

"DATASPEED" TAPE-TO-TAPE SYSTEM
WITH ERROR DETECTION AND CORRECTION

TYPE 4

DESCRIPTION

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1. GENERAL		
1.01 This section provides the description for the "DATASPEED" Tape-To-Tape System Type 4 with automatic error detection and correction (EDC) capabilities. The system is used		

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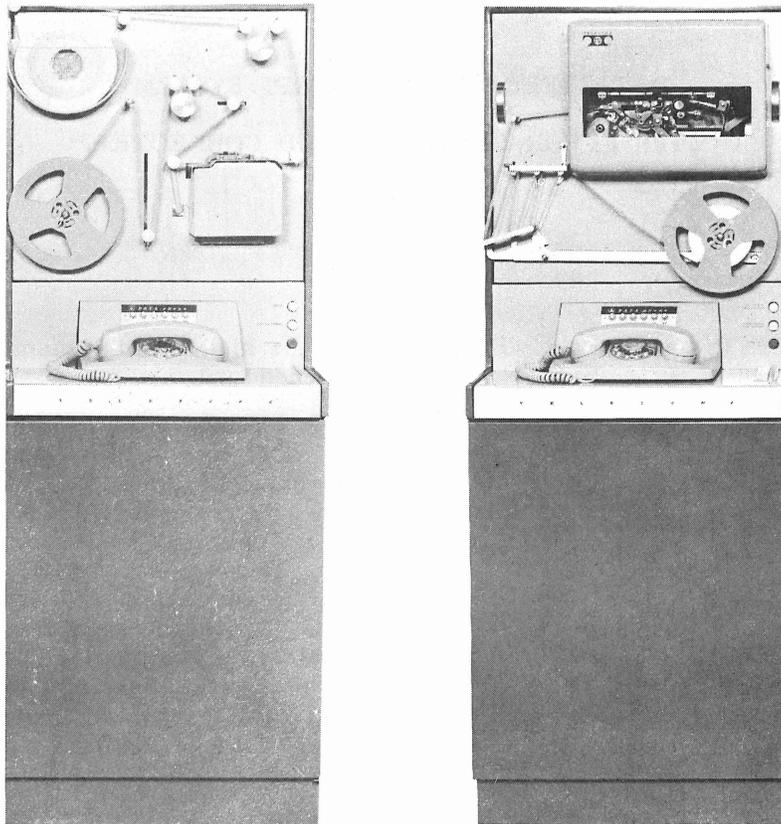


Figure 1 - High Speed Tape-To-Tape System (Type 4)

1.05 Automatic notification of a received error and request for retransmission is accomplished by use of the EDC logic with the reverse channel (RC) feature of the data sets. If the data set has no reverse channel feature, a separate return line must be provided for reverse channel communication.

1.06 At 1050 wpm, with error detection and correction switched off, the system is fully compatible with the non-EDC High Speed Tape-To-Tape System (Type 2).

1.07 The basic system consists of one Tape Sender 4A terminal and one Tape Receiver 4B terminal. To achieve operation, the terminals are connected to 117v ac, 60 Hz, and a communications channel, using the appropriate data sets. If a change of transmission speed is desired in the field, it is only necessary to make minor adjustments in the equipment and change the sender and receiver oscillators (2.06).

1.08 Refer to the appropriate description sections for detailed information, including the method of operation, of Tape Sender 4A and Tape Receiver 4B.

2. TECHNICAL DATA

2.01 Transmission is serial. The input at the sender is any 5 to 8 level punched tape, 11/16, 7/8, or 1 inch wide. The reader has two reading heads; the first develops the transmitted data, the second one develops the two check characters for each 80 character block. The sender can handle 800 (or 3000 - see 2.06) feet of tape. When running EDC, each tape must contain at least 80 fill characters preceding the data, and must contain at least 80 fill characters following the data.

2.02 The output at the receiver consists of a product tape which is identical to the input tape except for an additional 80 characters of "all marks" (delete) indicating the location of an errored block. The punch has a photo electric reader for reading the tape. This is used to generate the check characters. The punch uses a universal punch block that can punch 11/16, 7/8 or 1 inch wide paper tape. The receiver has a 3000 foot supply of tape and a takeup reel with a minimum capacity of 500 feet.

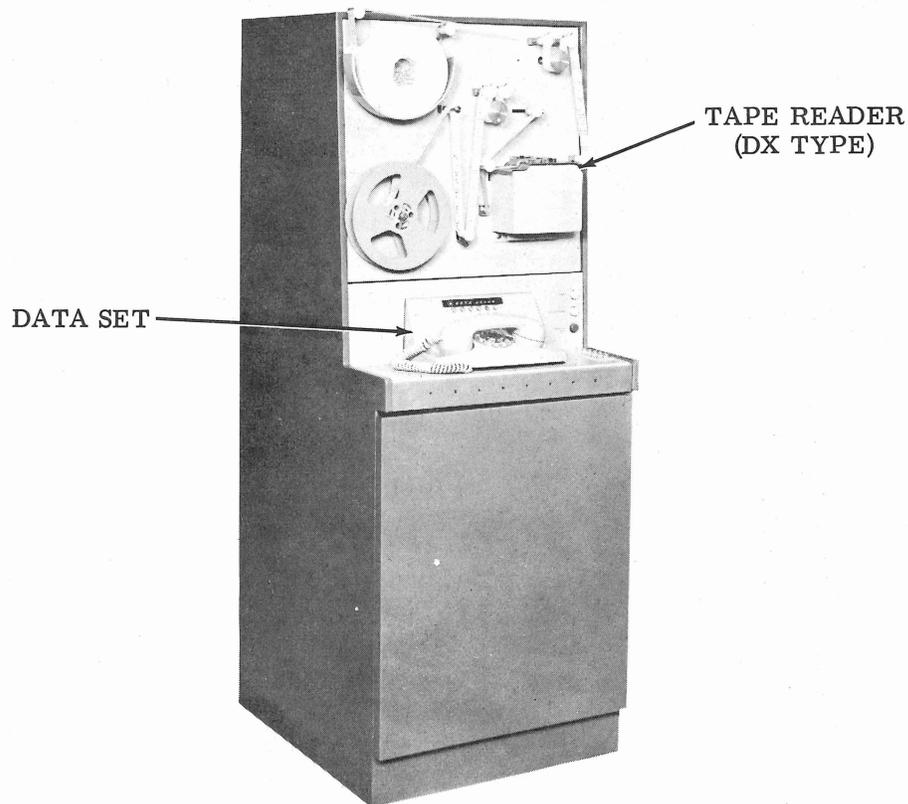


Figure 2 - Tape Sender 4A

2.03 Transmission speed is 1050 wpm. Transmission at 1200 wpm is possible, but requires special accessories (2.06). Inputs and outputs of the data sets are all standard EIA signals (see Part 7).

2.04 Both terminals, sender and receiver, have provisions for manual or unattended operation. The sender has a feed alarm and a tape out alarm. The receiver has a feed alarm, a backup alarm, and a low tape warning flasher. Both terminals have non-EDC modes.

2.05 The sender has a reader test feature for independently checking out the reader. Similarly, the receiver has a punch test feature for checking the operation of the punch.

2.06 Extra Features for the terminals are:

- (a) Tape handling for both terminals may be increased to 3000 feet.
- (b) Vertical parity (TP308510 for Sender and TP308511 for Receiver) may be added for 5 to 7 level transmission. The unused 8th level is then used for the vertical parity generation.

(c) A send/receive adapter cable (TP308514) is available so that one data set can be used for both sender and receiver terminals at one location (located side-by-side). A Send-Receive switch, located in the sender, selects which terminal the data set serves.

(d) A discrete calling recognizer accessory (TP308513) is available to provide protection for an unattended sender, preventing it from transmitting to an unauthorized receiver. A 14 bit code is sent by the receiver and must be recognized by the called sender before transmission can begin.

(e) A spare connector on the wiring field is provided for use in connecting external equipment (not yet available) for data analysis and display. This is provided at both sender and receiver terminals.

(f) For transmission at 1200 wpm the following alternate oscillators are required:
 Sender - TFO Oscillator (TP305811)
 Receiver - LCO Oscillator (TP303137)

2.07 Refer to Part 4 for a description of data format, and to Part 7 for data set interface information.

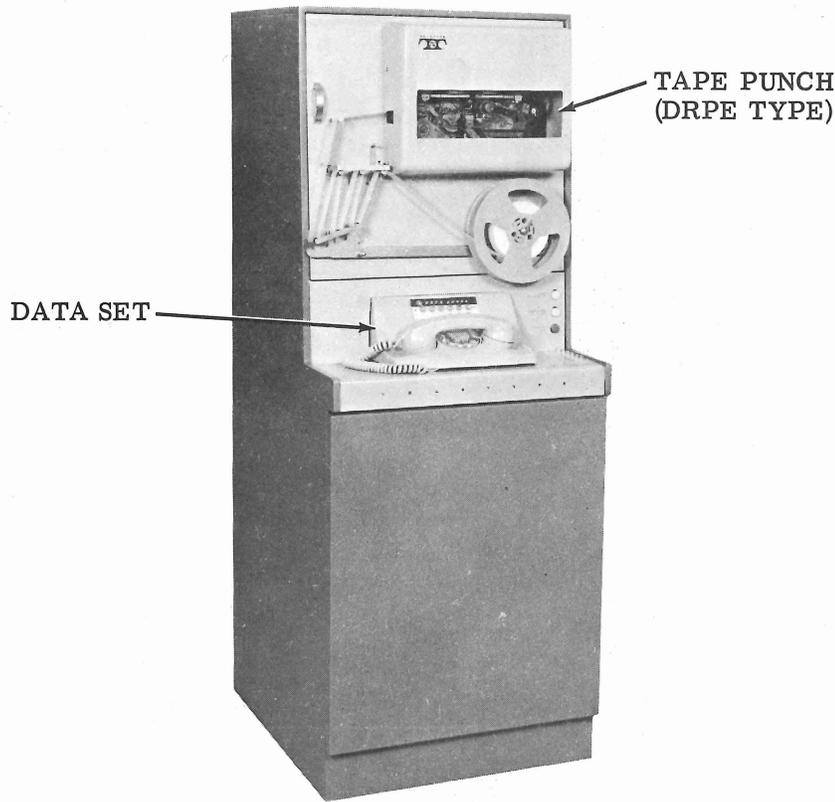


Figure 3 - Tape Receiver 4B

2.08 Refer to the sections for Tape Sender 4A and Tape Receiver 4B for data on power requirements, sizes and weight, and other similar information.

