The subscriber access line interface levels are specified in paragraph 4.3.3 of the above reference. The circuit design engineer is responsible for insuring that the AUTODIN data access levels match the required AUTOVON interface levels.

7. Modem Synchronization.

a. Interconnection of the various communications equipments that make up a data system requires precise synchronization to maintain the end-to-end integrity of the data information. Each successive data signal processing circuit must select the correct binary data information at the proper instant. Such synchronization is effected by a timing pulse which is derived from a stable oscillator. This pulse is also called a clocking pulse and the overall device which produces this pulse is called a clock. Data systems used in the DCS employ modems which have either internal or external clocks. External clocks are generally more stable and accurate than internal clocks, but they are also more sophisticated and expensive. It makes good sense to use a single external master station clock at locations where many data equipments must be timed. On the other hand, it is often difficult to justify an expensive clock to serve a single data equipment.

b. The timing for all data receive circuitry should be provided by a local clock which automatically corrects its phase to the phase of the incoming data signal. The stability of this clock should be such that system synchronism is maintained during brief signal interruptions. Clock signals appearing at equipments should be nearly square wave and at a rate equal to twice that of the data signal. That is to say, each clocking pulse should consist of both a positive and negative pulse, each of equal duration, with such duration being equal to one-half of the data bit. The rise and fall time of such pulses should not exceed the limits established by the MIL STD 188B low level keying.

c. In view of the factors discussed above, the synchronous modem, when equipped with an internal clock, should provide both corrected and uncorrected timing signals to its associated data equipment. In case the modem is not equipped with an internal clock, then it must accept external timing for operation of its modulator circuits, correct the phase of this timing to that of the incoming data signal, and time its demodulator circuits as well as its associated data receiving equipment. The proper phase relationship between clock and data signals must be determined and provided at all interface points for proper operation of the data system.

d. In addition to the factors discussed above, the clock accuracy and stability requirement is determined by the overall concept of system operation. The AUTODIN system concept of operation is covered in other portions of this document. For example, should the clock be sufficiently stable and accurate to maintain system synchronization without phase correction for a period in excess of 24 hours, then automatic synchronization would not be required and the system could be manually resynchronized daily. This would prevent erroneous correction due to transmission system noise. On the other hand, if the data system is capable of quickly and automatically resynchronizing after a loss of sync, then highly accurate and stable clocks would not be required. AUTODIN uses moderately stable internal clocks at subscriber locations and a master clock at each ASC. Other systems might well consider the use of external master clocks, as this type of operation is preferred where economically justifiable.

8. Modem Interface Characteristics. Standard DCS modem interface characteristics are described in DCAC 330-175-1, paragraphs 3.2.1.2.2.3 and 3.2.1.2.3.3. The specific modems and interface characteristics applicable to the overseas AUTODIN are described below:

a. Analog Interface. The analog signal transmitted between modems on a circuit must be compatible; i.e., the receive modem (demodulator) must be able to correctly interpret the signal transmitted from the send modem (modulator). Types of medems to be used in the DCS for various speeds of digital service have not been standardized; however, the following specific modems are currently in use for implementation of the overseas AUTODIN: Modem, Telegraph, MD-700(P)/G for 45 to 75 BPS service; Modem, Low Speed Wire-Line, MD-674(P)/G for 150 through 1200 BPS service; Modem, Digital Data, MD-701/UY for 2400 BPS service; and Digital Data Communication Set, AN/USC-10(V) for 2400 BPS service over HF radio facilities and dual 1200 BPS service over satellite facilities. The first three types of modem are not suitable for use over HF radio facilities.

b. Digital Data Interface. Compatibility of serial digital interface characteristics of the modems and their associated digital terminals must be assured for successful system operation. The objective is that modems used in the DCS provide the MIL STD-188B low level interface. Specific electrical interface parameters of modems used in the overseas AUTODIN are listed in subparagraph e below. These parameters, although varying somewhat from the MIL STD in some details, are compatible with the standard.

c. Timing Interface. The modem timing input and output interface requirements are discussed, in general, elsewhere in this chapter. The electrical parameters of the timing interfaces used in the overseas AUTODIN are listed in subparagraph e below.

d. Other Modem Interfaces. Digital modems used in the DCS may provide alarm leads for extension to associated terminal equipment or to remote indicators, as dictated by system operational requirements. For example, modems used in the overseas AUTODIN provide transmit and receive loss of carrier, transmit and receive loss of transitions and sync inhibit leads for extension to external terminations. The latter lead is utilized for control of the automatic synchronization feature utilized in the AUTODIN.

e. AUTODIN Modem Electrical Interface Parameters. The following characteristics apply only to the MD-700(P)/G, MD-674(P)/G and MD-701/UY modems. The AN/USC-10(V) modem electrical characteristics conform to requirements of MIL-STD-188B.

Transmitter input resistance	6800 ohms ± 10%
Transmitter input capacitance	1500 picofarads, maximum
Transmitter input sensitivity	± 0.5 volts

Transmitter output impedance	600 ohms ± 10% over the frequency band of interest, balanced and ungrounded
Transmitter carrier output level	+3 DBM to -20 DBM
Receiver input impedance	600 ohms ± 10% over the frequency band of interest, balanced and ungrounded
Receiver output impedance	100 ohms, maximum
Receiver, dynamic range	+7 DBM to -35 DBM
Receiver output voltage	±6 volts
Timing output voltage	±6 volts
Timing output impedance	100 ohms, maximum
Timing input sensitivity	±0.5 volts
Timing input impedance	6800 ohms ±10%
Timing input capacitance	1500 picofarads, maximum

9. Digital Interface Levels. The following signal levels apply to the digital interface between the transmission facility (data modem, converter or physical circuit) and the digital terminal. The digital interface electrical characteristics specified in DCAC 330-175-1, paragraph 3.2.1.2.2.5, should be consulted for further definitions of these interface requirements. Since the intent is to convert to the standard low level interface mode of operation, and new devices procured should provide this capability as the normal interface or as a built-in option.

a. Low Level Digital Modem or Converter Interface. The open circuit transmitting voltage (data or timing signals; where applicable) will be positive and negative 6±1.0 volts. Positive voltage indicates a marking or binary one condition and negative voltage indicates a spacing or binary zero condition.

b. High Level Interface. Generally, existing VFCT systems and leased telegraph (75 BPS or lower) circuits provide a high level digital interface. In addition, 75 BPS (or lower) circuits via physical circuits (cable) presently operate at high level. In these cases a DC level converter is utilized between the high level facility and the low level digital terminal. The following requirements apply to the high level interface:

(1) The standard high level voltage for polar operation will be positive and negative 60 volts ±2 percent. The transmitter output current shall be 0.020 ampere ±10 percent. Positive voltage indicates a marking or binary one condition and negative voltage indicates a spacing or binary zero condition. This is the preferred high level mode of operation.

(2) The standard high level voltage for neutral operation will be 130 volts ±2 percent. The operating current shall be either 0.020 ampere ±2.5 percent or 0.060 ampere ±2.5 percent. Current indicates a marking or binary one condition and no current indicates a spacing or binary zero condition. This mode of operation is not preferred.

10. <u>Single Channel and Low Speed Data Transmission Levels.</u>

a. Transmission levels within AUTODIN should be chosen such that the following requirements are met:

(1) Optimum composite data transmission level is -13 dbm0 at each voice frequency system interface.

(2) Power assignment for each data channel (subscriber) should be such that the data signal to noise ratio is the same for all data channels (subchannels) on a given voice frequency channel.

b. Requirement a.(1) imposes problems which can be solved by using DCA standardized levels which are verified by system tests to determine specific transmission levels under all operational loading conditions which provide maximum signal to noise performance on all channels.

c. Requirement a.(2) should be met as follows:

(1) Low speed and single channel modem output levels should be adjusted such that the following requirements are met:

(a) The composite level of the required combination of low speed or single channel modems at subscriber and ASC must match the optimum transmission level required by the connecting transmission facility.

(b) The 150 BPS modem output power should be adjusted to twice the single channel (75 BPS) output power and the 300 BPS modem output power should be adjusted to four times the single channel output power.

(2) Input and output amplifiers associated with transmission combining and dividing bridges should be adjusted such that the following requirements are met.

(a) Composite data levels must match the optimum transmission level required by the connecting transmission facility.

(b) All transmission levels into a given resistive bridge should be equalized on a single data tone basis. It is recommended that, from a transmission level viewpoint, each 150 BPS channel be treated as <u>two</u> single channel tones and each 300 BPS channel be considered as <u>four</u> single channel tones.

d. The following method for calculating modem output levels is recommended:

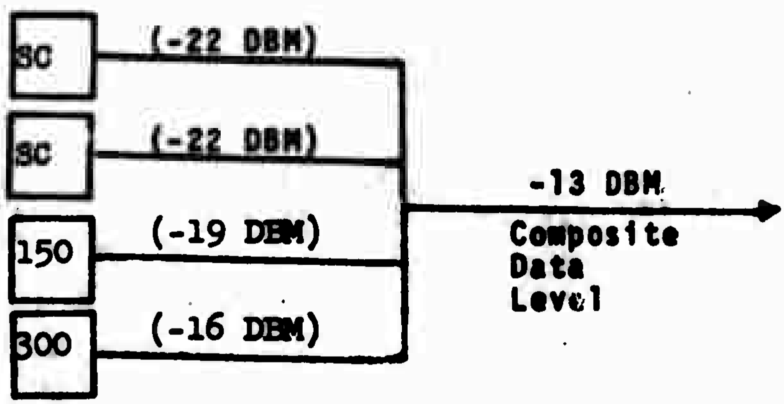
(1) MOL = CDL - (10 log E) + K

where:

MOL = Modem output level
CDL = Composite Data Level (all channels)
E = Equivalent number of data tones (considering each single channel modem as one tone, each 150 BPS modem as two tones, and each 300 BPS modem as four tones).
K = 0 for single channel modem
3 for 150 BPS modem

(2) Examples:

(a)

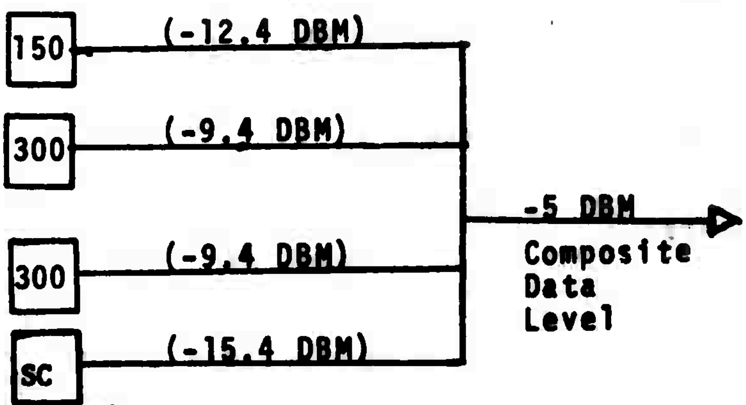


$$MOL_{sc} = CDL - (10 \log E) + K$$
$$= -13 - (10 \log 8) + 0$$
$$= -13 - (9) + 0$$
$$= -22 \text{ DBM}$$

$$MOL_{150} = CL - (10 \log E) + K$$
$$= -13 - (10 \log 8) + 3$$
$$= -13 - (9) + 3$$
$$= -19 \text{ DBM}$$

$$MOL_{300} = CDL - (10 \log E) + K$$
$$= -13 - (10 \log 8) + 6$$
$$= -13 - (9) + 6$$
$$= -22 + 6$$
$$= -16 \text{ DBM}$$

(b)



$$MOL_{150} = CDL - (10 \log E) + K$$
$$= -5 - (10 \log 11) + 3$$
$$= -5 - (10.4) + 3$$
$$= -15.4 + 3$$
$$= -12.4 \text{ DBM}$$

$$MOL_{300} = CDL - (10 \log E) + K$$
$$= -5 - (10 \log 11) + 6$$
$$= -5 - (10.4) + 6$$
$$= -15.4 + 6$$
$$= -9.4 \text{ DBM}$$

$$MOL_{sc} = CDL - (10 \log E) + K$$
$$= -5 - (10 \log 11) + \emptyset$$
$$= -5 - (10.4)$$
$$= -15.4 \text{ DBM}$$

e. The following method for calculating gains of amplifiers associated with combining/dividing resistive bridges is recommended:

(1) Input amplifier gain.

$GI = B_{in} - (IA_{in} - 10 \log E)$

where:

GI = Input amp. gain

B_{in} = Single Tone Level at resistive bridge input in DBM (Must be the same for all bridge inputs).

IA_{in} = Composite data level at input to input amplifier in DBM.

E = Equivalent number of data tones, considering SC tones as one tone each, 150 BPS tones as two tones each and 300 BPS tones as four tones each.

(2) Output amplifier gain.

$GO = OA_{out} - (B_{out} + 10 \log_e E)$

where:

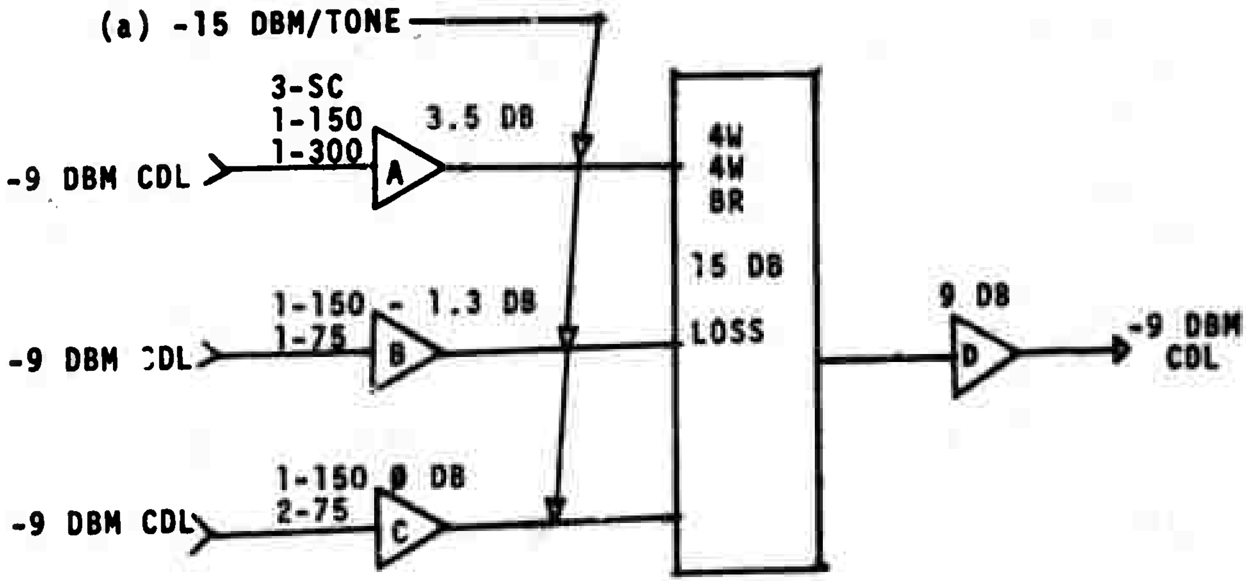
GO = Output amp. gain

OA out = composite data level required at output of output amplifier in DBM.

