

Bell System

# TECHNICAL REFERENCE

86B - TYPES  
DATA SELECTIVE  
CALLING SYSTEM  
STATIONS  
NOVEMBER 1968



**Bell System Data Communications**

**TECHNICAL REFERENCE MANUAL**

●  
**86 B - Types**  
**Data Selective**  
**Calling System Stations**

●  
**November 1968**  
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**ENGINEERING DIRECTOR - TRANSMISSION SERVICES**



## NOTICE

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## 1. INTRODUCTION

New 4-row private line full duplex data selective calling service station arrangements have been developed by the Bell System for data services. The 86B1 stations provide for 100 word per minute operation using Model 33- and 35- type teletypewriter equipment. The 86B2 stations provide for 150 word per minute operation using Model 37-type teletypewriter equipment. Both types of stations employ the same on-line operating procedure and control dialogue using the USA Standard Code for Information Interchange (USASCII), USAS X3.4 - 1967.

As illustrated in Figure 1, these stations may be employed in multipoint systems that are controlled by a customer-provided computer. The line control station (computer switcher) governs the selection of stations for sending and receiving. Compared to existing Bell System full-duplex selective calling service stations, such as the 81D types, the 86B full-duplex stations offer an improved and more secure system operation and a widely expanded list of station and system features.

In the past, the design of full-duplex selective calling service stations has been dependent on the inherent capabilities of the terminal devices employed. This has generally resulted in narrowly defined operating systems that are not readily adaptable to modern computer-oriented systems. In the case of the 86B full-duplex stations, however, the design has employed solid state electronic technology to provide station arrangements that are more flexible in their operation and capable of handling the required, on-line administrative functions independent of the terminal equipment. The 86B station control logic provides a variety of features to maintain the flexibility required to adapt to computer-controlled systems that may employ somewhat different operational procedures.

The normal operation of 86B-type stations permits simultaneous transmission of messages in two directions with interruption of traffic pickup to call-in (select) receivers for message delivery and interruption of message delivery to poll senders for traffic pickup. In brief, to pickup traffic the line control station (computer switcher) interrupts any message delivery in process and polls the individual outlying stations in turn asking each station whether or not

it has traffic to send. The outlying 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. The line control station may then send any information that is to be printed at the selected sending station (e.g., a time and date or message number record) before reinitiating the transmission from the selected sender and before resuming delivery of any interrupted message delivery. The selected sending station then sends the entire message, including the heading and the text, and stops either upon detection of the start of heading indicator of another message or upon detection of the end of transmission indicator. In the case of a multiple message pickup (selected sending station stopped upon detection of a start of heading indicator), the line control station must then take the appropriate action, as indicated above, to reinitiate the transmission from the station. In the case of a termination of transmission (selected sending station stopped upon detection of an end of transmission indicator), the selected sending station will automatically assume the idle, unselected condition. The line control station may then interrupt any message delivery in process and proceed with the polling routine with the next station in the polling round, looking for another station with traffic to send.

To deliver messages, the line control station (computer switcher) interrupts any pickup of traffic in progress to initiate call-in. The call-in process consists of the line control station asking each of the indicated receiving stations on the line individually in turn whether or not it is ready to receive the message. The outlying stations respond when called 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 line control station will invoke the message intercept routine being employed in the system. When all of the available addressed stations on the line have been called in, the line control station reinitiates the pickup of traffic from any selected sending station that may have had its transmission interrupted by this call-in process, unblinds all selected receivers, and initiates delivery of the message. Transmission of the end of transmission indicator at the end of the message delivery causes the selected

receiving stations to assume the idle, unselected condition. The line control station may then proceed with the next message delivery by interrupting any pickup of traffic in progress to initiate the next call-in process.

It will be possible to associate customer-provided equipment with 86B stations and their components in several ways. First, a customer-provided computer switcher (CPT) may be employed as the line control station for 86B stations.\* The Bell System outlying stations are able to provide a flexible arrangement that, in general, will result in the final definition of available system features as being those attributable to the line control station itself. This, then allows a certain amount of tailoring of the station operation to fit the particular system needs.

Second, customer-provided terminals (CPTs) may be employed in place of Bell System teletypewriter equipments as the terminal devices at outlying stations. This arrangement would retain the 86B station control logic to handle the polling and call-in functions of the system. The 86B station control logic is designed to accommodate this permissive change in terminal device equipments. This arrangement may be offered for service at such time as the 86B station control logic with an appropriate EIA-RS232B interface is available.

In a future issue, this technical reference will provide all of the detailed information that is required to enable customer-provided equipment to be associated with 86B station components in either of the arrangements listed above. This issue of the technical reference, however, provides only that information required in order to program a computer switcher as the line control station. The type of information provided includes a brief description of the salient features of the Bell System teletypewriter outlying station and how the station control logic operates, a review of the on-line signal characteristics of the 86B stations, and a detailed examination of the operational aspects of 86B stations.

\*

A standard 150 Baud Private Line Channel interface arrangement will be used. Reference should be made to:

Bell System Data Communications Tech-

nical Reference 150 Baud Private Line Channels Interface Specification February, 1968.

which is available from:

Engineering Director -  
Data Communications  
American Telephone & Telegraph Company  
195 Broadway  
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Future issues of this technical reference will include specific information pertaining to the interface arrangements provided to allow customer-provided equipment to be used in place of Bell System teletypewriters as the outlying station terminal devices when such an interface arrangement is made available.

## 2. GENERAL CHARACTERISTICS OF 86B STATIONS

The 86B stations incorporate many features that are not now available with existing Bell System teletypewriter selective calling systems. Some of these features that directly or indirectly affect on-line operation are described briefly in this section to aid in the understanding of the capabilities and limitations that are available when 86B stations or components are employed in full-duplex selective calling systems controlled by customer-provided computer switchers.