3. GENERAL OPERATION

3.01 Refer to Figures 4 and 5 for a basic functional description of the system.

3.02 As shown in Figures 4 and 5, each terminal contains a data set which is used to establish the communications and data transmitting link. Serial data is transmitted from sender to receiver, and reverse channel is transmitted from receiver to sender. Certain control functions of the terminals are derived from signals from the data sets.

3.03 Each terminal contains a station control module which provides polar to normal signal conversion between the terminals and the data sets. It also is responsible for most of the control of the terminal, including alarms, motor control, unattended answering, reverse channel control, etc.

3.04 The transmitting distributor module receives parallel data from the reader and converts it into serial data for transmission by the data set. The receiving distributor module reconverts the serial data back into parallel data for punching. The receiving distributor module also contains the punch drivers which control the punch pin magnets.

3.05 The sender reads the input tape with a high speed tape reader equipped with a reversible drive which can read the tape in the forward direction and can back the tape up to re-read errored data. The reader has two sets of reading contacts. The first set is used to read the tape for data transmission; the second set is used to generate redundancy information for error detection. An extra contact reads the feed holes and is used for a feed error indication.

3.06 The receiver uses a high speed tape punch to produce the output tape. The punch is equipped with a back-up mechanism which backs the tape up through the punch block so that errors may be deleted by overpunching. The punch also is equipped with a photo-reader. Eight photo cells read the tape after it has been

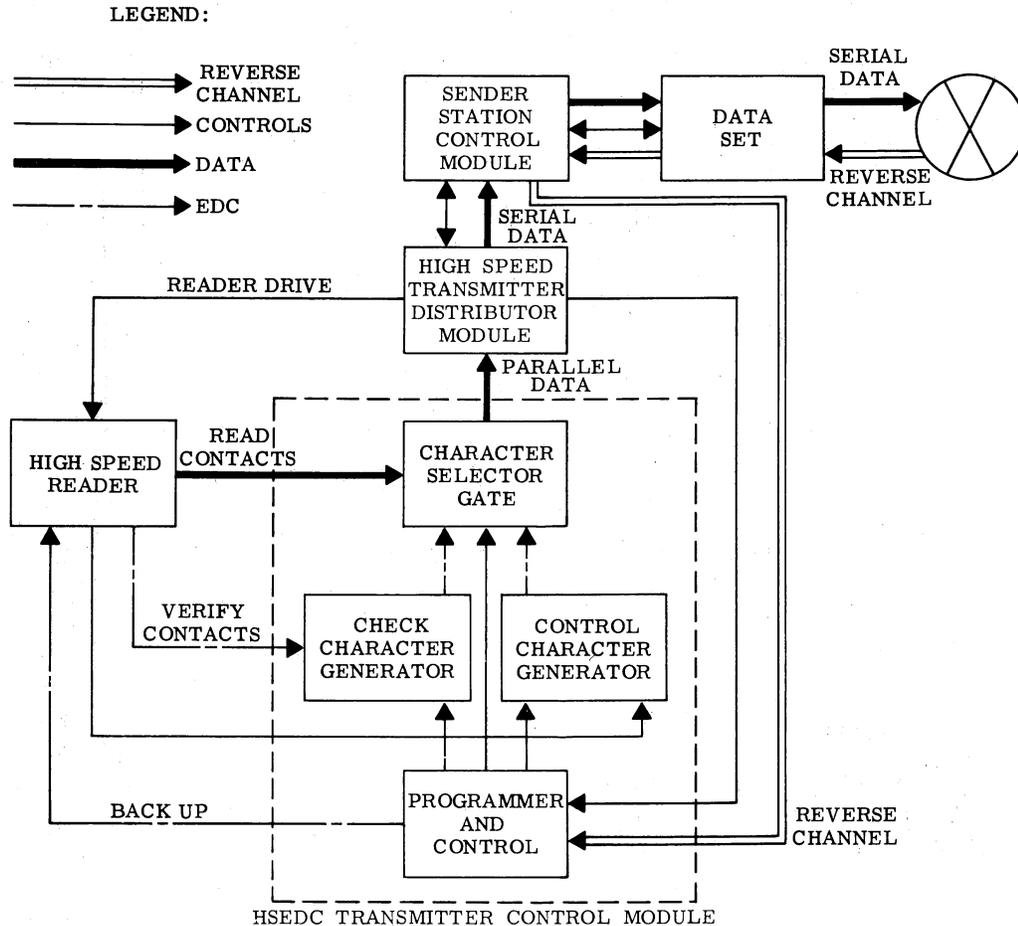


Figure 4 - Block Diagram of Tape Sender 4A

punched to generate the redundancy information (from the product tape) for error detection. A ninth photo cell senses the feed hole and is used for a feed error indication.

3.07 Each terminal has an error detection and correction (EDC) module. All of the functions of EDC operation are handled in these modules.

3.08 The sender EDC module has four basic functions. The programmer and control portion controls the entire module. The control character generator generates certain control characters. These are fixed characters and cannot be changed. The check character generator takes signals from the verify contacts of the reader and generates two check characters for error detection. The control characters, check characters, and data are all fed to the

character selector gate. This gate is controlled by the programmer and its function is to insert the control characters and check characters into the transmitted data in the proper sequence. A detailed description of this sequence is described in Part 5.

3.09 The receiver EDC module has four basic functions. The programmer and control portion controls the punch and backup mechanism, and it programs the error detection procedure. The control character recognizer checks the validity of the control characters, and also checks for block synchronization. The check character generator generates the two check characters from the photo reader outputs. These two check characters are then compared with the two transmitted check characters. This comparison is done in the check character comparer and any discrepancy means an error has been detected.

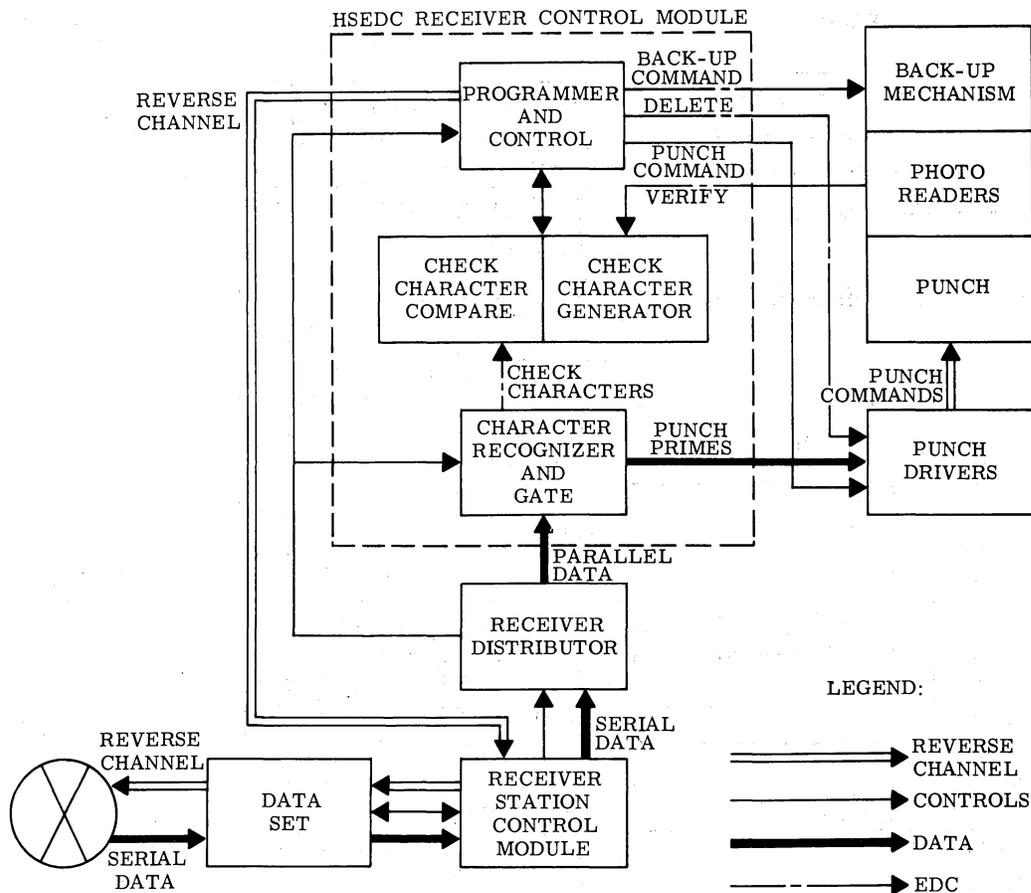


Figure 5 - Block Diagram of Tape Receiver 4B

4. DATA FORMAT

FIXED CHARACTERS

4.01 The input punched tape can use any 5 through 8 level code. The fixed characters have been especially chosen to differ from standard codes.

4.02 The sender ready (SR) character has levels 1, 5, 6, 7 marking. This character is sent by the sender when it is ready to start transmission. The sender continues to send SRs at a rate of 25 per second until it detects reverse channel.

4.03 The block numbers (BN) character consists of:

- BN1, levels 1, 3, 6, 8 marking
- BN2, levels 2, 4, 5, 7 marking
- BN3, levels 1, 2, 7, 8 marking

A BN is transmitted immediately prior to each 80 character block. The progression 1, 2, 3, 1, 2, 3, 1, etc, is followed. When the input tape is backed up for rereading, the BN is correspondingly lowered. A description of the block synchronization feature of the system is described in Part 5.

4.04 The end-of-block (EOB) character has levels 2, 3, 4, 5, 6, 7, 8 marking. The EOB character is transmitted immediately following each 80 character block. It is used for determining if any characters of the 80 character block have been lost or added.

