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Bell System

TECHNICAL REFERENCE

85A1 AND 85A2 DATA SELECTIVE CALLING SERVICE STATIONS OCTOBER, 1971

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Bell System Data Communications

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85A1 and 85A2 Data Selective Calling Service Stations

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ENGINEERING DIRECTOR - TRANSMISSION SERVICES

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This Technical Reference supersedes the following Technical Reference:

"85A1 Data Selective Calling System — April 1968"

PREFACE

References are made throughout this Technical Reference to 85A-type controllers of the earlier and latest designs. To clarify this point, a new station controller is now available for the 85A System. This controller will be provided for new system applications. Additions to existing systems will continue to use controllers of the earlier design. If there is a question of which controller is used in a specific application, the local Telephone Company representative should be contacted.

Some specific differences in the operation of the old and new controllers are listed below:

(a) The old controller unselects on either a low paper (friction feed) or a paper out (sprocket feed) condition that occurs during transmission. The new controller, however, provides an option which permits the station to operate on the basis of:

(1) Continuing to send when a low paper condition occurs (friction feed) until it unselects on EOT or,

(2) Stopping transmission when a paper out condition occurs (sprocket feed). As a manual override feature, normal transmission can be caused to resume by operating the PAPER alarm key at the station and holding it operated.

(b) A change in the logic of the "CAN" response has been incorporated in the new controller. This change is significant since it now permits the computer switcher to determine the readiness of the receiver to accept traffic as a part of the poll response. The computer, therefore, must be programmed to accommodate the "CAN" response in a different manner for stations with the new controller than was done for those with the old controller. The responses to poll and meaning of the responses for stations having the old and new controllers are listed below:

Earlier Controller	Latest Controller
NAK – No traffic	*NAK – No traffic; not ready to receive.
CAN – Last message improperly received.	**CAN – No traffic; ready to receive.
***ACK – Traffic	***ACK – Traffic; ready to receive.

(c) Since the polling responses differ for the old and new controllers, they should not be intermixed on the same circuit.

(d) The echoplex mode of operation is no longer available

(e) Stations with the earlier type controller are limited to 100 WPM operation. Those with the newer type controller will operate at either 100 or 150 words per minute.

Detailed operational differences are covered under appropriate sections of this manual.

* The NAK response is generated by stations with the new controller if the receiver is not ready even though traffic is available.

** The satisfactoriness of a message delivery to a station with the new controller may still be checked by means of the call-in or roll-call process.

*** SIC or "start of transmission" are also valid responses denoting traffic for stations with both old and new controllers.

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1. INTRODUCTION

The 85A1 and 85A2 Data Selective Calling Service Stations are private line, half duplex, teletypewriter station arrangements intended for use in multipoint data systems. Two speeds of operation are available. The 85A1 stations provide for 100-word per minute operation using 33- and 35-type teletypewriter equipment. The 85A2 stations provide for 150-word per minute operation using 37-type teletypewriter equipment. Both types of stations employ the same on-line operating procedure and control dialogue, and both use the American National Standard Code for Information Interchange, commonly referred to as ASCII, ANS X3.4 — 1968. The 33- and 35-type machines produce only upper case printing whereas both upper and lower case printing can be obtained with the 37-type equipment.

Compared to earlier Bell System half-duplex selective calling service stations, such as the 83B-types, the 85A-type stations offer not only a much higher degree of flexibility in their operational capabilities but also the potential for vastly improved system operation. The design of their control logic allows a large selection of feature options. Thus, the stations will accommodate numerous differences in operational behavior that might be desired by various users in their individual system applications.

As previously indicated these stations can be employed in a multipoint system that involves multistation lines. This is illustrated in Figure 1, which shows that the system configuration also requires a customer-provided computer switcher to serve as the line control station. As the line control station, the computer switcher administers the system and governs the selection of stations for sending and receiving. It also provides the store-and-forward capability required for dealing with traffic that originates from a station on one line but is destined for delivery to a station on another line.

Although a mixture of 85A1 and 85A2 stations cannot be employed on the same multistation line, they can be used on different lines in the same system. When they are used in the same system, it is not necessary for the computer switcher to translate to upper case any lower case alpha characters that are originated by an 85A2 station and destined for delivery to an 85A1 that has a page printer as its teletypewriter. Such characters will automatically be printed as their equivalent upper case characters by the 85A1 station teletypewriter.

It should be noted, however, that lower case characters that are received by a reperforator at an 85A1 station will be perforated in the tape as lower case characters.

The normal operation of 85A-type stations permits the line control station to:

(1) Pick up one or more messages from a selected sending station,

(2) Deliver a message to a selected receiving station,

(3) Deliver a message simultaneously to two or more selected receiving stations that are on the same line, or

(4) Cause the text of a message that is being transmitted from a selected sending station to be received directly by one or more selected receiving stations on the same line as the originator concurrent with its transmission by the originator.

Because of feature options, however, there are many variations possible in the details of how a system can operate with 85A stations. For purposes of the brief description that follows, a method of operation will be discussed that involves maximum use of the station capabilities.

To pick up traffic, the computer switcher "polls" the individual stations in turn, asking each station whether or not it has traffic to

send. The stations respond, when polled, with discrete indications of their traffic-to-send status. When a station is selected to send, it transmits a Start of Heading indicator and stops (option). The computer switcher may then send any information that is to be printed at the selected sending station (e.g., originating date and time, or originating message number record) before restarting transmission from the selected sender.

The selected sending station then sends the entire heading of the message to the computer switcher and stops (option). The heading contains the address information of those stations that have been designated by the originator as recipients for this message. The computer switcher translates the address information into the appropriate station call-in codes, in the process of which it can verify the validity of the heading information.

If the message is intended for stations that are on the same line as the originator, the computer switcher normally selects those stations as receivers by initiating the call-in process before having the selected sending station transmit the text of the message to enable delivery of the message directly from the originator to the available intended receivers. When applicable, this method of operation, termed "intraline" operation, results in the most efficient utilization of the line, because the line is used only once to accomplish both the pickup and the delivery of the message.

If the message is not intended for delivery to stations that are on the same line as the originator, the call-in process is by-passed at this time, or if it is desired (option) to treat all message handling transactions in the same way, the originator's transmission to the line is not stopped at the end of the heading.*

*Store and forward handling is then required in either case. For simplicity, store and forward operation is referred to in this document as "interline" operation, even when the addressed stations are on the same line as the originator.

The "call-in" process used for message delivery consists of the computer switcher asking each of the addressed receiving stations individually in turn whether or not it is ready to receive the message. The stations respond with discrete indications of their ready-to-receive status. Stations that respond ready-to-receive to call-in, automatically become selected receivers. In the case of stations that respond not-ready-to-receive to repeated call-in attempts, the computer switcher initiates the message intercept routine being employed in the system. When all of the available addressed stations on the line have been called in, the computer switcher unblinds all selected receivers. It then instructs the selected sending station to resume transmission, as previously mentioned. The call-in process is the same when the computer switcher undertakes delivery of a message of its own. In this case, of course, there is no selected sender involved.

In the case when there is a selected sending station, that station then sends the text of the message directly to all selected receivers, and stops (option) upon detection of the End-of-Text indicator. The computer switcher can now perform a "roll-call" function (option) to determine the satisfactoriness of the delivery before releasing the selected receivers and instructing the originating station to resume transmission.

Following this, the originating station sends either the Start of Heading indicator of another message or the End of Transmission indicator and stops.

In the case of a multiple message pickup, when the selected sending station sends the Start of Heading indicator and stops, the computer switcher must take appropriate action, as indicated earlier, to deliver a possible date and time or message number record to the originator and to reinitiate the transmission from the selected sending station in order to get the heading information of the next message. In the case of a termination of transmission (selected sending station sends

End of Transmission indicator and stops), the selected sending station will automatically assume the idle, unselected condition. The computer switcher may then proceed to poll the next station in the polling round, searching for another station with traffic to send, or it may proceed with a delivery of its own by initiating the call-in process.

The operational flexibility of the 85A stations is such that, in general, the final definition of available system features can be those attributable to the customer-provided computer switcher that serves as the line control station. This Technical Reference, therefore, covers the kind of information required for programming a computer switcher as the line control station. Included are a brief discussion of the salient features of the 85A stations and how the station controller logic operates, a review of the on-line signal characteristics of an 85A system, and a detailed examination of some of the operational aspects of 85A stations, including available user options.

For details covering the standard 150-baud private line channel interface arrangement to be used with the computer switcher that serves as the line control station, and for information on the transmission characteristics of the channel and transmission performance objectives for the computer switcher, reference should be made to:

PUB 41003
Bell System Data Communications
Technical Reference
150-Baud Private Line Channels
Interface Specification
February 1968

2. GENERAL CHARACTERISTICS OF 85A STATIONS

The 85A stations incorporate many features not previously available with Bell System selective calling service teletypewriter stations. Some of these features that directly or indirectly affect on-line operation are described briefly in this section, to aid in understanding the capabilities that are available and the limitations that apply when these stations are employed in a system controlled by a customer-provided computer switcher.

Figure 2 illustrates the general organization of the 85A station. The teletypewriter serves as the source and sink for information signals. The station control unit serves as the source and sink for administrative signals. The teletypewriter is not actively involved in the logic organization of the station but provides the stimuli required by the station control unit regarding traffic-to-send and ready-to-receive conditions. The station control unit includes all of the requisite character detection and character generation capability, along with the necessary logic, to accommodate the on-line administrative procedures of the system. This separation of machine functions and control functions results in a versatile station arrangement and accounts for many of the new features available to 85A systems.

An 85A1 station can employ either 33- or 35-type teletypewriter equipment. An 85A2 station employs 37-type teletypewriter equipment. Both the 85A1 and 85A2 stations are available in station arrangements that make use of (1) an automatic send-receive teletypewriter (ASR), (2) a receiving-only page teletypewriter (RO), or (3) a receiving-only typing reperforator tape punch (ROTR). In the case of arrangements that employ the ASR or RO teletypewriters it is possible, also, to use an auxiliary receiving device (RO or ROTR) as a slave to the primary teletypewriter. Further, with certain limitations it is possible to use the tape punch of the ASR in the role of an auxiliary receiving device.

The auxiliary receiver can be cut on and off during any message delivery, under control of on-line signals. When so controlled, its cut-on and cut-off are normally accomplished within the text of a message as a part of the message delivery process and, hence, require no special administrative action on the part of the computer switcher. The control character DC2 (Device Control 2) in the text will cut on the

auxiliary receiver. The control character DC4 (Device Control 4) in text, or the control character ETX (End of Text) at the end of the text, will cut it off.

However, when it becomes necessary to abort a message delivery, the computer switcher will have to act to insure that an auxiliary receiving device that is in the cut-on state at the time of the delivery abort is cut off so that a subsequent message delivery to that station will not commence with the auxiliary receiving device left in the cut-on state. The ETX that is included as a part of a delivery abort procedure will bring about the required auxiliary receiving device cut-off function (see Section 4.17 — Delivery Abort — Interline Operation).

The typical message sent by an 85A station has the following format:

S O H	Heading	S T X	Message Text	E T X

There is a heading section that contains the addresses of those stations that are to receive the message text, and there is a section that contains the message text itself. The control codes SOH (Start of Heading), STX (Start of Text), and ETX (End of Text) are message format delineators that are used to denote the beginning and the end of the different elements of the message.

The station controller can optionally be arranged to stop transmission upon detection of any of these codes. This capability permits programming the computer switcher to provide services such as:

1. Interjecting originating date and time information and/or message numbering at whatever point seems appropriate for the particular system application.
2. Calling in intended receivers on the same line (stop on STX) to provide the intraline type operation.
3. Interjecting delivery date and time information and/or message numbering at whatever point following STX seems appropriate for the particular system application.
4. Providing the roll-call feature for intraline operation (stop on ETX), to verify satisfactoriness of a message delivery before dismissal of the addressed on-line station(s).

A number of messages can be grouped together to form a single "transmission" that is picked up as a result of a single poll. The end of a transmission, whether the transmission comprises a group of messages or only one, is denoted by the control code EOT (End of Transmission) following the ETX of the last message. When a selected sending station transmits the EOT character it stops and automatically reverts to the idle, unselected condition.

In an 85A System, a selected transmitting station normally sends the entire heading section of the message to the computer switcher and stops. The computer switcher then translates the addresses in the heading into individual station call-in codes*. The call-in of receiving stations is performed by the computer switcher. There is no direct call-in of receiving stations by an originating station.

Because the station logic is transparent to what is in the heading portion of the message, the addressing capability that is employed is governed only by the abilities of the computer switcher. Consequently, in most applications, multicharacter mnemonic codes can be employed to increase the meaningfulness and capacity of station addressing. Moreover, this transparency allows the use of personal address information (such as the name of the individual to whom the message should

* These are the station code characters (SCCs) referred to throughout this document. They serve, also as the station polling codes. See footnotes relating to SCCs in Section 4.2 — Polling Operation and Responses and Section 4.7 — Call-In Operation and Responses.

ultimately be delivered) or directives, etc., (such as "for action" or "for information") in the message heading to supplement the mnemonic addresses. Such supplemental information may be made distinguishable from regular address codes by any characters that can be recognized by the computer switcher and that are not used to delineate the different elements of the message.

The selection of receiving stations, on the other hand, involves the use of single character station call-in codes only. The call-in operation involves asking each intended receiver individually if it is ready to receive and receiving a discrete response concerning its readiness to receive. There are no group or broadcast call-in codes available with 85A stations. Stations are arranged to respond to one and only one station call-in code. Group and broadcast address codes can be used in the message heading, of course, but they must be translated into individual call-in codes before the process of selecting receivers begins.

The call-in operation is arranged so that as each receiver responds to call-in that it is ready to receive, it alone is unblinded. Hence, it is possible to deliver separate information to each receiving station during the call-in process without other selected stations receiving it. A universal unblind code function is provided so that when the call-in process has been completed, all selected receiving stations will receive the message text delivery at the same time.

Because of the separation of teletypewriter machine functions and control functions in the station organization, it is possible to exercise motor control and turn off the teletypewriter motors whenever the station is not directly involved with message preparation, pickup, or delivery. This may be a very desirable capability at locations that principally receive traffic, since it results in a quiet environment.

The motors of primary RO or ROTR teletypewriters are always under automatic control and are, therefore, off except when the station is receiving a message delivery. Much of the time this is true, too, of the 33 ASR teletypewriter. In the case of the 35- or 37-type ASR teletypewriters, turning off motors and putting them under automatic control can be effected by the station attendant.

Having such an automatic motor control feature means that sufficient time must be provided during the call-in process to insure that the motors of the teletypewriters that are to receive data are permitted to attain proper operating speed before data signals are sent to them over the line. The 85A station controller logic does not provide for this timing function in connection with its response to call-in. Consequently, the computer switcher must be programmed to supply the required timing. Detailed information concerning this and other timing requirements is given in Section 3.7 — Timing Considerations.

A new and potentially useful feature of the 85A stations is their ability to indicate that the last message delivery was not properly received. In the earlier design of the 85A1 station, this indication is in the form of a discrete response given automatically to the first roll-call, poll, or call-in after the delivery in question. In the later design of the 85A1 station, and for all 85A2 stations, the indication is a discrete response given automatically only to the first roll-call or call-in after the delivery in question. In all cases, the response is given only once, so subsequent polling, roll-call, or call-in attempts will result in normal responses based upon traffic-to-send or ready-to-receive states of the station.

The station logic bases its decision on whether a delivery is satisfactory or not upon such things as message format checks, machine operation checks, service continuity checks, and (optionally) parity checks on received data. In the 85A stations parity checking is performed automatically on all received characters, and when a character with a parity error is received from the line, the teletypewriter prints (or, in the case of an ROTR, prints and punches) an "underline" character (having incorrect parity) as a substitute for the character with the parity error.

An important use of the ability to check the satisfactoriness of the last delivery is to implement a roll-call function in the system operation. This means performing another call-in of each of the receiving stations before dismissing them after a delivery, to determine if a redelivery of text to any station is required. Normally, this action is performed immediately after the ETX of a message, as a single check of the entire text. When implemented in this manner, it can be used for intraline message deliveries as well as for deliveries made from the computer switcher.

In the case of deliveries from the computer switcher, however, there is nothing to preclude performing the function as many times as desired during a delivery. Consequently, in the latter case, by electing to have parity error detection as one of the delivery checks, a simplified form of error control is possible. (For further details on this capability, see Section 4.9 — Roll-Call Operation and Responses.)

Another notable feature of the 85A station, one that may be very important in a system, is the ability (optional) to use a station identity check as a part of the call-in process, to virtually eliminate any possibility of misdelivery of a message to the wrong station. With this feature, each receiving station is assigned a discrete Station Identity Code (SIC) that is used as the ready-to-receive response to call-in. The computer switcher can then verify that the proper stations have been selected to receive before message delivery proceeds*.

3. ON-LINE SIGNAL CHARACTERISTICS

A computer switcher employed as a line control station should have the following on-line signal characteristics in order to be compatible with 85A1 and 85A2 stations.

* There are over 90 characters in the ASCII set that can be assigned as station address codes and as Station Identity Codes. Thus, in a given system there can be well over 8,000 discrete pairings of characters — call-in code with SIC — before duplication becomes necessary.

3.1 Code

The transmission code employed on-line should be ANS X3.4-1968, the American National Standard Code for Information Interchange (ASCII). This code is illustrated in Figure 3.

3.2 Transmission Speeds

Acceptable transmission speeds are 100 wpm (10 characters per second) when 33- or 35-type teletypewriter terminals or combinations thereof are employed in 85A1 stations, or 150 wpm (15 characters per second) when 37-type teletypewriter terminals are employed in 85A2 stations.

3.3 Character Structure

At the operating speed of 100 wpm (10 characters/sec.) the on-line character structure should be 11.0 units — a 1.0 unit start pulse, seven 1.0 unit information bits, a 1.0 unit parity bit, and a 2.0 unit stop interval. This results in a transmission rate of 110 bauds. Even parity should be employed for all characters transmitted on-line.

At the operating speed of 150 wpm (15 characters/sec.), the on-line character structure should be 10.0 units — a 1.0 unit start pulse, seven 1.0 unit information bits, a 1.0 unit parity bit, and a 1.0 unit stop interval. This results in a transmission rate of 150 bauds. Even parity should be employed for all characters transmitted on-line.

3.4 Bit Order

Transmission of information bits within a character should be low order bit first. The parity bit is considered to be the eighth bit following the start pulse.

3.5 Distortion Requirements

The computer switcher should transmit data with not more than 5 percent telegraph distortion. In addition, the computer switcher should be capable of accepting incoming signals with up to 40 percent telegraph distortion. Detailed information relative to these distortion requirements is covered in PUB 41003 referred to earlier.