B_{out} = Single Data Tone Level at resistive bridge output in DBM.

E = Equivalent number of data tones, considering SC tones as one tone each, 150 BPS tones as two tones each and 300 BPS tones as four tones each.

(3) Examples:

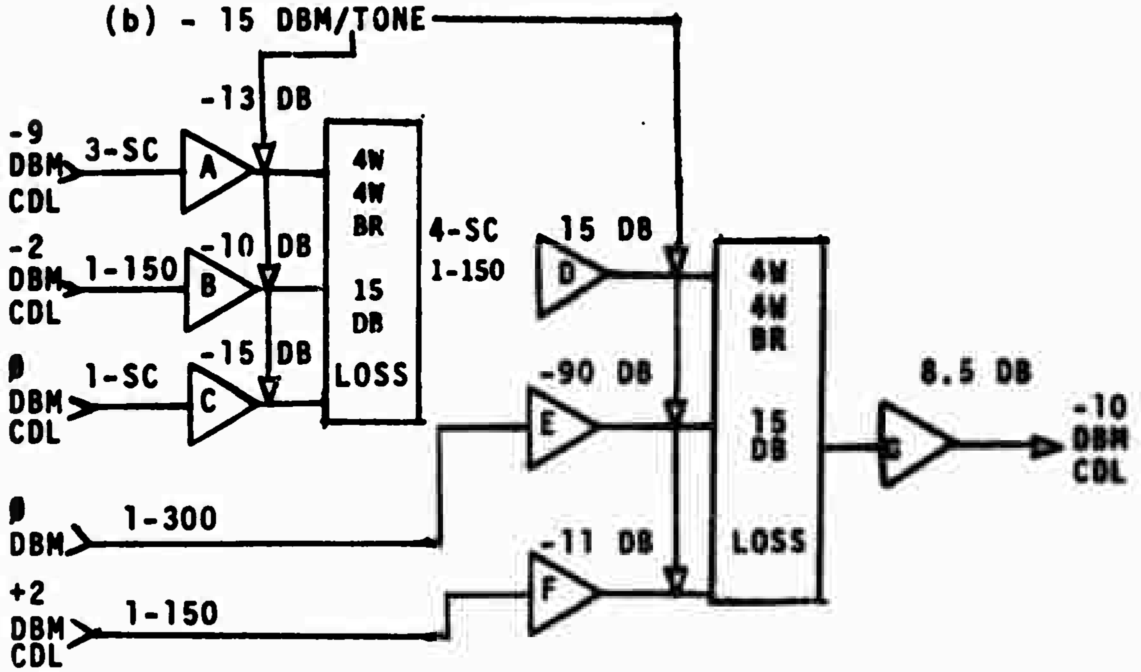


$$
\begin{aligned}
GI_A &= B_{in} - (IA_{in} - 10 \log E) \\
&= -15 - (-9 - 10 \log 9) \\
&= -15 - (-9 - 9.5) \\
&= -15 - (-18.5) \\
&= -15 + 18.5 \\
&= 3.5 \text{ DB}
\end{aligned}
$$

$$
\begin{aligned}
GI_B &= B_{in} - (IA_{in} - 10 \log E) \\
&= -15 - (-9 - 10 \log 3) \\
&= -15 - (-9 - 4.7) \\
&= -15 + 13.7 \\
&= -1.3 \text{ DB}
\end{aligned}
$$

$$
\begin{aligned}
GI_C &= B_{in} - (IA_{in} - 10 \log E) \\
&= -15 - (-9 - 10 \log 4) \\
&= -15 - (-9 - 6) \\
&= -15 + 15 \\
&= 0 \text{DB}
\end{aligned}
$$

$$
\begin{aligned}
GO_D &= OA_{out} - (B_{out} + 10 \log E) \\
&= -9 - (-30 + 10 \log 16) \\
&= -9 - (-30 + 12) \\
&= -9 - (-18) \\
&= 9 \text{ DB}
\end{aligned}
$$



$$GI_A = B_{in} - (IA - 10 \log E)$$
$$= -15 - (-9 - 10 \log 3)$$
$$= -15 - (-9 - 4.7)$$
$$= -1.3 \text{ DB}$$

$$GI_B = B_{in} - (IA_{in} - 10 \log E)$$
$$= -15 - (-2 - 10 \log 2)$$
$$= -15 - (-2 - 3)$$
$$= -10 \text{ DB}$$

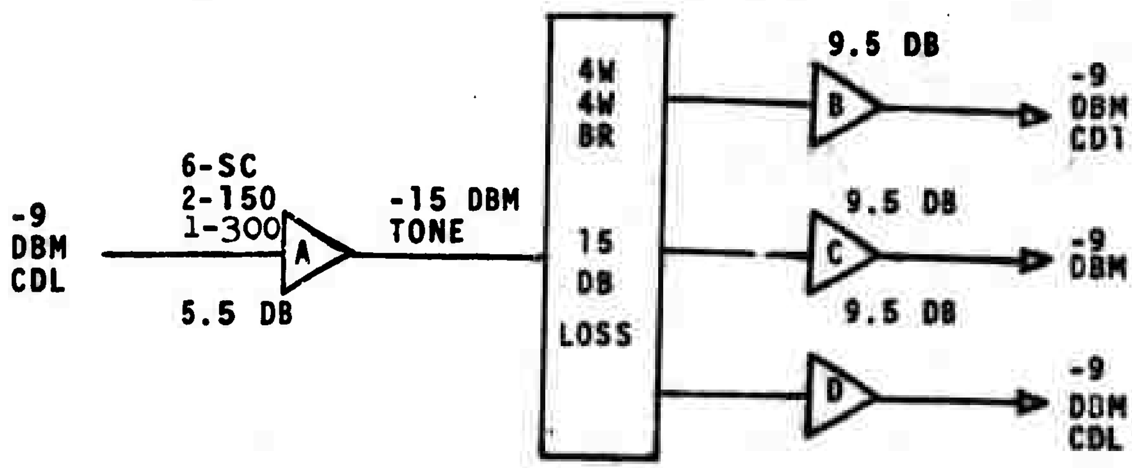
$$GI_C = B_{in} - (IA_{in} - 10 \log E)$$
$$= -15 - (\emptyset - 10 \log 1)$$
$$= -15 - (0)$$
$$= -15 \text{ DB}$$

Amplifier D gain should be 15 DB to compensate for the first four way four wire bridge loss.

$$
\begin{aligned}
GI_E &= B_{in} - (IA_{in} - 10 \log E) \\
&= -15 - (0 - (-10 \log 4) \\
&= -15 - (-6) \\
&= -9 \text{ DB}
\end{aligned}
$$

$$
\begin{aligned}
GI_F &= B_{in} - (IA_{in} - 10 \log E) \\
&= -15 - (+2 - 10 \log 4) \\
&= -15 - (2-6) \\
&= -15 - (-4) \\
&= -11 \text{ DB}
\end{aligned}
$$

$$
\begin{aligned}
GO_G &= OA_{out} - (B_{out} + 10 \log E) \\
&= -10 - (-30 + 10 \log 12) \\
&= -10 - (-30 + 11.5) \\
&= -10 - (-18.5) \\
&= -10 + 18.5 \\
&= 8.5 \text{ DB}
\end{aligned}
$$



$$
\begin{aligned}
GI_A &= B_{in} = (IA_{in} - 10 \log E) \\
&= -15 - (-9 - 10 \log 14) \\
&= -15 - (-9 - 11.5) \\
&= -15 - (-20.5) \\
&= 5.5 \text{ DB}
\end{aligned}
$$

$$
\begin{aligned}
GO_{BCD} &= OA_{out} - (B_{out} + 10 \log E) \\
&= -9 - (-30 + 11.5) \\
&= -9 - (-18.5) \\
&= 9.5 \text{ DB}
\end{aligned}
$$

f. Network system level alignment.

(1) Individual modem output levels can be adjusted to values determined above as follows:

(a) Connect output of modems (which have been paralleled) to the transmission line.

(b) Bridge power level indicator (Volume Indicator or decibel meter calibrated in DBM) across transmission line.

(c) Activate modems, one at a time and adjust output level potentiometer for proper output level.

(d) Activate all modems and the correct composite transmission level should appear on the line. Note: It may be convenient to operate the composite level several DB higher than the line requirement and install a variable attenuator between the modem composite output bus and the line. This arrangement will simplify the adjustment of the transmission input level to the line.

(2) Bridging amplifier gains can be adjusted as follows:

(a) Connect resistive bridge and amplifiers to patch bay.

(b) Terminate all inputs and outputs not being tested with 600 ohm resistors.

(c) Connect 1000 HZ tone to one input bridging amplifier input and adjust oscillator output power to composite tone level.

(d) Measure the power output of the input amplifier with power level indicator (Volume Indicator or DB meter calibrated in DBM) on bridging basis.

(e) Adjust amplifier output level to equal input level plus calculated gain required.

(f) Repeat f(2)(b) through (d) for each input amplifier.

(g) Connect 1000 Hz tone to one input bridging amplifier input and adjust oscillator output power to composite tone level.

(h) Measure the input level of the output amplifier and record. (Measure on bridging basis).

(i) Measure the output level of the output amplifier and adjust the output amplifier gain until the output level minus input level equals specified gain.

(j) Repeat f(2)(i) for each output amplifier.

(k) Verify correct adjustment under operating conditions by activating operationally and measuring composite tone outputs from output amplifier(s). Slight adjustment in output amplifier gain may be necessary to match transmission channel input level requirements. All amplifier levels should be measured and recorded at this time for circuit maintenance purposes.

(l) A spectrum or wave analyzer, if available, may be connected to any amplifier input or output to verify correct level adjustments. In making such measurements it is first necessary that normal tone levels (modulation rate, active tone frequencies, normal transmission level point etc.) be determined.

g. The transmission level concept recommended above should provide optimum network performance. This concept is admittedly complex and presents implementation problems. One might well question the advisability of such a concept and suggest alternate methods. Several concepts were considered and discarded. The alternatives considered were as follows:

(1) Simply adjust the power output of each modem to an equal value such that the composite power matches the transmission line level requirement. This concept favors SC

transmission inasmuch as the SC modem signal occupies one half the 150 BPS noise spectrum and one fourth the 300 BPS noise spectrum, therefore the 150 BPS signal must suffer a 3 dB noise penalty and the 300 BPS signal, a 6 dB penalty.

(2) Adjust the transmission bridges for zero net loss between bridge input and output terminations. This adjustment is acceptable only when all inputs contain an equal number of data tones. This is usually not the case. With usual configurations, this concept results in up to 10 dB difference in individual tone levels at the bridge output. Combination of alternatives g(1) and (2) would impose a worst case 300 BPS noise penalty of 16 dB.

(3) Adjust modem power outputs to equal levels on a single data tone DBM0 basis and maintain these levels throughout the network. This concept could cause a noise penalty of up to 12 dB. Normal composite data transmission levels throughout the network would depend upon the number of data tones assigned and therefore could present as many as 16 different normal composite transmission levels to the technical controller. Such a concept would create undue signal to noise penalities and operational problems.

h. The recommended concept poses several problems which in some instances, are considered advantages.

(1) Transmission net losses through the bridges in most cases will not be equal. Therefore, net loss testing on a system basis should be avoided; e.g., from subscriber to switch. Such testing would provide useless information and would require deactivation of branches not involved in the test. The 1 KHZ test tone might well fall within the bandpass of a shared subscriber data channel disrupting service. The unequal net loss actually provides a noise advantage. The unequal net loss also prevents overload of transmission systems connected to the output of the bridge whenever standard test tone is inadvertently applied simultaneously to all bridge inputs.

(2) Noise contribution from transmission facilities which are combined by the bridges is a problem worthy of consideration. It is obvious that an excessively high noise level on any of the interconnected transmission facilities would disrupt service on all connected data subscribers. Such facilities should be disconnected from bridging inputs and the

high noise problem corrected before reconnection. Suitable bandpass filters inserted between each transmission facility and bridge input would minimize this problem. Such filters are not currently available, and therefore could not be provided for AUTODIN. It is interesting to note that the unequal net loss provided by the recommended concept actually tends to weigh (on a flat amplitude basis) the noise contribution from each interconnected VF line. VF lines carrying a larger number of data tones will "contribute" more noise than VF lines carrying lesser number of tones. This is caused by the greater gain necessary in the input amplifier coupling the VF channel with a larger number of data tones to the bridge than that required by a VF channel with a lesser number of tones. The net result is that application of the recommended concept will minimize the total noise contribution caused by the bridging technique.