CHECK CHARACTERS

4.05 There are two check characters — horizontal and spiral — which are derived from the 80 characters in the block. Each check character level is obtained by choosing

one level from each of the 80 characters in the block, and summing the marks appearing in those levels. The two schemes of level selection are described in 4.06. If the sum obtained is odd, the sender generates a space for that level and the receiver generates a mark for that level. If the sum obtained is even, the sender generates a mark for that level and the receiver generates a space for that level. These characters do not appear in the tape.

4.06 The level selection schemes are:

L = level of check character
M = level of each character

For CK1 (horizontal check character), $M = L$. This means, for example, that the 1st level of CK1 is derived from the sum of the marks in the 1st levels of the 80 characters in the block. For CK2 (spiral check character) use Chart 1 to select the proper levels. The lower section of the chart indicates which level of each character is to be selected, the particular line being chosen to correspond to the check character level being generated. Example: If the 4th level of CK2 is being generated the level line begins with a 4. Read down the chart to see which characters will have the 4th level used in the sum. The 4th level will be used from characters 1, 9, 17, 25, etc. Similarly the 5th level of characters 2, 10, 18, 26, etc. Continue this selection scheme for all 80 characters. Generation of CK2 is done on a character-by-character basis, with the next higher level being used with each successive character. After the 8th level has been added in, the 1st level of the following character is added, and so on until the last character of the block has been reached.

4.07 When reading 7 level tape, the 8th level of each of the 80 characters will be a mark.

4.08 When reading 6 level tape, the 7th and 8th levels of each of the 80 characters will be marks.

4.09 When reading 5 level tape, the 7th and 8th levels of each of the 80 characters will be marks and the 1st levels will be spaces.

Note: The sender and receiver do not generate identical check characters. However, they are identical before one in receiver is inverted. Marks in the sender's CK1 and CK2 correspond to spaces in the receiver's CK1 and CK2 and vice versa.

5. EDC OPERATION

DATA FLOW BETWEEN TERMINALS

5.01 Refer to Charts 6 through 13 for a graphic illustration of system operation. Charts 6 through 11 show data flow between terminals. Charts 12 and 13 show simplified logic diagrams for each terminal.

5.02 For data on establishing a call, refer to Charts 2 through 5. The call is established in a standard manner with manual (Charts 2 and 3) or unattended (Charts 4 and 5) operation being possible.

Note: The sender precedes each transmission with 1 to 3 seconds of a 2025 Hz tone or spacing signal to disable echo suppressors.

OPERATION WITHOUT ERRORS (See Chart 6)

5.03 The sender sends SR characters to indicate that it is ready to send. When the receiver recognizes an SR character, it turns on the reverse channel, indicating that it is ready to receive.

5.04 When the sender detects reverse channel on, it sends a BN, followed by an 80 character block. The sender then sends the EOB character and checks to see if reverse channel is on. If reverse channel is on, the sender then sends CK1 and CK2 followed by the next higher BN and the next 80 character block.

5.05 After detecting SRs, the receiver waits until it receives a non-SR character. The first non-SR character received will be a BN. After receiving a proper BN, the receiver punches the 80 character block and checks for a valid EOB.

5.06 The receiver then checks the received CK1 and CK2 with those generated from the product tape to determine if an error has occurred. If no error is detected, the receiver then checks the next BN, punches the next block and continues the procedure of punching and checking already described.

OPERATION WITH TEXT ERROR, INVALID BN, OR INVALID EOB (See Chart 7)

5.07 If an error occurs in transmission, the CK1 and/or CK2 characters will not be the same when compared by the receiver.

5.08 If any one of the three characters, CK1, CK2, or EOB, is in error or the BN is invalid the receiver turns reverse channel off and goes into an error correcting mode. All incoming data is ignored and the tape is backed up 80 characters through the punch block. The tape is then over-punched with the delete character (all marks). The receiver then waits for an SR and transmission proceeds as described in 5.03 through 5.06. The BN that the receiver will be looking for is the one for the errored block, ie, the receiver will be looking for a retransmission of the errored block.

5.09 The sender loses reverse channel while it is transmitting the block following the errored block. It does not check for reverse channel, however, until it has sent the EOB character.

5.10 When an error has occurred and reverse channel is detected off, the sender will go into its error correction mode. The sender puts mark hold (steady mark) on the line and the reader backs the tape up 2 blocks (160 characters). The BN is decreased by two numbers in order to maintain synchronization of the BNs with the tape. When the reader backup is complete, the errored block is in a position for re-reading. The sender then starts sending SRs and transmission is reestablished as described in 5.03 through 5.06.

BN SYNCHRONIZATION

A. Normal BN Operation

5.11 The sender advances one BN after each block sent. Similarly, the receiver advances one BN after each block that is successfully punched. In normal operation without errors, these BNs will always agree and transmission will remain in synchronism. See Chart 6.

B. Received Block Number is Low

5.12 The following combinations represent a block low condition.

Received BN:	BN1	BN2	BN3
Expected BN:	BN2	BN3	BN1

If the received BN is low, it means that the data being sent has already been received and punched. Thus, according to Chart 8, the receiver ignores all incoming data and leaves reverse channel on. Nothing happens until the

next BN is received, which will then be the correct BN.

5.13 It is possible that a low BN condition could coincide with the start of transmission, since the BN starting point of each terminal is arbitrary. Thus, the first block may be completely ignored by the receiver. As a result, all transmitted messages must be preceded by 80 characters of fill in data.

C. Received Block Number is High

5.14 The following combinations represent a block high condition:

Received BN:	BN2	BN3	BN1
Expected BN:	BN1	BN2	BN3

If the received BN is high, it means that some data has been missed by the receiver. See Chart 9. This could occur with a momentary break in transmission or during an error correction mode if the reader fails to back up enough. Upon detecting a BN high condition, the receiver immediately turns off reverse channel. The sender detects the absence of reverse channel when sending the EOB character so it goes into its error correcting mode described in 5.10. The BN is decreased by two numbers and the next BN received will be the correct one. The receiver in the meantime punches the block that was preceded by a high BN but an error is recorded. Then the punch deletes the block and awaits a retransmission of the errored block per 5.03. The next block transmitted will be the correct one because the sender has backed up two blocks.

5.15 When beginning a transmission, the first BN may be high since the starting BN is arbitrary. As a result, the reader may have to back up two blocks after having read only one block. This means that a leader of at least 80 characters is required for proper tape handling of each message sent.

D. Invalid Block Number

5.16 If an invalid block number is received, it usually represents errored transmission, so this condition is treated the same as an error in the tape. Refer to 5.07 for the error correction operation.

E. Incomplete Block

5.17 If the transmission of data ceases or is interrupted while a block is being punched, this condition is called an incomplete block and

the following corrective actions occur. See Chart 10.

F. Transmission Break

5.18 With a break in transmission, the carrier and data are lost. See Chart 10. Upon loss of carrier, the receiver immediately turns off reverse channel. Loss of data triggers a pad out circuit which causes the punch to complete the 80 character block. This condition produces a block with meaningless characters, so the receiver goes into the error correction mode described in 5.08. When the sender reaches the end of the block, it checks for presence of reverse channel. Because reverse channel is off, the sender backs up 2 blocks and begins sending SRs. When transmission is resumed, the receiver will detect these SRs and transmission will proceed.

5.19 If the break is in the communications channel, ordinarily the call will be lost and retransmission can only be done by establishing a new connection. In such a case, the tape should be backed up one additional block to allow for resynchronization.

5.20 It is possible that a break in transmission could be accompanied by a peculiar noise condition that could be interpreted as reverse channel by the sender. In such a case, the sender would proceed to send the next block. If this condition lasts no more than 2 blocks resynchronization will occur and no data will be lost. Should this condition last for longer than 2 blocks data will be lost.

G. Tape Out

5.21 When the sender reaches the end of its message, transmission stops due to lack of data to read. See Chart 10. In manual operation, the carrier will remain on the line but data will not be sent. This condition also starts the pad out circuit to finish the 80 character block. Since there will be no check characters sent, there is no means for checking the validity of what data was punched in this incomplete block. Thus, the block is deleted and the receiver waits for more transmission. Ordinarily this would be the point where a new tape is put in the reader or the call is dropped.

5.22 If a message tape has no fill in characters at the end, a maximum of 79 characters at the end of the tape will be deleted because of the tape-out action described in 5.21.

H. Run/Stop Control (See charts 12 and 13)

5.23 At the sender, the transmission may be stopped by pressing the STOP/ALARM-RESET button. The sender will then back up the tape 80 characters and will decrease the block number one number. At this point the call may be dropped or transmission may be restarted by pressing the STOP/ALARM-RESET button again.

5.24 At the receiver, the transmission may be stopped by pressing the STOP/ALARM-RESET button. The receiver will then finish punching the block, will back up and delete that block. At this point, the call may be dropped or transmission may be restarted by pressing the STOP/ALARM-RESET button again.

6. NON-EDC OPERATION

6.01 By pressing the NON-EDC button the system can be operated without the error detection and correction feature. The sender will send the input tape without pause and the receiver will punch all incoming data. See Chart 11.

6.02 The sender will put mark hold on the line until it detects reverse channel on. Transmission of data will start and continue until reverse channel is turned off or the reader runs out of tape. In manual operation, it will then place mark hold on the line again. If the sender is transmitting to a terminal which has no reverse channel feature, a switch on the sender's EDC module can be turned on to simulate reverse channel.

6.03 Transmission can be stopped and started at the sender by pressing the STOP/ALARM-RESET button.

6.04 The receiver will not punch any tape as long as the mark hold is on the line. When the first character appears, the start transition causes the character to be punched. The receiver will punch any character that is received. Punching stops when mark hold appears on the line.

6.05 Transmission can be stopped and started at the receiver by pressing the STOP/ALARM-RESET button. However, some transmitted data will be lost because the receiver stops punching immediately while the sender continues to send until it receives notification that the receiver has stopped (lack of reverse

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channel). The number of characters that will be lost depends on the transmission rate and the line propagation time. If a sender is stopped by the receiver, the tape should be manually backed up 80 characters before transmission is re-started. This will provide some overlap of data but no characters will be lost.