3.6 BREAK Signal

A BREAK signal is used by the computer switcher for interrupting transmission from a sending station. This signal is not included in the ASCII set. To generate a BREAK signal, the computer switcher should send a minimum of 400 milliseconds and a maximum of 750 milliseconds of continuously spacing signal *. A station that is sending will stop transmission upon detecting a BREAK signal.

3.7 Timing Considerations

This section provides information concerning timing considerations that a computer switcher should observe when operating as the line control station.

3.7.1 Station Motor Turn On

The use of automatic motor control at 85A receiving stations requires that the computer switcher provide sufficient time after a call-in function to allow the teletypewriter motors to attain proper operating speed before data signals are delivered to the line. Otherwise, it is likely that the teletypewriter will not be in synchronism with the data signals and will record erroneous characters until it achieves synchronism.

As mentioned in Section 2, the station controller logic does not provide for a delay in the response to call-in when the teletypewriter motor is off. It takes about 750 milliseconds for the slowest teletypewriter motor to attain proper operating speed. Therefore, the computer switcher should wait for a minimum of 750 milliseconds after receipt of the ready-to-receive response from a called-in station before sending any information intended for it. During this waiting interval the computer switcher must maintain a steady marking condition on the line.**

* A continuously spacing signal is one in which there are no marking intervals. The transmission of a succession of NULL characters during this period will not result in a continuously spacing signal, because of the (marking) stop bits involved, and therefore will not meet this requirement.

When several stations are being called in and the stations in the system employ controllers of the latest design, this delay is needed only once — following the ready-to-receive response of the last station called — unless separate information (e.g., a delivery message number) is to be delivered to each station during the call-in process. However, when the stations in the system employ controllers of earlier design, the computer switcher must introduce this delay following the ready-to-receive response from each station, regardless of whether or not separate information is to be sent to that station.

3.7.2 Transmission Turn-Around

In the normal course of system operation, there will be various times when the computer switcher will receive data signals from the station indicating that the computer switcher should assume the role of sender. These data signals are referred to in this document as "transmission turn-around" signals.

Typical examples of such signals are responses to polling, call-in, or roll-call, and the EOT character denoting the end of a transmission. Whenever a transmission turn-around signal is received, the computer switcher must exercise care that its transmission does not begin before the line is idle and the stations are in a condition to receive data signals.

The characteristics of the station are such that each character it transmits must be sent in its entirety, including the full specified stop interval, before it can act correctly on the next character to be sent or received. Consequently, even though the computer switcher may be able to recognize a transmission turn-

** The requirement to maintain a steady marking condition means that there can be no activity whatsoever on the line. Transmitting DELETE characters during this waiting interval does not result in a steady marking condition (because of the spacing start bit of each DELETE character) and, therefore, does not satisfy this requirement.

around character during receipt of the parity bit and be ready to respond immediately, it must nevertheless delay initiating any outward transmission for a period of time at least equal to the remainder of the full character interval, including the total stop interval time. Otherwise, the station is likely to lose synchronism.

As a positive safeguard to insure that the line is truly idle, the computer switcher should allow for the receipt of at least 30 milliseconds of continuous marking, after receipt of the parity bit of the transmission turn-around character, before sending to the line.

3.7.3 One Character Buffer Delay

In order to provide screening of received characters so only pertinent information is delivered to the teletypewriter terminal, the station controller incorporates a one character buffer store. Each character received is "pushed through" to the teletypewriter by the next character received. Consequently, whenever transmission of message text from the computer switcher to a station is to be halted for some period of time, either to allow for a mechanical operation by the teletypewriter (e.g., tabulation or form feed) or because a natural end of the information stream has been reached, the computer switcher should send at least one character to act as a "pushing character" to insure that the last information text character reaches the teletypewriter terminal. This type of "pushing character" is required after each of the following control codes:

HT — Horizontal Tabulation
VT — Vertical Tabulation
FF — Form Feed
EOT — End of Transmission (Option)*

* A pushing character is required only when delivery of the EOT to the teletypewriter terminal is desired (e.g., a refile station that uses an ROTR as the primary receiver).

In the cases cited above, a suitable and suggested pushing character is the DELETE character. The DELETE character is what is normally used as a timing character when the above control codes are generated by a station. However, for computer switcher generated messages, the next regular printing character can be employed as the pushing character after HT, VT, and FF control codes since it will stay in the buffer storage at the station until it is pushed through when transmission resumes. In certain cases, a control code may even be employed to serve the pushing function and at the same time pass along the control information. An example of this might be the use of the End of Text code (ETX) following the Form Feed (FF) character at the conclusion of a message delivery.

3.7.4 Station Mechanical Functions

Timing is required after various machine control commands to allow the station teletypewriter to complete the necessary mechanical operation. Perhaps the most often used commands of this type involve the carriage return— line feed function. When this function is performed at an operating speed of 150 wpm, two "fill" characters, or their equivalent, are required following the Carriage Return (CR) character to allow sufficient time for the maximum physical return of the typing mechanism. The Line Feed (LF) character provides one of these timing character intervals. The other may be a timed interval of continuous marking, or a DELETE character. It is suggested that the computer switcher adopt the policy of sending the sequence CR LF DEL when executing this function to allow sufficient time for the carriage return operation to be completed independently of the type of teletypewriter terminal or transmission speed employed.

In systems that employ teletypewriter terminals equipped with the "New Line" feature, where both the carriage return operation and the line feed operation are executed upon receipt of a single control character (LF), two DELETE characters, or an equivalent interval of

continuous marking signal, are required at an operating speed of 150 wpm to allow sufficient time for the maximum physical return and proper positioning of the typing mechanism. Therefore, when the "New Line" feature is employed, it is suggested that the computer switcher adopt the practice of always sending the sequence LF DEL DEL when executing this function, independently of the type of teletypewriter terminal or transmission speed employed.

The timing required for the tabulation and form feeding functions varies according to the tab settings and length of form employed. Therefore, it is not possible to specify here exact timing intervals required for them. However, it is possible to indicate the operating speeds for the tabulation and form feeding functions for the various types of teletypewriters that may be employed in 85A stations. This information is given in terms of the number of spaces or lines moved per character interval during the execution of the indicated function. The following chart shows these values.

Type of Teletype-writer	Tabulation		Form Feeding
	Horizontal	Vertical	
33	-	-	6:1*
35	3:1	6:1*	6:1*
37	3:1	3:1	3:1

* At the option of the customer, the 33- and 35-type teletypewriters can be modified to have vertical tabulation and form feeding ratios of 3:1 instead of 6:1. Thus, the feeding ratios for any system application should be verified before timing intervals are programmed to permit such mechanical functions.

These figures mean that in the process of tabulating horizontally, for instance, the 35- or 37-type teletypewriter printing mechanism moves three spaces during a character interval, i.e., during an interval of 100 milliseconds in the case of the 35-type, or during an interval of 66.67 milliseconds in the case of the 37-type.

A station, after transmitting a tabulation character (HT or VT) or a Form Feed character (FF), stops sending until it completes the performance of the indicated function. This automatically provides the timing needed by the receiving terminal when intraline operation is involved. Also, it provides a rather precise indication to the computer switcher of the timing required (for a receiving teletypewriter with the same tabulation and form feeding ratios as the originator) if the message must be handled on a store-and-forward basis.

Thus, the computer switcher, when it is to make a message delivery, either can duplicate this timing that was furnished it by the originating station or can be programmed to provide the timing required for each operation on the basis of knowing the various settings employed in the system for tabulating and form feeding functions. And, thus, the timing either can be quite exact, based upon the amount of mechanical movement required to carry out the operation from the point of execution, or it can be gross, based upon the maximum mechanical movement that could be possible for the particular function.

3.7.5 Response and Intercharacter Time-Outs

Timing is required in the computer switcher in the form of gross time-out functions to signify when certain time intervals have elapsed while waiting for particular events to occur. Two such timing intervals are necessary — one for inquiry response time-outs and the other for intercharacter time-outs.

Because the station uses an electronic controller to generate responses to inquiries, such as polling, call-in, and roll-call, the computer switcher can expect to receive them within the limits of the round trip transmission delay time for the system layout. Under almost all circumstances, a time-out interval of 600 milliseconds (minimum) should be adequate for these responses. However, a system time-out interval of one second is recommended for the purpose, to accommodate even the most abnormal cases.

For the intercharacter time-out interval that is to be employed by the computer switcher on text received from an 85A station, it is suggested that the period be long enough to allow the operator at a station time to clear a taut tape or twisted tape condition without losing control of the line. A recommended intercharacter time-out interval, therefore, is approximately 30 seconds.

4. DETAILED SYSTEM OPERATIONAL PROCEDURES

This section covers the operational aspects of an 85A System line and describes the related features, capabilities, and limitations. The material is organized such that it follows the logical sequence of events illustrated in Sequence Charts SC1 and SC2. Also provided are Sequence Charts SC3, SC4, SC5 and SC6 which present comparable information in a different and somewhat more comprehensive form. Reference should be made to all these charts as an aid to the understanding of what follows.

The description is aimed at covering the optional as well as the required operating features of the 85A station. Principal emphasis, however, is placed on the kind of information that is needed for programming the computer switcher that handles the operation of a system that employs these stations.

4.1 System Initialization — Idle State

When the power is applied at a station, the station controller will automatically become activated and assume the "idle" state. In this condition the station controller will be sensitive to line signals and can become selected to send or selected to receive when the proper signals are detected. Because it is possible for noise on the line to generate such signals, it is recommended that at the time of initial system turn-on, or at any other time when the line has been left in the idle state for an extended period of time, the computer switcher check to see that the incoming line is idle before proceeding with the system operation.

If the incoming line is not idle, the computer switcher should initiate an emergency stop action (see Section 4.14 — Emergency Stop) to clear the line and return it to the idle state. If the incoming line is idle, it is suggested that the computer switcher perform a normalizing procedure by sending the Turn-Around sequence (see Section 4.15 — Turn-Around) to insure that any station not in the idle state will be restored to an idle condition.

With the line in the "idle" state the computer switcher can:

(a) proceed with the polling operation in an attempt to pick up traffic,
(b) proceed with the call-in operation to deliver traffic,
(c) proceed to test poll, or
(d) although not normally desirable, do nothing and leave the line in the "idle" condition.

4.2 Polling Operation and Responses

The computer switcher initiates the polling process from the "idle" state by sending the control character DLE (Data Link Escape) to the line. This character will define the beginning of polling and will activate the appropriate logic at the stations. The computer switcher

should then send the Station Code Character (SCC) of the station to be polled and wait for a response from the station. The SCC for each station should be a single character chosen from the set of printing graphics in the ASCII code. The printing graphics are those characters in Columns 2 through 7 of Figure 3. (SPACE and DELETE are nonprinting and therefore, not to be selected for SCC assignment. Also, until the list of others has been exhausted, it would be desirable to avoid choosing as SCCs those characters, such as the period and comma, that are difficult to distinguish between when poorly printed. The consideration here is that legible printing of SCCs is essential to telephone company testing and trouble clearing activities.) Each station on a given line must have a different SCC. To the extent possible, it would be desirable to avoid duplication of SCCs for stations on different lines, also.

The responses received as a result of the polling operation are described below. Differences in responses between stations employing controllers of the latest type and those with earlier type controllers are noted for completeness. The responses are:

A. A traffic-to-send response.
B. A no-traffic-to-send response.
C. An invalid response.
D. No response at all.
E. (Earlier controllers, only) A message-improperly-received response.

The reaction of the computer switcher should be appropriate, of course, to the response received.

A. Traffic-To-Send Response

There are three traffic-to-send responses that are available with 85A Stations. Receipt of any of these responses to normal polling means that the polled station has assumed the selected-to-send state.

The standard traffic-to-send response is the automatic starting of transmission from the teletypewriter at the polled station. If this response is employed, it may be necessary for the computer switcher to have storage available to accept the data at the time the station is polled.

An optional traffic-to-send response is the single control character ACK (Acknowledge), generated by the station controller logic and used universally as the traffic-to-send response for all stations. Employing this response permits the computer switcher to obtain the necessary storage before allowing the station to proceed.

A discrete, single character Station Identity Code (SIC)* can be used as an alternate, optional traffic-to-send response in place of the universal ACK response. The use of the SIC response provides discrete identification of the station selected to send, in addition to allowing time for the computer switcher to obtain the necessary storage. The use of the SIC response in polling in place of the ACK response requires that a station employ the SIC response in place of the ACK response also during the call-in, roll-call, and test poll operations as well (Cf. Sections 4.7, 4.9 and 4.16).

To activate transmission from the station when either the ACK response or the SIC response is employed, the computer switcher should send the control character STX (Start of Text). STX is used as a transmission go-ahead code. If, after the computer switcher has sent the STX code, there is no trans-

*The SIC that is chosen for each station should be a single character that meets the same requirements as defined earlier for the SCC. One precaution must be observed. On a given line, the characters assigned as SICs must not duplicate any chosen for SCCs; otherwise the SIC response to polling that is returned by one station will be misinterpreted by another (whose SCC it duplicates) as polling.

mission from the station within the system time-out (minimum 600 milliseconds, recommended, one second), it is suggested that the computer switcher send the STX code a second time. Should a predetermined number of attempts prove unsuccessful in starting transmission from the station, either of two courses of action is recommended. If an alarm at the station is deemed not to be warranted, then the turn-around sequence (see Section 4.15 — Turn-Around) should be sent with a service message. If a station alarm indication is warranted, the emergency stop sequence (see Section 4.14 — Emergency Stop) should be sent, with or without a service message as desired. The polling process should then be started over again with the next station to be polled.

No matter which traffic-to-send response is employed, the transmission of information from the station teletypewriter may include any number of DELETE (fill) characters before the Start of Heading character (SOH). Such DELETE characters serve as tape lead-in or intertransmission fill and are present because of the mechanical make-up of the station teletypewriter. It is possible, by proper placement or repositioning of the tape in the teletypewriter, to minimize and sometimes eliminate the number of DELETE characters that precede the SOH of the message. This action, however, will seldom be taken. Therefore, the computer switcher should be prepared to accept numerous DELETE characters before the SOH code.

If transmission from a station starts as expected but consists only of a number of DELETE characters and then stops, it probably means that the station actually had no traffic but that those DELETE characters had been treated by the station as traffic. When this occurs, the computer switcher should deal with the condition in much the same way as just described for the failure of transmission to start. That is, after the system time-out interval, the computer switcher should initiate a turn-around action (see Section 4.15 — Turn-Around) with an appropriate service message and start the polling process over again with the next station to be polled.

However, under similar conditions, if the transmission of DELETE characters from the station terminates with some character that is neither DELETE nor SOH, it means that the station found other than SOH as the Start of Heading code of the message and, therefore, stopped because this constituted a message format violation. Under those circumstances it is recommended that the computer switcher deal with the condition differently. After the system time-out interval, the computer switcher should initiate an emergency stop action (see Section 4.14 — Emergency Stop) with an appropriate service message and start the polling process over again with the next station to be polled.

B. No-Traffic-To-Send Response

The polling responses given by stations when they have no traffic to send depend upon whether they employ controllers of the latest type or whether of the earlier type.

(1) Stations with Latest Type Controllers. There are two, single character, no-traffic-to-send responses, depending upon the ready-to-receive status of the station. A response that consists of the control character CAN (Cancel) indicates that the station has no traffic to send but it is ready to receive if called-in rather than polled. A response that consists of the control character NAK (Negative Acknowledge) indicates not only that the station has no traffic to send but also that

it will give a not-ready-to-receive response if called in rather than polled*.

(2) Stations With Earlier Type Controllers. The no-traffic-to-send response is the control character NAK (Negative Acknowledge), irrespective of whether or not the station would be found ready to receive if called-in rather than polled.

It is suggested that when any of the foregoing no-traffic-to-send responses are received, the computer switcher send the SCC of the next station to be polled. There is no requirement to resend the DLE character to redefine a polling operation because all stations on the line have remained in the polling state. Note: Resending the DLE character at this point, while unnecessary, will not adversely affect station operation.

C. Invalid Response

An invalid response is any response that is not NAK, CAN, or the traffic-to-send response being employed, either DELETEs and SOH, ACK, or SIC (Station Identity Code).

If the invalid response takes the form of a single character, it is suggested that the computer switcher repoll the station in question by first sending an EOT code to normalize the line, and then sending the polling initiation code DLE followed by the SCC of that particular station. The assumption is that the first response was legitimate but had been affected by noise on the line in such a manner that the computer switcher could not recognize it as a valid response.

* The most likely reason for the NAK response is that the station teletypewriter has been placed in the OFF-LINE mode while tape is being perforated.

If the invalid response takes the form of continuous transmission from a station, it is suggested that the computer switcher take action to stop the station's sending. There are two choices. If an alarm at the station is deemed not to be warranted, then the turn-around sequence (see Section 4.15 — Turn-Around) should be sent with a service message. If a station alarm indication is warranted, the emergency stop sequence (see Section 4.14 — Emergency Stop) should be sent, with or without a service message as desired. The polling process should then be started over again with the next station to be polled.

D. No Response

The computer switcher should employ a response time-out function that will provide an indication when expected responses are not received within some specified time interval. Responses from stations can be expected within 600 milliseconds under most circumstances. A system response time-out of one second has already been recommended.

It is suggested that in the case of a no-response timeout, the computer switcher repoll the station in question by sending the polling initiation code DLE plus the SCC of that particular station. Since there was no response of any kind, it is probably not necessary at this point to initiate a turn-around or an emergency stop action as in the case of an invalid response. It is assumed that what most likely happened was that when the SCC was sent the first time it was affected by noise on the line in such a manner that none of the stations recognized it as a Station Code Character. However, if a repolling of the station still elicits no response, the failure is probably the result of the station somehow having been left in a selected to send state. To deal with this

condition, it is suggested that the computer switcher send either the turn-around sequence (see Section 4.15 — Turn-Around) with a service message or the emergency stop sequence (see Section 4.14 — Emergency Stop) with or without a service message as desired, and then start the polling process over again with the next station to be polled.

E. Message-Improperly-Received Response (Earlier Controllers, Only)

A station that employs the earlier type controller will give a message-improperly-received response to polling if the last message delivery to that station was unsatisfactory and the station was not called, roll-called, or polled since that delivery took place.

The message-improperly-received response is the control character CAN (Cancel). It is given only once, in response to the first polling operation or the first roll-call or call-in operation after the delivery in question, and its meaning is independent of the traffic-to-send status of the polled station. Hence, to determine the traffic-to-send status of the station when the CAN response is received, the computer switcher must send the SCC of that station again.