Figure 2 illustrates the general organization of the full-duplex Bell System 86B station. The sending teletypewriter terminal device serves as the source of information signals. The station control unit serves as both the source and sink for administrative signals. The sending and receiving teletypewriter terminal devices are not actively involved in the logic organization of the station, but provide 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 character detection and generation capability required along with the necessary logic to complement the on-line administrative procedures of the system. This separation of machine and control results in a more flexible station arrangement and accounts for many of the new features available with the 86B stations.

An 86B1 station may employ either all 33- or all 35-type teletypewriter equipment as the terminal devices. An 86B2 station employs 37-type teletypewriter equipment as the terminal devices. The feasibility of using 33-type teletypewriter equipment on this type of service is being studied. Both the 86B1 and 86B2 stations will be available in station arrangements that employ (1) an automatic send-receive (ASR) terminal and a receiving-only page printer (RO) terminal in combination, (2) as ASR terminal and a receiving-only tape punch (ROTR) terminal in combination, (3) an RO terminal alone, or (4) an ROTR terminal alone. In the case of arrangements (1) and (3), it will also be possible to employ an auxiliary receiving device (RO or ROTR) as a slave to the primary RO terminal. This auxiliary receiver may be cut on and off during any message delivery under on-line signal control.

The cut on and cut off of an auxiliary receiving terminal device is normally accomplished within the text of a message delivery and, hence, requires no special action on the part of the line control station. The control character DC2 (Device Control 2) in text will cut on the auxiliary receiving device. 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 off the auxiliary receiving device. 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 cut-on at the time of the delivery abort is cut off so that a subsequent message delivery to that station will not automatically commence with the auxiliary receiving device in the cut-on state. A DC4 or ETX included as a part of a delivery abort service message will provide the required auxiliary receiving device cut-off function.

The typical message sent by an 86B station has the following format:

S		S		E
O	Heading	T	Message Text	T
H		X		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 characters SOH (Start of Heading), STX (Start

of Text), and EXT (End of Text) are message format delineators and are used to define the beginning and the end of the different elements of the message. A number of messages may be grouped together to form a single transmission that will be picked up as a result of a single poll. The end of a transmission is delimited by the control character EOT (End of Transmission) following the EXT of the last message.

86B stations offer "continuous tape" operation in that it is not necessary to tear the tape and handle pieces of tape in the normal operation of the station. The station control logic automatically insures that a transmission is available before giving a traffic-to-send response to polling. A differential EOT counter in the station control logic counts in EOTs generated from keyboard (during tape preparation) and counts out EOTs when they are transmitted. As long as the EOT count is not zero, the station control logic will behave in the fashion described below. When the EOT count falls to zero, the station control logic will give a no-traffic-to-send response to polling independent of whether there is tape in the tape reader or not.

Associated with the EOT count feature is another feature that guarantees that a transmission from a selected sending station will not begin with the customary number of DELETE characters often used to physically separate transmissions in tape. Whenever the 86B station is in the IDLE condition and the EOT count is positive, the station control logic causes the tape reader to advance through any DELETE characters used as a tape leader until the SOH character delineating the start of the heading is detected. Only then will the station control logic respond affirmatively to polling. The subsequent transmission by the station will then be an SOH character followed by the heading as prepared by the originator. This feature offers two obvious advantages. First, the line control station need not be arranged to take any special action on leading DELETES as a result of a poll. Second, by discarding such inter-transmission "fill" characters as an overlap operation off-line, better utilization is made of the available line capacity for actual message traffic.

86B stations incorporate two types of responses to a poll - regular pickup or priority pickup. This feature permits system organiza-

tion such that certain traffic can be qualified as being more important from a pickup standpoint by the station attendant than other traffic in the system. An attendant control is provided at 86B stations that, when operated, conditions the station control logic to respond to polling with the priority-pickup response in place of the regular-pickup response. There is no automatic insertion of a priority indication in the message itself as a result of this action other than that possibly put in by the attendant to govern the delivery of the message. The use of this feature is up to the program organization since the difference between the two responses can obviously be ignored within the program structure.

The 86B station response to polling is designed to also include information pertaining to the readiness of the receiving terminal device at the station to receive. Such information obtained as a response to polling can be useful in determining whether or not a delivery to the station responding should be attempted at this time or not. Again, this is the type of information that can be ignored by the system program if it is considered to be of little value for the particular system implementation planned. However, the computer switcher must be prepared to accept such information from 86B stations as a part of a polling response, whether the computer switcher plans to make use of this information or not.

With 86B station operation, a selected station sends the entire message (heading plus text) to the line control station (computer switcher) without stopping. The computer switcher is then responsible for translating the addresses in the heading into the necessary individual station call-in codes and performing the call-in of receiving stations upon delivery of the message. The 86B station control logic is transparent to what is in the heading portion of a message. Therefore, the addressing capability that can be employed in any system is governed only by the capabilities of the computer switcher. Consequently, multicharacter mnemonic addresses can be employed to increase the meaningfulness and capacity of station addressing, and user assigned message numbering and delivery precedence indicators, for example, can be employed to expand the feature capability of system operation.

The call-in (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. Group or broadcast call-in codes are not available with the 86B stations. Stations will be arranged to respond to one and only one station call-in code. Group and broadcast address codes may be employed by the user in the message heading, but they must be translated into individual call-in codes by the computer switcher before the process of selecting receivers begins. The call-in operation is arranged so that as each selected receiving station responds to call-in that it is ready to receive, it alone is unblinded. Hence, it is possible to deliver separate information to each selected receiving station during the call-in process without other selected receiving stations receiving it. A system unblind code function is provided so that all selected receiving stations will receive the message text delivery from the line control station at the same time.

Because of the separation of machine functions and control functions in the station organization, it is possible to exercise motor control and turn off the teletypewriter motors whenever the associated station equipment is not directly involved with message preparation, pickup or delivery. This may be a very desirable feature at locations that principally receive traffic, thereby resulting in a considerably quieter environment. However, having such a feature means that sufficient time must be allowed during the call-in process to insure that the motors of the receiving terminal devices get up to proper operating speed before data signals are sent on the line. The 86B station control logic does not provide explicitly for such a timing function in connection with its response to a call-in. Consequently, the computer switcher must be programmed to provide the required timing when motor control at 86B stations is employed. Detailed information concerning the timing required to allow for teletypewriter motors to get to proper operating speed is given in Section 3.6 - Timing Considerations.