Binary State	One	Zero
Signal Condition	Marking	Spacing
Paper Tape	Hole	No Hole
Control function	OFF	ON
EIA voltage	-3 to -25V	+3 to +25V
Normal signal voltage	0V	-6V

7. DATA SET INTERFACE

7.01 The following data set (202C2) leads are available (EIA RS232 Standard).

Receiver	Sender	Lead	Function
X	X	1	Protective Ground
	X	2	Transmitted Data
X		3	Received Data
	X	4	Request to Send
	X	5	Clear to Send
X	X	6	Data Set Ready
X	X	7	Signal Ground
X		8	Data Carrier Detector
X		11	Supervisory Trans.
	X	12	Supervisory Rec.
		15*	Serial Clock - Transmit
		17*	Serial Clock - Receive
X	X	20	Data Terminal Ready
X	X	22	Ring Indicator

*For possible future use.

7.02 Standard EIA voltage levels are used at receiver and sender terminals for data and control functions. These functions are stated briefly as:

7.03 The data stream described in Part 5 appears at the transmitted data lead of the sender for the transmission and at the received data lead at the receiver after reception.

7.04 Reverse channel is transmitted over the supervisory data channel. The receiver applies the reverse channel signal (on or off) to the supervisory transmitted data lead and it is received at the sender on the supervisory received data lead.

7.05 At 1050 wpm, the sender has its own clock and the receiver operates start-stop directly from the received data. After the procedures for establishing a call have been completed the sender begins sending SRs and must get reverse channel before it can begin transmission. The receiver is ready to receive when it detects a carrier except that in EDC operation it requires an SR to start.

7.06 Each transmission is preceded by (202C2 data set) 1-3 seconds of a 2025 Hz (spacing) tone which disables all echo suppressors. Therefore, lack of reverse channel before transmission can be tolerated as is the case when the sender calls the receiver.

7.07 Refer to the appropriate section for a detailed description of the data set interface.

CHART 1 - CK2 LEVEL SELECTOR

M CHARACTER LEVEL

<p>L Check Character Level</p>	1st level	1	2	3	4	5	6	7	8
	2nd level	2	3	4	5	6	7	8	1
	3rd level	3	4	5	6	7	8	1	2
	4th level	4	5	6	7	8	1	2	3
	5th level	5	6	7	8	1	2	3	4
	6th level	6	7	8	1	2	3	4	5
	7th level	7	8	1	2	3	4	5	6
	8th level	8	1	2	3	4	5	6	7
Character number (80 character block)		1	2	3	4	5	6	7	8
		9	10	11	12	13	14	15	16
		17	18	19	20	21	22	23	24
		25	26	27	28	29	30	31	32
		33	34	35	36	37	38	39	40
		41	42	43	44	45	46	47	48
		49	50	51	52	53	54	55	56
		57	58	59	60	61	62	63	64
		65	66	67	68	69	70	71	72
		73	74	75	76	77	78	79	80