It is anticipated that the message-improperly-received response will find more useful application as a part of a roll-call function (see Section 4.9 — Roll-Call Operation) performed at the end of each message delivery than it will as one of the normal polling responses. A listing of the various causes for the message-improperly-received response is given in Section 4.10 — Causes for CAN Response.

4.3 Definition of End of Polling

As stated above, the control character DLE defines the beginning of the polling operation. There are three ways to define the end of the polling operation. First, to terminate all operation on the line and return all stations to the "idle" state, the computer switcher should send the control character EOT (End of Transmission). Upon detection of this code all outlying stations will assume the "idle" state.

Second, to terminate the polling operation in order to initiate a call-in operation (see Section 4.7 — Call-In Operation and Responses), the computer switcher should send the control character ENQ (Enquiry). Upon detection of this code all stations on the line will activate the appropriate station logic to assume the call-in mode and begin looking for their Station Code Character (SCC), which serves as a call-in code.

Third, when the response to polling indicates that a station has traffic to send, the SOH character subsequently sent by that station defines the end of polling for all of the other stations on the line.

4.4 Stop and/or Unblind on SOH (Options)

Two separate installer implemented options are available at the station: one to stop the transmitter of a sending station and the other to unblind the station receiver when the station sends the SOH of the message. Four arrangements may result using these options.

First, not employing either option results in the entire message heading, SOH through STX, being sent to the computer switcher with no local printed copy of the heading*. No local copy of the heading may be desirable if preprinted forms are employed that have no space provided for the heading information.

Second, employing the Unblind on SOH option alone provides a printed record of the message heading as it is sent, indicating which stations are to receive the message.

* The term "Blind Heading Option" is used interchangeably in this document to designate operation in which the message heading is not printed locally.

In both of the above arrangements, not employing the Stop on SOH option imposes the requirement that the computer switcher must always have adequate storage available to accept at least the heading of the message once the station transmitter starts sending.

Third, employing the Stop on SOH option alone provides a convenient place to halt transmission while the computer switcher acquires the storage necessary to handle the message. This arrangement can take the place of either of the specific traffic-to-send responses, ACK or SIC, since they all provide a stopping function to permit acquisition of storage.

Fourth, employing both options allows both the acquisition of storage and the copying of the heading, plus it allows the computer switcher to deliver an originating message number and/or date and time record to the originator before the station sends the heading, so that this information will appear first on the originator's local copy.

Because of the manner in which SOH is detected at the station there is no timing character required after the SOH to allow for stopping the transmitter. Thus, with the stop on SOH option the computer switcher may begin transmission to the line as soon as the SOH character has been fully received (but note the precaution of Section 3.7.2).

The control character STX (Start of Text) should be sent by the computer switcher to restart the transmitter at the selected sending station. If, having sent the STX code, the computer switcher receives no response from the station within the system response time-out interval (minimum 600 milliseconds, recommended, one second), it is suggested that the computer switcher send the STX code a second time. If a predetermined number of attempts to start the computer switcher initiate an emergency stop action (see Section 4.14 — Emergency Stop), with or without an appropriate service message as desired, and start the polling process over again with the next station in the polling round. Optionally, the computer switcher could be programmed to deactivate the station by sending the turn-around sequence (see Section 4.15 — Turn-Around).

Inherent in the aforementioned choice of SOH options are certain related considerations that must be observed. If the Blind Heading option is chosen, then it is mandatory for all normal types of operation, that the Stop on STX Option also be chosen (see Section 4.5 — Stop on STX, and Section 4.6 a Negate Stop on STX). This is to enable the computer switcher, when the station stops on STX, to send the control character sequence ENQ DC2 STX which, in addition to restarting the station's transmission, will unblind it for printing local copy of the message text. The ENQ DC2 of this sequence performs the unblinding function; the STX, the restarting function. Hence, it is possible to have information, such as a date and time record or originating message number sent to the station by the computer switcher following the DC2 and before the computer switcher restarts the station transmitter with the STX.

When intraline operation is employed stopping on STX is required for another reason, to allow the computer switcher to call in the addressed stations that are on the same line as the originator. And again the sequence ENQ DC2 STX is necessary to perform, among other functions, the unblinding of the originating station for copying the message text. The originating station must always be unblinded during transmission of the message text if its teletypewriter is to provide the necessary timing intervals that must accompany the horizontal or vertical tabulation or the form feed functions.

4.5 Stop on STX

Even when the Blind Heading option is not chosen, normal station operation is for the transmitter to be stopped, after it has sent the message heading, when the station controller detects the STX code being sent from the tape.

Stopping on STX allows the computer switcher to send originating message numbering and date and time information to the sending station after the heading of the message. It also allows the computer switcher to call in any stations that might have been designated as addressees in the heading. Therefore, stopping on STX allows intraline operation, where the text of the message is to be received by selected receiving stations as it is being sent by the originator.

Because of the manner in which STX is detected at the station, no character is required after STX to allow time for stopping the transmitter. Hence, the computer switcher may begin transmission to the line as soon as the STX character has been fully received (but note the precaution of Section 3.7.2).

When this Stop on STX operation is employed, the computer switcher should send the sequence ENQ DC2 STX to restart the transmitter at the selected sending station when the switcher is ready to accept further transmission. If, having sent this sequence, the computer switcher receives no response from the station within the system response time-out interval (minimum 600 milliseconds, recommended, one second) it is suggested that the computer switcher send the STX code of the sequence a second time. If a predetermined number of attempts to start the transmitter are unsuccessful, it is recommended that the computer switcher initiate an emergency stop action (see Section 4.14 — Emergency Stop), with or without an appropriate service message as desired, and start the polling process over again with the next station in the polling round.

4.6 Negate Stop on STX (Option)

An installer implemented option is available in the station controller that will negate the Stop on STX function described in Section 4.5 and allow the transmitter to continue to transmit to the line*. This choice of procedure defines interline operation where all messages are sent to the line control station before they are delivered to any addressed stations.

4.7 Call-In Operation and Responses

The call-in operation may be initiated by the computer switcher as a result of a heading received in an intraline operation, or it may be initiated from the "idle" state because the computer switcher is going to originate an outgoing message. In either case the computer switcher should initiate the call-in process by sending the control character ENQ (Enquiry). This character defines the beginning of each call-in operation. It blinds the selected sending station (in intraline operation) and all previously selected receiving stations, and it activates the appropriate logic at all stations on the line to look for the Station Code Character (SCC).

Immediately following the sending of the ENQ code, the computer switcher should send the SCC** of the station to be called in and wait for a response from that station.

* Note the fact that this option is incompatible with the Blind Heading option if local copy of the message text is desired, or if it is desired to furnish information to the selected sending station such as a date and time record or originating message number (see Section 4.4 — Stop and/or Unblind on SOH).

** The SCC chosen to identify a particular station must be the same as that used for polling. Considerations relating to the choice of SCCs are discussed in the footnote to Section 4.2 — Polling Operation and Responses.

The stations require detection of the sequence ENQ SCC in order to become selected, so the computer switcher should send the ENQ code with each SCC generated.

The response received from a station as a result of the call-in operation may be any of the following five types:

A. A Ready-to-receive response.

B. A not-ready-to-receive response.

C. A message-improperly-received response.

D. An invalid response.

E. No response at all.

The reaction of the computer switcher should be somewhat different for each of these possible responses.

A. Ready-To-Receive Response

There are two types of ready-to-receive responses that are available with the 85A station. The receipt of either type of response means that the called-in station has assumed the selected-to-receive state and is unblinded.

The standard ready-to-receive response is the single control character ACK (Acknowledge). When this response is received, the computer switcher knows that some station detected its call-in code, but does not have positive assurance that it was the correct station.

As an optional ready-to-receive response, each station can be arranged to use a discrete single-character Station Identity Code (SIC) in place of the universal ACK response*. When the SIC response is received, the computer switcher can verify that the proper station responded to the call-in procedure**. The use of the SIC response in place of the ACK response in call-in requires that a station employ the SIC response in place of the ACK response during the polling, roll-call and test poll operations as well. And it is desirable, but not mandatory, that the SIC chosen for a station be different from its SCC. This provides the utmost protection available with the verification facility.

A ready-to-receive response to call-in means that the station is unblinded and will copy any information sent to it. Since the ENQ code used as a part of the call-in code sequence blinds all other selected stations, it is possible to deliver separate information to each receiving station when it is called in without other selected stations receiving it. A delivery message number is an example of such per station information.

B. Not-Ready-To-Receive Response

The not-ready-to-receive response is the single control character NAK (Negative Acknowledge). This response can result from the station being low on paper or out of paper, momentarily out of service, in an off-line mode, etc. While the condition persists, a momentary audible and visual alarm will be given at the station each time it receives its call-in code. Since this alarm will tend to spur the station attendant to correct a transitory condition, it may be advantageous for the computer switcher to repeat the call-in sequence a predetermined number of times in the expectation that the not-ready-to-receive status of the station will change to that of ready-to-receive.

The decision as to what is done with messages that cannot be delivered at the time of initial call-in is dependent upon the computer switcher and how it is programmed.

* Considerations relating to the selection of SICs are discussed in a footnote to Section 4.2 (A) — Traffic-To-Send-Response.

** This potentiality was discussed earlier, in Section 2.0 — General Characteristics of 85A Stations.

C. Message-Improperly-Received Response

The message - improperly - received response is the single control character CAN (Cancel). This response constitutes a report of an unsatisfactory message delivery on the last message delivered to this station and is independent of the station's ready-to-receive status. The message-improperly-received response is given only once in response to the first polling operation (by stations with earlier controllers* only) or the first call-in or roll-call operation (by stations with either type controllers) after the delivery in question. Hence, to determine the ready-to-receive status of the station, the computer switcher should send the sequence ENQ SCC for that station again.

It is anticipated that the message-improperly-received response will find more useful application as a part of a roll-call function performed at the end of each message delivery than it will as a normal call-in response. A detailed description of the roll-call function is given in Section 4.9 — Roll-Call Operation and Responses. The various causes for the message-improperly-received response are listed in Section 4.10 — Causes for CAN Response.

D. Invalid Response

An invalid response is any response that is not NAK, CAN, or the ready-to-receive response being employed, either ACK or SIC (Station Identity Code). Because it is not possible to selectively unselect one receiving station without unselecting all selected receivers, it is suggested that the following procedures be adopted when an invalid response is received.

If the invalid response takes the form of a single character, it is suggested that the computer switcher call in the station again by sending the sequence ENQ SCC for that particular station. The assumption is that the first response was legitimate but had been affected by noise on the line in such a manner that the computer switcher could not recognize it as a valid response.

If the invalid response takes the form of continuous transmission, it is suggested that the computer switcher initiate an emergency stop action (see Section 4.14 — Emergency Stop), with an appropriate service message.

When this emergency stop action is taken in connection with the attempted call-in of a station on an intraline message delivery operation, the selected sending station will be affected by it also. The selected sending station will become unselected along with the already selected receivers and the station whose call-in response took the form of continuous transmission. Since the tape at the now unselected originating station will have to be repositioned in the station transmitter and the Emergency Stop alarm restored before the affected message can be reoriginated. probably the most appropriate subsequent action that could be taken by the computer switcher would be to start the polling process over again with the next station in the polling round. Alternatively, it could initiate an interline delivery operation if it had traffic in queue awaiting delivery.

When the foregoing emergency stop action is taken in connection with the attempted call-in of a station on an interline message delivery operation, only the already selected receivers and the station whose response took the form of continuous transmission are affected.In this case, it is recommended that the computer switcher repeat the entire call-in process, starting with the first addressee.

In the interline message delivery case an optional method of dealing with the call-in anomaly would be for the

* See Section 4.2 (E) — Polling Operating and Responses — Message-Improperly-Received Response (Earlier Controllers, Only).

computer switcher to stop the continuous transmission by employing the turn-around sequence (see Section 4.15 — Turn-Around) instead of the emergency stop action, accompanied by a service message to explain to the already selected receivers why they were being dismissed without receiving a complete message delivery.

E. No Response

The computer switcher should employ a response time-out function that will limit the length of time it will wait for an expected response. Responses from stations can be expected within 600 milliseconds under most circumstances. A system time-out of one second, therefore, has already been recommended for this purpose.

If a no-response time-out should occur, it is suggested that the computer switcher call in the station again by sending the sequence ENQ SCC for that particular station. Since there was a total absence of response, it probably is neither necessary nor desirable to initiate an emergency stop action as in the case of an invalid response.

An emergency stop action is not prohibited but if it were to be employed, it would have the same effect as just described for its use in the case of an invalid response (see D. — Invalid Response, above) and thus its application here would be a rather drastic measure. Likewise, initiating a turn-around action, although not barred, seems inappropriate.

It is assumed that the most likely reason for no response was that when the sequence ENQ SCC was sent the first time it was affected by noise on the line in such a manner that none of the stations recognized it as its call-in sequence.

After all of the available addressees have been called-in and after any separate information for each station has been delivered during the call-in process, the computer switcher should send the sequence ENQ DC2 to unblind all selected stations (including the originator in the case of intraline operation). The computer switcher may then send any information that is common to all stations, including the originator. The date and time record is a possible example of such common information.

The computer switcher should then send the STX code. If this is an interline operation, the computer switcher itself will follow the STX code with the message text. If this is an intraline operation, the STX code will cause the selected sending station to resume transmission, sending the message text. All of the selected receivers will copy the message text as it is being transmitted.

In the intraline case, if the STX does not cause transmission from the sending station to restart within the system response time-out interval (minimum 600 milliseconds, recommended, one second), it is suggested that the computer switcher repeat sending the sequence ENQ DC2 STX. If a predetermined number of such attempts to restart transmission from the originating station are unsuccessful, it is recommended that the computer switcher initiate an emergency stop action (see Section 4.14 — Emergency Stop), accompanied by an appropriate service message, and start the polling process over again with the next station in the polling round.

4.8 Stop on ETX (Option)

An installer implemented option is available in the station controller that will stop the station transmitter when the control character ETX (End of Text) has been transmitted and will keep the station in an unblinded state if it was unblinded. This option must be chosen in a system in which (1) the Roll-Call function is employed, (2) the computer switcher wishes to send information to all selected stations following the delivery of the message text (e.g., a date and time record), or (3) multiple message transmission is employed in which the Stop on SOH option and/or the Unblind on

SOH option are involved (see Section 4.4 — Stop and/or Unblind on SOH) or in which the Stop on STX option is involved (see Section 4.5 — Stop on STX). If for some reason, a kind of system operation is desired in which all traffic from the station is transmitted without local copy to the computer switcher for store and forward handling, this can be made possible by choosing none of the options mentioned here in the multiple message transmission case and by choosing, also, not to stop on ETX. Under these conditions, once transmission from the station is started it proceeds without stopping until the control character EOT (End of Transmission) is detected by the station controller, regardless of whether the transmission comprises only one message or whether it consists of a multiplicity of messages. The timing information normally provided by the station for the tabulation and form feed functions (see Section 3.7.4 — Station Mechanical Functions) would, of course be lost!

Because of the manner in which ETX is detected in the station controller no character is required after the ETX to allow time for stopping the transmitter. The computer switcher may begin transmission to the line as soon as the ETX character has been fully received (but note the precaution of Section 3.7.2).

How the computer switcher should proceed, having exercised the Stop on ETX option, is covered in Section 4.9 — Roll-Call Operation — when the desired action is to perform a roll-call function or deliver separate information to each receiving station after the delivery of the message text, or in Section 4.11 — Multiple Message Transmissions— when the desired action is to allow the selected sending station to send another message without having to be polled in the normal manner.

4.9 Roll-Call Operation and Responses

Roll-Call is an interrogative process performed on already selected receiving stations at the conclusion of a message delivery to obtain an indication of whether or not the stations received the delivery satisfactorily.

As stated in the preceding section, the roll-call operation requires the use of the Stop-on-ETX option. When the computer switcher detects the ETX code*, it should initiate the roll-call operation in the same way that it initiates a call-in operation, by sending the control character ENQ (Enquiry).

* The ETX code here is a transmission turn-around signal, and as such, should be dealt with as discussed in Section 3.7.2 — Transmission Turn-Around.

This character defines the beginning of the roll-call operation, blinds the selected sender and all selected receivers, and activates the appropriate logic in each of the selected stations to look for the Station Code Character (SCC). The computer switcher should then send the SCC of the first selected receiver and wait for its response.

Since a roll-call operation is simply using a call-in operation under special system conditions, the responses evoked by the roll-call operation will be similar to those received for a call-in operation:

A. A ready-to-receive (message-satisfactorily-received) response.

B. A not-ready-to-receive response.

C. A message-improperly-received response.

D. An invalid response.

E. No response at all.

The reaction of the computer switcher to these responses, however, should be somewhat different from that to normal call-in responses.

A. Ready-To-Receive (Message-Satisfactorily-Received) Response

There are two types of "message-satisfactorily-received" responses that are available with the 85A stations. Either type means that the station acknowledges that the last message was received satisfactorily, to the extent that the delivery did not violate any of the conditions listed in Section 4.10 — Causes for CAN Response — and that the station is in an unblinded state.

The standard message-satisfactorily-received response is the single control character ACK (Acknowledge). When this response is received, the computer switcher knows that some station detected its call-in code, but the ACK response does not, of itself, give positive assurance that it was the correct station that responded. By an installer implemented option, however, the station can be arranged to use the discrete, single character Station Identity Code (SIC) in place of this universal ACK response*. Then when the SIC response is received, the computer switcher can verify that the proper station responded to roll-call.

It is suggested that systems that employ the roll-call function utilize the SIC response to provide maximum assurance that proper records are kept regarding the satisfactoriness of message deliveries. The use of a SIC response in place of the ACK response in roll-call requires that a station employ the SIC response in place of the ACK response during the polling, call-in, and test poll operations as well. And, as has previously been stated, it is desirable, but not mandatory that the SIC chosen for a station be different from its SCC, to afford the utmost protection available.

A message-satisfactorily-received response to roll-call means that the station is unblinded and will copy any information sent to it. Since the ENQ code used as a part of the roll-call operation blinds all other selected stations, it is possible to deliver separate information to each receiving station during the roll-call process without its being copied by other selected stations. A delivery message number, or a coded ending that means message received satisfactorily are examples of such per station information.

*Considerations relating to the selection of SICs are discussed in a footnote to Section 4.2(A) — Traffic-To-Send-Response.

B. Not-Ready-To-Receive Response

The not-ready-to-receive response is the single control character NAK (Negative Acknowledge). In proper operation this response should not be received as a result of an initial roll-call execution because whatever would cause it should normally first cause a message-improperly-received response. Receipt of a NAK response indicates that the station has somehow become unselected and initialized** (or that it had never been selected) and that it now is in a not-ready-to-receive state.