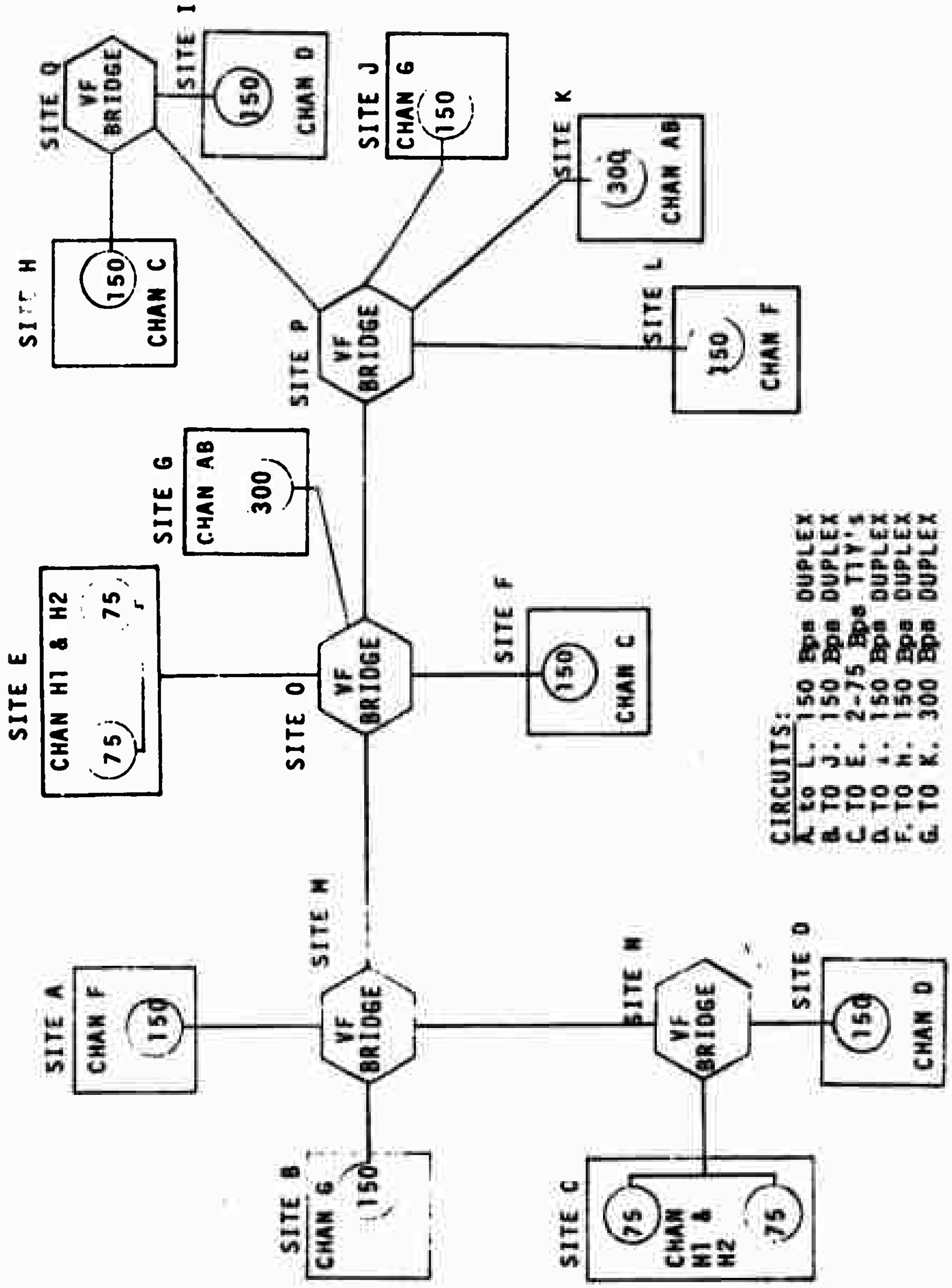


FIGURE 12-1. TYPICAL NETWORK CONFIGURATION

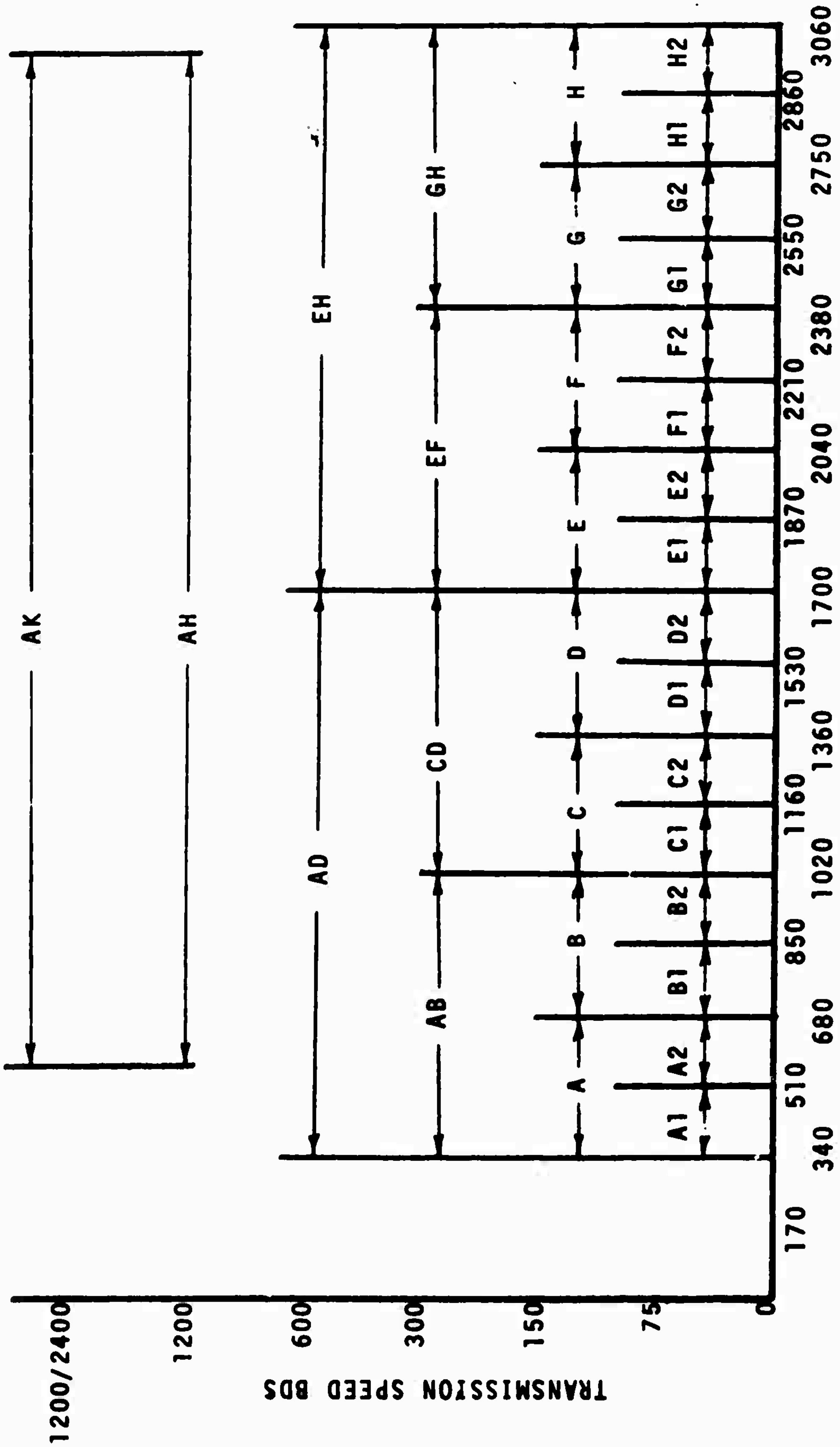


FIGURE 12-2. DCS STANDARD MODEM FREQUENCY ALLOCATION PLAN

CHAPTER 13. SYSTEM INTEGRITY

(TO BE ADDED AT A LATER DATE)

CHAPTER 14. CHARACTER USAGE AND CODE EQUIVALENCY

1. Character Usage. Although the AUTODIN Switching Centers can accommodate all 128 characters of the ASCII the limited character handling capabilities of a large number of terminal equipments, requires that restrictions be placed on the number of ASCII characters allowed to be entered into the system. These restrictions will remain in effect until the Fieldata Code and limited capability terminals are phased out of the DCS AUTODIN. Table 1 defines those ASCII characters restricted for use in the DCS AUTODIN during the interim period prior to the phase out of the Fieldata Codes. Tables 2, 3 and 4 identify the allowable characters based on machine codes (ASCII, ITA#2, and Hollerith Card Code).

2. Code Equivalency.

a. The Code equivalent tables must be used to equate codes only as indicated by their titles; that is, machine code to line code, line code to line code, and line code to machine code. All tables are read left to right only. To determine the equivalent, find the desired character in the originating code in the left columns, and select the code to which it is to be equated on the right columns. A note at the end of each table specifies which codes can be translated to other codes.

b. Code conversion in these tables is for characters used in the text portion of a message only, and does not cover characters used for control and framing functions.

3. Machine Codes.

a. General. Input/Output devices will operate in one of three different machine codes:

(1) ASCII - Associated with eight-level paper tape input/output devices.

(2) Hollerith - Associated with 80-column card input/output devices.

(3) ITA #2 - Associated with five-level paper tape input/output devices.

The reader device will process ASCII paper tape with even parity data characters; therefore, the perforator must produce even parity characters from its punching mechanism. Hollerith and ITA #2 do not have parity bits. The machine codes for magnetic tape input/output devices have been considered, but due to the wide variety of levels and parity have been omitted from tne charts. At present, AUTODIN does not specify a standard machine code for magnetic tape input/output devices; therefore, messages can only be exchanged between terminals possessing like or equivalent equipment.

b. Input Codes. This document defines the ASCII as consisting of 128 characters, the Hollerith code as consisting of 64 characters, and the ITA #2 code as consisting of 58 characters. The reader devices at the terminals will be allowed to introduce into the AUTODIN system 73 ASCII characters, 64 Hollerith characters, and 58 ITA #2 characters. It will be necessary, therefore, that nonallowable characters be inhibited at the reader if those characters are contained in the reading media. The characters to be inhibited are identified in table 1.

c. Conversion of Input Codes. The AUTODIN terminals are required to perform conversion from the machine code of the device to the line code on the transmit side. Allowed conversions are as follows:

ASCII to ASCII
Hollerith to ASCII
Hollerith to Fieldata
ITA #2 to ASCII
ITA #2 to Fieldata
ITA #2 to ITA #2

d. Output Codes. Although there are limitations on the number of characters which can be introduced into the system by an AUTODIN terminal, it is conceivable that non-AUTODIN terminals, such as OMTN's, NARC's, etc., will be allowed to use existing equipment which may introduce characters into the system which have been classified as nonallowable. For this reason, and due to expansion planning, output codes should provide equivalent characters for the transparent data codes of an ASC. The output codes are ASCII, Hollerith, and ITA #2. It is required that output devices be capable of punching 73 ASCII characters, 64 Hollerith characters, and 58 ITA #2 characters. The breakdown is as follows:

		ASCII	Hollerith	ITA #2
	Alphabetics	26	26	26
	Numerics	10	10	10
Punch	Graphics	27	27	15
	Space	1	1	1
	Machine Functions	2	--	4
	Special Purpose Functions	7	--	2
	TOTAL	73	64	58

		ASCII	Hollerith	ITA #2
	Alphabetics	26	26	26
	Numerics	10	10	10
Print	Graphics	27	27	15
	Space	1	1	1
	Machine Functions	--	--	--
	Special Purpose Functions	--	--	--
	TOTAL	64	64	52

The machine functions are:

LF - Line Feed
CR - Carriage Return
LTRS - Letters
FIGS - Figures

The special purpose function characters for ASCII are SI (equivalent to ITA #2 LTRS), SO (equivalent to ITA #2 FIGS), NUL (equivalent to ITA #2 blank), BEL, DC4, EM and DEL. The special purpose function characters for ITA #2 are Blank and BEL. It must be noted that the ASCII paper tape punch (reperforator) will produce even parity characters on the paper tape. The Hollerith cards and the ITA #2 tape are not parity-oriented.

e. Conversion of Output Codes. AUTODIN terminals are required to perform conversion from the line code on the receive side to the machine code of the output device. Allowed conversion are as follows:

ASCII to ASCII
ASCII to Hollerith
ASCII to ITA #2
Fieldata to Hollerith
Fieldata to ITA #2
ITA #2 to ITA #2

4. Line Codes.

a. General. ASCII, Fieldata, and ITA #2 are allowed as line codes in the AUTODIN system. A subscriber terminal is allowed to operate with one of these codes, and it must use the same code on its receive line as it does on its transmit line. A government-owned ASC can operate with ASCII and ITA #2 and a leased ASC can operate with all three line codes. A government-owned ASC is capable of accepting 128 odd parity ASCII characters and 58 ITA #2 characters in the text portion of a message, while a leased ASC is capable of accepting 128 odd parity ASCII characters, 74 odd parity Fieldata characters, and 58 ITA #2 characters in the text portion of a message. The leased ASC's will not code-convert Fieldata odd parity special and control characters (see supplement 1, table 3, columns 0, 1, and 3) when these characters appear in the text portion of a message. In ITA #2, alphabetic symbols will be preceded by letters shift, and numeric and graphic symbols will be preceded by figures shift. Machine functions and space are not case-oriented. At an ASC, code conversion is performed from the receive line code to the internal code and from the internal code to the transmit line code.

b. ASC Internal Codes. The internal code of the government-owned ASC is ASCII. Table 2 does not show a separate column for the ASC's internal code, because the bit configuration is identical to the column shown as "Receive Line Code-ASCII." The internal code of the leased ASC's is Extended Fieldata, shown in table 2. It must be noted that Extended Fieldata is not oriented toward odd or even parity but rather code conversion is performed strictly on a bit-structure basis.

c. Conversion of Line Codes. Conversion from the receive line code to the transmit line code can take place as follows:

ASCII to ASCII
ASCII to Fieldata
ASCII to ITA #2
Fieldata to ASCII
Fieldata to Fieldata
Fieldata to ITA #2
ITA #2 to ASCII
ITA #2 to Fieldata
ITA #2 to ITA #2

Prior to the phase-out of Fieldata, the leased ASC will perform the entire above conversion, but the government-owned ASC is not required to perform the conversions involving Fieldata.

5. Abbreviations. The following abbreviations are used in the code conversion tables:

a. ASCII - American Standard Code for Information Interchange.

b. ITA #2 - International Telegraph Alphabet #2.

c. RMK - Remark

d. Pnt - Print

e. NP - No Print or No Punch (as appropriate for that column.

TABLE 14-1. CHARACTER USE LIMITATION IN THE AUTODIN NETWORK PRIOR TO THE "PHASEOUT" OF FIELDATA

a	s	ACK
b	t	BS
c	u	HT
d	v	VT
e	w	FF
f	x	DLE
g	y	DC_1
h	z	DC_2
i	\	DC_3
k	{	SYN
l	}	ETB
m	¦	CAN
n	SOH	SUB
o	STX	ESC
p	ETX	FS
q	EOT	GS
r	ENQ	RS
j	~	NAK
		US

TABLE 14-2. CHARACTERS PERMITTED IN ASCII (73)

A	S	!	<
B	T	"	=
C	U	#	>
D	V	$	_
E	W	&	[
F	X	'	@
G	Y	(	^
H	Z	)	\
I	Ø	,	]
J	1	-	BEL
K	2	.	LF
L	3	/	CR
M	4	:	SO
N	5	;	SI
O	6	?	EM
P	7	%	DEL
Q	8	*	NUL
R	9	+	SPACE
			DC4

TABLE 14-3. CHARACTERS PERMITTED IN ITA #2 (58)

A	T	#
B	U	$
C	V	&
D	W	'
E	X	(
F	Y	)
G	Z	,
H	Ø	-
I	1	.
J	2	/
K	3	:
L	4	;
M	5	?
N	6	BELL
O	7	LF
P	8	CR
Q	9	SPACE
R	!	FIGS
S	"	LTRS
		BLANK

TABLE 14-4. CHARACTERS PERMITTED IN HOLLERITH (64)

A	R	8
B	S	9
C	T	#
D	U	%
E	V	&
F	W	
G	X	-
H	Y	.
I	Z	/
J	Ø	<
K	1	>
L	2	[
M	3	\
N	4	∧
O	5	SPACE
P	6	*
Q	7	
		1

TABLE 14-4. CHARACTERS PERMITTED IN HOLLERITH (Continued)