CHART 2 - MANUAL CALL SET UP - SENDER ORIGINATES CALL

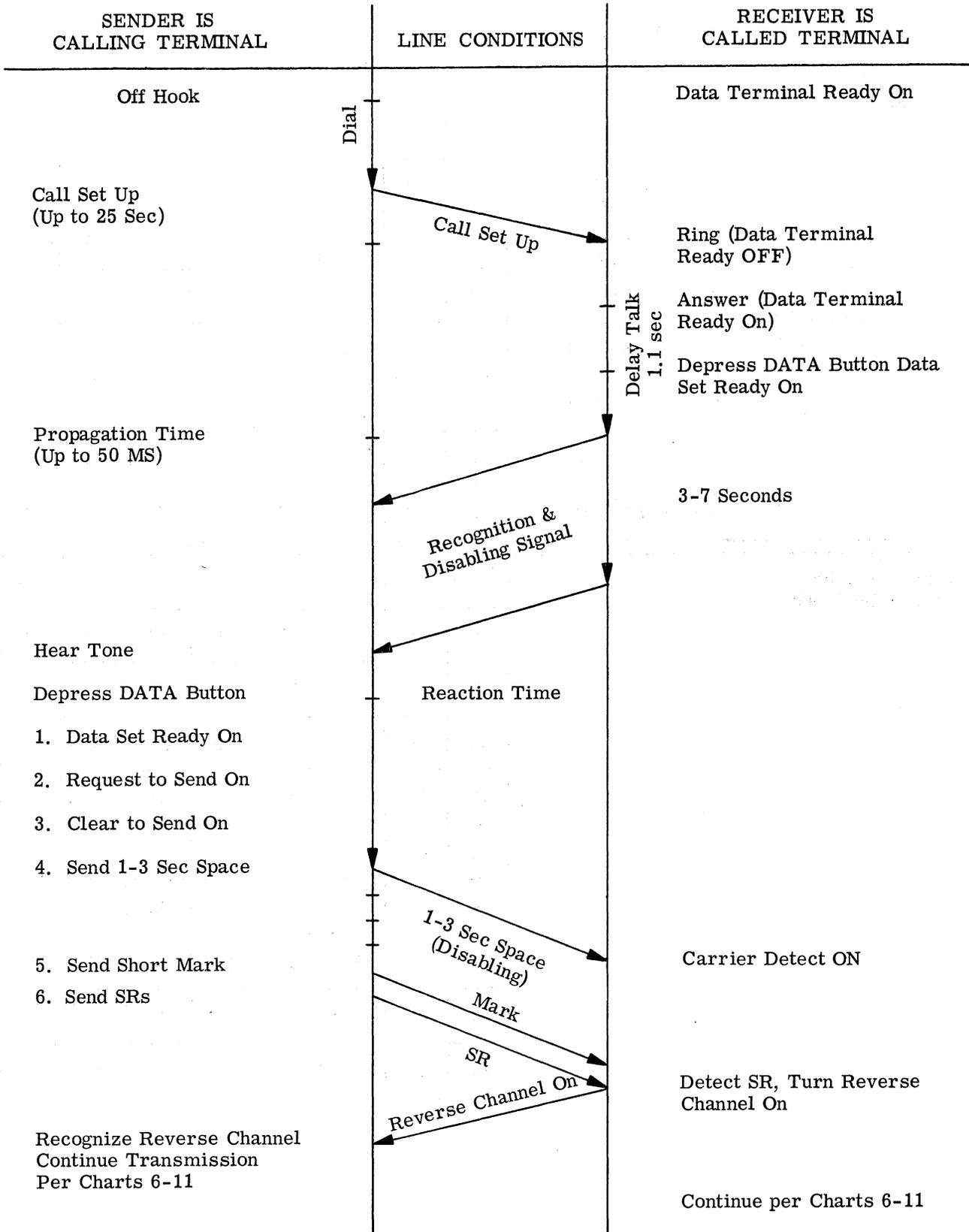


CHART 3 - MANUAL CALL SET UP - RECEIVER ORIGINATES CALL

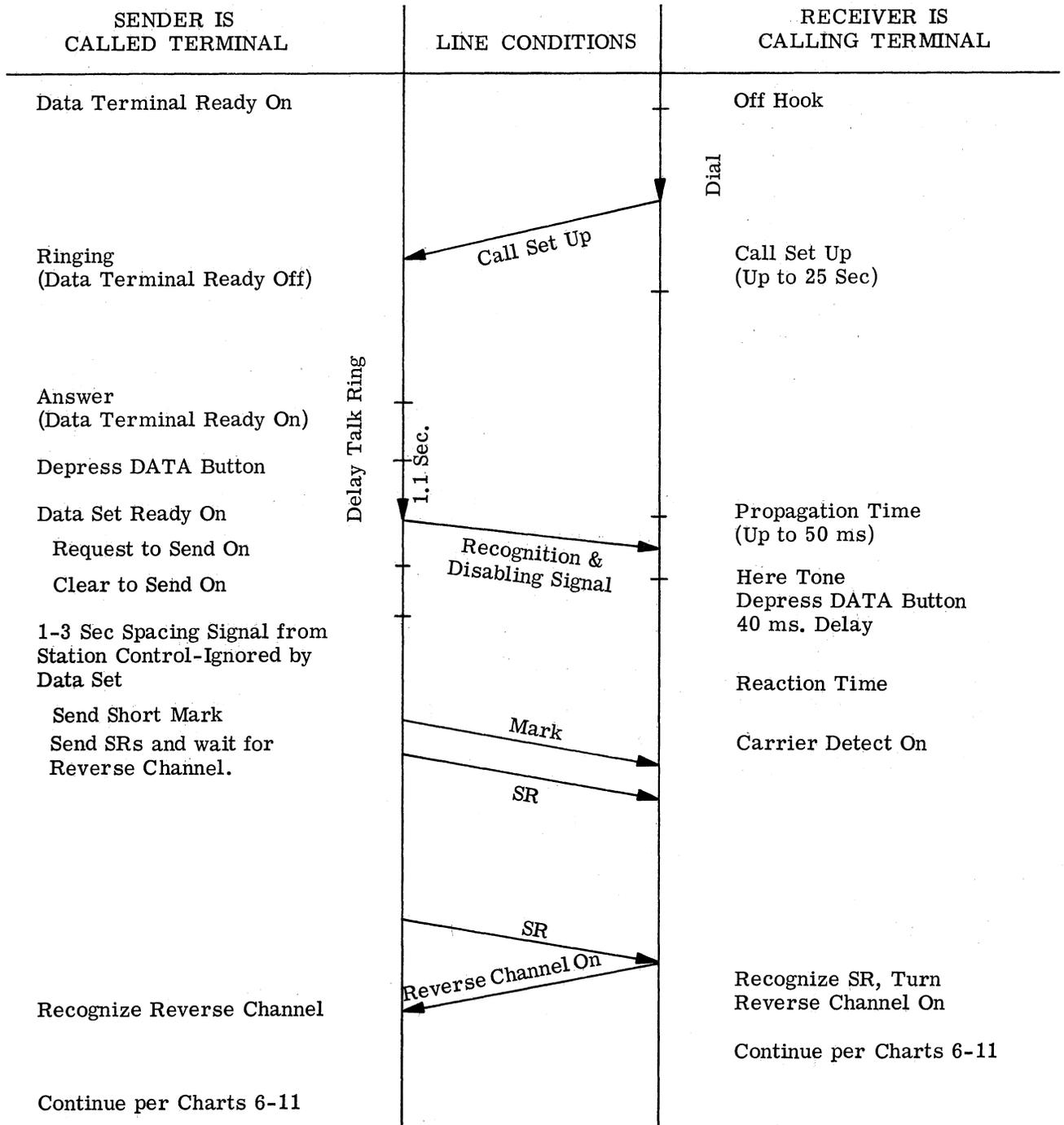


CHART 4 - CALL SET UP - UNATTENDED RECEIVER

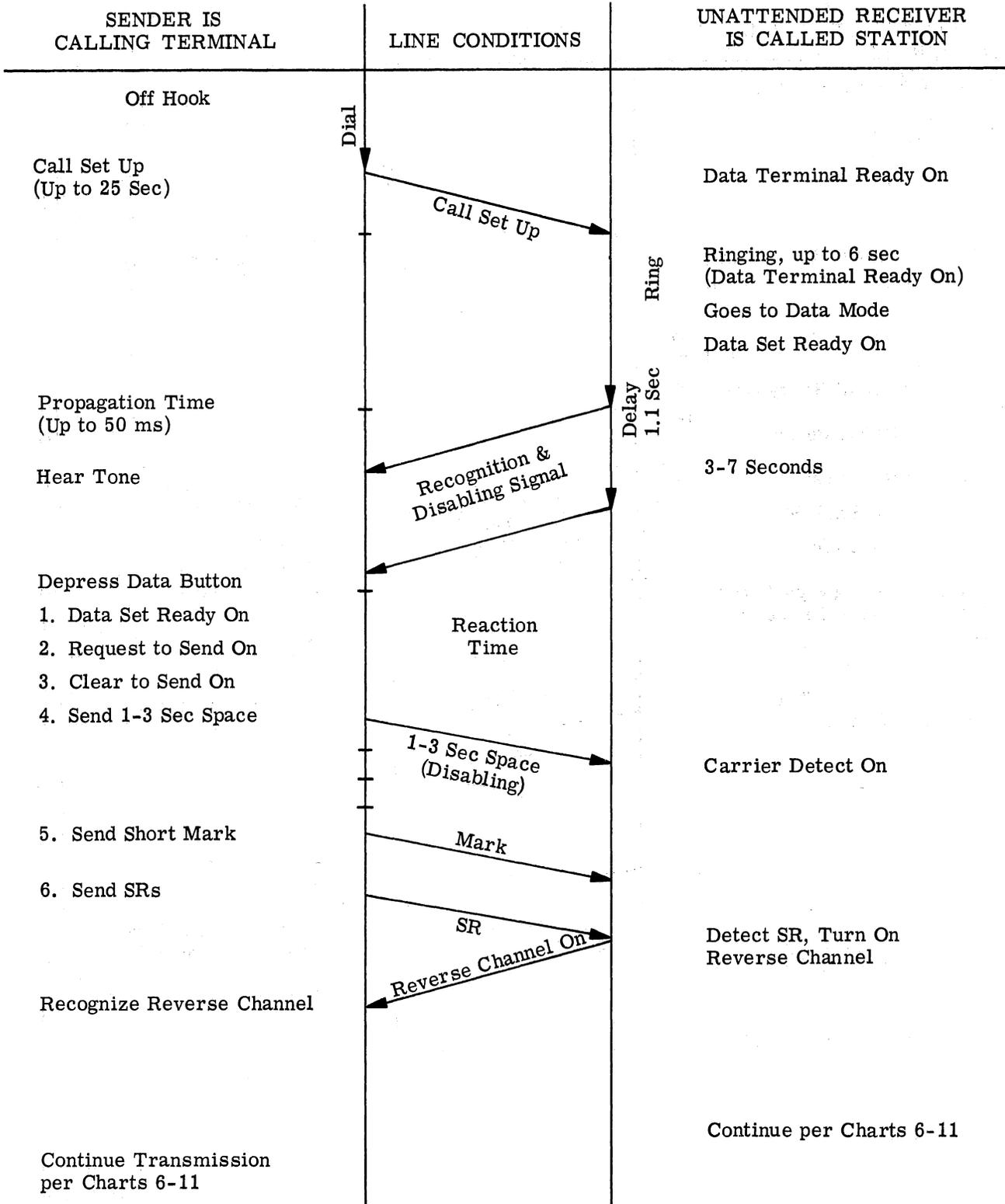


CHART 5 - CALL SET UP - UNATTENDED SENDER