If NAK is received in response to a roll-call operation, it is suggested that the computer switcher equate it to a message-improperly-received response and proceed according to the prescribed system method of handling the redelivery of a message that is not properly received.

C. Message-Improperly-Received Response*

The message-improperly-received response is the single control character CAN (Cancel). This response indicates that the message delivered to the roll-called station was not received satisfactorily. The computer switcher can take note of this response and deal with the redelivery of the message to the affected station in the manner prescribed for the particular system application.

** This could occur if a momentary failure of commercial power took place at the station during the message delivery, for example, or if the operator inadvertently placed the station in an OFF-LINE mode following receipt of ETX but before the station had been roll-called.

* As was stated in Section 4.7(C) this response is given only once, in answer to the first roll-call, call-in, or, with earlier controllers, polling operation following the affected message delivery.

A station is not in an unblinded condition when it gives a CAN response. Hence, if it is desired at this time to have the computer switcher deliver some information to this station alone, the roll-call of this station should be repeated immediately. If, as expected, a ready-to-receive response is then received, the computer switcher can deliver such information to this station alone (e.g., a statement that the last message will be retransmitted)**. If a not-ready-to-receive response is received, however, the computer switcher should recognize that the station has become unselected, is unable to receive from the line and, therefore, cannot accept the information.

If it is important that the message be redelivered as soon as possible, the roll-call operation should first be completed for all selected stations and the stations unselected by EOT in the usual manner. Then the computer switcher can try to handle the unsuccessful delivery on a completely new delivery attempt that is performed in the normal way. If this still finds the affected station not ready to receive, however, redelivery of the message will have to be postponed until a later time when the station becomes available again for receiving. A listing of the various causes for the message-improperly-received response is given in Section 4.10 — Causes for CAN Response.

**Although it would be possible for the computer switcher to redeliver the message itself to this station alone, instead of some other information, this procedure is not recommended for the reason that the checks normally made by the station with respect to the satisfactoriness of the delivery would not under these circumstances be performed.

D. Invalid Response

An invalid response to roll-call is any response that is not NAK, CAN, or the "message-satisfactorily-received" response being employed, either ACK or SIC (Station Identity Code). Since the roll-call is intended to provide a station interrogation function, it is suggested that the following procedures be observed when an invalid response is received.

If the invalid response takes the form of a single character, it is suggested that the computer switcher roll-call the station again by repeating the sequence ENQ SCC for that ENQ SCC for that particular station. The assumption is that the first response was legitimate but had been affected by noise on the line in such a manner that the computer switcher could not recognize it as a valid response.

If the response to a second roll-call is the ACK response, information may be sent at this time by the computer switcher indicating to the station attendant that the validity of the last message received is in question and that a redelivery will be made. (The invalid response could have been a garbled CAN.)

If the invalid response takes the form of continuous transmission, it is suggested that the computer switcher initiate an emergency stop action (see Section 4.14 — Emergency Stop), with or without an appropriate service message. If this emergency stop action is necessary when the computer switcher is performing a roll-call in connection with an intraline message delivery, the originating station will receive the emergency stop alarm and the sending of any subsequent messages in its transmission will be inhibited until the alarm condition has been restored at the station and the station has been polled again.

E. No Response

The computer switcher should employ a response time-out function that will limit

the length of time it will wait for an expected response. This interval should be a minimum of 600 milliseconds; one second is recommended, however. If a no-response time-out should occur, it is suggested that the computer switcher roll-call the station again by sending the sequence ENQ SCC for that particular station. Since there was a total absence of response, it is not likely that the station has already sent a message-improperly-received response. It is assumed that the most likely reason for the absence of the roll-call response is that when the sequence ENQ SCC was sent the first time it was affected by noise on the line in such a manner that none of the stations recognized it as its roll-call code sequence. If repeated roll-call attempts fail to evoke a response from a station, it is a matter of choice whether or not the computer switcher should undertake to redeliver the message to that station.

After all of the selected receivers have been roll-called and after any separate information intended for each station has been delivered during the roll-call process, the computer switcher may send the sequence ENQ DC2 to unblind the sender and all selected receivers again for delivery of any common information (e.g., date and time), if this is desired.

If this is an intraline operation, where a station is the originator, then after roll-call is completed the computer switcher should send a distinct go-ahead code to cause the originating station to resume transmission and, at the same time, to cause the selected receiving stations to assume the "idle" state. The prescribed go-ahead code for this purpose is the sequence DLE STX. Upon receipt of this sequence, the originating station will:

(a) Send an EOT code if the system is one that uses only single message transmissions,

(b) Send an EOT code, possibly preceded by DELETEs, if the system is one that allows multiple message transmissions* and the message just sent was the last in a transmission, or

(c) Send any intermessage DELETE characters in the tape plus the SOH of the next message if the system is one that allows multiple message transmissions and the last message in the transmission has not yet been sent.

If this is an interline operation, in which the computer switcher is delivering messages to the line, then, after the roll-call process is completed, the computer switcher should send the EOT code to cause all selected receiving stations to return to the "idle" state.

The roll-call function can be employed at any time during message delivery. Therefore, it is possible to use this function to provide a very elementary type of error control on deliveries from the computer switcher. The capability comes about because of a station option that allows parity error detection to be one of the factors that can cause a message-improperly-received response (See Section 4.10 — Reasons for CAN Response). If this station option is chosen, the computer switcher can deliver a block of information (e.g., one line of copy) and then roll-call to see if each station received the block without parity errors. If parity errors were detected, then the block can be retransmitted to each station requiring it, treating the retransmitted block as separate information for that station alone.

There is a limitation governing such retransmission of blocks; the retransmission must be performed either just for one station at a time or else it must encompass all selected receivers. In systems with a sizeable amount of multiple address traffic that includes messages with more than two addresses, this could be an important limitation. Moreover, in order to redeliver a block of information after a roll-call has uncovered a message-improperly-received response, it is necessary to repeat the roll-call for the station involved and receive an ACK response from it before that station becomes unblinded and in condition to record the retransmitted block, a

*See Section 4.11 — Multiple Message Transmissions.

process that could consume a significant amount of line time if required very often in the course of a message delivery.

Because of these constraints, employing the roll-call function to provide error control with retransmission may prove to have only moderate usefulness in the ordinary system. On the other hand, it could prove to be an especially useful and time-saving mode of operation in the delivery of very long messages whose accuracy was of paramount importance.

4.10 Causes For CAN Response

A station will respond to call-in or roll-call, or, in the case of the earlier controllers, to polling, whichever occurs first following a message delivery, with the message-improperly-received response CAN* if any of the following conditions occurred during the course of that delivery:

(a) A paper-out condition was detected on a sprocket-feed machine.

(b) The teletypewriter failed to respond to the received signals.

(c) The mode switch on the teletypewriter was operated to the OFF-LINE position before the station detected ETX.

(d) A loss of incoming carrier was detected.

(e) The teletypewriter lost commercial power (not both teletypewriter and controller, however).

(f) A selected receiver detected ETX while blinded.

(g) A selected receiver detected EOT or DLE before detecting ETX.

(h) A selected receiver detected the sequence ENQ EOT (part of emergency stop action).

*As was stated in Section 4.7(C) this response is given only once for the affected message delivery.

(i) A selected receiver detected a parity error in the message (station option).

As illustrated by (c), (f) and (g), the station performs a certain amount of message format checking. This is included primarily to insure that messages are indeed delivered to the appropriate stations as intended and not merely sent "to the wind." Without certain format checks it would be possible for messages to be lost, even though transmitted in the prescribed fashion.

4.11 Multiple Message Transmissions

Multiple message transmission capability from the stations of an 85A system is provided for intraline operation through the use of the Stop-on-ETX option described in Section 4.8 and the availability of the distinct go-ahead code that causes a selected sending station to resume transmission while causing selected receiving stations to become unselected. As mentioned earlier, the distinct go-ahead code is the sequence DLE STX. This stopping on ETX, followed by the go-ahead on DLE STX, also provides the means for exercising control over the selected sending station when the multiple message transmission involves interline operation.

Multiple message transmission capability allows the station attendant to decide how many messages the station should be arranged to send in one transmission when it is polled. The customer can establish administrative rules regarding the upper limit on this number and can enforce them by appropriate programming of the computer switcher.* The same procedures used for enforcement also would make possible the provision of a day-to-day, or even hour-to-hour, varying traffic pickup pattern to optimize the overall traffic pickup operation of the system.

* Enforcement would consist of employing the emergency stop procedure (See Section 4.14 — Emergency Stop) to halt transmission from a station that was exceeding its prescribed limit.

Multiple message transmission capability affords a means for picking up a number of messages from a given station that is more efficient than having to expend line time to repoll the station after each message pickup to determine its traffic-to-send status.

To restart a transmitter when employing multiple message transmission capability, the computer switcher should send the sequence DLE STX. For intraline operation the DLE code will cause any selected receiving stations to become unselected and to assume the polling state. In addition, the DLE will reset the controller logic at the selected sending station so that its normal functions will be performed for the next message. The STX of this sequence will cause the selected sending station to resume transmission. When the selected sending station restarts its sending, the SOH of its next message will terminate the polling state as far as other stations on the line are concerned. In the case of no more messages in the transmission the EOT code used to define the end of the transmission, will terminate the polling mode in addition to returning all stations to the "idle" state.

For interline operation, the effects of the DLE STX sequence are essentially the same except, of course, that there are no selected receivers that need to become unselected.

If, when the computer switcher has sent the sequence DLE STX, there is no response from the station within the system response time-out interval (minimum 600 milliseconds, recommended, one second) it is suggested that the computer switcher send the sequence DLE STX a second time. If repeated attempts to restart the transmitter are unsuccessful, it is recommended that the computer switcher initiate an emergency stop action (see Section 4.14 — Emergency Stop), with or without an appropriate service message, and start the polling process over again with the next station in the polling round. Another recommended procedure for dealing with this condition is for the computer switcher to send the turn-around sequence (see Section 4.15 — Turn-Around). Unlike the emergency stop action, the turn-around procedure will not cause an alarm at the station.

4.12 Stop on EOT — End of Transmission

A selected sending station will stop sending and will assume the "idle" state when it transmits the control character EOT (End of Transmission). One "fill" character (DELETE being recommended for the purpose) is required after the EOT in the tape at the sending station to supply the timing required to stop the transmitter after the EOT character has been detected. This "fill" character is not sent to the line, however; and the transmission turn-around timing (see Section 3.7.2 — Transmission Turn-Around) of the computer switcher need not take it into account.

After the end-of-transmission indication has been received, the computer switcher should either initiate a polling operation or initiate a call-in operation. Selected receiving stations will become unselected and will assume the "idle" state when they receive the EOT character.

4.13 EOT Passed to Terminal (Option)

Normally the EOT that is sent to receiving stations to designate the end of a transmission is consumed within the logic of the station controller and is not passed through to the teletypewriter terminal. However, in order to allow for refile service when the primary receiver at a station is an ROTR (Receiving Only Typing Reperforator) an option is provided in the controller, implemented at time of installation, that allows the EOT code to be passed through it. Because of the one-character storage that is an integral part of the controller logic, a "pushing" character is required to get the EOT into the terminal. Hence, when this option is employed and messages are originated by the computer switcher (interline operation), the computer switcher should send one DELETE character immediately after sending an EOT.

In those special cases of intraline operation when the EOT comes directly from the

originator's tape*, the pushing character, when needed, must be transmitted by the computer switcher after the originating station has sent the EOT**. In other cases of intraline operation, however, the selected receiving stations are caused to become unselected by the DLE of the DLE STX sequence (see Section 4.11 — Multiple Message Transmissions) and they, therefore, do not receive an EOT at the end of a message delivery.

4.14 Emergency Stop

An emergency stop function is available that provides the means for the computer switcher to stop the transmission in progress from a station in case message heading errors or other irregularities are detected during the system operation. The stations are not capable of initiating emergency stop action toward the computer switcher, however. The complete format for the emergency stop function, including an explanatory service message, is:

	E	D		E E E
Break Pause	N	C	Service Message	N O O
	Q	2		Q T T

To perform the emergency stop action, the computer switcher should send the BREAK signal (minimum 400 milliseconds, maximum 750 milliseconds of continuously spacing signal) to the line followed by a PAUSE that consists of either at least one DELETE character or at least one character interval of continuous marking. The PAUSE is required in order to insure that stations have regained synchronism before the computer switcher sends specific coded information on the line. It is the BREAK signal that actually stops a transmitter station and blinds it. Fortuitously, it may also blind selected receiving stations.

*In general, this would be the case only for single message transmission without roll-call.

**The pushing character in this case can be a DELETE that is especially sent by the computer switcher at that time or it can be the next character sent to the line by the computer switcher in the normal course of system operation, e.g., the DLE of a new polling sequence or the ENQ of a call-in procedure.

As is indicated by the format for the emergency stop function, a service message can be included. The information it contains can be quite helpful to the station attendants in clarifying what action is being taken, or why it is being taken, and what can be expected next. If the service message is to be included, as is generally recommended, the computer switcher must send the station unblind code sequence ENQ DC2 to insure that all of the selected stations that were interrupted are in the unblinded state*. The service message, which follows this, will then appear in hard copy form at all selected stations. The service message itself should not include the control character EOT. Whether or not it ends with the ETX character is optional (cf. Section 4.15 — Turn-Around, on this point).

Following the service message, if any, the computer switcher should send the station alarm sequence ENQ EOT to activate both visual and audible alarms at those stations that were interrupted. Then, to return all stations to the common logical "idle" state, the computer switcher should follow the ENQ EOT sequence with another EOT character.

4.15 Turn-Around

In some circumstances, taking advantage of the turn-around capability may be deemed preferable to using the emergency stop function for stopping transmission from a selected sending station. Possible examples of this have been cited throughout this document.

The potential advantage of the turn-around sequence over the emergency stop is that the turn-around sequence stops the station transmitter without causing the emergency stop alarm at the station and without locking up the station transmitter.

* If the system operation is one in which the service message is not employed as part of the emergency stop function, then the unblind code sequence ENQ DC2 can be omitted from the emergency stop format.

The complete format for the turn-around function is:

	E	D	**	E
Break Pause	N	C	Service Message	O
	Q	2		T

Note that this is the same as the emergency stop format except for omission of the station alarm sequence ENQ EOT that occurs in the emergency stop format between the service message and the final EOT. Apart from considerations relating to this omitted alarm sequence and the necessity for including the ETX character, all the information detailed in Section 4.14 — Emergency Stop applies equally well to the turn-around procedure and should be observed in connection with its use.

4.16 Test Poll and Responses

Test poll is an operational state into which stations of an 85A system line can be placed to obtain responses that will supply information relating to their status. When in the test poll mode, the behavior of the stations depends upon whether they employ controllers of earlier design or whether they use the latest type controllers. The two cases will be discussed separately.

1. Systems Having Stations with Earlier Type Controllers

   The fields of application for the test poll feature in systems of this type are:

   (a) To survey the traffic-to-send status of the stations on a line without placing them in a selected-to-send state, or

   (b) Optionally, to scan the ready-to-receive status of stations on a line without selecting them as receivers.

   (c) To pick up any message-improperly—received responses without selecting the interrogated stations.

   (d) To check the operability of the line if some anomalous condition should occur during message pickup or delivery.

   To place stations with earlier type controllers in the test poll mode, the computer switcher should send the three-character sequence ENQ EOT DLE to an idle line. It should be noted that if all stations on the line are idle, the sending of this sequence will not cause any audible or visual alarm at the test-polled stations.

   The first two characters ENQ EOT are the same as employed in an emergency stop action. Hence, going into a test poll routine can be a natural extension of an emergency stop action by sending DLE instead of EOT after the sequence ENQ EOT. An emergency stop action is often required in order to obtain an idle line. The DLE following ENQ EOT defines the beginning of the test poll mode so that as each Station Code Character (SCC) is sent by the computer switcher, the corresponding station will respond.

   To terminate a test poll routine, the computer switcher should send one of the following control codes:

   EOT — to return the line to the "idle" state, or

   DLE — to put the line in the normal polling state.

   At the time of installation, stations with the earlier type controllers can be arranged, optionally, either to give indications of their ready-to-send status or of their ready-to-receive status when test polled.

   When arranged to give indications of their ready-to-send status in the test poll

** The service message, if used, must end with the control character ETX; if a service message is not used, an ETX character must be included in this format, immediately ahead of the EOT. The ETX character is necessary to prevent a selected receiver from treating the turn-around function as a message format violation and giving an alarm.

mode, the responses they produce as a result of a test poll operation may be any of the following five types:

A. A traffic-to-send response
B. A no-traffic-to-send response
C. A message-improperly-received response
D. An invalid response
E. No response at all

The reaction of the computer switcher should be somewhat different for each of these possible responses.

A. Traffic-To-Send Response

There are two types of traffic-to-send responses to a test poll that are available with the 85A1 stations. The standard traffic-to-send response is the single control character ACK (Acknowledge). This is the response that can be expected when the corresponding response to a normal poll is either the universal traffic-to-send response character ACK or the automatic transmission of traffic from the polled station.

An optional traffic-to-send response to a test poll is the discrete, single-character Station Identity Code (SIC) used in place of the universal ACK response mentioned above. A SIC response provides discrete identification of a station with traffic to send. Its use in test poll in place of the ACK response requires that it be employed in place of the ACK response during the polling, call-in, and roll-call operations as well.

B. No-Traffic-To-Send Response

The no-traffic-to-send response to test poll is the control character NAK (Negative Acknowledge), just as in the case of a normal polling operation (cf. Section 4.2[*B*] [2], but note that the DLE character must not be repeated when test polling the next station).

C. Message-Improperly-Received Response

The message-improperly-received response to a test poll is the control character CAN (Cancel). This response constitutes an unsatisfactory message delivery report on the last message delivered to this station and is independent of the ready-to-send state of the station. The message-improperly-received response is given only once in response to the first polling operation or the first roll-call or call-in operation after the delivery in question. Hence, to determine the ready-to-send status of the station when its first response to a test poll is CAN, the computer switcher should send the SCC of that station again. DLE must not be repeated when sending the SCC again or all the stations on the line will assume the normal polling state.

D. Invalid Response

An invalid response to a test poll is any response that is not NAK, CAN, or the traffic-to-send response being employed, either ACK or the specific SIC (Station Identity Code).

When the invalid response is a single character, it is suggested that the computer switcher repeat the test poll mode sequence ENQ EOT DLE and again send the SCC of the station that was being test polled when the invalid response was received.

If the invalid response should take the form of continuous transmission from some station, it is suggested that the computer switcher initiate an emergency stop action (see Section 4.14 — Emergency Stop) with or without a service message to the interrupted station. It should then send DLE (instead of the EOT after the ENQ EOT of the emergency

stop sequence) and resume the test poll routine with the last station test polled.