A new and potentially useful feature of the 86B station is its ability to indicate at the

end of a message delivery whether or not the message was received properly. This feature is called roll-call. The indication is in the form of a unique discrete response given to a call-in type operation performed at the end of the message delivery. The 86B station control logic bases its decision on whether a message delivery is good or not on such things as message format checks, machine operation checks, and service continuity checks.

Another important feature of the 86B stations that may be quite useful in connection with providing secure service with computer switcher operation is the use of the Station Identity Check as a part of the call-in and roll-call processes to increase the probability of message delivery to the proper station. Each receiving station can be assigned a discrete Station Identity Code that is different than its call-in code. Since Station Identity Codes are integral parts of the responses to call-in and roll-call functions, the computer switcher can check that the proper stations have been selected to receive before proceeding with the message delivery and that the proper station is responding with respect to the properness of the message delivery.

Because an interruption of message delivery is required in order to poll, a feature is provided with 86B stations that allows "cocking" the sending stations so that a sending station will automatically request polling when it has traffic to send. This feature would have its greatest value during periods when the traffic pickup activity is low. The delivery of messages can then proceed without the necessity for interruptions in order to determine if there are any stations with traffic to send. The "cocking" function conditions sending stations to automatically generate their Station Identity Code as the request for polling. The computer switcher then needs only to monitor the incoming line for such polling requests. The use of the Station Identity Code as the polling request provides a positive indication of where in the polling round to initiate the polling function when the traffic becomes available at only one station at a time. In the case where two stations generate the polling request simultaneously, the identity aspect may be lost, but the indication that the polling function should be initiated is still received. This feature is implemented so that during those intervals when responses are

expected from receiving stations (e.g., during call-in or roll-call) the generation of the polling request is automatically inhibited at the station until the call-in or roll-call function is completed.

If "cocking" is employed and if no polling request is received in some specified time interval (for example, 15 minutes), it is suggested that the computer switcher initiate the polling function anyway to verify that none of the stations have traffic to send. If this polling round indicates that there are no stations with traffic to send, the computer switcher may then initiate the "cocking" function again. This periodic initiation of the polling function will protect against situations where the "cocking" function was, for one reason or another, not detected by the 86B stations or where the polling request generated by a station was not detected by the computer switcher. By specifying the maximum time interval that the sending stations will be left "cocked" before performance of a polling function, the maximum delay that a transmission may experience because the "cocking" function was not detected by 86B stations or because the polling request was not detected by the computer switcher can be controlled.

### 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 86B1 and 86B2 outlying stations.

#### 3.1 CODE

The transmission code employed on line should be USAS X.3.4-1967, the USA Standard Code for Information Interchange (USASCII). This code is illustrated in Figure 3.

#### 3.2 TRANSMISSION SPEED

Acceptable transmission speeds are 100 wpm (10 characters per second) when combinations of 33- and 35-type teletypewriter terminals are employed in 86B1 stations or 150 wpm (15 characters per second) when 37-type teletypewriter terminals are employed in 86B2 stations.

### 3.3 CHARACTER STRUCTURE

At the operating speed of 100 wpm (10 char/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 pulse. Even parity should be employed for all characters transmitted on line.

At the operating speed of 150 wpm (15 char/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 pulse. 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 less than 5 percent telegraph distortion. Likewise, the computer switcher should be capable of accepting incoming signals with up to 40 percent telegraph distortion. In cases where the computer switcher is unable to meet the above requirements, special engineering shall be required.

The above values represent long-term objectives for acceptable sending and receiving telegraph distortion tolerances on 150 baud private-line transmission channels. As the state of the art improves, it is anticipated that these sending and receiving distortion requirements will become 3 percent and 45 percent, respectively.

Detailed information concerning these distortion requirements is covered in the document referred to earlier.

Bell System Data Communications  
Technical Reference  
150 Baud Private Line Channels  
Interface Specifications  
August, 1966

### 3.6 TIMING CONSIDERATIONS

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

#### 3.6.1 Station Motor Turn On

The use of automatic motor control at an 86B receiving station requires that the computer switcher provide sufficient time after the call-in to allow the teletypewriter motors to get up to proper operating speed before data signals are delivered to the station. Otherwise, erroneous characters are likely to be detected and acted upon by the receiving teletypewriter. As mentioned earlier, the outlying station control logic does not provide for a delay in the response to call-in when the receiving teletypewriter motor is off.

Under worst case conditions, it takes 750 milliseconds for a teletypewriter motor to attain proper operating speed. Taking into account the two character response to call-in but ignoring any propagation delay, the computer switcher, then, should wait for a minimum of 650 milliseconds for 150 wpm operation and a minimum of 550 milliseconds for 100 wpm operation and maintain a steady marking condition on the line before sending any information intended for the called-in receiver. This will allow sufficient time for the motor in any of the various types of receiving teletypewriter terminals that may be employed to attain the proper operating speed.

If several stations are being called in and there is a need for delivery of separate information to each station during the call-in process (e.g., terminating message numbering), then the computer switcher should introduce this delay, after the call-in of each station. However, if there is no need for separate information to be delivered to each station during the call-in, then this delay need only be employed once, after the call-in of the last station.

#### 3.6.2 Interrupting Sending Station, Inhibiting Polling Request Signal, or Uncocking Sending Stations

If the computer switcher is going to (1) call-in or roll-call selected receiving stations

while a selected sending station is transmitting or when the sending stations are in the cocked state or (2) poll when the sending stations are in the cocked state, the computer switcher must wait (pause), after having initiated such an action, for the incoming line to the computer to become idle before proceeding with the call-in, roll-call, or polling operation. In the case of an interrupted transmission from a selected sending station, this pause will permit the selected sender to come to a graceful stop, with all transmitted characters from the selected sending station received by the computer switcher before responses are generated by any other station. In the case of a previously cocked line, this pause will permit any already generated polling request to be received without interference of polling, call-in, or roll-call responses from any other station. If the incoming line to the computer is already idle, that is, neither in a transmit mode nor a cocked state, it will not be necessary to wait (pause) before proceeding with a call-in, roll-call, or polling operation.