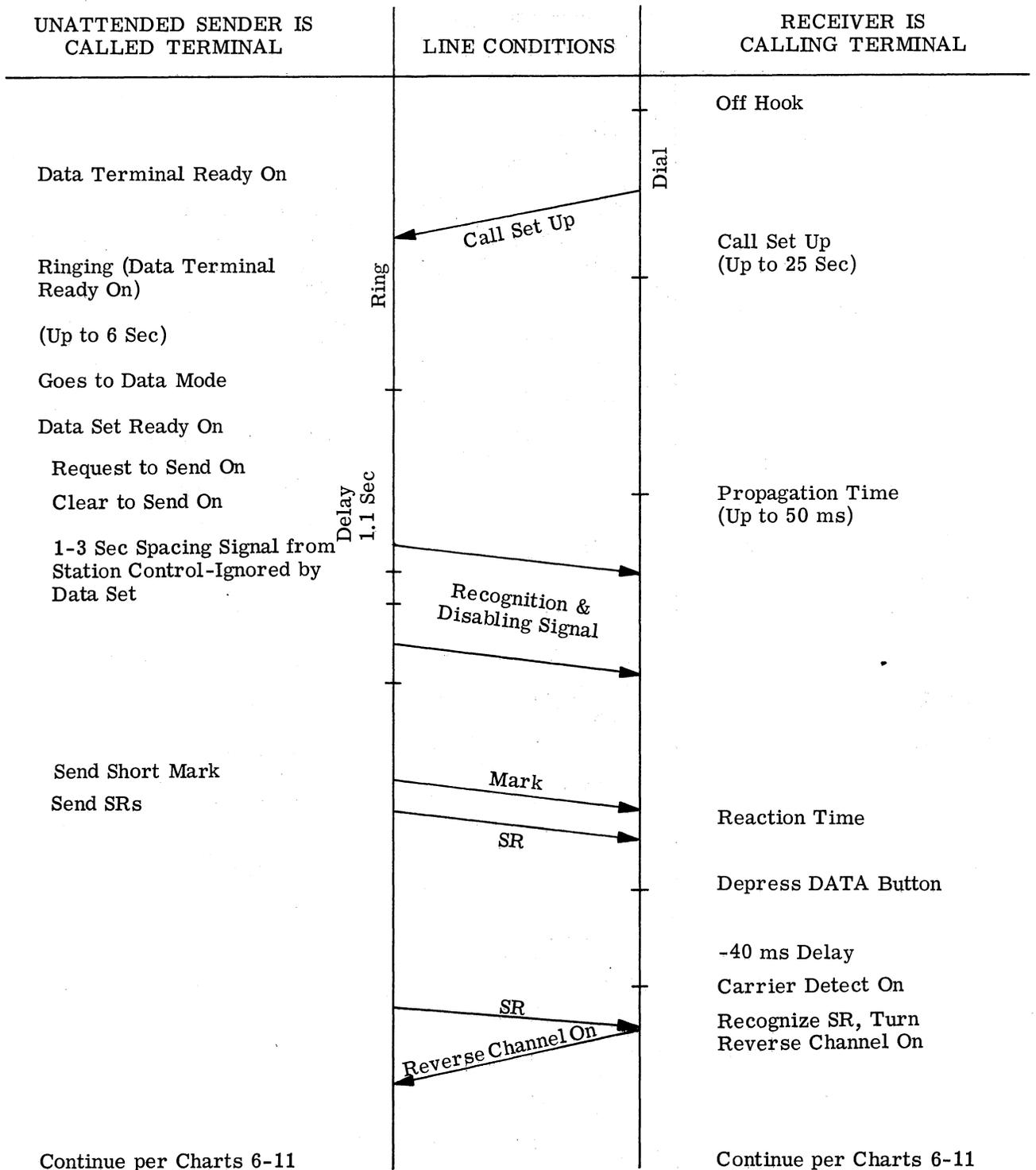


CHART 6 - EDC - NO DETECTED ERROR TRANSMISSION

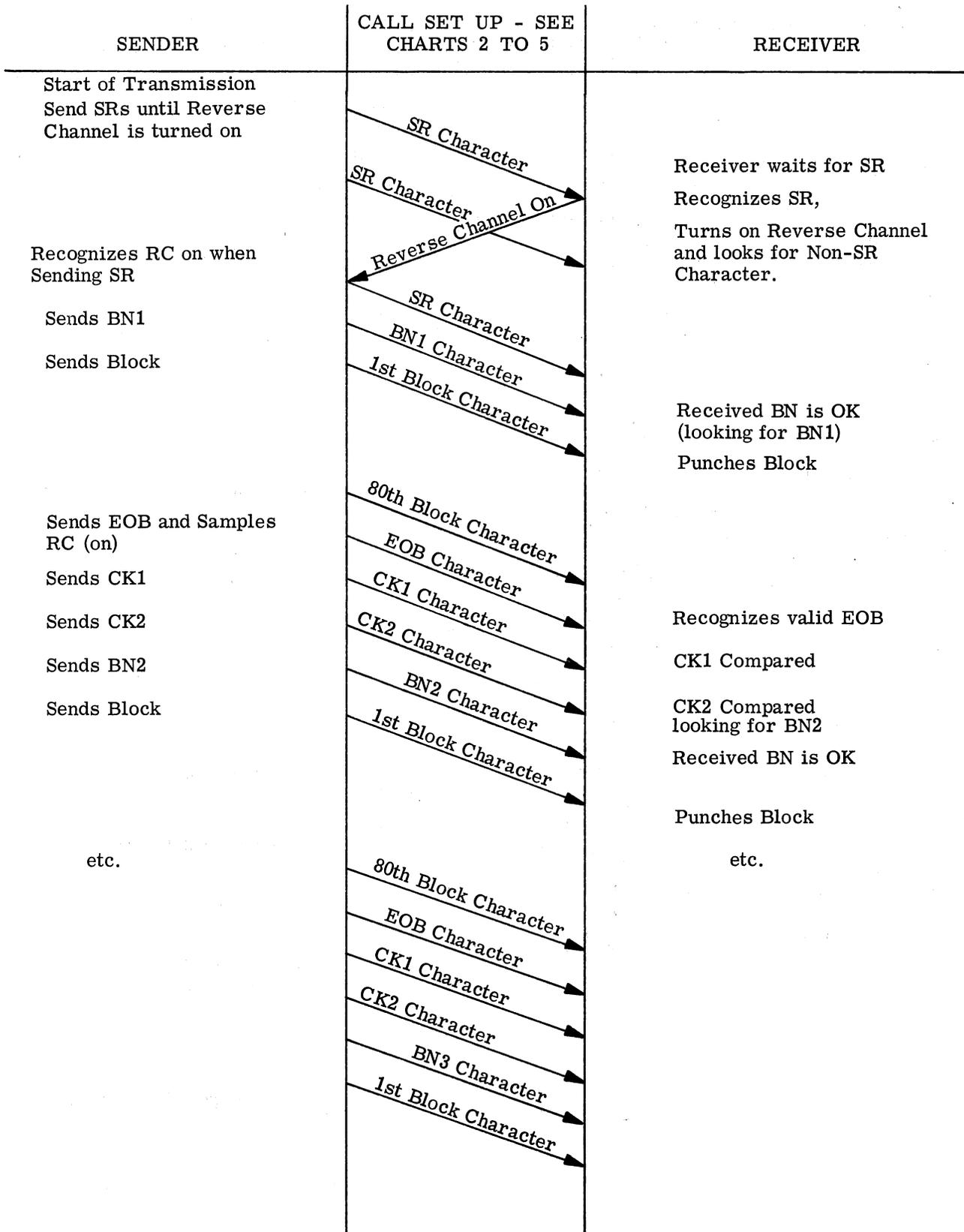


CHART 7 - TEXT ERROR (INVALID EOB)

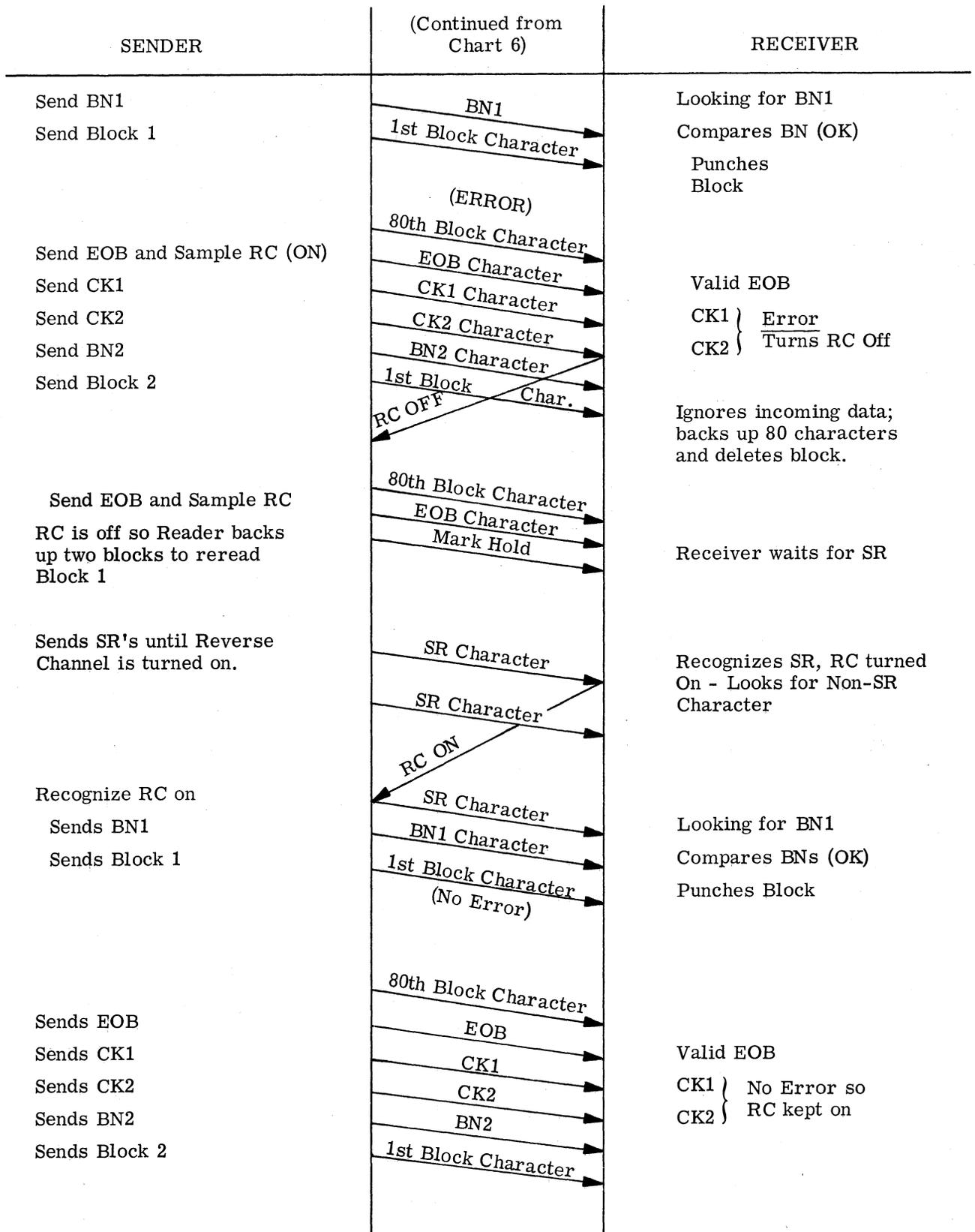
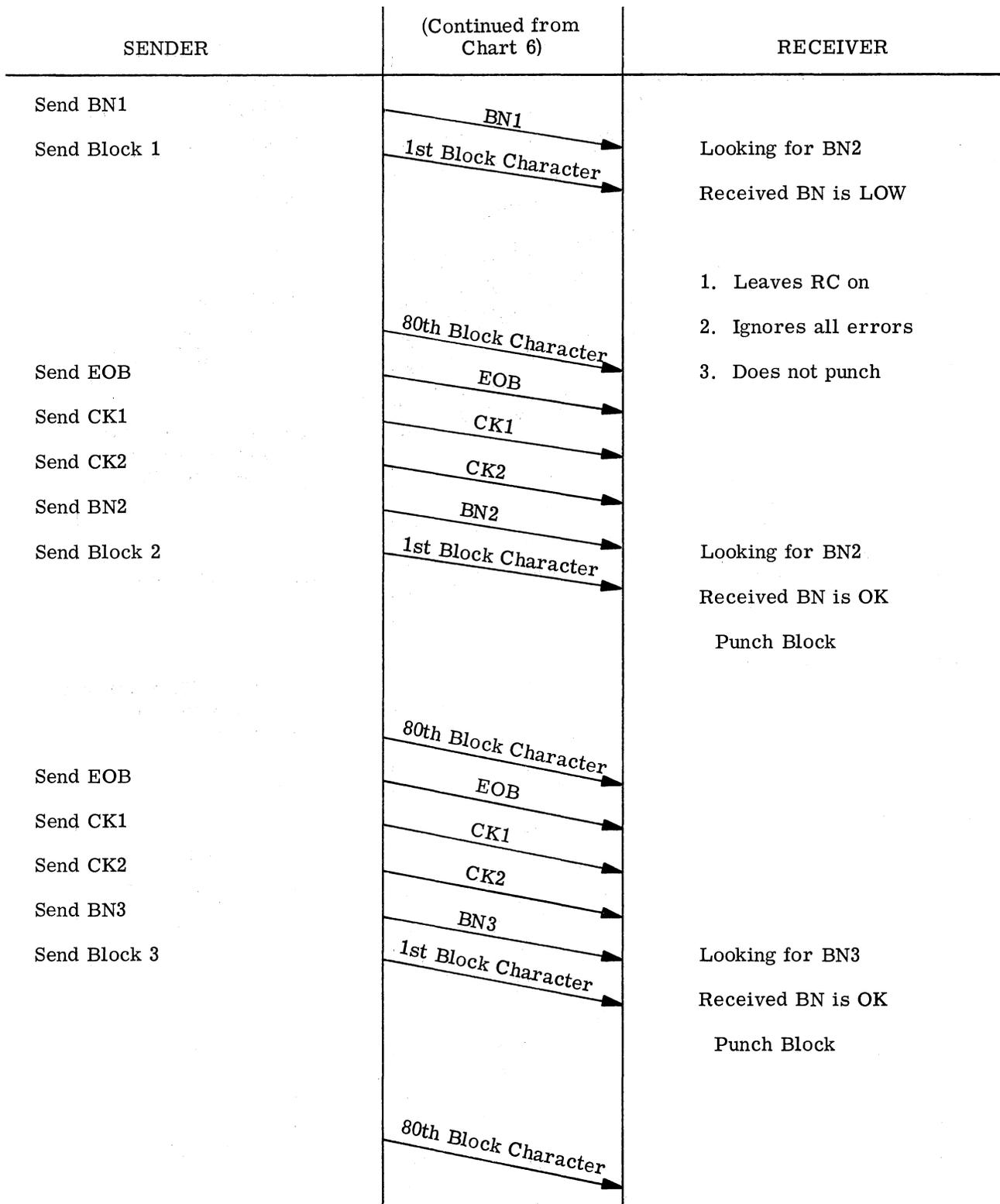
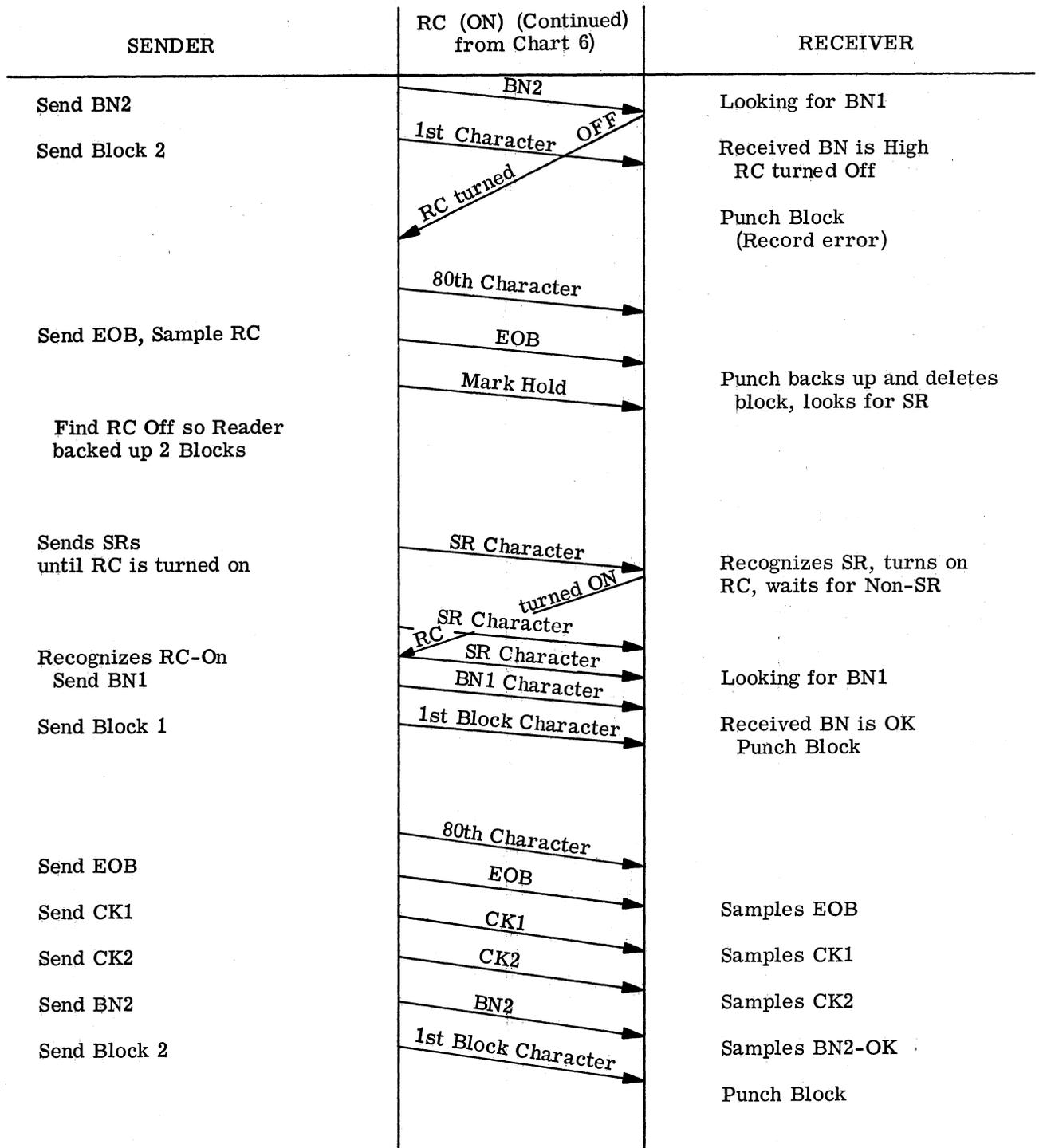