E. No Response

The computer switcher should employ a response time-out function that will limit the length of time it will wait for an expected response. Responses from stations can be expected within 600 milliseconds under most circumstances. A system time-out of one second, therefore, has already been recommended for this purpose.

If a no-response time-out should occur, it is suggested that the computer switcher send the SCC of the station in question again. If there is still no response, then the computer switcher should send the test poll mode sequence ENQ EOT DLE and the SCC of the station in question again. If there is still no response, it is suggested that the computer switcher proceed to test poll the next station in turn, treating the nonresponding station as one that is in trouble.

When stations with earlier type controllers are arranged with the option of giving indications of their ready-to-receive status in the test poll mode, the responses received as a result of a test poll operation may be any of the following five types:

F. A ready-to-receive response
G. A not-ready-to-receive response
H. A message-improperly-received response
I. An invalid response
J. No response at all

The reaction of the computer switcher should be somewhat different for each of these possible responses.

F. Ready-To-Receive Response

There are two types of ready-to-receive responses to a test poll that are available with the 85A stations. The standard ready-to-receive response is the single control character ACK (Acknowledge). Receipt of this response is an indication that some station is ready to receive, but it does not give positive assurance that the responding station was indeed the station that was test polled.

An optional ready-to-receive response to a test poll is the discrete single-character Station Identity Code (SIC), used in place of the universal ACK response mentioned above. A SIC response provides discrete identification of the responding station. Its use in test poll in place of the ACK response requires that it be employed in place of the ACK response during the polling, call-in, and roll-call operations as well.

G. Not-Ready-To-Receive Response

The not-ready-to-receive response to a test poll is the single control character NAK (Negative Acknowledge). This response can result from the station's being out of paper, momentarily in an out-of-service condition, in an off-line mode, etc.

H. Message-Improperly-Received Response

The message-improperly-received response to a test poll is the control character CAN (Cancel). This response constitutes an unsatisfactory message delivery report on the last message delivered to this station and is independent of the station's ready-to-receive status. The message-improperly-received response is given only once in response to the first polling operation or the first roll-call or call-in operation after the delivery in question. Hence, to determine the ready-to-receive status of the station when its first response to

test poll is CAN, the computer switcher should send the SCC of that station again. DLE must not be repeated when sending the SCC again or all the stations on the line will assume the normal polling state.

I. Invalid Response

An invalid response to a test poll is any response that is not NAK, CAN, or the ready-to-receive response being employed, either ACK or the specific SIC (Station Identity Code).

When the invalid response takes the form of a single character, it is suggested that the computer switcher repeat the test poll mode sequence ENQ EOT DLE and send the SCC for the particular station again.

If the invalid response should take the form of continuous transmission from some station, it is suggested that the computer switcher initiate an emergency stop action (see Section 4.14 — Emergency Stop), with or without a service message to the interrupted station. It should then send DLE (instead of the EOT after the ENQ EOT of the emergency stop sequence) and resume the test poll operation with the last station test polled.

J. No Response

The computer switcher should employ a response time-out function that will limit the length of time it will wait for an expected response. Responses from stations can be expected within 600 milliseconds under most circumstances. A system time-out of one second, therefore, has already been recommended for this purpose.

If a no-response time-out should occur, the computer switcher should send the SCC for that particular station again. If there is still no response, then the computer switcher should send the test poll mode sequence ENQ EOT DLE and the SCC of the station in question again. If there is still no response, it is suggested that the computer switcher proceed to test poll the next station in turn, treating the nonresponding station as one that is in trouble.

2. Systems Having Stations with Latest Type Controllers

The fields of application for the test poll feature in systems of this type are:

(a) To survey the traffic-to-send status of the stations on a line without placing them in a selected-to-send state. This process discloses, at the same time, the ready-to-receive status of the stations that are test polled.

(b) To check the operability of the line if some anomalous condition should occur during message pickup or delivery.

Note that, unlike in the case of systems that employ stations with the earlier type controllers, the test poll function cannot be used here to pick up message-improperly-received responses. These, however, can be picked up through the use of the roll-call operation (see Section 4.9 — Roll-Call Operation). And if the roll-call operation is not used, message-improperly-received responses will be given by the affected stations when they are next called-in (see Item C of Section 4.7 — Call-In Operation and Responses).

The stations on a line are placed in the test poll mode in the same way as are those that have the earlier type controllers, and the same procedures are

applicable for terminating the test poll routine.

The responses resulting from a test poll of stations with the latest type controllers may be any of the following five types:

A. A traffic-to-send response
B. A no-traffic-to-send but ready-to-receive response
C. A no-traffic-to-send and not-ready-to-receive response
D. An invalid response
E. No response at all

The reaction of the computer switcher should be somewhat different for each of these possible responses.

A. Traffic-To-Send Response

There are available for test poll two types of traffic-to-send responses. They are the same as those available for stations with the earlier type controllers and all the considerations relating to them also are the same (see Section 4.16 (1)(A), above).

B. No-Traffic-To-Send but Ready-To-Receive Response

This response to a test poll is the control character CAN (Cancel). It has the same meaning as does the CAN response in the normal polling operation involving stations with controllers of the latest type (cf. Section 4.2 (B) (1), but note that the DLE character must not be repeated when test polling the next station).

The indication this response provides as to the station's ready-to-receive status obviates the need for the optional ready-to-receive test poll response of stations having earlier controllers. However, use of the control character CAN, thus, precludes its use as a test poll response that indicates a message improperly received.

C. No-Traffic-To-Send and Not-Ready-To-Receive Response

This response to a test poll is the control character NAK (Negative Acknowledge). It has the same meaning as does the NAK response in the normal polling operation involving stations with controllers of the latest type (cf. Section 4.2 (B) (1), but note that the DLE character must not be repeated when test polling the next station).

D. Invalid Response

An invalid response to a test poll is any response that is not CAN, NAK, or the traffic-to-send response being employed, either ACK or the specific SIC (Station Identity Code).

An invalid response to a test poll from a station with the latest type controller should be dealt with in the same way as is discussed in Section 4.16 (1) (D), above, for the station with a controller of the earlier type.

E. No Response

When a test poll evokes no response from a station with the latest type controller, the condition should be dealt with in the same way as is discussed in Section 4.16 (1)(E), above, for the station with a controller of the earlier type.

4.17 Delivery Abort — Interline Operation

To abort the process of message delivery from the computer switcher (interline operation) and restore the selected receiving stations to the "idle" state, certain on-line control procedures should be followed. These vary, depending upon whether the abort action is taken:

(a) After one or more stations has been called in and has given a ready-to-receive response, but transmission of

the message text has not yet started, or

(b) After the delivery has progressed to the point where the computer switcher has started to send the message text.

In the first instance (a) the computer switcher should send the sequence ENQ EXT EOT *. The ENQ DC2 of this sequence will unblind the already selected receiving stations; the ETX will satisfy the message format check requirement that a selected receiver detect an ETX before detecting an EOT (see Section 4.10 — Causes for CAN Response, Item g); and the EOT will cause the selected receivers to return to the "idle" state.

If during the call-in process, per station information had been sent to any station (see Section 4.7 — Call-in Operation and Responses, Item A — Ready-to-Receive Response), it would be desirable to include a service message, following the ENQ DC2 and before the ETX, to explain that the delivery was being aborted. This service message should not contain another ETX, of course.

If the abort action is to be taken after the message delivery has progressed into the text (b), then, since the selected stations are already in an unblinded condition, only an ETX EOT sequence is necessary*. In this case, too, it would be desirable to precede the ETX with an explanatory service message.

*If the stations employ controllers of the earlier design, time must be allowed in all cases for the teletypewriter motor of the last station called in to reach operating speed before the computer switcher sends the ENQ of this sequence. This timing requirement applies, also, when the stations employ controllers of the latest design and the abort procedure is to include the explanatory service message mentioned later. (Information on the timing requirements is given in Section 3.7.1 — Station Motor Turn On.) If the controllers involved are of the latest design, however, and there is to be no explanatory service message, the ENQ can be sent without waiting for the motor of the last called-in station to reach operating speed.

4.18 Loop-Back

Loop-Back is an operating mode wherein the station will respond to control sequences (polling, call-in, etc.) in the normal fashion, but will send back to the line all message text characters it receives. This function is provided to facilitate remote testing of stations by Bell System maintenance personnel. It is not intended for use by customers. However, since it is possible for a station to get into this operating mode inadvertently as a result of a particular control character sequence, it is mentioned here for the purpose of listing its symptons and indicating how to return the line to normal.

The receipt of the sequence ENQ SCC anytime after the sequence ENQ EOT but before an EOT or a DLE will cause the station designated by the SCC to assume the loop-back mode.

A station that gets into the loop-back mode inadvertently will produce garbling of all characters sent to the line from the computer switcher. Therefore, if it is suspected that a station is in the loop-back mode, the computer switcher should take action to terminate the possible condition by sending:

Break Pause

E
O — to return the line to the "idle" state, or
T

Break Pause

E E
N O — to prepare the line for entry into a test poll.

Alternatively, an emergency stop action could be initiated (see Section 4.14 — Emergency Stop), with or without a service message, to normalize the line.

** Note that if an auxiliary receiver had been cut on during this text transmission, the ETX will insure that it will not be left in the cut-on state as a result of the abort action.

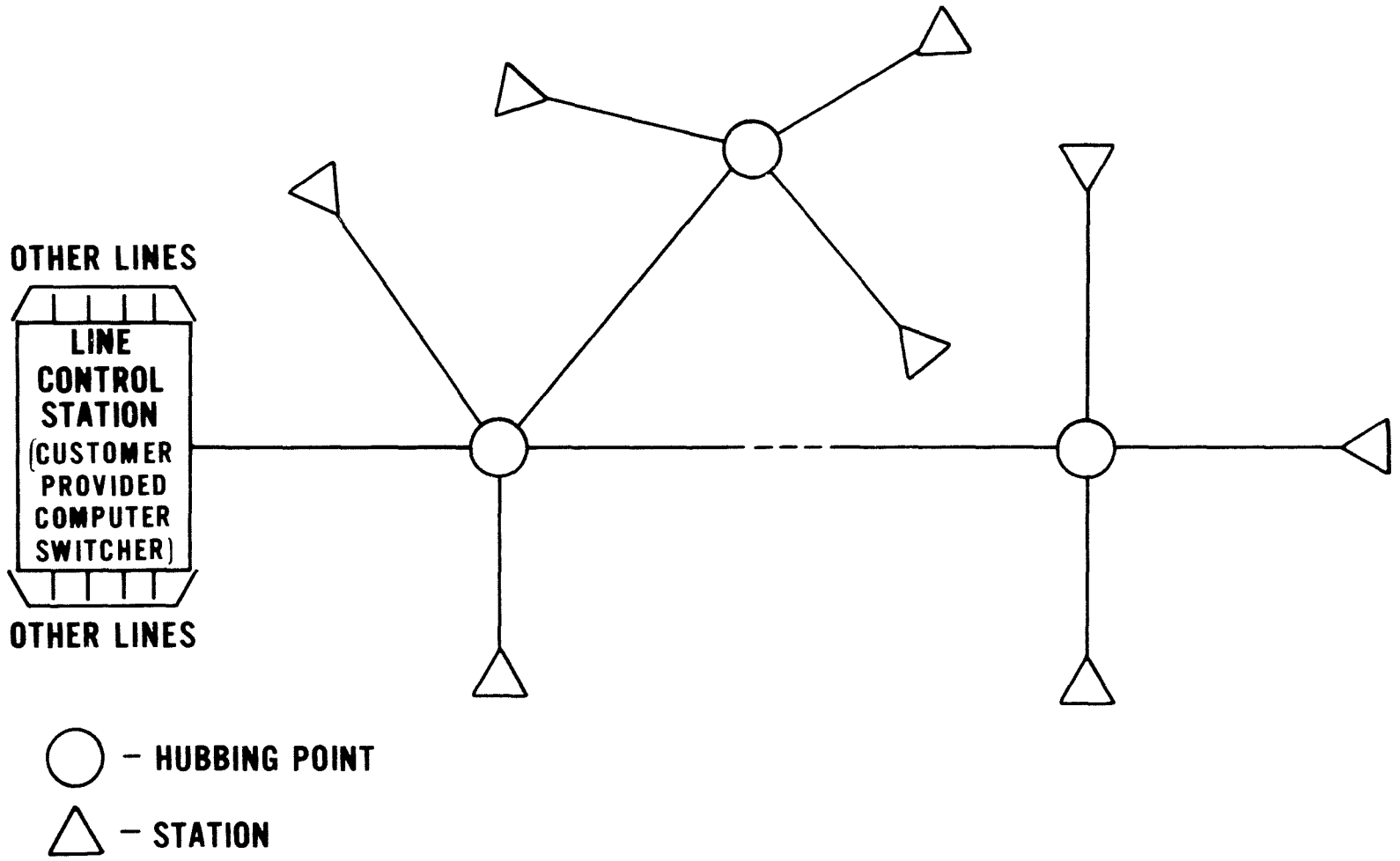


FIGURE 1 - BLOCK DIAGRAM REPRESENTATION OF TYPICAL 85A SYSTEM LINE

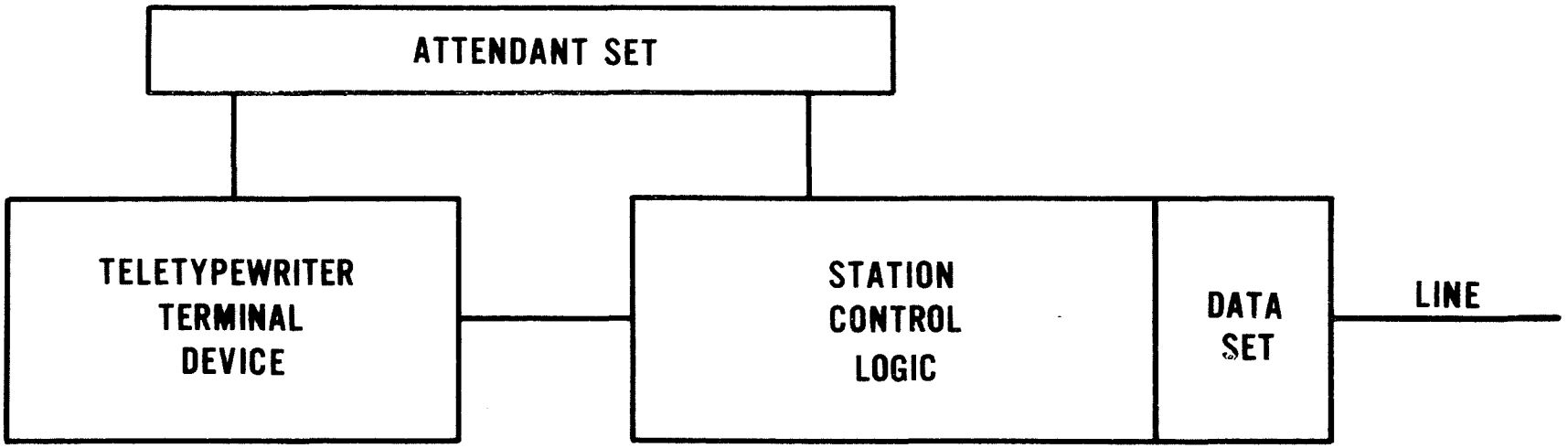
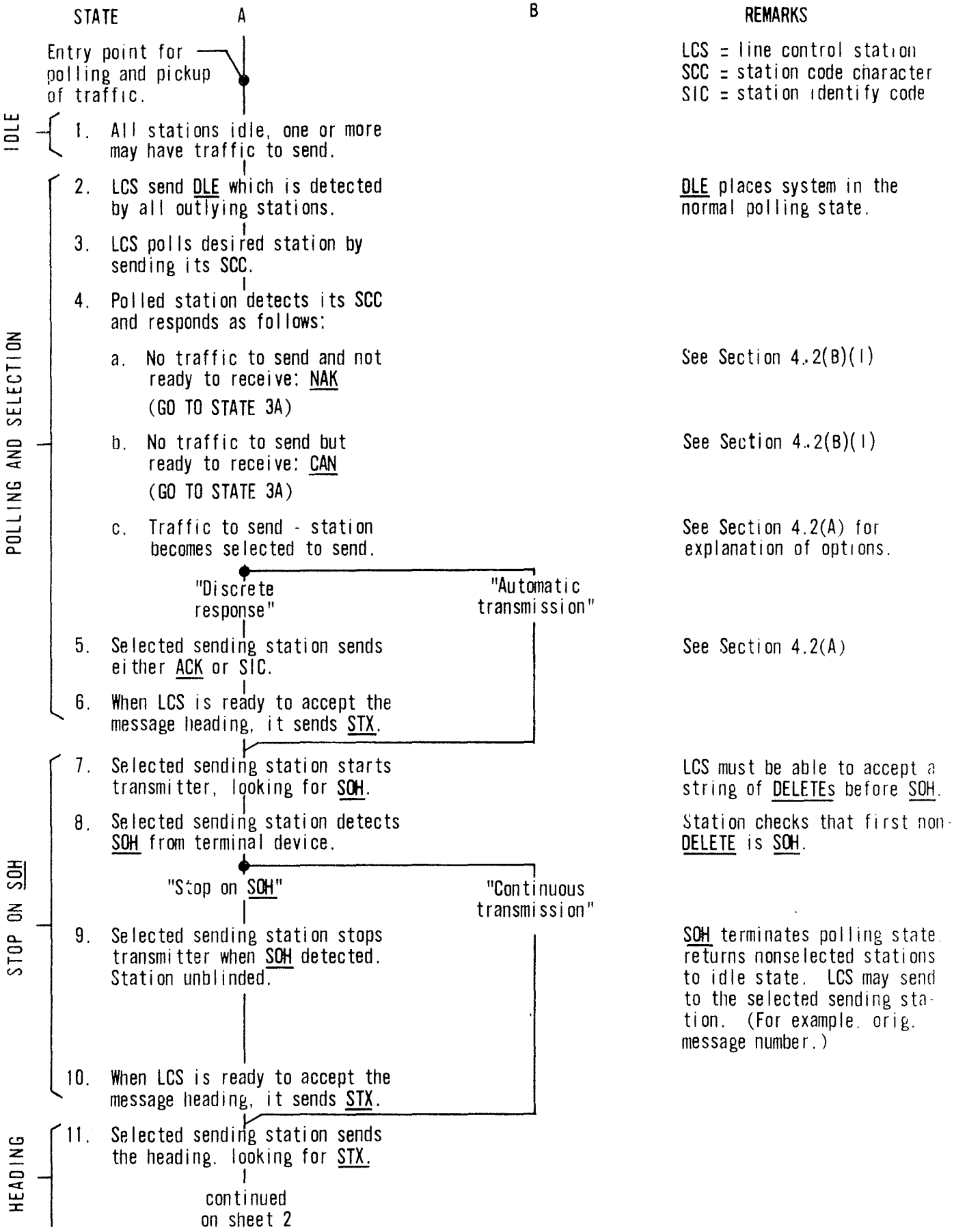