!	:
"	;
$	=
'	?
(	@
)	]
+	-

TABLE 14-5. AUTODIN CODE EQUIVALENTS MACHINE-TO-LINE

		MACHINE CODE			LINE CODE																							
		ASCII	HOLLERITH	ITA #2	ASCII									FIELDATA									ITA #2					
DATA CHARACTER	SHF	Read	Read	Read	Char	8	7	6	5	4	3	2	1	Char	8	7	6	5	4	3	2	1	Char	5	4	3	2	1
A		1,7	12,1	1,2	A	1	1	0	0	0	0	0	1	A	0	1	0	0	0	1	1	0	A	0	0	0	1	1
B		2,7	12,2	1,4,5	B	1	1	0	0	0	0	1	0	B	1	1	0	0	0	1	1	1	B	1	1	0	0	1
C		1,2,7,8	12,3	2,3,4	C	0	1	0	0	0	0	1	1	C	1	1	0	0	1	0	0	0	C	0	1	1	1	0
D		3,7	12,4	1,4	D	1	1	0	0	0	1	0	0	D	0	1	0	0	1	0	0	1	D	0	1	0	0	1
E		1,3,7,8	12,5	1	E	0	1	0	0	0	1	0	1	E	0	1	0	0	1	0	1	0	E	0	0	0	0	1
F		2,3,7,8	12,6	1,3,4	F	0	1	0	0	0	1	1	0	F	1	1	0	0	1	0	1	1	F	0	1	1	0	1
G		1,2,3,7	12,7	2,4,5	G	1	1	0	0	0	1	1	1	G	0	1	0	0	1	1	0	0	G	1	1	0	1	0
H		4,7	12,8	3,5	H	1	1	0	0	1	0	0	0	H	1	1	0	0	1	1	0	1	H	1	0	1	0	0
I		1,4,7,8	12,9	2,3	I	0	1	0	0	1	0	0	1	I	1	1	0	0	1	1	1	0	I	0	0	1	1	0
J		2,4,7,8	11,1	1,2,4	J	0	1	0	0	1	0	1	0	J	0	1	0	0	1	1	1	1	J	0	1	0	1	1
K		1,2,4,7	11,2	1,2,3,4	K	1	1	0	0	1	0	1	1	K	1	1	0	1	0	0	0	0	K	0	1	1	1	1
L		3,4,7,8	11,3	2,5	L	0	1	0	0	1	1	0	0	L	0	1	0	1	0	0	0	1	L	1	0	0	1	0
M		1,3,4,7	11,4	3,4,5	M	1	1	0	0	1	1	0	1	M	0	1	0	1	0	0	1	0	M	1	1	1	0	0
N		2,3,4,7	11,5	3,4	N	1	1	0	0	1	1	1	0	N	1	1	0	1	0	0	1	1	N	0	1	1	0	0
O		1,2,3,4,7,8	11,6	4,5	O	0	1	0	0	1	1	1	1	O	0	1	0	1	0	1	0	0	O	1	1	0	0	0
P		5,7	11,7	2,3,5	P	1	1	0	1	0	0	0	0	P	1	1	0	1	0	1	0	1	P	1	0	1	1	0
Q		1,5,7,8	11,8	1,2,3,5	Q	0	1	0	1	0	0	0	1	Q	1	1	0	1	0	1	1	0	Q	1	0	1	1	1
R		2,5,7,8	11,9	2,4	R	0	1	0	1	0	0	1	0	R	0	1	0	1	0	1	1	1	R	0	1	0	1	0
S		1,2,5,7	Ø,2	1,3	S	1	1	0	1	0	0	1	1	S	0	1	0	1	1	0	0	0	S	0	0	1	0	1
T		3,5,7,8	Ø,3	5	T	0	1	0	1	0	1	0	0	T	1	1	0	1	1	0	0	1	T	1	0	0	0	0
U		1,3,5,7	Ø,4	1,2,3	U	1	1	0	1	0	1	0	1	U	1	1	0	1	1	0	1	0	U	0	0	1	1	1
V		2,3,5,7	Ø,5	2,3,4,5	V	1	1	0	1	0	1	1	0	V	0	1	0	1	1	0	1	1	V	1	1	1	1	0
W		1,2,3,5,7,8	Ø,6	1,2,5	W	0	1	0	1	0	1	1	1	W	1	1	0	1	1	1	0	0	W	1	0	0	1	1
X		4,5,7,8	Ø,7	1,3,4,5	X	0	1	0	1	1	0	0	0	X	0	1	0	1	1	1	0	1	X	1	1	1	0	1
Y		1,4,5,7	Ø,8	1,3,5	Y	1	1	0	1	1	0	0	1	Y	0	1	0	1	1	1	1	0	Y	1	0	1	0	1
Z		2,4,5,7	Ø,9	1,5	Z	1	1	0	1	1	0	1	0	Z	1	1	0	1	1	1	1	1	Z	1	0	0	0	1
a	1	1,6,7,8																										
b	1	2,6,7,8																										
c	1	1,2,6,7																										
d	1	3,6,7,8																										
e	1	1,3,6,7																										
f	1	2,3,6,7																										
g	1	1,2,3,6,7,8																										
h	1	4,6,7,8																										
i	1	1,4,6,7																										
j	1	2,4,6,7																										
k	1	1,2,4,6,7,8																										
l	1	3,4,6,7																										
m	1	1,3,4,6,7,8																										
n	1	2,3,4,6,7,8																										
o	1	1,2,3,4,6,7																										
p	1	5,6,7,8																										
q	1	1,5,6,7																										

*See note at end of table.

TABLE 14-5. AUTODIN CODE EQUIVALENTS MACHINE-TO-LINE (CONTINUED)

		MACHINE CODE			LINE CODE					
		ASCII	HOLLERITH	ITA #2	ASCII		FIELDATA		ITA #2	
DATA CHARACTER	BNK	Read	Read	Read	Char	8 7 6 5 4 3 2 1	Char	8 7 6 5 4 3 2 1	Char	5 4 3 2 1
r	1	2.5.6.7								
s	1	1.2.5.6.7.8								
t	1	3.5.6.7								
u	1	1.3.5.6.7.8								
v	1	2.3.5.6.7.8								
w	1	1.2.3.5.6.7								
x	1	4.5.6.7								
y	1	1.4.5.6.7.8								
z	1	2.4.5.6.7.8								
ø		5.6	ø	2.3.5	ø	1 0 1 1 0 0 0 0	ø	0 1 1 1 0 0 0 0	ø	1 0 1 1 0
1		1.5.6.8	1	1.2.3.5	1	0 0 1 1 0 0 0 1	1	1 1 1 1 0 0 0 1	1	1 0 1 1 1
2		4.5.6.8	2	1.2.5	2	0 0 1 1 0 0 1 0	2	1 1 1 1 0 0 1 0	2	1 0 0 1 1
3		1.2.5.6	3	1	3	1 0 1 1 0 0 1 1	3	0 1 1 1 0 0 1 1	3	0 0 0 0 1
4		3.5.6.8	4	2.4	4	0 0 1 1 0 1 0 0	4	1 1 1 1 0 1 0 0	4	0 1 0 1 0
5		1.3.5.6	5	5	5	1 0 1 1 0 1 0 1	5	0 1 1 1 0 1 0 1	5	1 0 0 0 0
6		2.3.5.6	6	1.3.5	6	1 0 1 1 0 1 1 0	6	0 1 1 1 0 1 1 0	6	1 0 1 0 1
7		1.2.3.5.6.8	7	1.2.3	7	0 0 1 1 0 1 1 1	7	1 1 1 1 0 1 1 1	7	0 0 1 1 1
8		4.5.6.8	8	2.3	8	0 0 1 1 1 0 0 0	8	1 1 1 1 1 0 0 0	8	0 0 1 1 0
9		1.4.5.6	9	4.5	9	1 0 1 1 1 0 0 1	9	0 1 1 1 1 0 0 1	9	1 1 0 0 0
! Exclamation point		1.6.8	11.7.8	1.3.4	!	1 0 1 0 0 0 0 1	!	0 1 1 0 1 1 0 1	!	0 1 1 0 1
" Quotation Marks		2.6	7.8	1.5	"	1 0 1 0 0 0 1 0	"	1 1 1 0 1 0 1 0	"	1 0 0 0 1
# Number Sign		1.2.6.8	3.8	3.5	#	0 0 1 0 0 0 1 1	#	1 0 1 0 0 0 0 1	#	1 0 1 0 0
$ Dollar Sign		3.6	ø.6.8	1.4	$	1 0 1 0 0 1 0 0	$	0 1 1 0 0 1 1 1	$	0 1 0 0 1
% Percent		1.3.6.8	ø.4.8		%	0 0 1 0 0 1 0 1	%	0 0 1 0 0 1 1 0		
& Ampersand		2.3.6.8	ø.1	2.4.5	&	0 0 1 0 0 1 1 0	&	0 0 1 0 1 0 0 1	&	1 1 0 1 0
' Apostrophe		1.2.3.6	2.8	1.2.4	'	1 0 1 0 0 1 1 1	'	0 1 1 1 1 0 1 0	'	0 1 0 1 1
(Opening Parenthesis		4.6	12.6.8	1.2.3.4	(	1 0 1 0 1 0 0 0	(	1 1 1 0 1 0 0 1	(	0 1 1 1 1
) Closing Parenthesis		1.4.6.8	6.8	2.5	)	0 0 1 0 1 0 0 1	)	1 1 1 0 0 0 0 0	)	1 0 0 1 0
* Asterisk		2.4.6.8	11.4.8		*	0 0 1 0 1 0 1 0	*	0 1 1 0 1 0 0 0		
+ Plus		1.2.4.6	12.5.8		+	1 0 1 0 1 0 1 1				
, Comma		3.4.6.8	ø.3.8	3.4	,	0 0 1 0 1 1 0 0	,	0 1 1 0 1 1 1 0	,	0 1 1 0 0
- Hyphen or Minus		1.3.4.6	12	1.2	-	1 0 1 0 1 1 0 1	-	0 1 1 0 0 0 0 1	-	0 0 0 1 1
. Period		2.3.4.6	12.3.8	3.4.5	.	1 0 1 0 1 1 1 0	.	1 1 1 1 1 1 0 1	.	1 1 1 0 0
/ Slant		1.2.3.4.6.8	11	1.3.4.5	/	0 0 1 0 1 1 1 1	/	0 1 1 1 1 1 0 0	/	1 1 1 0 1
: Colon		2.4.5.6	5.8	2.3.4	:	1 0 1 1 1 0 1 0	:	0 1 1 0 1 0 1 1	:	0 1 1 1 0
; Semi-Colon		1.2.4.5.6.8	11.6.8	2.3.4.5	;	0 0 1 1 1 0 1 1	;	1 1 1 1 1 0 1 1	;	1 1 1 1 0
< Less than		3.4.5.6	12.4.8		<	1 0 1 1 1 1 0 0	<	1 1 1 0 0 0 1 1		
= Equals		1.3.4.5.6.8	12.7.8		=	0 0 1 1 1 1 0 1				
> Greater Than		2.3.4.5.6.8	4.8		>	0 0 1 1 1 1 1 0	>	1 1 1 0 0 1 0 1		
? Question Mark		1.2.3.4.5.6	ø.5.8	1.4.5	?	1 0 1 1 1 1 1 1	?	1 1 1 0 1 1 0 0	?	1 1 0 0 1
` Grave Accent	1	6.7								
[Opening Bracket	2	1.2.4.5.7.8	11.3.8		[	0 1 0 1 1 0 1 1	○	1 0 1 0 1 1 0 1		
\ Reverse Slant	3	3.4.5.7	12.ø		\	1 1 0 1 1 1 0 0	+o	1 0 1 0 1 1 1 0		

TABLE 14-5. AUTODIN CODE EQUIVALENTS MACHINE-TO-LINE (CONTINUED)

		MACHINE CODE			LINE CODE					
		ASCII	[illegible]	ITA #2	ASCII		FIELDATA		ITA #2	
DATA CHARACTER	[illegible]	Read	Read	Read	Char	8 7 6 5 4 3 2 1	Char	8 7 6 5 4 3 2 1	Char	5 4 3 2 1
] Closing Bracket		1,3,4,5,7,8	11,5,8		]	0 1 0 1 1 1 0 1				
^ Circumflex	8	2,3,4,5,7,8	11,∅		^	0 1 0 1 1 1 1 0	∂	0 0 1 0 1 1 1 1		
_ Underline		1,2,3,4,5,7	∅,2,8		_	1 1 0 1 1 1 1 1				
@ Commercial At		7,8	[illegible]		@	0 1 0 0 0 0 0 0	@	0 0 1 0 0 1 0 1		
{ Opening [illegible]	1	1,2,4,5,6,7								
| [illegible]	1	3,4,5,6,7,8								
} Closing [illegible]	1	1,3,4,5,6,7								
~ [illegible]	1	2,3,4,5,6,7								
Space	5,6	6,8	NP	3	SP	0 0 1 0 0 0 0 0	SP	0 1 0 0 0 1 0 1	SP	0 0 1 0 0
NUL	7	NP		NP	NUL	1 0 0 0 0 0 0 0	MS	0 1 0 0 0 0 0 0	BLK	0 0 0 0 0
SOH	1	1,8								
STX	1	2,8								
ETX	1	1,2								
EOT	1	3,8								
ENQ	1	1,3								
ACK	1	2,3								
BEL		1,2,3,8		1,3	BEL	0 0 0 0 0 1 1 1	BEL	1 0 1 0 1 0 0 0	BEL	0 0 1 0 1
BS	1	4,8								
HT	1	1,4								
LF		2,4		2	LF	1 0 0 0 1 0 1 0	LF	0 1 0 0 0 0 1 1	LF	0 0 0 1 0
VT	1	1,2,4,8								
FF	1	3,4								
CR		1,3,4,8		4	CR	0 0 0 0 1 1 0 1	CR	1 1 0 0 0 1 0 0	CR	0 1 0 0 0
SO	8	2,3,4,8		1,2,4,5	SO	0 0 0 0 1 1 1 0	UC	1 1 0 0 0 0 0 1	FIG	1 1 0 1 1
SI	8	1,2,3,4		1,2,3,4,5	SI	1 0 0 0 1 1 1 1	LC	1 1 0 0 0 0 1 0	LTR	1 1 1 1 1
DLE	1	5,8								
DC1	1	1,5								
DC2	1	2,5								
DC3	1	1,2,5,8								
DC4		3,5			DC4	1 0 0 1 0 1 0 0				
NAK	1	1,3,5,8								
SYN	1	2,3,5,8								
ETB	1	1,2,3,5								
CAN	1	4,5								
EM		1,4,5,8			EM	0 0 0 1 1 0 0 1				
SUB	1	2,4,5,8								
ESC	1	1,2,4,5								
FS	1	3,4,5,8								
GS	1	1,3,4,5								
RS	1	2,3,4,5								
US	1	1,2,3,4,5,8								
DEL		1,2,3,4,5,6,7,8			DEL	0 1 1 1 1 1 1 1				

TABLE 14-5. AUTODIN CODE EQUIVALENTS MACHINE-TO-LINE (CONTINUED)

REMARKS:

1. These ASCII characters will not be translated to the line code. These characters will be inhibited at the paper tape reader.

2. ° (Degree) is fieldata line code equivalent.

3. $\overset{+}{\circ}$ (Plus over Zero) is fieldata line code equivalent.

4. $\overset{-}{\circ}$ (Minus over Zero) is fieldata line code equivalent.