CHART 8 - BN LOW



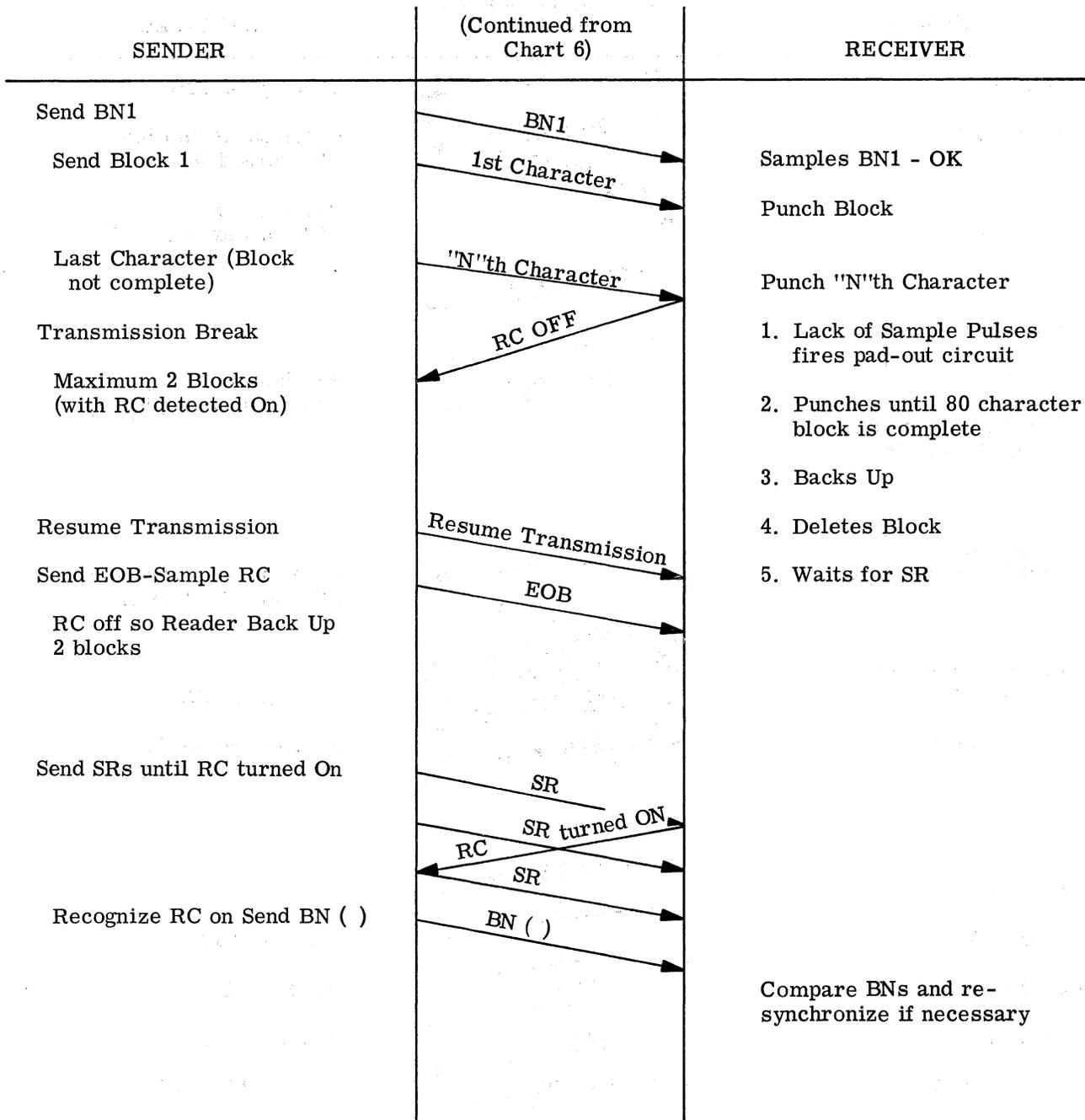
(Continue per Chart 6)

CHART 9 - BN HIGH



(Continue per Chart 6)

CHART 10 - INCOMPLETE BLOCK
(TRANSMISSION BREAK OR TAPE OUT)



(Continue per Chart 6)