FIGURE 2 - BLOCK DIAGRAM REPRESENTATION OF TYPICAL 85A STATION

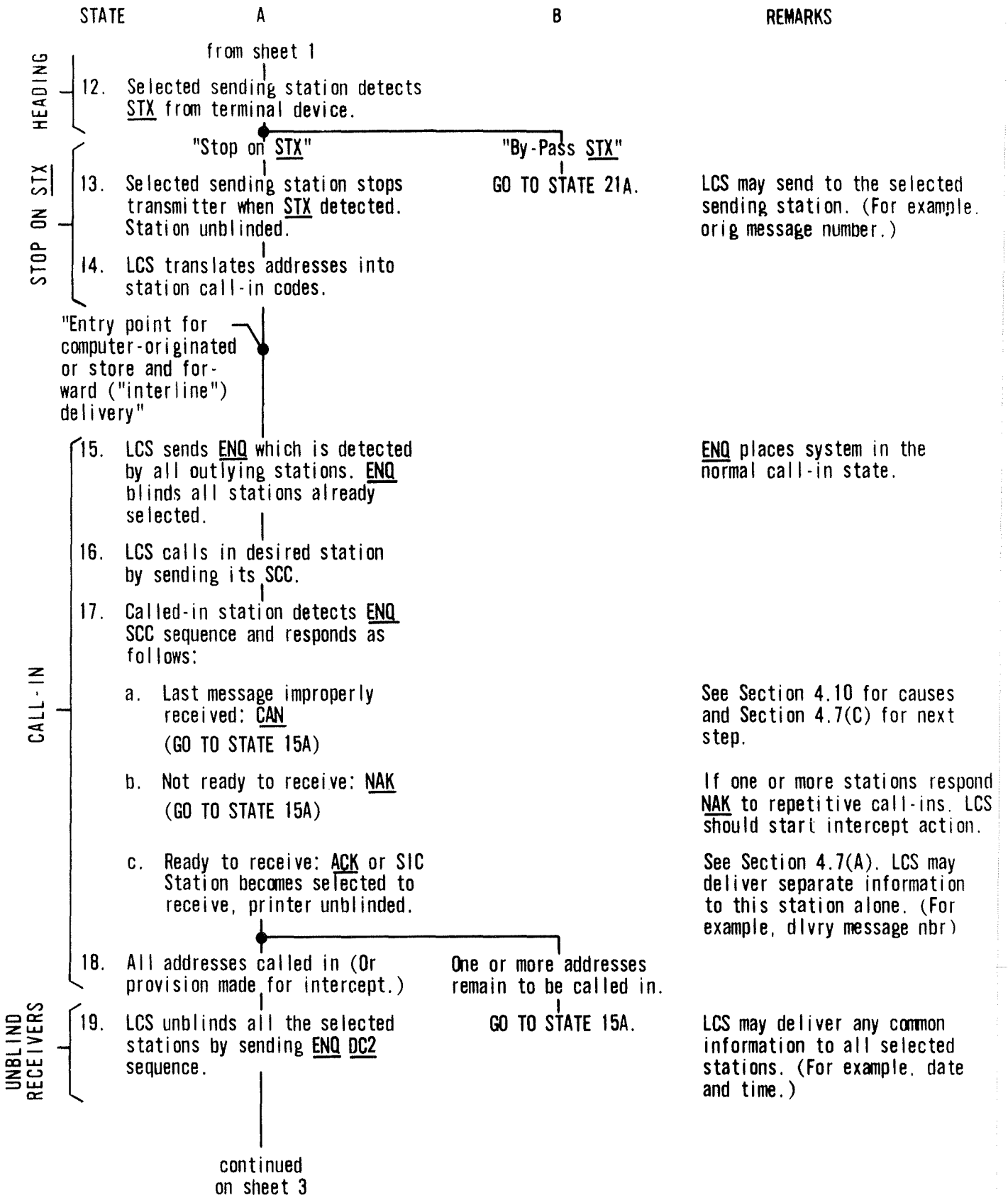
AMERICAN NATIONAL STANDARD
CODE FOR INFORMATION INTERCHANGE
ANS X3.4 - 1968

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

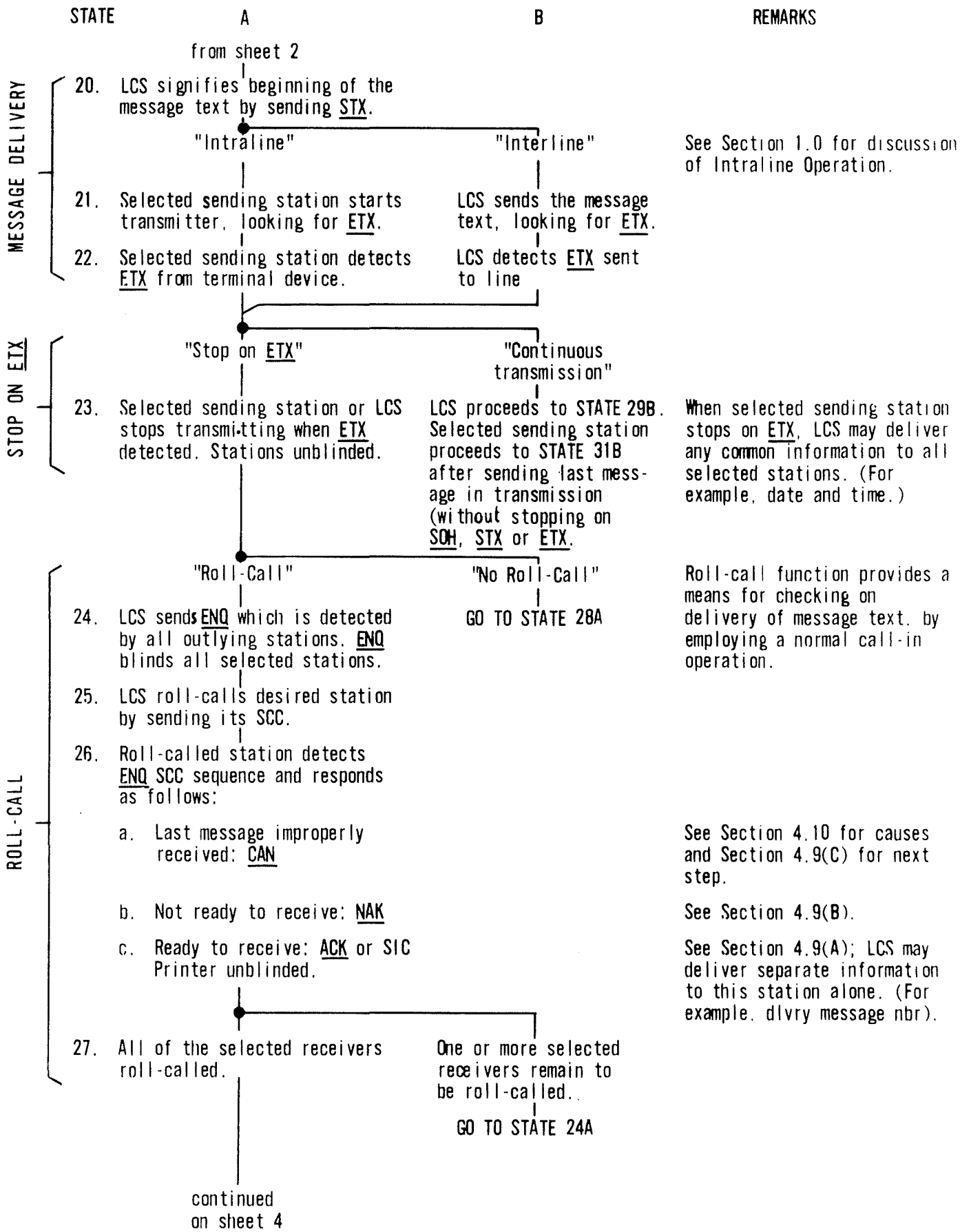
FIGURE 3



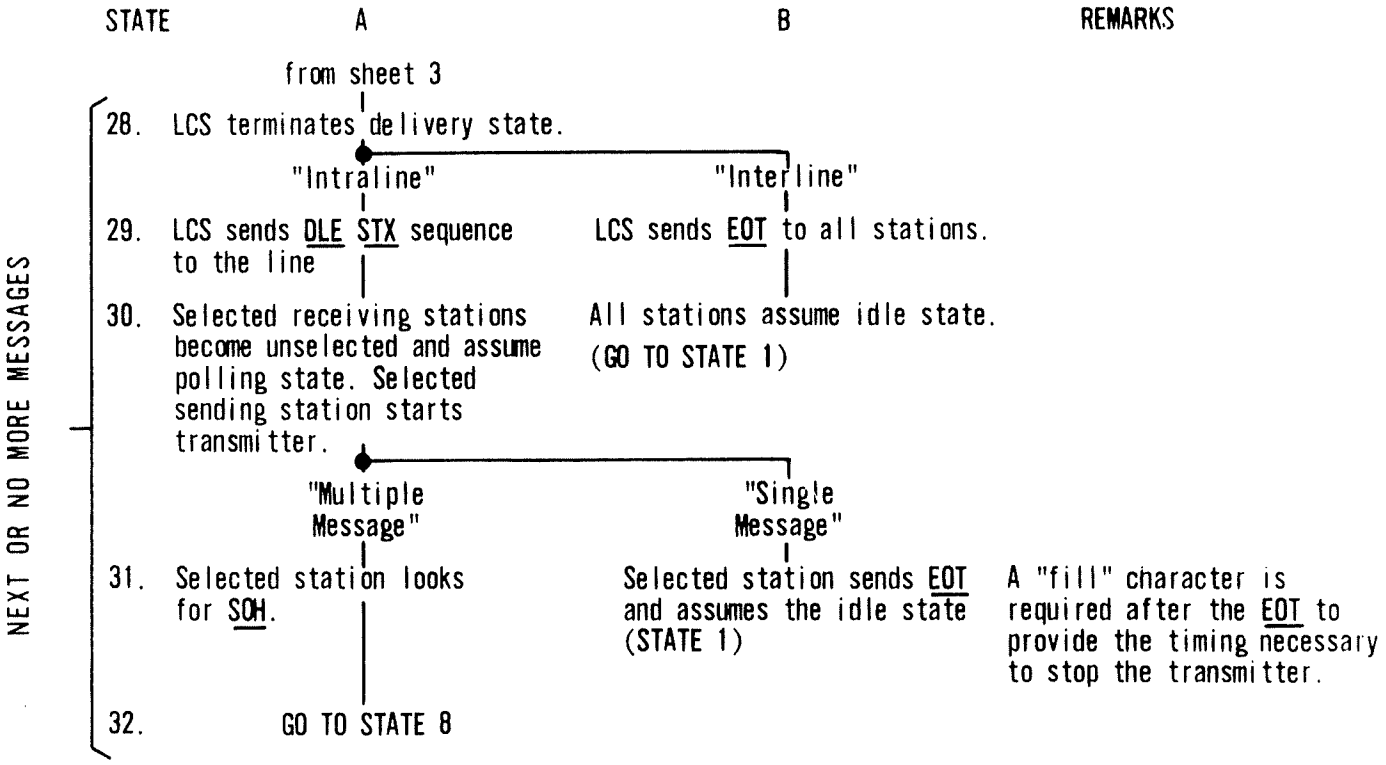
SCI - SUGGESTED OPERATION OF 85A SYSTEM LINE
(WITH LATEST TYPE STATION CONTROLLER)



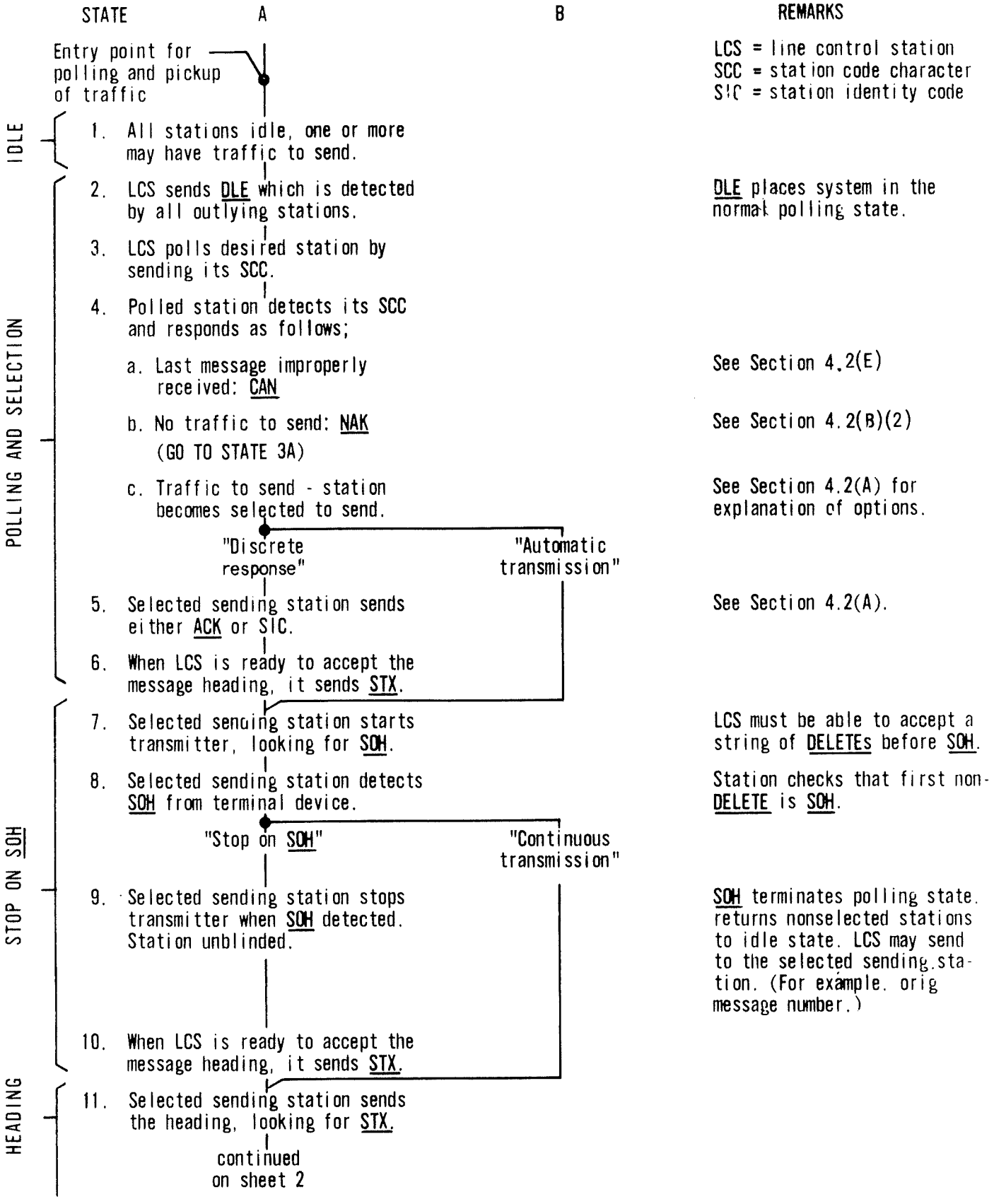
SCI - SUGGESTED OPERATION OF 85A SYSTEM LINE
(WITH LATEST TYPE STATION CONTROLLER)



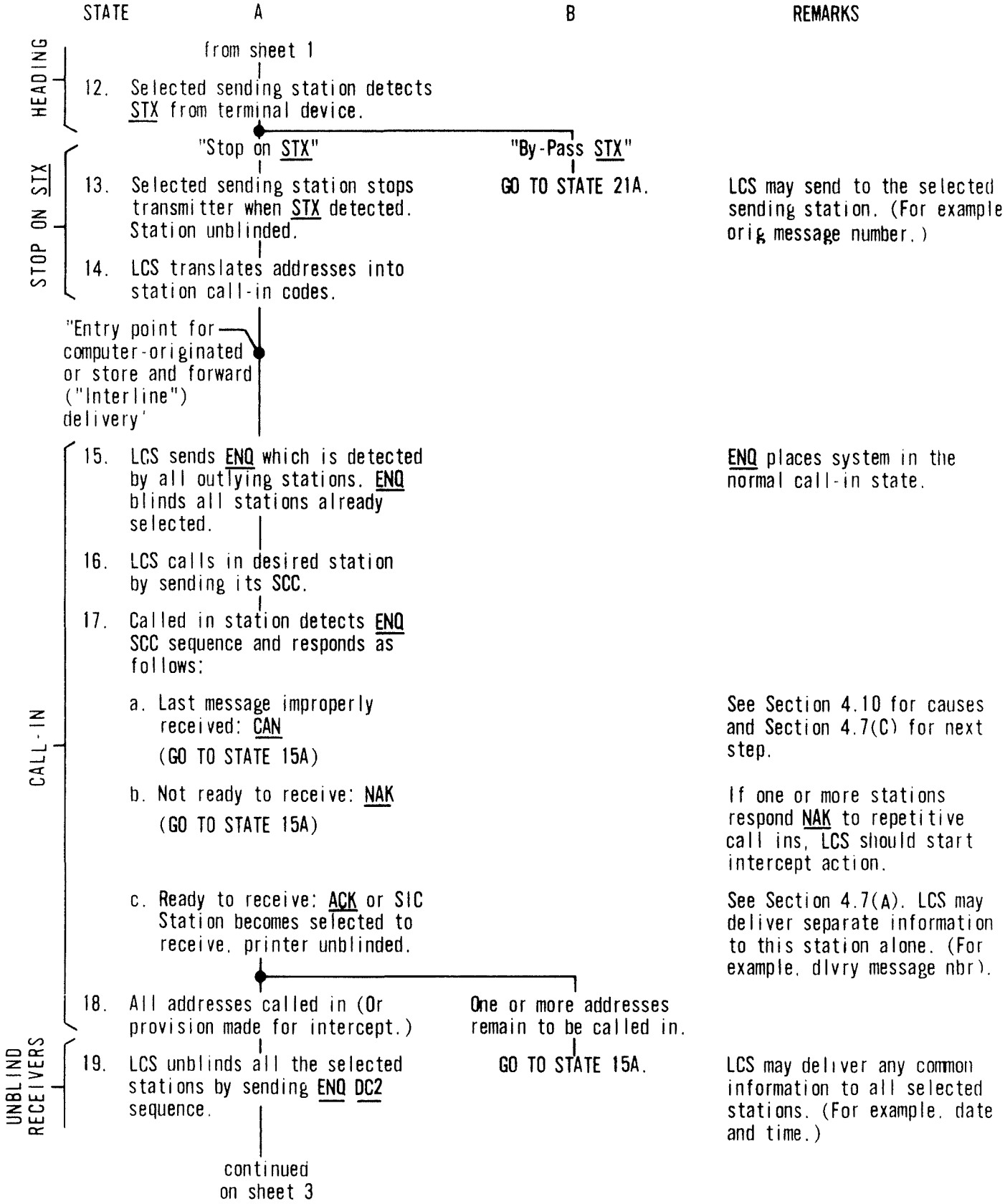
SCI - SUGGESTED OPERATION OF 85A SYSTEM LINE
(WITH LATEST TYPE STATION CONTROLLER)