5. Space is a "normally nonprinting" character.

6. NP indicates No Print or No Punch as appropriate.

7. M.S. (Master Space) is fieldata line code equivalent and BLK (Blank) is ITA # 2 line code equivalent.

8. U.S. (Upper Case) is fieldata line code equivalent and FIG (Figure) is ITA # 2 line code equivalent.

9. L.C. (Lower Case) is fieldata line code equivalent and LTR (Letters) is ITA # 2 line code equivalent.

NOTE: This table is valid for machine code to line code equivalents as follows:

MACHINE	TO LINE
ASCII	ASCII
HOLLERITH	ASCII
HOLLERITH	FIELDATA
ITA # 2	ASCII
ITA # 2	FIELDATA
ITA # 2	ITA # 2

TABLE 14-6. AUTODIN CODE EQUIVALENTS LINE-TO-LINE

		RECEIVE LINE CODE			INTERNAL CODE**		TRANSMIT LINE CODE***					
		ASCII	FIELDATA	ITA #2	EXTENDED FIELDATA		ASCII		FIELDATA		ITA #2	
DATA CHARACTER	NOTE*	8 7 6 5 4 3 2 1	8 7 6 5 4 3 2 1	5 4 3 2 1	Char	8 7 6 5 4 3 2 1	Char	8 7 6 5 4 3 2 1	Char	8 7 6 5 4 3 2 1	Char	5 4 3 2 1
A		1 1 0 0 0 0 0 1	0 1 0 0 0 1 1 0	0 0 0 1 1	A	0 1 0 0 0 1 1 0	A		A		A	
B		1 1 0 0 0 0 1 0	1 1 0 0 0 1 1 1	1 1 0 0 1	B	0 1 0 0 0 1 1 1	B		B		B	
C		0 1 0 0 0 0 1 1	1 1 0 0 1 0 0 0	0 1 1 1 0	C	0 1 0 0 1 0 0 0	C		C		C	
D		1 1 0 0 0 1 0 0	0 1 0 0 1 0 0 1	0 1 0 0 1	D	0 1 0 0 1 0 0 1	D		D		D	
E		0 1 0 0 0 1 0 1	0 1 0 0 1 0 1 0	0 0 0 0 1	E	0 1 0 0 1 0 1 0	E		E		E	
F		0 1 0 0 0 1 1 0	1 1 0 0 1 0 1 1	0 1 1 0 1	F	0 1 0 0 1 0 1 1	F		F		F	
G		1 1 0 0 0 1 1 1	0 1 0 0 1 1 0 0	1 1 0 1 0	G	0 1 0 0 1 1 0 0	G		G		G	
H		1 1 0 0 1 0 0 0	1 1 0 0 1 1 0 1	1 0 1 0 0	H	0 1 0 0 1 1 0 1	H		H		H	
I		0 1 0 0 1 0 0 1	1 1 0 0 1 1 1 0	0 0 1 1 0	I	0 1 0 0 1 1 1 0	I		I		I	
J		0 1 0 0 1 0 1 0	0 1 0 0 1 1 1 1	0 1 0 1 1	J	0 1 0 0 1 1 1 1	J		J		J	
K		1 1 0 0 1 0 1 1	1 1 0 1 0 0 0 0	0 1 1 1 1	K	0 1 0 1 0 0 0 0	K		K		K	
L		0 1 0 0 1 1 0 0	0 1 0 1 0 0 0 1	1 0 0 1 0	L	0 1 0 1 0 0 0 1	L		L		L	
M		1 1 0 0 1 1 0 1	0 1 0 1 0 0 1 0	1 1 1 0 0	M	0 1 0 1 0 0 1 0	M		M		M	
N		1 1 0 0 1 1 1 0	1 1 0 1 0 0 1 1	0 1 1 0 0	N	0 1 0 1 0 0 1 1	N		N		N	
O		0 1 0 0 1 1 1 1	0 1 0 1 0 1 0 0	1 1 0 0 0	O	0 1 0 1 0 1 0 0	O		O		O	
P		1 1 0 1 0 0 0 0	1 1 0 1 0 1 0 1	1 0 1 1 0	P	0 1 0 1 0 1 0 1	P		P		P	
Q		0 1 0 1 0 0 0 1	1 1 0 1 0 1 1 0	1 0 1 1 1	Q	0 1 0 1 0 1 1 0	Q		Q		Q	
R		0 1 0 1 0 0 1 0	0 1 0 1 0 1 1 1	0 1 0 1 0	R	0 1 0 1 0 1 1 1	R		R		R	
S		1 1 0 1 0 0 1 1	0 1 0 1 1 0 0 0	0 0 1 0 1	S	0 1 0 1 1 0 0 0	S		S		S	
T		0 1 0 1 0 1 0 0	1 1 0 1 1 0 0 1	1 0 0 0 0	T	0 1 0 1 1 0 0 1	T		T		T	
U		1 1 0 1 0 1 0 1	1 1 0 1 1 0 1 0	0 0 1 1 1	U	0 1 0 1 1 0 1 0	U		U		U	
V		1 1 0 1 0 1 1 0	0 1 0 1 1 0 1 1	1 1 1 1 0	V	0 1 0 1 1 0 1 1	V		V		V	
W		0 1 0 1 0 1 1 1	1 1 0 1 1 1 0 0	1 0 0 1 1	W	0 1 0 1 1 1 0 0	W		W		W	
X		0 1 0 1 1 0 0 0	0 1 0 1 1 1 0 1	1 1 1 0 1	X	0 1 0 1 1 1 0 1	X		X		X	
Y		1 1 0 1 1 0 0 1	0 1 0 1 1 1 1 0	1 0 1 0 1	Y	0 1 0 1 1 1 1 0	Y		Y		Y	
Z		1 1 0 1 1 0 1 0	1 1 0 1 1 1 1 1	1 0 0 0 1	Z	0 1 0 1 1 1 1 1	Z		Z		Z	
a		0 1 1 0 0 0 0 1			a	1 1 0 0 0 1 1 0	a		A	0 1 0 0 0 1 1 0	A	0 0 0 1 1
b		0 1 1 0 0 0 1 0			b	1 1 0 0 0 1 1 1	b		B	1 1 0 0 0 1 1 1	B	1 1 0 0 1
c		1 1 1 0 0 0 1 1			c	1 1 0 0 1 0 0 0	c		C	1 1 0 0 1 0 [illegible]	C	0 1 1 1 0
d		0 1 1 0 0 1 0 0			d	1 1 0 0 1 0 0 1	d		D	0 1 0 0 1 0 0 1	D	0 1 0 0 1
e		1 1 1 0 0 1 0 1			e	1 1 0 0 1 0 1 0	e		E	0 1 0 0 1 0 1 0	E	0 0 0 0 1
f		1 1 1 0 0 1 1 0			f	1 1 0 0 1 0 1 1	f		F	1 1 0 0 1 0 1 1	F	0 1 1 0 1
g		0 1 1 0 0 1 1 1			g	1 1 0 0 1 1 0 0	g		G	0 1 0 0 1 1 0 0	G	1 1 0 1 0
h		0 1 1 0 1 0 0 0			h	1 1 0 0 1 1 0 1	h		H	1 1 0 0 1 1 0 1	H	1 0 1 0 0
i		1 1 1 0 1 0 0 1			i	1 1 0 0 1 1 1 0	i		I	1 1 0 0 1 1 1 0	I	0 0 1 1 0
j		1 1 1 0 1 0 1 0			j	1 1 0 0 1 1 1 1	j		J	0 1 0 0 1 1 1 1	J	0 1 0 1 1
k		0 1 1 0 1 0 1 1			k	1 1 0 1 0 0 0 0	k		K	1 1 0 1 0 0 0 0	K	0 1 1 1 1
l		1 1 1 0 1 1 0 0			l	1 1 0 1 0 0 0 1	l		L	0 1 0 1 0 0 0 1	L	1 0 0 1 0
m		0 1 1 0 1 1 0 1			m	1 1 0 1 0 0 1 0	m		M	0 1 0 1 0 0 1 0	M	1 1 1 0 0
n		0 1 1 0 1 1 1 0			n	1 1 0 1 0 0 1 1	n		N	1 1 0 1 0 0 1 1	N	0 1 1 0 0
o		1 1 1 0 1 1 1 1			o	1 1 0 1 0 1 0 0	o		O	0 1 0 1 0 1 0 0	O	1 1 0 0 0
p		0 1 1 1 0 0 0 0			p	1 1 0 1 0 1 0 1	p		P	1 1 0 1 0 1 0 1	P	1 0 1 1 0
q		1 1 1 1 0 0 0 1			q	1 1 0 1 0 1 1 0	q		Q	1 1 0 1 0 1 1 0	Q	1 0 1 1 1

*See Note 1 at end of Table. **See Note 2 at end of Table. ***See Note 3 at end of table

TABLE 14-6. AUTODIN CODE EQUIVALENTS LINE-TO-LINE (CONTINUED)

DATA CHARACTER	SHF	RECEIVE LINE CODE ASCII 8 7 6 5 4 3 2 1	RECEIVE LINE CODE FIELDATA 8 7 6 5 4 3 2 1	RECEIVE LINE CODE ITA #2 5 4 3 2 1	INTERNAL CODE EXTENDED FIELDATA Char	INTERNAL CODE EXTENDED FIELDATA 8 7 6 5 4 3 2 1	TRANSMIT LINE CODE ASCII Char	TRANSMIT LINE CODE ASCII 8 7 6 5 4 3 2 1	TRANSMIT LINE CODE FIELDATA Char	TRANSMIT LINE CODE FIELDATA 8 7 6 5 4 3 2 1	TRANSMIT LINE CODE ITA #2 Char	TRANSMIT LINE CODE ITA #2 5 4 3 2 1
r		11110010			r	11010111	r		R	01010111	R	01010
s		01110011			s	11011000	s		S	01011000	S	001[illegible]1
t		11110100			t	11011001	t		T	11011001	T	10000
u		01110101			u	11011010	u		U	11011010	U	00111
v		01110110			v	11011011	v		V	01011011	V	11110
w		11110111			w	11011100	w		W	11011100	W	10011
x		11111000			x	11011101	x		X	[illegible]1011101	X	11101
y		01111001			y	11011110	y		Y	01011110	Y	10101
z		01[illegible]11010			z	11011111	z		Z	11011111	Z	10001
∅		10110000	01110000	10110	∅	01110000	∅		∅		∅	
1		[illegible]	11110001	10111	1	[illegible]1110001	1		1		1	
2		[illegible]0110010	111100[illegible]0	1[illegible]011	2	[illegible]1110[illegible][illegible]0	2		2		2	
3		10110011	01110[illegible]11	00001	3	01110011	3		3		3	
4		00110100	1111[illegible]100	01010	4	01110100	4		4		4	
5		10110101	01110101	10000	5	01110101	5		5		5	
6		10110110	01110110	10101	6	01110110	6		6		6	
7		00110111	11110111	00111	7	01110111	7		7		7	
8		00111000	11111000	00110	8	01111000	8		8		8	
9		10111001	01111001	11000	9	01111001	9		9		9	
! Exclamation /BANG		10100001	01101101	01101	!	01101101	!		!		!	
" Quotation Mark		10100010	11101010	10001	"	01101010	"		"		"	
# Number Sign		00100011	10100001	10100	#	00100001	#		#		#	
$ Dollar Sign		10100100	01100111	01001	$	01100111	$		$		$	
% Percent		00100101	00100110		%	00100110	%		%		[illegible]	00100
& Ampersand		00100110	00101001	11010	&	00101001	&		&		&	
' Apostrophe		10100111	01111010	01011	'	01111010	'		'		'	
(Opening Parenthesis		10101000	11101001	01111	(	01101001	(		(		(	
) Closing Parenthesis		00101001	11100000	10010	)	01100000	)		)		)	
* Asterisk		00101010	01101000		*	01101000	*		*		SP	00100
+ Plus		10101011	01100010		+	01100010	+		+		SP	00100
, Comma		00101100	01101110	01100	,	01101110	,		,		,	
- Hyphen or Minus		10101101	01100001	00011	-	01100001	-		-		-	
. Period		10101110	11111101	11100	.	01111101	.		.		.	
/ Slant		00101111	01111100	11101	/	01111100	/		/		/	
: Colon		10111010	01101011	01110	:	01101011	:		:		:	
; Semi Colon		00111011	11111011	11110	;	01111011	;		;		;	
< Less than		10111100	11100011		<	01100011	<		<		SP	00100
= Equals		00111101	01100100		=	01100100	=		=		SP	00100
> Greater than		00111110	11100101		>	01100101	>		>		SP	00100
? Question Mark		[illegible]	11101100	11001	?	01101100	?		?		?	
` Grave Accent	1	11100000			`	10100111	`		¢	10100111	SP	00100
[Opening Bracket	2	01011011			[	11101001	[		[illegible]	10101101	SP	0010[illegible]
\ Reverse Slant	3	11011100			\	10101110	\		[illegible]	10101110	SP	00100

TABLE 14-6. AUTODIN CODE EQUIVALENTS LINE-TO-LINE (CONTINUED)