For almost all system configuration a pause of 600 milliseconds will be sufficient to stop any transmitting selected sending station and to allow the incoming line to the computer switcher to become idle. Therefore, when the incoming line was previously cocked, the computer switcher should wait for a minimum of 600 milliseconds after sending DLE (Data Link Escape) to initiate the polling function before proceeding with the polling operation. When initiating a call-in or roll-call function with the incoming line in either the transmit mode or the cocked mode, the computer switcher should wait for a minimum of 500 milliseconds after sending the sequence ENQ DEL (Enquiry-Delete) to initiate a call-in or roll-call function before proceeding with the call-in or roll-call of selected receiving stations. The ENQ character performs the required interrupt. The DEL character serves as a fill character to satisfy the ENQ sequence expected at the 86B stations.

### 3.6.3 One Character Buffer Delay

In order to provide screening of received characters so only pertinent information is delivered to the terminal devices, the outlying station control unit incorporates a one-character buffer store. Each character received is pushed through to the terminal device by the next character received. Consequently, whenever the transmission of message text to an outlying

station is to be halted for some period of time to either allow for some mechanical operation by the terminal device 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 terminal device. This type of pushing character is required after each of the following control codes:

HT – Horizontal Tabulation  
VT – Vertical Tabulation  
FF – Form Feed

A pushing character is also required after any message number, time and date record, or equivalent, sent to the outlying station during call-in or roll-call operations.

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 an outlying 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 outlying 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 character (ETX) following the FF character at the conclusion of a message delivery.

### 3.6.4 Outlying Station Mechanical Functions

Timing is required after various machine control functions to allow time for the teletypewriter terminal device to complete the necessary mechanical operation. Perhaps the most often used function of this type is the carriage return – line feed function. When performing this function 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 always sending the sequence CR LF DEL when executing this function to allow sufficient time for the carriage return function to be completed independent of the type of teletypewriter terminal or the transmission speed employed.

The timing required for the tabulation and form feed 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 these functions. However, it is possible to indicate the operating speeds for the tabulation and form feed functions for the various teletypewriter equipments that may be employed in 86B 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 indicates these values:

Terminal Device	Tabulation		Form Feeding
	Horizontal	Vertical	
33	—	—	6:1
35	3:1	6:1	6:1
37	3:1	3:1	3:1

These figures mean, for instance, that the 35-type teletypewriter printing mechanism moves three spaces during a character interval in the process of horizontal tabulation. Thus, knowing the settings for tabulation and form feed functions employed in the system, the computer switcher can be programmed to provide the timing required for each function. This timing can either be quite exact based on the amount of mechanical movement required to complete the operation from the point of execution, or it can be gross based on the maximum mechanical movement possible for the particular function.

The 35-type teletypewriter can be modified to have vertical tabulation and form feed ratios of 3:1 instead of 6:1. Thus, the feeding ratios for any system application should be verified before programming time intervals to permit such mechanical functions.

### 3.6.5 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 been expended waiting for particular events to occur. Two such timing intervals are inquiry response time-outs and intercharacter time-outs.

With teletypewriter terminals as outlying stations, the responses to inquires, like polling and call-in, can be expected within the limits of the transmission delay time for the system layout. Under almost all circumstances, a time-out interval having a minimum of 600 milliseconds for this function should be quite satisfactory.

It is suggested that, if an intercharacter time-out interval is employed by the computer switcher on text received from an 86B station, that it be long enough to allow the operator at the outlying station sufficient time to clear a taut tape or twisted tape condition without losing control of the line. A recommended timing interval for this function is approximately 30 seconds. An intercharacter time-out of this magnitude is required if the HOLD feature available with 86B stations is to be employed in the system (see Section 4.6 – HOLD Feature).

## 4. DETAILED SYSTEM OPERATIONAL PROCEDURES

This section covers the allowable operational aspects of an 86B station and describes the features, capabilities, and limitations that exist. This material is organized such that it generally follows the logical sequence of events illustrated in Sequence Charts SC1 & SC2. Both sequence charts should be referenced to aid in the understanding of the station operation being described.

### 4.1 SYSTEM INITIALIZATION – IDLE STATE

When the power is turned ON at an 86B station, the station control logic will automatically become activated and assume the "idle" state. In this condition the station control logic will be sensitive to line signals and will become selected to send or selected to receive if the proper signals are detected. Because it is possible for noise on the line to generate 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 any 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 4.8 – Emergency Stop)

to silence the incoming line and to get all sending elements of the system in step with one another. The computer switcher should then send the control character EOT (End of Transmission) followed by the control character DC2 (Device Control 2) to insure that any receiving elements of the system not in the "idle" state (e.g., selected to receive) return to the "idle" state and that all station elements are initialized to perform their operations in step with the computer switcher.

With the system in the "idle" state the computer switcher can -

- (1) proceed with the polling operation looking for stations with traffic to pickup,
- (2) proceed with the call-in operation to start message delivery, or
- (3) although not normally desirable, do nothing and leave the line in the "idle" condition.

Since 86B stations are arranged for full-duplex operation, the computer switcher can do either (1) or (2) first and then proceed directly with the other, interrupting traffic pickup or message delivery as required.

#### 4.2 POLLING OPERATION AND RESPONSES

The computer switcher initiates the polling operation by sending the control character DLE (Data Link Escape). This character will define the beginning of polling and will activate the appropriate logic in the 86B stations. If a message delivery was in progress, the DLE causes the station control logic at selected receiving stations to blind their receivers to signals on the line until an unblind code is detected. If the incoming line was cocked when the polling operation is initiated, the computer switcher should wait for a minimum of 600 milliseconds after sending the DLE to insure that the incoming line is idle (see Section 3.6 - Timing Considerations). The computer switcher should then send the station polling code (SPC) of the sending station to be polled and wait for a response from the station. The SPC for each station should be a single character chosen from the set of 96 printing graphics in ASCII. The only characters not available for use as SPCs are X, W, and +. These three characters are required to provide specific station functions that are described elsewhere in the document.