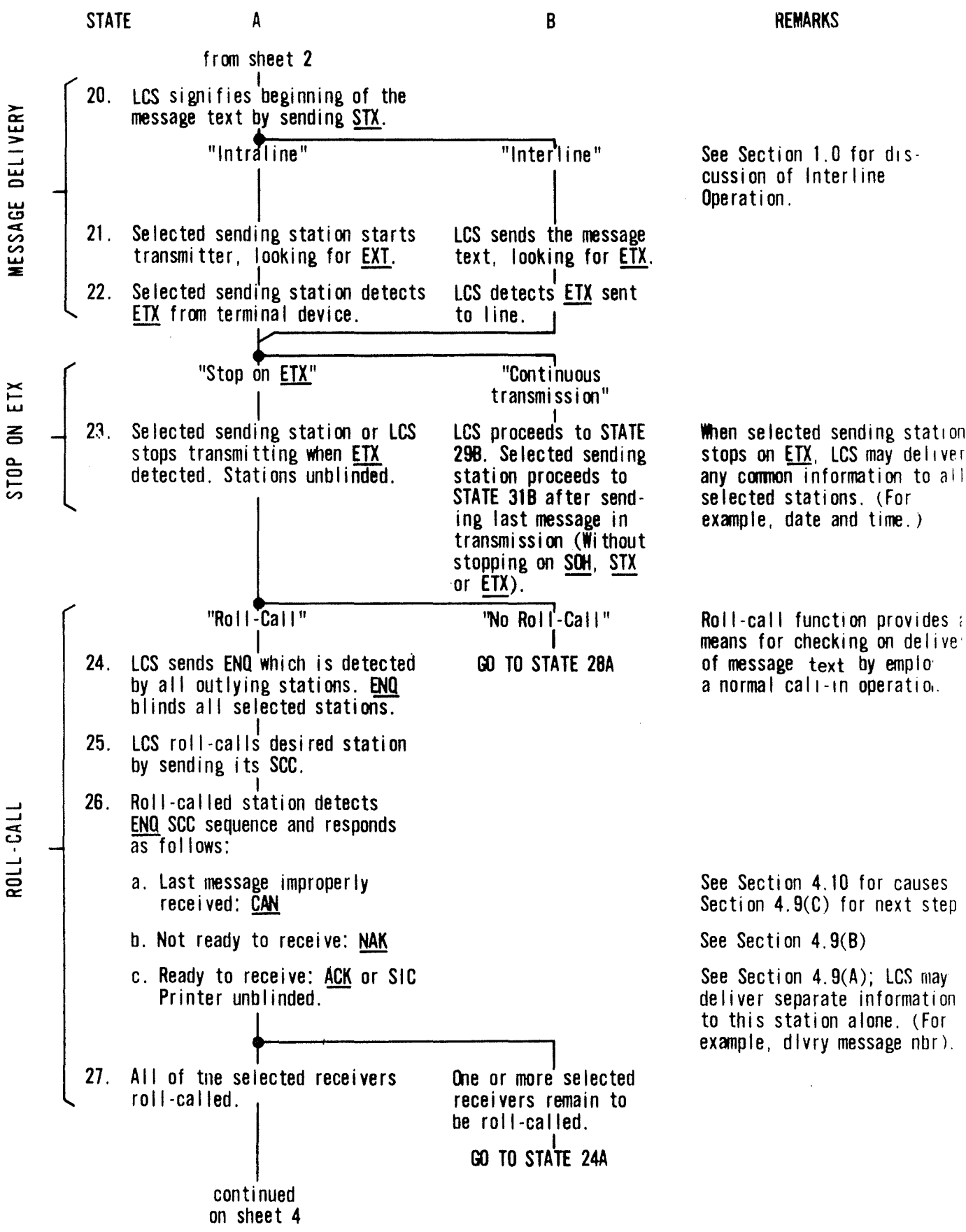
SCI - SUGGESTED OPERATION OF 85A SYSTEM LINE
(WITH LATEST TYPE STATION CONTROLLER)



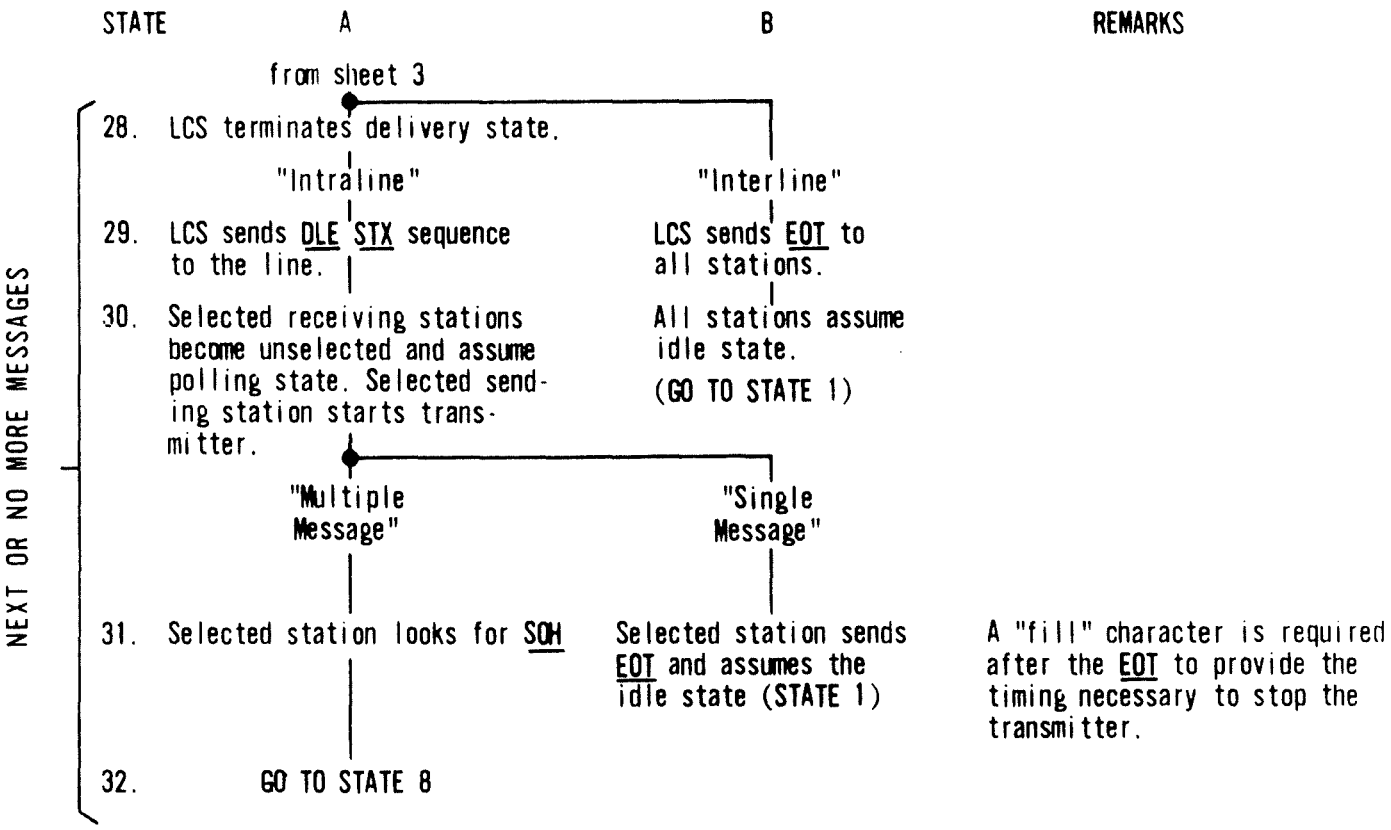
SC2 - SUGGESTED OPERATION OF 85A1 SYSTEM LINE
(WITH EARLIER TYPE STATION CONTROLLER)



SC2 - SUGGESTED OPERATION OF 85A1 SYSTEM LINE
(WITH EARLIER TYPE STATION CONTROLLER)



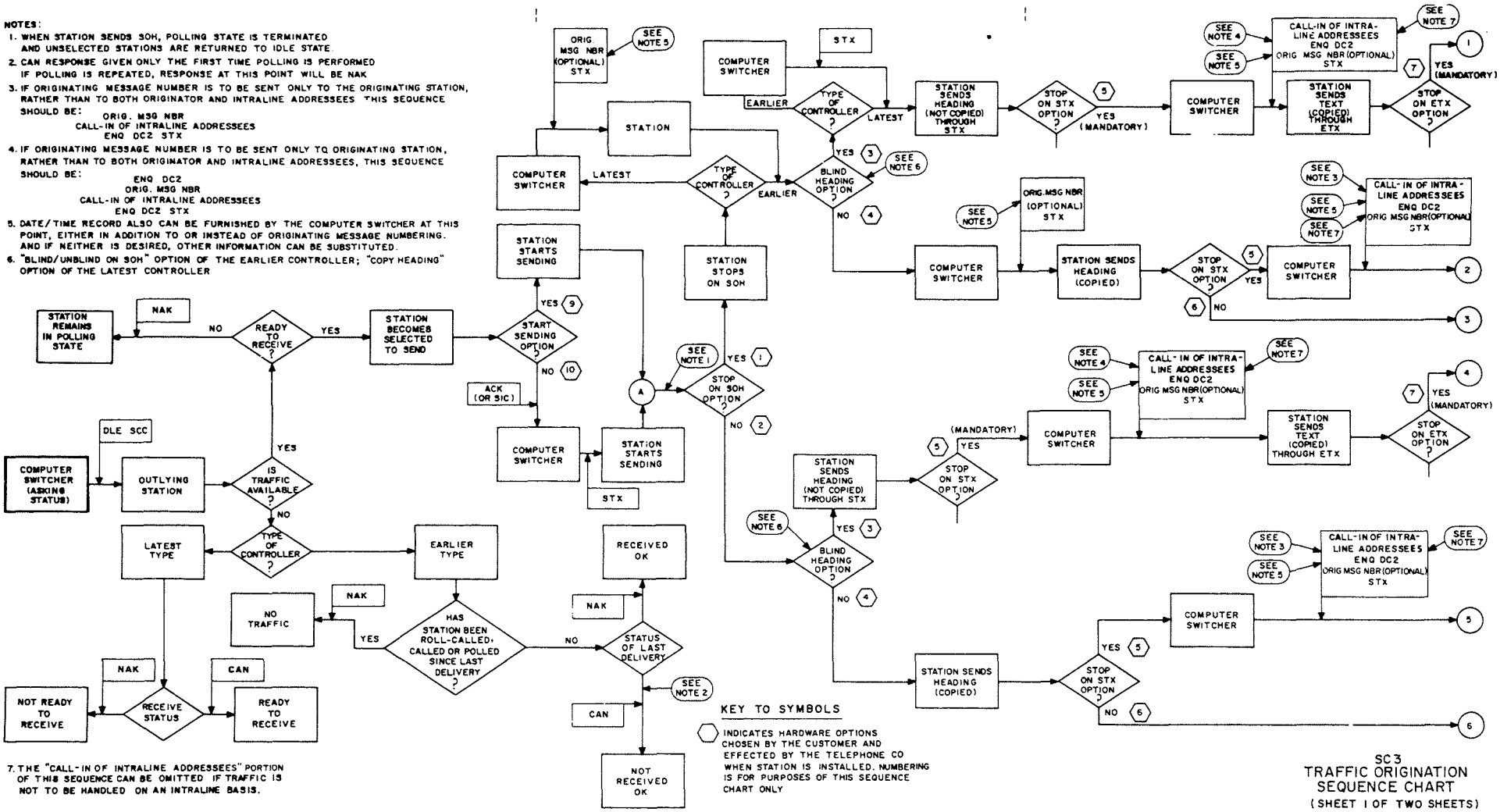
SC2 - SUGGESTED OPERATION OF 85AI SYSTEM LINE
(WITH EARLIER TYPE STATION CONTROLLER)



SC2 - SUGGESTED OPERATION OF 85A1 SYSTEM LINE
(WITH EARLIER TYPE STATION CONTROLLER)

NOTES:

1. WHEN STATION SENDS SOH, POLLING STATE IS TERMINATED AND UNSELECTED STATIONS ARE RETURNED TO IDLE STATE.
2. CAN RESPONSE GIVEN ONLY THE FIRST TIME POLLING IS PERFORMED IF POLLING IS REPEATED, RESPONSE AT THIS POINT WILL BE NAK
3. IF ORIGINATING MESSAGE NUMBER IS TO BE SENT ONLY TO THE ORIGINATING STATION, RATHER THAN TO BOTH ORIGINATOR AND INTRALINE ADDRESSEES THIS SEQUENCE SHOULD BE:
   ORIG. MSG NBR
   CALL-IN OF INTRALINE ADDRESSEES
   ENQ DC2 STX
4. IF ORIGINATING MESSAGE NUMBER IS TO BE SENT ONLY TO ORIGINATING STATION, RATHER THAN TO BOTH ORIGINATOR AND INTRALINE ADDRESSEES, THIS SEQUENCE SHOULD BE:
   ENQ DC2
   ORIG. MSG NBR
   CALL-IN OF INTRALINE ADDRESSEES
   ENQ DC2 STX
5. DATE/TIME RECORD ALSO CAN BE FURNISHED BY THE COMPUTER SWITCHER AT THIS POINT, EITHER IN ADDITION TO OR INSTEAD OF ORIGINATING MESSAGE NUMBERING. AND IF NEITHER IS DESIRED, OTHER INFORMATION CAN BE SUBSTITUTED.
6. "BLIND/UNBLIND ON SOH" OPTION OF THE EARLIER CONTROLLER; "COPY HEADING" OPTION OF THE LATEST CONTROLLER

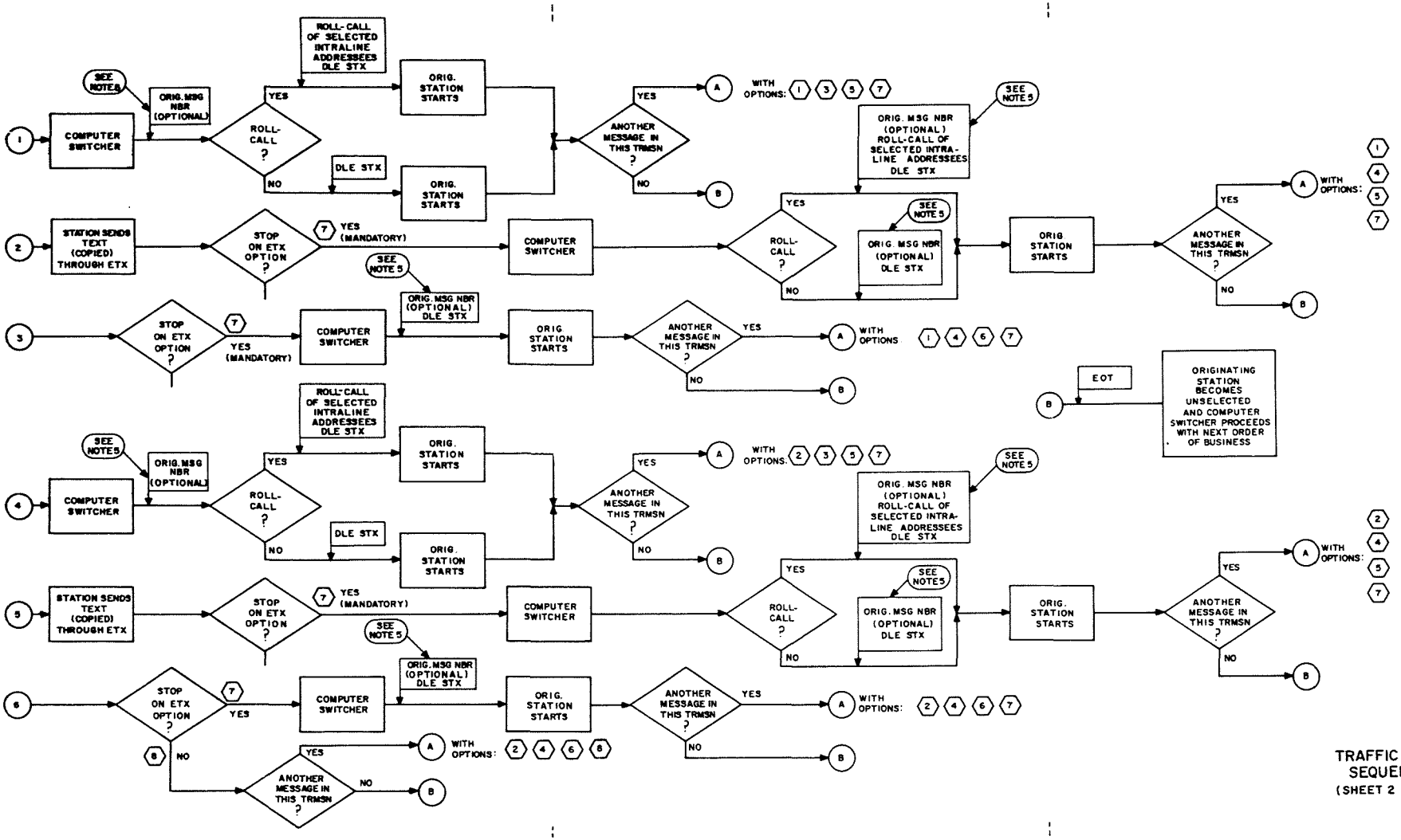


KEY TO SYMBOLS

⬡ INDICATES HARDWARE OPTIONS CHOSEN BY THE CUSTOMER AND EFFECTED BY THE TELEPHONE CO WHEN STATION IS INSTALLED. NUMBERING IS FOR PURPOSES OF THIS SEQUENCE CHART ONLY

7. THE "CALL-IN OF INTRALINE ADDRESSEES" PORTION OF THIS SEQUENCE CAN BE OMITTED IF TRAFFIC IS NOT TO BE HANDLED ON AN INTRALINE BASIS.