DATA CHARACTER	RMK	RECEIVE LINE CODE ASCII 8 7 6 5 4 3 2 1	RECEIVE FIELDATA 8 7 6 5 4 3 2 1	RECEIVE ITA #2 5 4 3 2 1	INTERNAL CODE EXTENDED FIELDATA Char	8 7 6 5 4 3 2 1	TRANSMIT LINE CODE ASCII Char	8 7 6 5 4 3 2 1	FIELDATA Char	8 7 6 5 4 3 2 1	ITA #2 Char	5 4 3 2 1
] Closing Bracket		0 1 0 1 1 1 0 1			]	1 1 1 0 0 0 0 0	]		OWD	0 0 1 0 0 0 1 1	SP	0 0 1 0 0
^ Circumflex	4	0 1 0 1 1 1 1 0			^	1 0 1 0 1 1 1 1	^		∃	0 0 1 0 1 1 1 1	SP	0 0 1 0 0
_ Underline		1 1 0 1 1 1 1 1	1 1 1 0 0 1 1 0		_	0 1 1 0 0 1 1 0	_		_		SP	0 0 1 0 0
● Commerical AT		0 1 0 0 0 0 0 0	0 0 1 0 0 1 0 1		●	0 0 1 0 0 1 0 1	●		●		SP	0 0 1 0 0
{ Opening Brace		1 1 1 1 1 0 1 1			{	1 1 1 0 0 0 1 1	{		OWD	0 0 1 0 0 0 1 1	SP	0 0 1 0 0
¦ Broken Vertical		0 1 1 1 1 1 0 0			¦	1 1 1 1 1 1 1 0	¦		OWD	0 0 1 0 0 0 1 1	SP	0 0 1 0 0
} Closing Brace		1 1 1 1 1 1 0 1			}	1 1 1 0 0 1 0 1	}		OWD	0 0 1 0 0 0 1 1	SP	0 0 1 0 0
~ Tilde		1 1 1 1 1 1 1 0			~	1 0 1 0 1 1 0 1	~		OWD	0 0 1 0 0 0 1 1	SP	0 0 1 0 0
SP		0 0 1 0 0 0 0 0	0 1 0 0 0 1 0 1	0 0 1 0 0	SP	0 1 0 0 0 1 0 1	SP		SP		SP	
NUL		1 0 0 0 0 0 0 0			NUL	1 1 0 0 0 0 0 0	NUL		MS	0 1 0 0 0 0 0 0	BLK	0 0 0 0 0
SOH		0 0 0 0 0 0 0 1			SOH	1 0 1 1 1 1 1 0	SOH		OWD	0 0 1 0 0 0 1 1	SP	0 0 1 0 0
STX		0 0 0 0 0 0 1 0			STX	1 0 1 1 1 0 1 0	STX		OWD	0 0 1 0 0 0 1 1	SP	0 0 1 0 0
ETX		1 0 0 0 0 0 1 1			ETX	1 0 1 1 1 0 0 1	ETX		OWD	0 0 1 0 0 0 1 1	SP	0 0 1 0 0
EOT		0 0 0 0 0 1 0 0			EOT	1 0 1 1 0 1 0 C	EOT		OWD	0 0 1 0 0 0 1 1	SP	0 0 1 0 0
ENQ		1 0 0 0 0 1 0 1			ENQ	1 0 1 1 0 0 1 1	ENQ		OWD	0 0 1 0 0 0 1 1	SP	C 0 1 0 0
ACK		1 0 0 0 0 1 1 0			ACK	1 0 1 1 0 0 0 1	ACK		OWD	0 0 1 0 0 0 1 1	SP	0 0 1 0 0
BEL		0 0 0 0 0 1 1 1	1 0 1 0 1 0 0 0	0 0 1 0 1	BEL	0 0 1 0 1 0 0 0	BEL		BEL		BEL	
BS		0 0 0 0 1 0 0 0			BS	1 1 1 0 1 0 1 0	BS		OWD	0 0 1 0 0 0 1 1	SP	0 0 1 0 0
HT		1 0 0 0 1 0 0 1			HT	1 1 1 0 0 0 1 0	HT		OWD	0 0 1 0 0 0 1 1	SP	0 0 1 0 0
LF		1 0 0 0 1 0 1 0	0 1 0 0 0 0 1 1	0 0 0 1 0	LF	0 1 0 0 0 0 1 1	LF		LF		LF	
VT		0 0 0 0 1 0 1 1			VT	1 1 1 0 1 0 1 1	VT		OWD	0 0 1 0 0 0 1 1	SP	0 0 1 0 0
FF		1 0 0 0 1 1 0 0			FF	1 1 1 0 1 1 0 0	FF		OWD	0 0 1 0 0 0 1 1	SP	0 0 1 0 0
CR		0 0 0 0 1 1 0 1	1 1 0 0 0 1 0 0	0 1 0 0 0	CR	0 1 0 0 0 1 0 0	CR		CR		CR	
SO		0 0 0 0 1 1 1 0			SO	1 1 1 0 1 1 0 1	SO		UC	1 1 0 0 0 0 0 1	FIG	1 1 0 1 1
SI		1 0 0 0 1 1 1 1			SI	1 1 1 0 1 1 1 0	SI		LC	1 1 0 0 0 0 1 0	LTR	1 1 1 1 1
DLE		0 0 0 1 0 0 0 0			DLE	1 1 1 1 0 0 0 0	DLE		OWD	0 0 1 0 0 0 1 1	SP	C C 1 C C
DC1		1 0 0 1 0 0 0 1			DC1	1 1 1 1 0 0 0 1	DC1		OWD	0 0 1 0 0 0 1 1	SP	0 0 1 0 0
DC2		1 0 0 1 0 0 1 0			DC2	1 1 1 1 0 0 1 0	DC2		OWD	0 0 1 0 0 0 1 1	SP	0 0 1 0 0
DC3		0 0 0 1 0 0 1 1			DC3	1 1 1 1 0 0 1 1	DC3		OWD	0 0 1 0 0 0 1 1	SP	0 0 1 0 0
DC4	5	1 0 0 1 0 1 0 0			DC4	1 1 1 0 1 1 1 1	DC4		●	1 1 1 0 1 1 1 1	SP	0 0 1 0 0
NAK		0 0 0 1 0 1 0 1			NAK	1 0 1 1 0 1 1 1	NAK		OWD	0 0 1 0 0 0 1 1	SP	0 0 1 0 0
SYN		0 0 0 1 0 1 1 0			SYN	1 1 1 0 0 0 0 1	SYN		OWD	0 0 1 0 0 0 1 1	SP	0 0 1 0 0
ETB		1 0 0 1 0 1 1 1			ETB	1 0 1 1 1 1 0 0	ETB		OWD	0 0 1 0 0 0 1 1	SP	0 0 1 0 0
CAN		1 0 0 1 1 0 0 0			CAN	1 0 1 1 1 0 0 0	CAN		OWD	0 0 1 0 0 0 1 1	SP	0 0 1 0 0
EM	6	0 0 0 1 1 0 0 1			EM	1 1 1 1 1 0 0 1	EM		·	1 1 1 1 1 1 1 0	SP	
SUB		0 0 0 1 1 0 1 0			SS	1 1 1 1 1 0 1 0	SS		OWD	0 0 1 0 0 0 1 1	SP	0 0 1 0 0
ESC		1 0 0 1 1 0 1 1			ESC	1 1 1 1 1 0 1 1	ESC		OWD	0 0 1 0 0 0 1 1	SP	0 0 1 0 0
FS		0 0 0 1 1 1 0 0			FS	1 1 1 1 0 1 0 0	FS		OWD	0 0 1 0 0 0 1 1	SP	0 0 1 0 0
GS		1 0 0 1 1 1 0 1			GS	1 1 1 1 0 1 0 1	GS		OWD	0 0 1 0 0 0 1 1	SP	0 0 1 0 0
RS		1 0 0 1 1 1 1 0			RS	1 1 1 1 0 1 1 0	RS		OWD	0 0 1 0 0 0 1 1	SP	0 0 1 0 0
US		0 0 0 1 1 1 1 1			US	1 1 1 1 0 1 1 1	US		OWD	0 0 1 0 0 0 1 1	SP	0 0 1 0 0
DEL	7	0 1 1 1 1 1 1 1			DEL	1 1 1 1 1 1 1 1	DEL		ı	0 1 1 1 1 1 1 1	SP	0 0 1 0 0
° Degree	2		1 0 1 0 1 1 0 1		°	0 0 1 0 1 1 0 1	[	0 1 0 1 1 0 1 1	°		SP	0 0 1 0 0
⊕ Plus over Zero	3		` 1 0 1 1 1 0		⊕	0 0 1 0 1 1 1 0	\	1 1 0 1 1 1 0 0	⊕		SP	0 0 1 0 0
⊖ Minus over Zero	4		0 0 1 0 1 1 1 1		⊖	0 0 1 0 1 1 1 1	^	0 1 0 1 1 1 1 0	⊖		SP	0 0 1 0 0

TABLE 14-6. AUTODIN CODE EQUIVALENTS LINE-TO-LINE (CONTINUED)

		RECEIVE LINE CODE			INTERNAL CODE		TRANSMIT LINE CODE					
		ASCII	FIELDATA	ITA #2	EXTENDED FIELDATA		ASCII		FIELDATA		ITA #2	
DATA CHARACTER	RMK	8 7 6 5 4 3 2 1	8 7 6 5 4 3 2 1	5 4 3 2 1	Char	8 7 6 5 4 3 2 1	Char	8 7 6 5 4 3 2 1	Char	8 7 6 5 4 3 2 1	Char	5 4 3 2 1
¢ Cent Sign	1		1 0 1 0 0 1 1 1		¢	0 0 1 0 0 1 1 1	\	[illegible] 1 [illegible] 0 0 0 0 0	¢		SP	0 0 1 0 0
i Ignore	7		0 1 1 1 1 1 1 1		①	0 1 1 1 1 1 1 1	DEL	0 1 1 1 1 1 1 1	i		SP	0 0 1 0 0
MS			0 1 0 0 0 0 0 0		MS	0 1 0 0 0 0 0 0	NUL	1 0 0 0 0 0 0 0	MS		BLK	0 0 0 0 0
FIG			1 1 0 0 0 0 0 1	1 1 0 1 1	FIG	0 1 0 0 0 0 0 1	SO	0 0 0 0 1 1 1 0	UC		FIG	
LTR			1 1 0 0 0 0 1 0	1 1 1 1 1	LTR	0 1 0 0 0 0 1 0	SI	1 0 0 0 1 1 1 1	LC		LTR	
● Stop	5		1 1 1 0 1 1 1 1		●	0 1 1 0 1 1 1 1	DC4	1 0 0 1 0 1 0 0	●		SP	0 0 1 0 0
CND			0 0 1 0 0 0 1 1		CND	0 0 1 0 0 0 1 1	CAN	1 0 0 1 1 0 0 0	CND		SP	0 0 1 0 0
⏥ Lozenge	6		1 1 1 1 1 1 1 0		⏥	0 1 1 1 1 1 1 0	EM	0 0 0 1 1 0 0 1	⏥		SP	0 0 1 0 0
BLK				0 0 0 0 0	MS	0 1 0 0 0 0 0 0	NUL	1 0 0 0 0 0 0 0	MS	0 1 0 0 0 0 0 0	BLK	

REMARKS:
1. ¢ (Cent sign) in Fieldata equals ` (Grave Accent) in ASCII, or vice versa.
2. o (Degree) in Fieldata equals [(Opening Bracket) in ASCII, or vice versa.
3. ȯ (Plus over zero) in Fieldata equals \ (Reverse Slant) in ASCII, or vice versa.
4. ō (Minus over zero) in Fieldata equals ^ (Circumflex) in ASCII, or vice versa.
5. ● (Stop) in Fieldata equals DC4 in ASCII, or vice versa.
6. ⏥ (Lozenge) in Fieldata equals EM in ASCII, or vice versa.
7. i (Ignore) in Fieldata equals BEL in ASCII, or vice versa.

NOTE 1: This table is valid for line to line code conversion as follows:

RECEIVE LINE TO TRANSMIT LINE	
ASCII	ASCII
ASCII	FIELDATA
ASCII	ITA #2
FIELDATA	ASCII
FIELDATA	FIELDATA
FIELDATA	ITA #2
ITA #2	ASCII
ITA #2	FIELDATA
ITA #2	ITA #2

NOTE 2: The internal code in leased ASCs is Extended Fieldata. Government-owned ASCs internal code is ASCII and the bit configuration is the same as the ASCII receive line code.

NOTE 3: Where the bit configuration for the transmit line code is not shown, it is intended to indicate that the same bit configuration exists as in the appropriate receive line code.

TABLE 14-7. AUTODIN CODE EQUIVALENT LINE-TO-MACHINE

		LINE CODE			MACHINE CODE					
		ASCII	FIELDATA	ITA #2	ASCII		HOLLERITH		ITA #2	
DATA CHARACTER	BNK	8 7 6 5 4 3 2 1	8 7 6 5 4 3 2 1	5 4 3 2 1	Pnt	Punch	Pnt	Punch	Pnt	Punch
A		1 1 0 0 0 0 0 1	0 1 0 0 0 1 1 0	0 0 0 1 1	A	1,7	A	12,1	A	1,2
B		1 1 0 0 0 0 1 0	1 1 0 0 0 1 1 1	1 1 0 0 1	B	2,7	B	12,2	B	1,4,5
C		0 1 0 0 0 0 1 1	1 1 0 0 1 0 0 0	0 1 1 1 0	C	1,2,7,8	C	12,3	C	2,3,4
D		1 1 0 0 0 1 0 0	0 1 0 0 1 0 0 1	0 1 0 0 1	D	3,7	D	12,4	D	1,4
E		0 1 0 0 0 1 0 1	0 1 0 0 1 0 1 0	0 0 0 0 1	E	1,3,7,8	E	12,5	E	1
F		0 1 0 0 0 1 1 0	1 1 0 0 1 0 1 1	0 1 1 0 1	F	2,3,7,8	F	12,6	F	1,3,4
G		1 1 0 0 0 1 1 1	0 1 0 0 1 1 0 0	1 1 0 1 0	G	1,2,3,7	G	12,7	G	2,4,5
H		1 1 0 0 1 0 0 0	1 1 0 0 1 1 0 1	1 0 1 0 0	H	4,7	H	12,8	H	3,5
I		0 1 0 0 1 0 0 1	1 1 0 0 1 1 1 0	0 0 1 1 0	I	1,4,7,8	I	12,9	I	2,3
J		0 1 0 0 1 0 1 0	0 1 0 0 1 1 1 1	0 1 0 1 1	J	2,4,7,8	J	11,1	J	1,2,4
K		1 1 0 0 1 0 1 1	1 1 0 1 0 0 0 0	0 1 1 1 1	K	1,2,4,7	K	11,2	K	1,2,3,4
L		0 1 0 0 1 1 0 0	0 1 0 1 0 0 0 1	1 0 0 1 0	L	3,4,7,8	L	11,3	L	2,5
M		1 1 0 0 1 1 0 1	0 1 0 1 0 0 1 0	1 1 1 0 0	M	1,3,4,7	M	11,4	M	3,4,5
N		1 1 0 0 1 1 1 0	1 1 0 1 0 0 1 1	0 1 1 0 0	N	2,3,4,7	N	11,5	N	3,4
O		0 1 0 0 1 1 1 1	0 1 0 1 0 1 0 0	1 1 0 0 0	O	1,2,3,4,7,8	O	11,6	O	4,5
P		1 1 0 1 0 0 0 0	1 1 0 1 0 1 0 1	1 0 1 1 0	P	5,7	P	11,7	P	2,3,5
Q		0 1 0 1 0 0 0 1	1 1 0 1 0 1 1 0	1 0 1 1 1	Q	1,5,7,8	Q	11,8	Q	1,2,3,5
R		0 1 0 1 0 0 1 0	0 1 0 1 0 1 1 1	0 1 0 1 0	R	2,5,7,8	R	11,9	R	2,4
S		1 1 0 1 0 0 1 1	0 1 0 1 1 0 0 0	0 0 1 0 1	S	1,2,5,7	S	Ø,2	S	1,3
T		0 1 0 1 0 1 0 0	1 1 0 1 1 0 0 1	1 0 0 0 0	T	3,5,7,8	T	Ø,3	T	5
U		1 1 0 1 0 1 0 1	1 1 0 1 1 0 1 0	0 0 1 1 1	U	1,3,5,7	U	Ø,4	U	1,2,3
V		1 1 0 1 0 1 1 0	0 1 0 1 1 0 1 1	1 1 1 1 0	V	2,3,5,7	V	Ø,5	V	2,3,4,5
W		0 1 0 1 0 1 1 1	1 1 0 1 1 1 0 0	1 0 0 1 1	W	1,2,3,5,7,8	W	Ø,6	W	1,2,5
X		0 1 0 1 1 0 0 0	0 1 0 1 1 1 0 1	1 1 1 0 1	X	4,5,7,8	X	Ø,7	X	1,3,4,5
Y		1 1 0 1 1 0 0 1	0 1 0 1 1 1 1 0	1 0 1 0 1	Y	1,4,5,7	Y	Ø,8	Y	1,3,5
Z		1 1 0 1 1 0 1 0	1 1 0 1 1 1 1 1	1 0 0 0 1	Z	2,4,5,7	Z	Ø,9	Z	1,5
a		0 1 1 0 0 0 0 1			A	1,7	A	12,1	A	1,2
b		0 1 1 0 0 0 1 0			B	2,7	B	12,2	B	1,4,5
c		1 1 1 0 0 0 1 1			C	1,2,7,8	C	12,3	C	2,3,4
d		0 1 1 0 0 1 0 0			D	3,7	D	12,4	D	1,4
e		1 1 1 0 0 1 0 1			E	1,3,7,8	E	12,5	E	1
f		1 1 1 0 0 1 1 0			F	2,3,7,8	F	12,6	F	1,3,4
g		0 1 1 0 0 1 1 1			G	1,2,3,7	G	12,7	G	2,4,5
h		0 1 1 0 1 0 0 0			H	4,7	H	12,8	H	3,5
i		1 1 1 0 1 0 0 1			I	1,4,7,8	I	12,9	I	2,3
j		1 1 1 0 1 0 1 0			J	2,4,7,8	J	11,1	J	1,2,4
k		0 1 1 0 1 0 1 1			K	1,2,4,7	K	11,2	K	1,2,3,4
l		1 1 1 0 1 1 0 0			L	3,4,7,8	L	11,3	L	2,5
m		0 1 1 0 1 1 0 1			M	1,3,4,7	M	11,4	M	3,4,5
n		0 1 1 0 1 1 1 0			N	2,3,4,7	N	11,5	N	3,4
o		1 1 1 0 1 1 1 1			O	1,2,3,4,7,8	O	11,6	O	4,5
p		0 1 1 1 0 0 0 0			P	5,7	P	11,7	P	2,3,5
q		1 1 1 1 0 0 0 1			Q	1,5,7,8	Q	11,8	Q	1,2,3,5
r		1 1 1 1 0 0 1 0			R	2,5,7,8	R	11,9	R	2,4

*See note at end of table.