The response received as a result of this polling operation may be any of the following five types:

- (1) a no-traffic-to-send response,
- (2) a regular-traffic-to-send response,
- (3) a priority-traffic-to-send response,
- (4) an invalid response, or
- (5) no response at all.

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

##### 1. No-Traffic-To-Send Response

There are two no-traffic-to-send responses, depending upon the ready-to-receive status of the receiving element at the station. The control character CAN (Cancel) indicates that the station has no traffic to send, but that its receiving element is ready to receive. The control character NAK (Negative Acknowledge) indicates that the station has no traffic to send, and that its receiving element is not ready to receive. 86B stations will respond to polling with one of these two no-traffic-to-send responses whenever the EOT count at the station is zero (no transmissions completed or ready to send).

It is suggested that, when either of these two responses is received, the computer switcher send the SPC of the next station to be polled. There is no need to resend the DLE character to redefine a polling operation, although the presence of a DLE character will not adversely affect 86B station operation.

##### 2. Regular-Traffic-To-Send Response

There are two regular-traffic-to-send responses, depending upon the ready-to-receive status of the receiving element at the station. The two character sequence R ACK (ACK = Control Character Acknowledge) indicates that the station has a regular pickup available, and that its receiving element is ready to receive. The two character sequence R NAK indicates that the station has a regular pickup available,

but that its receiving element is not ready to receive. 86B stations will respond to polling with one of these two regular-traffic-to-send responses whenever there is traffic to send and the PRIORITY key on the station attendant unit has not been operated.

An 86B station responds to polling without becoming selected as a sender. A separate sending-station-selection function is required in order to assign selected status to a sending station. This type of operation then allows the computer switcher to poll to determine which and how many stations have traffic ready to send before selecting a sender (status polling). This type of operation also allows the pickup of all traffic from stations indicating priority-pickup traffic before accepting any regular-pickup traffic.

If the computer switcher does not make any distinction between regular- and priority-pickup conditions, then the computer switcher, upon receiving a regular-pickup response, should proceed to the sending-station-selection function (see Section 4.3 – Definition of End of Polling). If the computer switcher does distinguish between regular- and priority-pickup conditions, then it is suggested that the computer switcher, upon receiving a regular-pickup response, send the SPC of the next station to be polled, as in the case of a no-traffic-to-send response, looking for a station with a priority pickup before deciding to select a station with regular-pickup traffic available.

### 3. Priority-Traffic-To-Send Response

There are two priority-traffic-to-send responses, depending upon the ready-to-receive status of the receiving element at the station. The two character sequence P ACK indicates that the station has a priority pickup available, and that its receiving element is ready to receive. The two character sequence P NAK indicates that the station has a priority pickup available, but that its receiving element is not

ready to receive. 86B stations will respond to polling with one of these two priority-traffic-to-send responses whenever there is traffic to send, and the PRIORITY key on the station attendant unit has been operated.

Since 86B stations respond to polling without becoming selected as a sender, a separate sending-station-selection function is required in order to assign selected status to a sending station. Under most circumstances the receipt of a priority-pickup response will mean that the computer switcher should proceed to the sending-station-selection function (see Section 4.3 – Definition of End of Polling). If for some reason a station giving a priority-pickup response is not to be selected to send, the computer switches can proceed with the polling function by sending the SPC of the next station to be polled as in the case of a no-traffic-to-send response.

### 4. Invalid Response

An invalid response is any response that is not one of the six previously defined responses – CAN, NAK, R ACK, R NAK, P ACK, or P NAK. If the invalid response takes the form of a single or two character response, it is suggested that the computer switcher repoll the station in question by sending DLE to redefine the polling operation followed by the SPC 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.

If the invalid response takes the form of continuous transmission from an outlying station, it is suggested that the computer switcher initiate an emergency stop action (see Section 4.8 – Emergency Stop) with an appropriate service message and start the polling process over again with the last station polled.

## 5. 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 teletypewriter outlying stations can be expected within 600 milliseconds under most circumstances.

It is suggested that in the case of a no response time-out the computer switcher repoll the station in question by sending DLE followed by the SPC of that particular station. Since there was no response of any kind, it is probably not necessary to initiate an emergency stop action as in the case of an invalid response. It is assumed that what most likely happened is that when the SPC 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 polling code.

The 86B stations are designed to always include the status of the receiving element at a station as part of the normal polling responses. This information is provided as an aid to the computer switcher in determining whether or not it is worthwhile attempting a delivery to the receiving element at a station. Since stations are probably more often polled than called-in for delivery, inclusion of such information in the polling response provides the computer switcher with a more up-to-date picture of the status of receiving elements in the system. This information need not be employed in its intended fashion, but the computer switcher should be arranged to accept the information and determine the proper traffic-to-send status of a polled station from its contents.

### 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 merely terminate the polling operation and return all sending stations to the "idle" state, the computer switcher should send the control character DC2 (Device Control 2). Upon detection of this code

all sending stations will assume the "idle" state. DC2 will also unblind any previously selected receiving stations blinded by DLE, so that an interrupted message delivery may be resumed.

Second, to terminate the polling operation in order to "cock" the sending stations, the computer switcher should send the two character sequence EOT DC2. Upon detection of EOT while in the polling state all sending stations will assume the cocked state. The DC2 code will activate the appropriate station logic to automatically generate their Station Identity Code (SIC) as a polling request signal when the stations have traffic to send. The computer switcher should then be prepared to accept a polling request signal when it is generated. If a message delivery had been interrupted by the DLE code at the beginning of the polling function, the DC2 code will unblind the selected receiving stations so that message delivery may be resumed. In general, cocking the sending stations just requires sending a DLE code to define the polling operation and at some later time, while still in the polling mode, sending the EOT DC2 sequence to define the end of polling and to initiate the cocking function.