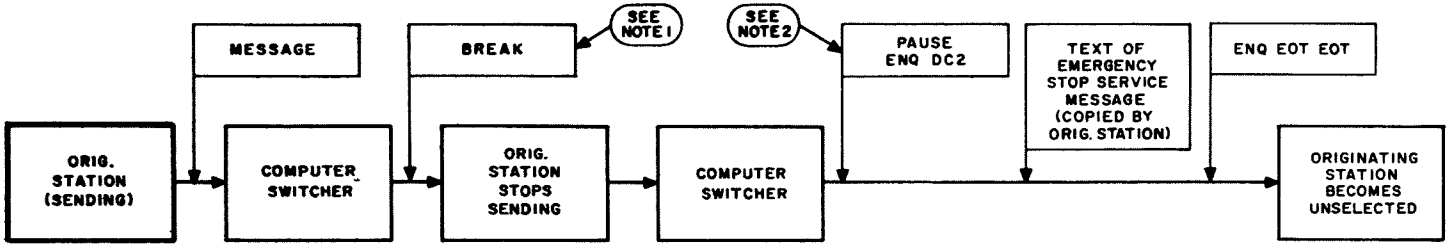
SC3
TRAFFIC ORIGINATION SEQUENCE CHART
(SHEET 1 OF TWO SHEETS)



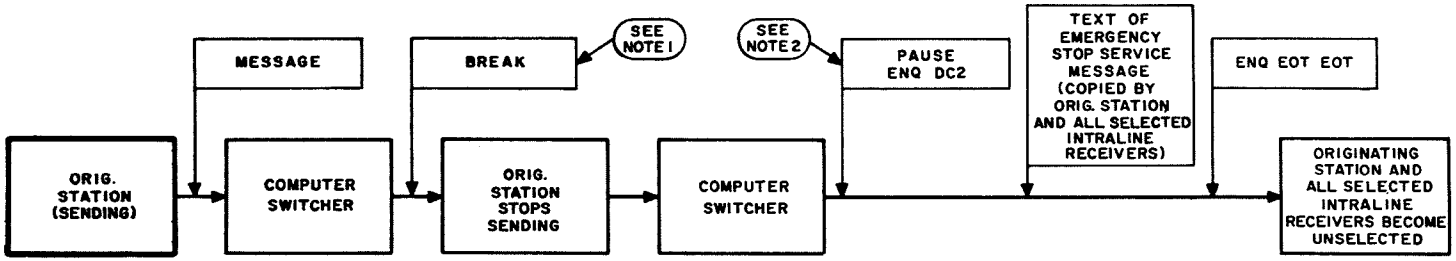
SC3
TRAFFIC ORIGINATION
SEQUENCE CHART
(SHEET 2 OF TWO SHEETS)

NOTES:

1. THE BREAK SIGNAL CONSISTS OF 400 MS. (MIN.) TO 750 MS. (MAX.) OF CONTINUOUS SPACING.
2. THE PAUSE INSURES THAT STATIONS WILL REGAIN SYNCHRONISM SO THAT THEY CAN RESPOND PROPERLY TO SUBSEQUENT LINE SIGNALS. IT MUST BE AT LEAST ONE DELETE CHARACTER, OR AT LEAST ONE CHARACTER INTERVAL OF CONTINUOUS MARKING.



(a) INTERLINE OPERATION

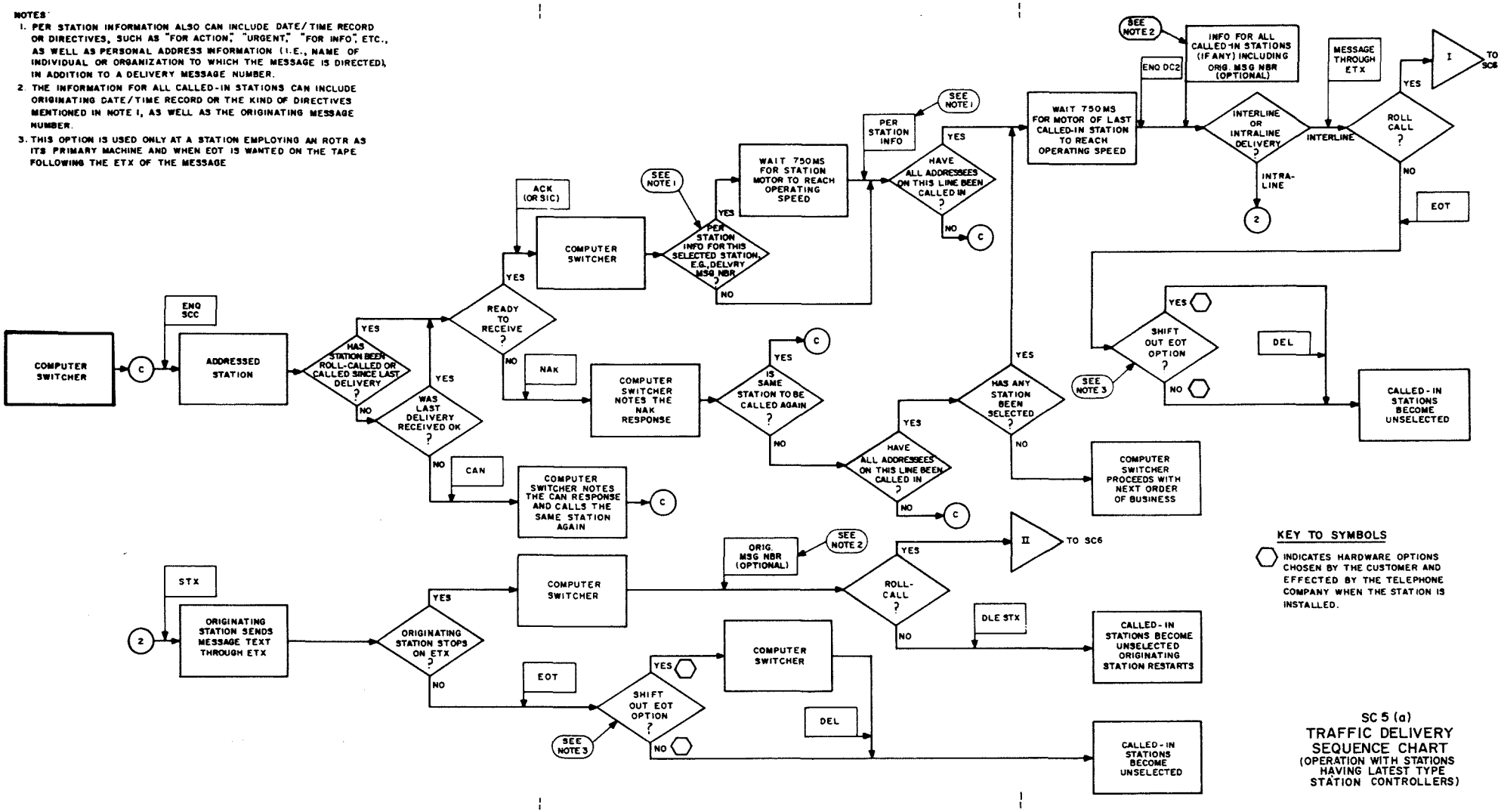


(b) INTRALINE OPERATION

SC 4
EMERGENCY STOP SEQUENCE CHART

NOTES:

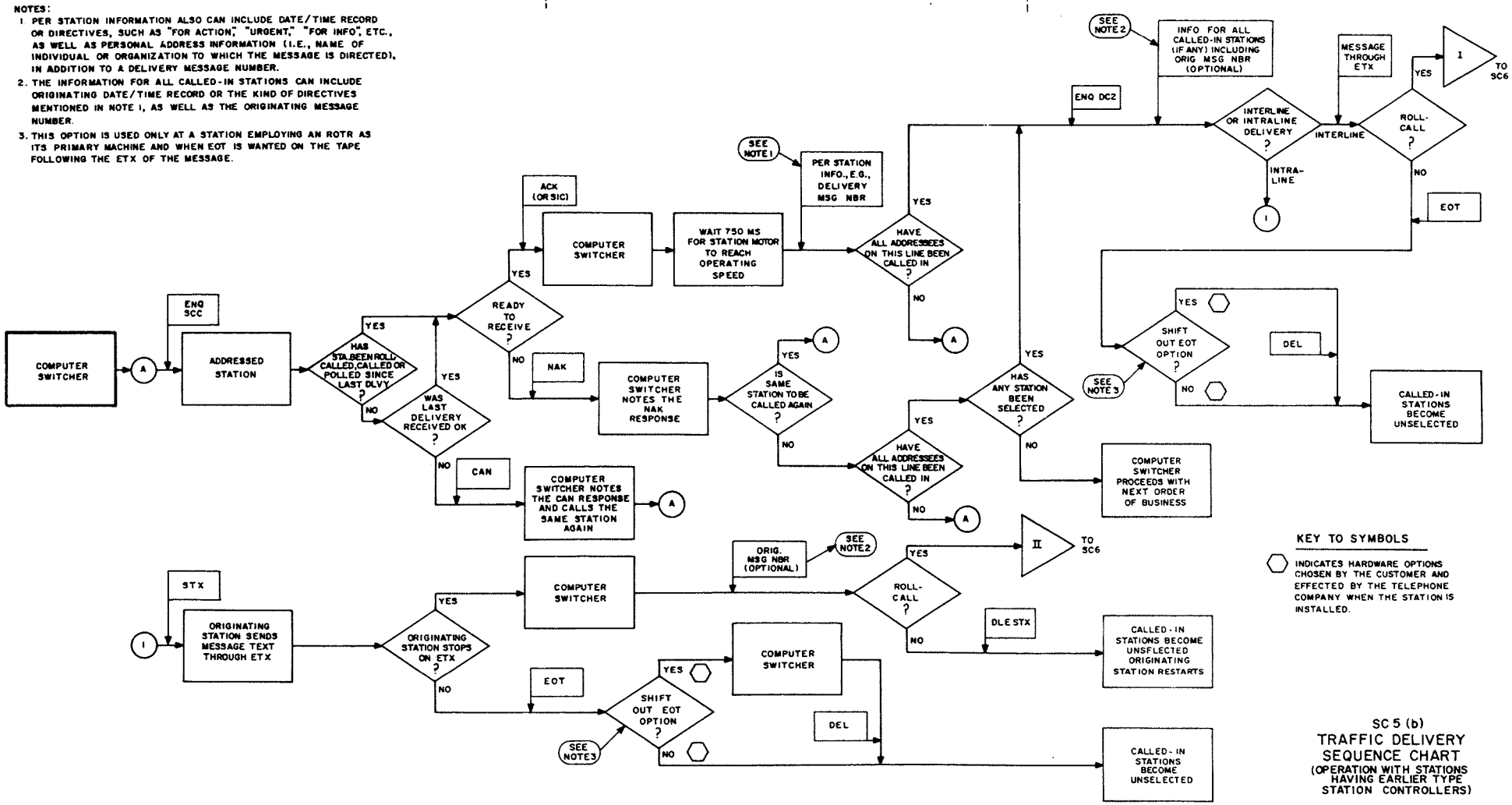
1. PER STATION INFORMATION ALSO CAN INCLUDE DATE/TIME RECORD OR DIRECTIVES, SUCH AS "FOR ACTION," "URGENT," "FOR INFO", ETC., AS WELL AS PERSONAL ADDRESS INFORMATION (I.E., NAME OF INDIVIDUAL OR ORGANIZATION TO WHICH THE MESSAGE IS DIRECTED), IN ADDITION TO A DELIVERY MESSAGE NUMBER.
2. THE INFORMATION FOR ALL CALLED-IN STATIONS CAN INCLUDE ORIGINATING DATE/TIME RECORD OR THE KIND OF DIRECTIVES MENTIONED IN NOTE 1, AS WELL AS THE ORIGINATING MESSAGE NUMBER.
3. THIS OPTION IS USED ONLY AT A STATION EMPLOYING AN ROTR AS ITS PRIMARY MACHINE AND WHEN EOT IS WANTED ON THE TAPE FOLLOWING THE ETX OF THE MESSAGE



SC 5 (a)
TRAFFIC DELIVERY SEQUENCE CHART
(OPERATION WITH STATIONS HAVING LATEST TYPE STATION CONTROLLERS)

NOTES:

1. PER STATION INFORMATION ALSO CAN INCLUDE DATE/TIME RECORD OR DIRECTIVES, SUCH AS "FOR ACTION," "URGENT," "FOR INFO", ETC., AS WELL AS PERSONAL ADDRESS INFORMATION (I.E., NAME OF INDIVIDUAL OR ORGANIZATION TO WHICH THE MESSAGE IS DIRECTED), IN ADDITION TO A DELIVERY MESSAGE NUMBER.
2. THE INFORMATION FOR ALL CALLED-IN STATIONS CAN INCLUDE ORIGINATING DATE/TIME RECORD OR THE KIND OF DIRECTIVES MENTIONED IN NOTE 1, AS WELL AS THE ORIGINATING MESSAGE NUMBER.
3. THIS OPTION IS USED ONLY AT A STATION EMPLOYING AN ROTR AS ITS PRIMARY MACHINE AND WHEN EOT IS WANTED ON THE TAPE FOLLOWING THE ETX OF THE MESSAGE.



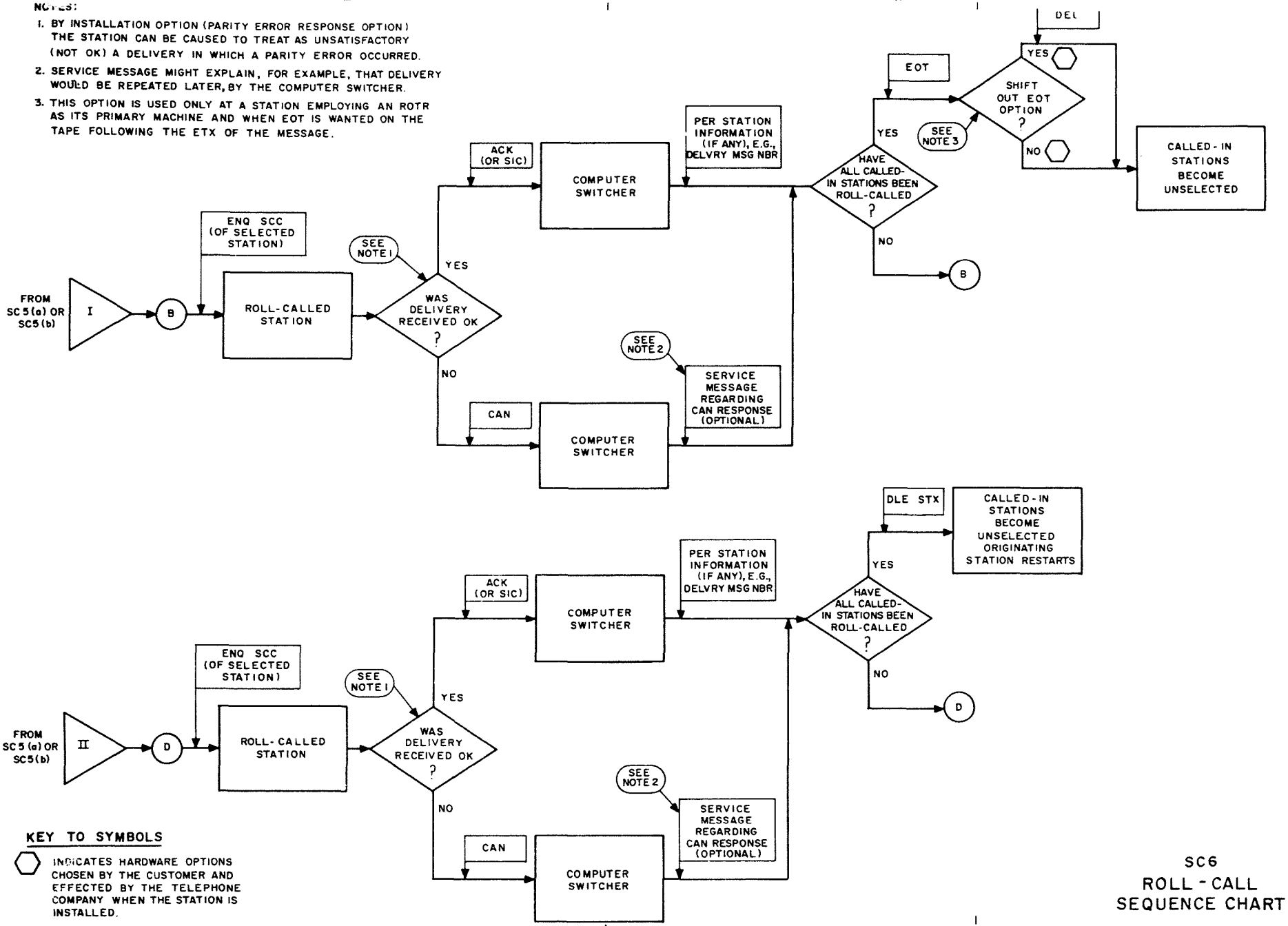
KEY TO SYMBOLS

⬡ INDICATES HARDWARE OPTIONS CHOSEN BY THE CUSTOMER AND EFFECTED BY THE TELEPHONE COMPANY WHEN THE STATION IS INSTALLED.

SC 5 (b)
TRAFFIC DELIVERY SEQUENCE CHART
(OPERATION WITH STATIONS HAVING EARLIER TYPE STATION CONTROLLERS)

NOTES:

1. BY INSTALLATION OPTION (PARITY ERROR RESPONSE OPTION) THE STATION CAN BE CAUSED TO TREAT AS UNSATISFACTORY (NOT OK) A DELIVERY IN WHICH A PARITY ERROR OCCURRED.
2. SERVICE MESSAGE MIGHT EXPLAIN, FOR EXAMPLE, THAT DELIVERY WOULD BE REPEATED LATER, BY THE COMPUTER SWITCHER.
3. THIS OPTION IS USED ONLY AT A STATION EMPLOYING AN ROTR AS ITS PRIMARY MACHINE AND WHEN EOT IS WANTED ON THE TAPE FOLLOWING THE ETX OF THE MESSAGE.



KEY TO SYMBOLS

⬡ INDICATES HARDWARE OPTIONS CHOSEN BY THE CUSTOMER AND EFFECTED BY THE TELEPHONE COMPANY WHEN THE STATION IS INSTALLED.

SC6
ROLL-CALL
SEQUENCE CHART