TABLE 14-7. AUTODIN CODE EQUIVALENT LINE-TO-MACHINE (CONTINUED)

DATA CHARACTER	RMK	LINE CODE ASCII 8 7 6 5 4 3 2 1	LINE CODE FIELDATA 8 7 6 5 4 3 2 1	LINE CODE ITA #2 5 4 3 2 1	MACHINE CODE ASCII Pnt	ASCII Punch	HOLLERITH Pnt	HOLLERITH Punch	ITA #2 Pnt	ITA #2 Punch
s		0 1 1 1 0 0 1 1			S	1,2,5,7	S	Ø,2	S	1,3
t		1 1 1 1 0 1 0 0			T	3,5,7,8	T	Ø,3	T	5
u		0 1 1 1 0 1 0 1			U	1,3,5,7	U	Ø,4	U	1,2,3
v		0 1 1 1 0 1 1 0			V	2,3,5,7	V	Ø,5	V	2,3,4,5
w		1 1 1 1 0 1 1 1			W	1,2,3,5,7,8	W	Ø,6	W	1,2,5
x		1 1 1 1 1 0 0 0			X	4,5,7,8	X	Ø,7	X	1,3,4,5
y		0 1 1 1 1 0 0 1			Y	1,4,5,7	Y	Ø,8	Y	1,3,5
z		0 1 1 1 1 0 1 0			Z	2,4,5,7	Z	Ø,9	Z	1,5
Ø		1 0 1 1 0 0 0 0	0 1 1 1 0 0 0 0	1 0 1 1 0	Ø	5,6	Ø	Ø	Ø	2,3,5
1		0 0 1 1 0 0 0 1	1 1 1 1 0 0 0 1	1 0 1 1 1	1	1,5,6,7	1	1	1	1,2,3,5
2		0 0 1 1 0 0 1 0	1 1 1 1 0 0 1 0	1 0 0 1 1	2	2,5,6,8	2	2	2	1,2,5
3		0 0 1 1 0 0 1 1	0 1 1 1 0 0 1 1	0 0 0 0 1	3	1,2,5,5	3	3	3	1
4		0 0 1 1 0 1 0 0	1 1 1 1 0 1 0 0	0 1 0 1 0	4	3,5,6,8	4	4	4	2,4
5		1 0 1 1 0 1 0 1	0 1 1 1 0 1 0 1	1 0 0 0 0	5	1,3,5,6	5	5	5	5
6		1 0 1 1 0 1 1 0	0 1 1 1 0 1 1 0	1 0 1 0 1	6	2,3,5,6	6	6	6	1,3,5
7		0 0 1 1 0 1 1 1	1 1 1 1 0 1 1 1	0 0 1 1 1	7	1,2,3,5,6,8	7	7	7	1,2,3
8		0 0 1 1 1 0 0 0	1 1 1 1 1 0 0 0	0 0 1 1 0	8	4,5,6,8	8	8	8	2,3
9		1 0 1 1 1 0 0 1	0 1 1 1 1 0 0 1	1 1 0 0 0	9	1,4,5,6	9	9	9	4,5
! Exclamation Point		1 0 1 0 0 0 0 1	0 1 1 0 1 1 0 1	0 1 1 0 1	!	1,6	!	11,7,8	!	1,3,4
" Quotation Mark		1 0 1 0 0 0 1 0	1 1 1 0 1 0 1 0	1 0 0 0 1	"	2,6	"	7,8	"	1,5
# Number Sign		0 0 1 0 0 0 1 1	1 0 1 0 0 0 0 1	1 0 1 0 0	#	1,2,6,8	#	3,8	#	3,5
$ Dollar Sign		1 0 1 0 0 1 0 0	0 1 1 0 0 1 1 1	0 1 0 0 1	$	3,6	$	Ø,6,8	$	1,4
% Percent		0 0 1 0 0 1 0 1	0 0 1 0 0 1 1 0		%	1,3,6,8	%	Ø,4,8	SP	3
& Ampersand		0 0 1 0 0 1 1 0	0 0 1 0 1 0 0 1	1 1 0 1 0	&	2,3,6,8	&	Ø,1	&	2,4,5
' Apostrophe		1 0 1 0 0 1 1 1	0 1 1 1 1 0 1 0	0 1 0 1 1	'	1,2,3,6	'	2,8	'	1,2,4
(Opening Parenthesis		1 0 1 0 1 0 0 0	1 1 1 0 1 0 0 1	0 1 1 1 1	(	4,6	(	12,6,8	(	1,2,3,4
) Closing Parenthesis		0 0 1 0 1 0 0 1	1 1 1 0 0 0 0 0	1 0 0 1 0	)	1,4,6,8	)	6,8	)	2,5
* Asterisk		0 0 1 0 1 0 1 0	0 1 1 0 1 0 0 0		*	2,4,6,8	*	11,4,8	SP	3
+ Plus		1 0 1 0 1 0 1 1	0 1 1 0 0 0 1 0		+	1,2,4,6	+	12,5,8	SP	3
, Comma		0 0 1 0 1 1 0 0	0 1 1 0 1 1 1 0	0 1 1 0 0	,	3,4,6,8	,	Ø,3,8	,	3,4
- Hypen or Minus		1 0 1 0 1 1 0 1	0 1 1 0 0 0 0 1	0 0 0 1 1	-	1,3,4,6	-	12	-	1,2
. Period		1 0 1 0 1 1 1 0	1 1 1 1 1 1 0 1	1 1 1 0 0	.	2,3,4,6	.	12,3,8	.	3,4,5
/ Slant		0 0 1 0 1 1 1 1	0 1 1 1 1 1 0 0	1 1 1 0 1	/	1,2,3,4,6,8	/	11	/	1,3,4,5
: Colon		1 0 1 1 1 0 1 0	0 1 1 0 1 0 1 1	0 1 1 1 0	:	2,4,5,6	:	5,8	:	2,3,4
; Semi Colon		0 0 1 1 1 0 1 1	1 1 1 1 1 0 1 1	1 1 1 1 0	;	1,2,4,5,6,8	;	11,6,8	;	2,3,4,5
< Less than		1 0 1 1 1 1 0 0	1 1 1 0 0 0 1 1		<	3,4,5,6	<	12,4,8	SP	3
= Equals		0 0 1 1 1 1 0 1	0 1 1 0 0 1 0 0		=	1,3,4,5,6,8	=	12,7,8	SP	3
> Greater than		0 0 1 1 1 1 1 0	1 1 1 0 0 1 0 1		>	2,3,4,5,6,8	>	4,8	SP	3
? Question Mark		1 0 1 1 1 1 1 1	1 1 1 0 1 1 0 0	1 1 0 0 1	?	1,2,3,4,5,6	?	Ø,5,8	?	1,4,5
_ Underline		1 1 0 1 1 1 1 1	1 1 1 0 0 1 1 0		_	1,2,3,4,5,7	_	Ø,2,8	SP	3
[Opening Bracket		0 1 0 1 1 0 1 1			[	1,2,4,5,7,8	[	11,3,8	SP	3
\ Reverse Slant		1 1 0 1 1 1 0 0			\	3,4,5,7	\	12,Ø	SP	3

TABLE 14-7. AUTODIN CODE EQUIVALENT LINE-TO-MACHINE (CONTINUED)

		LINE CODE			MACHINE CODE					
		ASCII	FIELDATA	ITA #2	ASCII		HOLLERITH		ITA #2	
DATA CHARACTER	RMK	8 7 6 5 4 3 2 1	8 7 6 5 4 3 2 1	5 4 3 2 1	Pnt	Punch	Pnt	Punch	Pnt	Punch
] Closing Bracket		0 1 0 1 1 1 0 1			]	1,3,4,5,7,8	]	11,5,8	SP	3
^ Circumflex		0 1 0 1 1 1 1 0			^	2,3,4,5,7,8	^	11,Ø	SP	3
\ Grave Accent	1	1 1 1 0 0 0 0 0			●	7,8	●	Ø,7,8	SP	3
@ Commerical at		0 1 0 0 0 0 0 0	0 0 1 0 0 1 0 1		●	7,8	●	Ø,7,8	SP	3
[Opening Brace	2	1 1 1 1 1 0 1 1			[	1,2,4,5,7,8	[	11,3,8	SP	3
~ Tilde Line	3	1 1 1 1 1 1 1 0			^	2,3,4,5,7,8	^	11,0	SP	3
] Closing Brace	4	1 1 1 1 1 1 0 1			]	1,3,4,5,7,8	]	11,5,8	SP	3
: Vertical Line	5	0 1 1 1 1 1 0 0			\	3,4,5,7	\	12,0	SP	3
DEL	6	0 1 1 1 1 1 1 1			NP	1,2,3,4,5,6,7,8	SP	NP	NP	1,2,3,4,5
NUL	7	1 0 0 0 0 0 0 0	0 1 0 0 0 0 0 0	0 0 0 0 0	NP	NP	•	11,4,8	NP	NP
SOH		0 0 0 0 0 0 0 1			•	2,4,6,8	•	11,4,8	SP	3
STX		0 0 0 0 0 0 1 0			•	2,4,6,8	•	11,4,8	SP	3
ETX		1 0 0 0 0 0 1 1			•	2,4,6,8	•	11,4,8	SP	3
EOT		0 0 0 0 0 1 0 0			•	2,4,6,8	•	11,4,8	SP	3
ENQ		1 0 0 0 0 1 0 1			•	2,4,6,8	•	11,4,8	SP	3
ACK		1 0 0 0 0 1 1 0			•	2,4,6,8	•	11,4,8	SP	3
BEL		0 0 0 0 0 1 1 1	1 0 1 0 1 0 0 0	0 0 1 0 1	NP	1,2,3,8	•	11,4,8	NP	1,3
BS		0 0 0 0 1 0 0 0			•	2,4,6,8	•	11,4,8	SP	3
HT		1 0 0 0 1 0 0 1			•	2,4,6,8	•	11,4,8	SP	3
LF		1 0 0 0 1 0 1 0	1 1 0 0 0 0 1 1	0 0 0 1 0	NP	2,4	•	11,4,8	NP	2
VT		0 0 0 0 1 0 1 1			•	2,4,6,8	•	11,4,8	SP	3
FF		1 0 0 0 1 1 0 0			•	2,4,6,8	•	11,4,8	SP	3
CR		0 0 0 0 1 1 0 1	1 1 0 0 0 1 0 0	0 1 0 0 0	NP	1,3,4,8	•	11,4,8	NP	4
SO	8	0 0 0 0 1 1 1 0	1 1 0 0 0 0 0 1	1 1 0 1 1	NP	2,3,4,8	•	11,4,8	NP	1,2,4,5
SI	9	1 0 0 0 1 1 1 1	1 1 0 0 0 0 1 0	1 1 1 1 1	NP	1,2,3,4	•	11,4,8	NP	1,2,3,4,5
DLE		0 0 0 1 0 0 0 0			•	2,4,6,8	•	11,4,8	SP	3
DC1		1 0 0 1 0 0 0 1			•	2,4,6,8	•	11,4,8	SP	3
DC2		1 0 0 1 0 0 1 0			•	2,4,6,8	•	11,4,8	SP	3
DC3		0 0 0 1 0 0 1 1			•	2,4,6,8	•	11,4,8	SP	3
DC4		1 0 0 1 0 1 0 0			NP	3,5	•	11,4,8	SP	3
NAK		0 0 0 1 0 1 0 1			•	2,4,6,8	•	11,4,8	SP	3
SYN		0 0 0 1 0 1 1 0			•	2,4,6,8	•	11,4,8	SP	3
ETB		1 0 0 1 0 1 1 1			•	2,4,6,8	•	11,4,8	SP	3
CAN		1 0 0 1 1 0 0 0			•	2,4,6,8	•	11,4,8	SP	3
EM		0 0 0 1 1 0 0 1			NP	1,4,5,8	•	11,4,8	SP	3
SUB		0 0 0 1 1 0 1 0			•	2,4,6,8	•	11,4,8	SP	3
ESC		1 0 0 1 1 0 1 1			•	2,4,6,8	•	11,4,8	SP	3
FS		0 0 0 1 1 1 0 0			•	2,4,6,8	•	11,4,8	SP	3
GS		1 0 0 1 1 1 0 1			•	2,4,6,8	•	11,4,8	SP	3
RS		1 0 0 1 1 1 1 0			•	2,4,6,8	•	11,4,8	SP	3
US		0 0 0 1 1 1 1 1			•	2,4,6,8	•	11,4,8	SP	3
SPACE		0 0 1 0 0 0 0 0	0 1 0 0 0 1 0 1	0 0 1 0 0	SP	6,8	SP	NP	SP	3
° Degree	10		1 0 1 0 1 1 0 1				[	11,3,8	SP	3

TABLE 14-7. AUTODIN CODE EQUIVALENT LINE-TO-MACHINE (CONTINUED)

		LINE CODE			MACHINE CODE					
		ASCII	FIELDATA	ITA #2	ASCII		HOLLERITH		ITA #2	
DATA CHARACTER	RMK	8 7 6 5 4 3 2 1	8 7 6 5 4 3 2 1	5 4 3 2 1	Pnt	Punch	Pnt	Punch	Pnt	Punch
⨦ Plus over Zero	11		1 0 1 0 1 1 1 0				/	12,Ø	SP	3
⨪ Minus over Zero	12		0 0 1 0 1 1 1 1				^	11,Ø	SP	3
¢ Cent Sign			1 0 1 0 0 1 1 1				•	11,4,8	SP	3
I Ignore			0 1 1 1 1 1 1 1				•	11,4,8	SP	3
● Stop			1 1 1 0 1 1 1 1				•	11,4,8	SP	3
OMD			0 0 1 0 0 0 1 1				•	11,4,8	SP	3
▱ Lozenge			1 1 1 1 1 1 1 0				•	11,4,8	SP	3

REMARKS:
1. @ (Commercial at) is ASCII and Hollerith machine code equivalent.
2. [(Opening bracket) is ASCII and Hollerith machine code equivalent.
3. ^ (Circumflex) is ASCII and Hollerith machine code equivalent.
4.] (Closing bracket) is ASCII and Hollerith machine code equivalent.
5. \ (Reverse Slant) is ASCII and Hollerith machine code equivalent.
6. SP (space) is Hollerith machine code equivalent and LTR (letter) is ITA #2 machine code equivalent.
7. DEL is MS (Master space) in Fieldata and BLK (Blank) in ITA #2 line codes.
8. SO is UC (Upper case) in Fieldata and FIG (Figures) in ITA #2 line codes.
9. SI is LC (Lower case) in Fieldata and LTR (Letters) in ITA #2 line codes.
10. [(Opening bracket) is Hollerith machine code equivalent.
11. \ (Reverse Slant) is Hollerith machine code equivalent.
12. ^ (Circumflex) is Hollerith machine code equivalent.