Third, when a response to polling indicates that an 86B station has traffic to send that should be picked up at this time, the computer switcher defines the end of the polling function by initiating a sending-station-selection function. The computer switcher should send the control character ENQ (Enquiry) followed immediately by the Call Enquiry Code (CEC) of the sending station to be selected. The receipt of the two character sequence by the sending station designated by the CEC will cause that station to assume the selected sending state (see Section 4.4 - Stop on SOH for Delivery to Sending Machine Printer). Detection of the ENQ code will define the end of polling for all other sending stations on the line.

With the use of the status poll concept described above, it is possible that the computer switcher knows that a sending station has traffic to send and, therefore, may wish to initiate a sending-station-selection function without actually polling and receiving responses from the stations. This condition is also true for the case where the sending stations had

been cocked and a polling request signal (the SIC of the station requesting polling) is received indicating the exact station with traffic to send. To initiate a direct sending-station-selection function without going through the poll-response routine, the computer switcher must first initiate the polling operation in the standard way by sending the DLE code and waiting, if necessary, to insure that the incoming line is idle. Then the computer switcher can send the ENQ CEC sequence to select the desired sending station and to define the end of polling for all other sending stations on the line.

At this point in the traffic pickup procedure, any selected receiving stations that were blinded by the DLE code used to define the beginning of the polling function are still blinded, and message delivery to such stations is still interrupted. The unblinding of any such selected receiving stations and the resumption of message delivery occurs after the Stop on SOH for Delivery to Sending Machine Printer function described in Section 4.4.

#### 4.4 STOP ON SOH FOR DELIVERY TO SENDING MACHINE PRINTER

As described above, the computer switcher selects a sending station by sending the two character sequence ENQ CEC while in the polling state. If, having sent the ENQ CEC sequence, the computer switcher receives either an invalid response, or no response from the outlying station within the system response time-out (recommended, 600 milliseconds), it is suggested that the computer switcher send DLE ENQ CEC to redefine polling and reselect the sending station designated by the CEC. If repeated attempts to start the transmitter, or obtain a valid response, are unsuccessful, it is recommended that the computer switcher initiate an emergency stop action (see Section 4.8 - Emergency Stop) with an appropriate service message, follow any system defined trouble report routine, and reactivate the polling function with either the next station to be polled or the next station to be selected as a sending station.

Independent of the station's original response to polling, it now may or may not have traffic to send. If it has no traffic to send at the time it is selected (tape removed or station taken out of service), the station control logic will send the control character NAK. The computer switcher can then proceed with another polling function, or cock the sending stations,

or leave the stations in the "idle" state. If either of the latter two actions are chosen, and if a message delivery had been interrupted by the polling function, then the computer switcher should send the control character DC2 to unblind selected receiving stations and resume delivery.

If the selected sending station has traffic to send at the time it is selected, it will send the control character SOH and stop. There are no DELETE (fill) characters preceding SOH.

The stop on SOH is provided for two reasons. First, it allows the computer switcher to acquire the storage necessary to handle the traffic pickup at the last possible moment so that blocks of storage are not held available, but unused, during the entire polling operation. Second, stopping on SOH provides a convenient place during traffic pickup to implement the delivery of a time, date, or message number record, or the like, to the selected sending machine printer, if so desired.

To deliver any sort of information (e.g., originating message numbers) to the selected sending machine printer just before traffic pickup so that it will appear first on the local copy of the transmitted message at the selected sending station, the computer switcher should send the control character DLE followed by DC1 (Device Control 1) after having received the SOH from the selected sending station. The DLE code defines the beginning of a polling function as it did previously, but the DC1 code terminates the polling function and also causes the selected sending station to transfer the sending machine printer to the receive side of the station line so that the information that follows will be directed to the sending machine printer rather than to the receiving machine printer. The computer switcher can then send the desired information to the station.

After having sent DLE DC1 and during the delivery of information to a selected station sending machine printer the incoming line into the computer switcher should be idle. Since the DLE code defines a polling function, it is possible that during the delivery of this information one of the six normal polling responses could be received. This would result if the DC1 code was either changed into a legitimate SPC by noise or errors on the line or mutilated such that some stations did not detect it as the DC1 code defining the end of

polling and, hence, reacted to characters in the information being delivered as if they were SPCs. In this event, it is suggested that the computer switcher resend the DLE DC1 combination plus the intended information, appropriately flagged as possible duplicate, to insure that the selected sending station has received it. No other action need be taken since the station that volunteered the response is not selected as a direct result of a poll and so is in no way an active participant in what is happening on the line. At the end of a delivery of information to the selected sending machine printer the computer switcher should send the control character DC2. This code will transfer the sending machine printer back to the send side of the station line, will start the station transmitter and will also unblind any selected receivers that may have been blinded by the DLE code in the initial polling function so that delivery of an interrupted message can be resumed.

If there is no need to deliver information to the selected sending machine printer, then the computer switcher should send the sequence DC1 DC2 after receiving an SOH to start the station transmitter and to unblind any selected receiving stations so that an interrupted message delivery may resume.

If, having sent the DC1 DC2 sequence, there is no response from the outlying station within the system response time-out (recommended, 600 milliseconds), it is suggested that the computer switcher send the sequence DLE DC1 DC2 again. If repeated attempts to start the transmitter are unsuccessful, it is recommended that the computer switcher initiate an emergency stop action (see Section 4.8 – Emergency Stop) with an appropriate service message, follow any system defined trouble report routine, and reactivate the polling function with either the next station to be polled or the next station to be selected as a sending station.

#### 4.5 PICKUP OF HEADING AND TEXT

Upon receipt of the DC2 code, the normal selected sending station operation is for the transmitter to send the heading of the message, STX, the text of the message, ETX, any inter-message fill characters (DELETES), and either SOH defining the start of another message in this transmission or EOT indicating the end of

the transmission. The transmitting station will stop after sending either SOH or EOT and not before, except for interruptions caused by call-in or roll-call functions (see Section 4.10 – Call-In Operation & Responses, and Section 4.11 – Roll-Call & Responses) or the use of the HOLD feature on the part of the station attendant to cause the transmitter to stop when the ETX code is sent.