CHART 11 - NON-EDC OPERATION

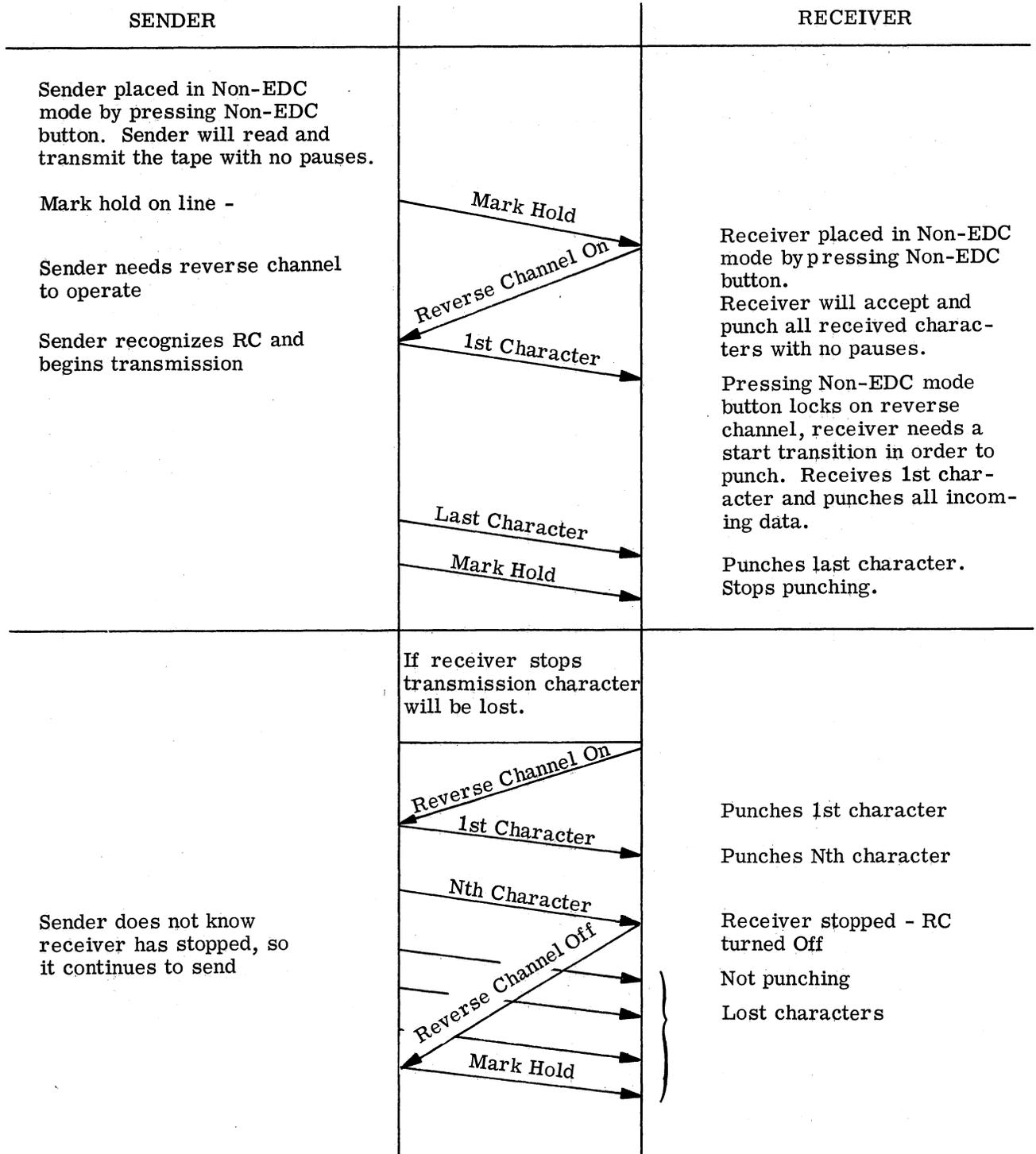
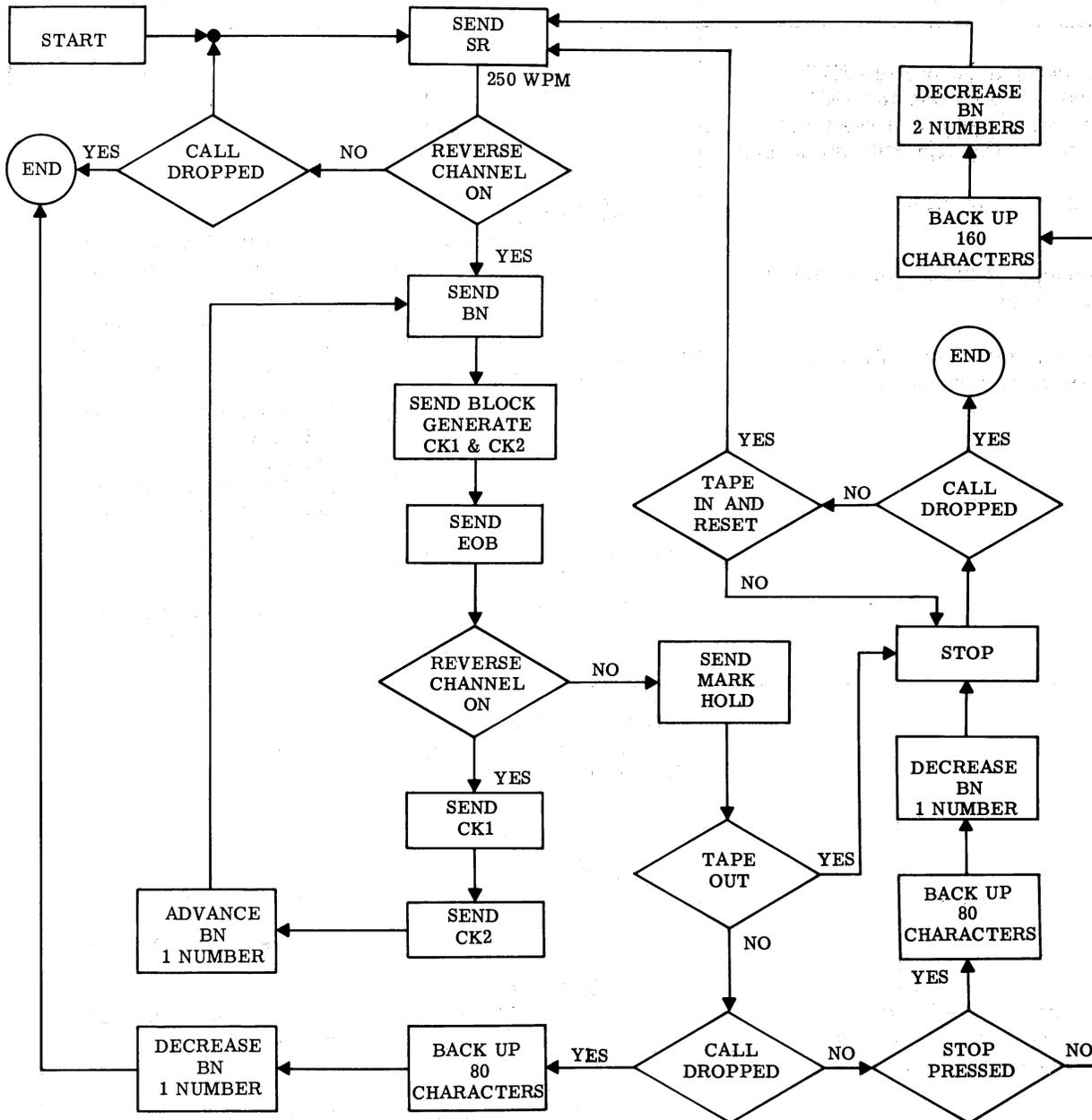
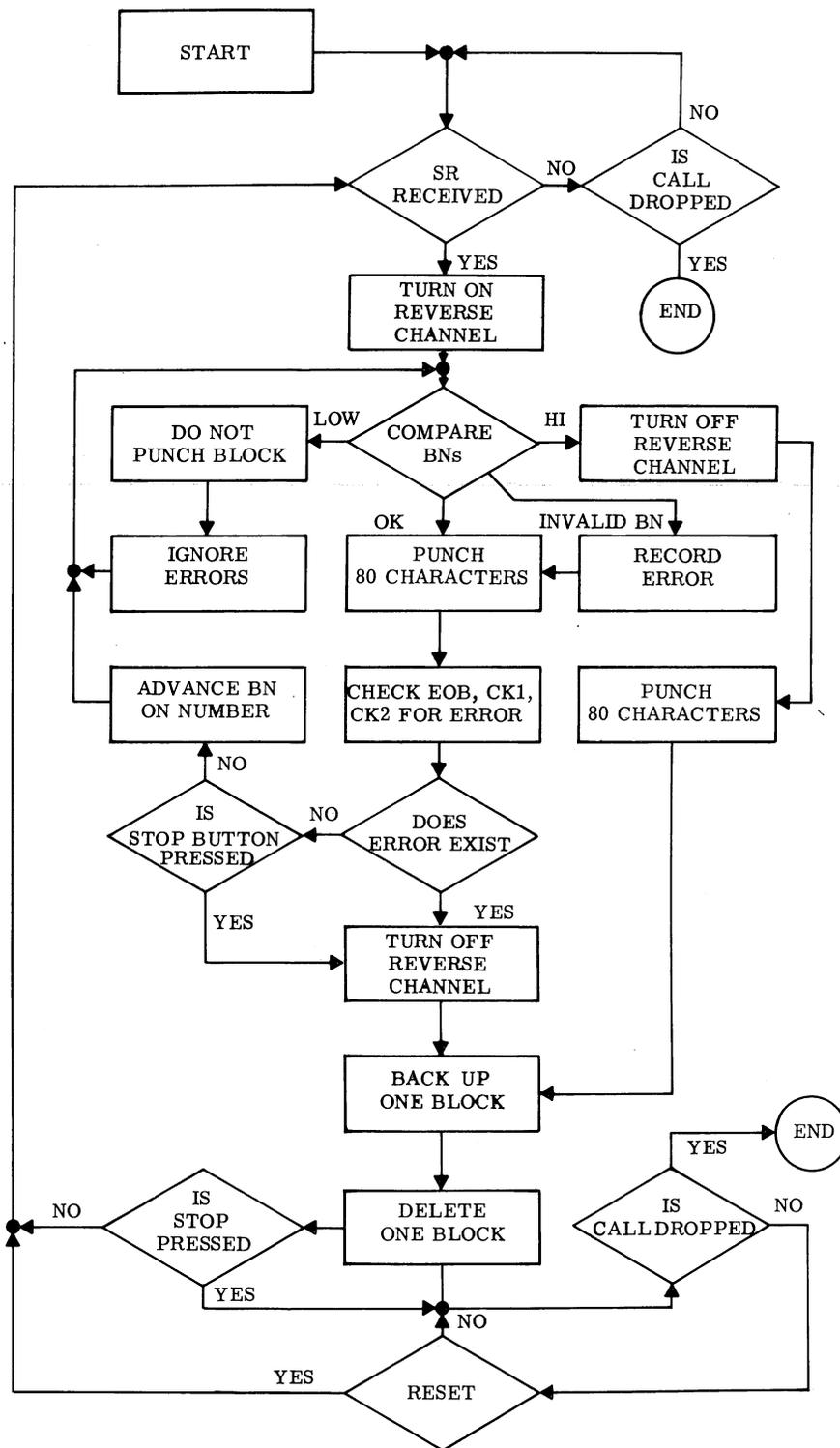


CHART 13 - SENDER LOGIC



- ◇ - DECISION OR FUNCTION
- ▭ - COMMAND INFORMATION OR FUNCTION DESCRIPTION
- - FINISH OR TRANSFER

CHART 12 - RECEIVER LOGIC



- ◇ - DECISION OR FUNCTION
- ▭ - COMMAND INFORMATION OR FUNCTION DESCRIPTION
- - FINISH OR TRANSFER