NOTE: This table is valid for line code to machine code equivalents as follows:

LINE TO MACHINE	
ASCII	ASCII
ASCII	HOLLERITH
ASCII	ITA #2
FIELDATA	HOLLERITH
FIELDATA	ITA #2
ITA #2	ITA #2

A-1

SUPPLEMENT-1. AUTODIN CODE REPRESENTATIONS

1. ASCII Odd Parity Character Representation. The standard seven-bit character representation, with b7, the high-order bit and b1, the low-order bit, is shown below.

a. Example: The bit representation for the character K, positioned in column 4, row 11, is:

b_7	b_6	b_5	b_4	b_3	b_2	b_1
1	0	0	1	0	1	1

b. The code table position for the character K may also be represented by the notation "column 4, row 11" or alternately as "4/11". The decimal equivalent of the binary number formed by bit b_7, b_6, and b_5, collectively, forms the column number, and decimal equivalent of the binary number formed by bit b_4, b_3, b_2, and b_1, collectively, forms the row number.

2. Legend. (For information purposes only)

a. Control Characters.

NUL	Null
SOH	Start of Heading (CC)
STX	Start of Text (CC)
ETX	End of Text (CC)
EOT	End of Transmission (CC)
ENQ	Enquiry (CC)
ACK	Acknowledge (CC)
BEL	Bell (audible or attention signal)
BS	Backspace (FE)
HT	Horizontal Tabulation (punched card skip) (FE)
LF	Line Feed (FE)
DLE	Data Link Escape (CC)
DC1	Device Control 1
DC2	Device Control 2
DC3	Device Control 3
DC4	Device Control 4 (stop)
NAK	Negative Acknowledge (CC)
SYN	Synchronous Idle (CC)
ETB	End of Transmission Block (CC)
CAN	Cancel (CC)
EM	End of Medium (CC)
SUB	Substitute (CC)
ESC	Escape (CC)
VT	Vertical Tabulation (FE)
FF	Form Feed (FE)
CR	Carriage Return (FE)
SO	Shift Out (CC)
SI	Shift In (CC)
FS	File Separator (IS)
GS	Group Separator (IS)
RS	Record Separator (IS)
US	Unit Separator (IS)
DEL	Delete*

b. Graphic Characters.

Column/Row	Symbol	Name
2/0	SP	Space (normally nonprinting)
2/1	!	Exclamation point
2/2	"	Quotation marks (Diaeresis)
2/3	#	Number sign
2/4	$	Dollar sign
2/5	%	Percent
2/6	&	Ampersand
2/7	'	Apostrophe (Closing signal/ quotation mark; acute accent)
2/8	(	Opening parenthesis
2/9	)	Closing parenthesis
2/10	*	Asterisk
2/11	+	Plus
2/12	,	Comma (Cedilla)
2/13	-	Hyphen (Minus)
2/14	.	Period (Decimal point)
2/15	/	Slant
3/10	:	colon
3/11	;	Semicolon
3/12	<	Less than
3/13	=	Equals
3/14	>	Greater than
3/15	?	Question mark
4/0	@	Commercial at
5/11	[	Opening bracket
5/12	\	Reverse slant
5/13	]	Closing bracket
5/14	^	Circumflex
5/15	_	Underline
6/0	`	Grave accent (Opening single quotation mark)
7/11	{	Opening brace
7/12	¦	Broken vertical line
7/13	}	Closing brace
7/14	~	Tilde

When used as diacritical marks, the symbols in 2/2, 2/7, 2/12, 5/14, 6/0, and 7/14 should be preceded by an alphabetic character and a BS (Backspace) in that sequence.

These characters should not be used in international interchange without determining that there is agreement between sender and recipient.

3. Definitions. (For information purposes only.)

a. General.

(1) (CC) Communication Control. A functional character intended to control or facilitate transmission of information over communication networks.

(2) (FE) Format Effector. A functional character which controls the layout or positioning of information in printing or display devices.

(3) (IS) Information Separator. A character which is used to separate and qualify information in a logical sense. This is a group of four such characters, which are to be used in a hierarchical order.

b. Control Characters.

(1) NUL. The all zeros character which may serve to accomplish time fill and media fill.

(2) SOH (Start of Heading). A communication control character used at the beginning of a sequence of characters which constitute a machine-sensible address or routing information. Such a sequence is referred to as the "heading." An STX character has the effect of terminating a heading.

(3) STX (Start of Text). A communication control character which precedes a sequence of characters that is to be treated as an entity and entirely transmitted through to the ultimate destination. Such a sequence is referred to as "text." STX may be used to terminate a sequence of characters started by SOH.

(4) ETX (End of Text). A communication control character used to terminate a sequence of characters started with STX and transmitted as an entity.

(5) EOT (End of Transmission). A communication control character used to indicate the conclusion of a transmission, which may have contained one or more texts and any associated headings.

(6) ENQ (Enquiry). A communication control character used in data communication systems as a request for a response from a remote station. It may be used as a "Who Are You" (WRU) to obtain identification, or may be used to obtain station status, or both.

(7) ACK (Acknowledge). A communication control character transmitted by a receiver as an affirmative response to a sender.

(8) BEL. A character for use when there is a need to call for human attention. It may control alarm or attention devices.

(9) BS (Backspace). A format effector which controls the movement of the printing position one printing space backward on the same printing line. (Applicable also to display devices.)

(10) HT (Horizontal Tabulation). A format effector which controls the movement of the printing position to the next in a series of predetermined positions along the printing line. (Applicable also to display devices and the skip function on punched cards.)

(11) LF (Line Feed). A format effector which controls the movement of the printing position to the next printing line. (Applicable also to display devices.)

(12) VT (Vertical Tabulation). A format effector which controls the movement of the printing position to the next in a series of predetermined printing lines. (Applicable also to display devices.)

(13) FF (Form Feed). A format effector which controls the movement of the printing position to the first predetermined printing line on the next form or page. (Applicable also to display devices.)

(14) CR (Carriage Return). A format effector which controls the movement of the printing position to the first printing position on the same printing line. (Applicable also to display devices).

(15) SO (Shift Out). A control character indicating that the code combinations which follow will be interpreted as outside the character set of the standard code table until a Shift In character is reached.

(16) SI (Shift In). A control character indicating that the code combinations which follow will be interpreted according to the standard code table.

(17) DLE (Data Link Escape). A communication control character which will change the meaning of a limited number of contiguously following characters. It is used exclusively to provide supplementary controls in data communication networks.

(18) DC1, DC2, DC3, DC4 (Device Controls). Characters for the control of ancillary devices associated with data processing or telecommunication systems, more specifically, switching device "on" or "off." (If a single "stop" control is required to interrupt or turn off ancillary devices, DC4 is the preferred assignment.)

(19) NAK (Negative Acknowledge). A communication control character transmitted by a receiver as a negative response to the sender.

(20) SYN (Synchronous Idle). A communication control character used by a synchronous transmission system in the absence of any other character to provide a signal from which synchronism may be achieved or retained.

(21) ETB (End of Transmission Block). A communication control character used to indicate the end of a block of data for communication purposes. ETB is used for blocking data where the block structure is not necessarily related to the processing format.

(22) CAN (Cancel). A control character used to indicate that the data with which it is sent is in error or is to be disregarded.

(23) EM (End of Medium). A control character associated with the sent data which may be used to identify the physical end of the medium, or the end of the used, or wanted, portion of information recorded on a medium. (The position of this character does not necessarily correspond to the physical end of the medium.)

(24) SUB (Substitute). A character that may be substituted for a character which is determined to be invalid or in error.

(25) ESC (Escape). A control character intended to provide code extension (supplementary characters) in general information interchange. The Escape character itself is a prefix affecting the interpretation of a limited number of contiguously following characters.

(26) FS (File Separator), GS (Group Separator), RS (Record Separator), and US (Unit Separator). These information separators may be used within data in optional fashion, except that their hierarchical relationship will be: FS is the most inclusive, then GS, then RS, and US is least inclusive. (The content and length of a File, Group, Record, or Unit are not specified).

(27) DEL (Delete). This character is used primarily to erase or obliterate erroneous or unwanted characters in perforated tape. (In the strict sense, DEL is not a control character).

c. Graphic Characters. SP (Space). A normally nonprinting graphic character used to separate words. It is also a format effector which controls the movement of the printing position, one printing position forward (Applicable also to display devices).

TABLE 1. AMERICAN STANDARD CODE FOR INFORMATION INTERCHANGE (ASCII)

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

NOTES:
1. Columns 2,3,4, and 5 indicate the printable characters in DCS AUTODIN
2. Columns 6 and 7 fold over into columns 4 and 5, respectively, except DEL. (See appendix C, table 3.)

TABLE 2. DCS AUTODIN CONTROL CODE FOR ASCII

b_4	b_3	b_2	b_1*									
				b_7	0	0	0	0	1	1	1	1
				b_6	0	0	1	1	0	0	1	1
				b_5	0	1	0	1	0	1	0	1
				ROW \ COLUMN	0	1	2	3	4	5	6	7
0	0	0	0	0						P		
0	0	0	1	1	SOH	REP**			A			
0	0	1	0	2	STX	RM**			B	R		
0	0	1	1	3	ETX				C	S		
0	1	0	0	4		STOP**			D	T		
0	1	0	1	5	ENQ**	NAK**			E	U		
0	1	1	0	6	ACK 1**	SYN			F			
0	1	1	1	7	INV**	ETB			G			
1	0	0	0	8		CAN**			H			
1	0	0	1	9		EM						
1	0	1	0	10		MC			J			
1	0	1	1	11					K			
1	1	0	0	12		ACK 2**						
1	1	0	1	13		START**			M			
1	1	1	0	14		WBT**						
1	1	1	1	15								DEL

*b_1 is the low order bit

** These control characters are transmitted in identical contiguous pairs.

TABLE 3. CONUS AUTODIN FIELDATA CODE

Bits C					0	0	0	0	1	1	1	1
Bits 1_2					0	0	1	1	0	0	1	1
Bits 1_1					0	1	0	1	0	1	0	1
8	4	2	1	COL / ROW	0	1	2	3	4	5	6	7
0	0	0	0	0				tel	M.S.	K	)	0 ZERO
0	0	0	1	1			#	ack-1	U.C.	L	- MINUS	1
0	0	1	0	2				ack-2	L.C.	M	+	2
0	0	1	1	3			OWD	req	L.F.	N	<	3
0	1	0	0	4				wbt	C.R.	O	=	4
0	1	0	1	5			●	rep	Sp.	P	>	5
0	1	1	0	6			%	SOM-L	A	Q	UNDER-LINE	6
0	1	1	1	7			¢	er	B	R	$	7
1	0	0	0	8			BELL	dm	C	S	*	8
1	0	0	1	9	IL		&	EOM	D	T	(	9
1	0	1	0	10			MC	SOLB	E	U	"	APOSTR.
1	0	1	1	11				EDB	F	V	:	;
1	1	0	0	12				EOLB	G	W	?	/ SLASH
1	1	0	1	13			° DEGREES	rm	H	X	;	.
1	1	1	0	14			$\pm$ 0	SOM-H	I	Y	, COMMA	▱
1	1	1	1	15			$\bar{0}$		J	Z	⊕	¡

COLUMN 3 is control code zone. Where a character in this zone is in lower case, it implies that the character immediately followed by itself constitutes a control code; e.g. ack-1, ack-1 = ACK 1.

TABLE 4. CONUS AUTODIN EXTENDED FIELDATA CODE

ROW	COLUMN	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	b_8	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
	b_7	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1
	b_6	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1
	b_5	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
	b_4 b_3 b_2 b_1																
0	0 0 0 0				tel	MS	K	)	ZERO					NUL	k	⌐	DLE
1	0 0 0 1			#	ack-1	FIGS	L	minus	1				ACK		l	SYN	DC1
2	0 0 1 0				ack-2	LTRS	M	+	2						m	HT	DC2
3	0 0 1 1			CND	req	LF	N	<	3				ENQ		n	{	DC3
4	0 1 0 0				wbt	CR	O	=	4				EOT		o		FS
5	0 1 0 1			●	rep	SPACE	P	>	5						p	}	GS
6	0 1 1 0			%	SOM-L	A	Q	_	6					a	q		RS
7	0 1 1 1			¢	ei	B	R	$	7			`	NAK	b	r		US
8	1 0 0 0			BELL	dm	C	S	*	8				CAN	c	s		
9	1 0 0 1			&	EOM	D	T	(	9				ETX	d	t	[	EM
10	1 0 1 0			MC	SOLB	E	U	"	'				STX	e	u	BS	SS
11	1 0 1 1				EOB	F	V	;	,					f	v	VT	ESC
12	1 1 0 0				EOLB	G	W	?	/				ETB	g	w	FF	
13	1 1 0 1			° Degree	rm	H	X	:	.			~		h	x	SO	
14	1 1 1 0			@	SOM-H	I	Y	.	▱			\	SOH	i	y	SI	¦
15	1 1 1 1			¬		J	Z	⊙	①			^		j	z	DC4	DELETE

Note: ① = ignore.

TABLE 5. INTERNATIONAL TELEGRAPH ALPHABET #2
(AMERICAN VERSION)

b_5			0	0	0	0	1	1	1	1
b_4			0	0	1	1	0	0	1	1
b_3			0	1	0	1	0	1	0	1
b_2	b_1									
0	0	UC	BLANK	SPACE	CARRIAGE RETURN	,	5	#	9	.
		LC	BLANK	SPACE	CARRIAGE RETURN	N	T	H	O	M
0	1	UC	3	BELL	$	!	"	6	?	/
		LC	E	S	D	F	Z	Y	B	X
1	0	UC	LINE FEED	8	4	:	)	ZERO	&	;
		LC	LINE FEED	I	R	C	L	P	G	V
1	1	UC	-	7	'	(	2	1	FIGURES	LETTERS
		LC	A	U	J	K	W	Q	FIGURES	LETTERS

TABLE 6. PARITY CHECKING RULES

CHARACTERS COUNTED IN BLOCK PARITY

CHARACTER PARITY FOR FRAMING CHARACTERS-EVEN

CHARACTER PARITY FOR TEXT CHARACTERS-ODD

CHARACTER	Bit																
PARITY BIT	8	1	0	1	1	0	0	1	0	1	1	0	1	0	1	0	1
INFORMATION BITS	7	0	1	1	1	1	1	1	0	1	1	1	1	1	0	0	1
	6	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
	5	0	1	0	0	1	1	1	0	0	0	0	0	0	1	1	0
	4	0	0	1	0	0	0	1	0	0	0	1	1	0	1	0	1
	3	0	1	0	0	0	0	0	0	1	0	1	0	1	0	1	1
	2	1	0	0	0	1	1	0	0	0	0	0	1	0	0	1	0
	1	0	1	0	1	0	0	1	0	0	1	0	1	1	1	1	0

EVEN PARITY FOR EACH ROW

START OF TEXT (column 1)

UNCLASSIFIED SECURITY (column 2)

EM (column 14)

END OF TRANSMISSION BLOCK (column 15)

BLOCK PARITY (column 16)