Because of the HOLD feature and because it is possible for tape in a transmitter to become taut or twisted accidentally during its transmission, it is recommended that a minimum intercharacter time-out interval of 30 seconds be employed to measure periods of unauthorized interruption in traffic pickup before corrective action is taken by the computer switcher. Should a seemingly unauthorized interruption in the traffic pickup take place, it is suggested that the computer switcher first try to restart the transmitter by sending the DLE DC1 DC2 sequence as a corrective action before exercising an emergency stop routine. This action is suggested since it is possible that the selected sending station will stop because of a seemingly authorized interrupt signal detected that was, in fact, the result of noise or errors on data being sent to selected receiving stations and was not an authorized interrupt sent by the computer switcher. If repeated attempts to start the transmitter are unsuccessful, it is recommended that the computer switcher initiate an emergency stop action (see Section 4.8 – Emergency Stop) with an appropriate service message, follow any system defined trouble report routine, and reactivate the polling function with either the next station to be polled or the next station to be selected as a sending station.

During the pickup of traffic from a selected sending station, it is recommended that the computer switcher monitor for receipt of repeated characters from a station. Such a check will then uncover an unlikely, but possible, stuck tape situation at the selected sending station. Under such circumstances the computer switcher should employ the emergency stop action and follow the same procedures as cited above.

#### 4.6 HOLD FEATURE

86B stations are equipped with a HOLD feature such that when a HOLD key control

on the attendant unit is operated, the transmitting station will automatically stop when the ETX code of the message being sent is transmitted. The station operator may then replace the tape being transmitted with one of greater urgency and cause resumption of transmission. The transmitter will then send until the SOH of the inserted message is transmitted, and will again stop in the normal fashion. By operating the HOLD key again the station attendant can cause the transmitter to again stop on the ETX of the inserted message. The original tape can then be reinserted into the transmitter and the transmission caused to resume. The operation is then back to normal with the transmitter again only stopping on SOH or EOT.

From the computer switcher viewpoint the only variance in this operation from what can normally be expected is the cessation of transmission for a period of time after the receipt of ETX. The 30 second intercharacter time-out interval described above should be ample time for the station attendant to perform the necessary exchanging of tapes. Therefore, no additional control other than the specified intercharacter time-out is required to accommodate this feature. However, if desired, separate intercharacter time-out intervals can be employed to distinguish between the ETX stop and any other stop (taut or twisted tape) to permit specification of a shorter time-out function for the latter case in the interest of conserving line time and maximizing the on-line efficiency of traffic pickup.

#### 4.7 SINGLE AND MULTIPLE MESSAGE PICK-UP

Transmission from stations may consist of single messages or multiple messages. As stated in Section 4.5 – Pickup of Heading and Text, a selected sending station sends until it detects either an SOH or an EOT, and then it stops.

If an SOH is detected and sent, the station stops and waits for the DLE DC1 DC2 command to resume transmission. As in the case of the stop on the first SOH in the transmission, the computer switcher can now acquire the storage necessary to handle this additional message and can deliver information to the selected sending machine printer (see Section 4.4 – Stop on SOH for Delivery to Sending Machine Printer). If information is to be delivered to the selected sending machine printer, the computer switcher

should send DLE DC1, the information to be delivered, and DC2. The DLE code will blind any selected receiving stations. The DC2 code will unblind any selected receiving stations and will restart the transmitter. If no information is to be delivered to the selected sending machine printer, then the computer switcher should send the sequence DLE DC1 DC2 to restart the transmitter.

If, having sent the proper restart code, there is no response from the outlying station within the system response time-out (recommended, 600 milliseconds), it is suggested that the computer switcher send the sequence DLE DC1 DC2 again. If repeated attempts to start the transmitter are unsuccessful, it is recommended that the computer switcher initiate an emergency stop action (see Section 4.8 – Emergency Stop) with an appropriate service message, follow any system defined trouble reporting routine, and reactivate the polling function with the next station to be polled or the next station to be selected as a sending station.

If an EOT is detected and sent, the selected sending station stops transmitting and automatically assumes the "idle" state. Upon detection of the EOT code the computer switcher should proceed with the polling function to poll the next station in the polling round or to select the next station available as a sending station.

If the computer switcher receives an EOT code from a selected sending station without an intervening ETX code, the incoming message format has been violated, and the validity of the traffic picked up is in question. However, the selected sending station is no longer selected, so the computer switcher can not initiate an emergency stop action to deliver a service message to the sending machine printer. In order to inform the station about the detected error in message format, the computer switcher will have to generate a message for delivery to the receiving element at the station explaining the situation.

#### 4.8 EMERGENCY STOP

An emergency stop function is available with 86B stations so the computer switcher can stop the traffic pickup in progress from a selected sending station in case an error condition or system irregularity is detected during the normal system operation. The 86B stations

are not capable of initiating emergency stop actions toward the computer switcher.

The complete message format for the emergency stop function is:

D	D			D	D
L	X	C	Service Message	C	C
E	1			3	2.

If necessary, the computer switcher interrupts any message delivery in progress and sends the control character DLE followed by the upper-case alpha character X. The DLE code blinds any selected receiving stations, stops the selected sending station transmitter, and defines the beginning of the polling function. The character X acts as a special SPC that causes an EMERGENCY STOP lamp to light at any selected sending station that receives the X while in the polling state.

With 86B stations there is a capability to include a service message as part of the emergency stop action. In general, service messages can be quite helpful to the selected sending station attendant in clarifying the reason for the interruption, what action is being taken, and what to expect next. If a service message is to be sent as part of the emergency stop action, the computer switcher should send the control character DC1 after the DLE X sequence, while the system is in the polling state, to transfer the selected sending machine printer to the receive side of the station line, since it is the sending machine printer that is associated with traffic transmitted from the station. The DC1 code defines the end of the polling function as far as all stations on the line are concerned so that the information in the service message will not be mistaken for SPCs. The computer switcher can then send the service message, explaining the reason for the interruption of traffic pickup, ending with the two character sequence DC3 DC2. The DC3 code causes the selected sending station to return to the unselected state and locks it in a no-traffic-to-send state until the EMERGENCY STOP lamp at the station is manually extinguished, indicating that the interrupted tape has been repositioned and is again ready for transmission. The DC2 code unblinds any selected receiving stations that were blinded by the DLE code so the computer switcher can resume delivery of the interrupted message.

The DC2 code also conditions all sending stations so that normal system operation may resume.

#### 4.9 LOOP-BACK

Loop-Back is an operating test mode wherein a selected 86B station will respond to control sequences (polling, call-in, etc.) in the normal fashion for that station, but will send back to the line all message text characters received. This function is provided to facilitate remote testing of outlying stations by Bell System maintenance personnel. It is not intended for use by customers. However, since it is possible for stations to get into this mode by detection of a particular two character sequence, it is mentioned here for the purpose of listing its symptoms and indicating how to return the system to normal.

The receipt of the character + anytime while in the polling state (after DLE but before an ENQ, DC1, or DC2) will cause an 86B station to assume the loop-back mode. The computer switcher can verify if one or more stations are accidentally in the loop-back mode by sending characters and checking to see if the same information is being received with one character delay. To terminate a possible loop back condition, the computer switcher should send the control character EOT. Since loop-back disrupts both traffic pickup and message delivery, the computer switcher should reinitialize the system and start over. The EOT should have reset the outgoing line from the computer switcher to the "idle" condition. However, EOT from the computer switcher has no affect on the selected sending status of a transmitter. Therefore, the computer switcher should follow the EOT code used to clear the loop-back condition with an emergency stop action (see Section 4.8 - Emergency Stop) with an appropriate service message to reset the incoming line into the computer switcher.

#### 4.10 CALL-IN OPERATION AND RESPONSES

Message delivery involves the use of a call-in operation to select receiving stations. To insure that all receiving stations are in the "idle" state after a period of inactivity on the outgoing line, it is recommended that the computer switcher send the two character sequence EOT DC2 before proceeding with the call-in

function. Call-in involves calling each intended receiving station individually and receiving a response indicating its ready-to-receive status.

To initiate the call-in function, the computer switcher should send the control character ENQ. The ENQ code will stop the transmitter at any selected sending station or will inhibit the generation of a polling request signal by any cocked sending stations, will define the beginning of a call-in function, will blind any previously selected receiving stations, and will activate the appropriate logic in each outlying receiving station to look for the Call Enquiry Code (CEC).

When an interruption of incoming traffic is required or when the generation of a polling request signal is being inhibited at cocked sending stations, the computer switcher must wait for a sufficient period of time to insure that the incoming line is idle and that all inbound traffic has been received before soliciting responses from intended receiving stations. A pause of 600 milliseconds is recommended for almost all system configurations. However, since the call-in operation involves the detection of a contiguous two character sequence starting with ENQ, it is recommended that when this pause is required the computer switcher send the character DEL (DELETE) immediately following the ENQ that initiates the call-in function. This will satisfy the ENQ-sequence logic at the 86B stations and will avoid the possibility of having noise or hits that may occur during the pause from erroneously satisfying the ENQ sequence at some station and causing a response before the incoming line is idle. The length of the pause required can then be shortened by the transmission time of the DEL character - 100 milliseconds at 100 wpm and 67 milliseconds at 150 wpm.

After the required pause the computer switcher should send the ENQ code again, this time followed immediately by the CEC of an intended receiving station, and wait for a response from the called station. The CEC for each station should be a single character chosen from the set of 96 graphics in ASCII, with the exception of DEL (Delete) which is reserved for uses such as that described above. Since the 86B stations require detection of the sequence ENQ CEC in order to become selected, the computer switcher must send the ENQ with each CEC generated.

When no interruption of incoming traffic is required and the sending stations are not cocked, the computer switcher does not need to pause before proceeding with the call-in function, and so, may send the CEC of an intended receiving station immediately after the initial ENQ code sent to define the beginning of a call-in function.

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

- (1) a ready-to-receive response,
- (2) a not-ready-to-receive response,
- (3) an invalid response, or
- (4) no response at all.

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

#### (1) Ready-To-Receive Response

The ready-to-receive response is the two character sequence SIC ACK, consisting of a Station Identity Code (SIC) followed by the control character Acknowledge (ACK). The receipt of a ready-to-receive response means that the called-in station has assumed the selected-to-receive state.

A ready-to-receive response to call-in means that the selected receiving 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 selected receiving station when it is called in without other selected receiving stations receiving it. Terminating message number is an example of such per station information.

Station Identity Codes can be chosen from the set of graphic characters in ASCII. By choosing a different CEC and a different SIC for each station in a given system, the computer switcher can verify that the proper stations are selected for each message delivery by matching the received SIC with the one that the computer switcher has stored as being paired with the CEC that was sent. With

over 90 different graphics available for both CECs and SICs, over 8100 stations can be handled by a given computer switcher before it becomes necessary to repeat any CEC-SIC combination.

(2) Not-Ready-To-Receive Response

The not-ready-to-receive response is the two character sequence SIC NAK. This response can result from the receiving station being out of paper, out of service, etc. The decision of what is done with messages that cannot be delivered at the time of initial call-in is dependent on the computer switcher and how it is programmed.

The inclusion of SIC as part of the not-ready-to-receive response allows the computer switcher to verify that the not-ready-to-receive response received actually came from the station called-in.

(3) Invalid Response

An invalid response is any response that is not SIC ACK or SIC NAK, with the SIC being the proper SIC. Because it is not possible to selectively de-select one selected receiving station without de-selecting all selected receiving stations, it is suggested that the following procedures be followed when an invalid response is received.

If the invalid response takes the form of continuous transmission it means that an interrupted selected sending station has been falsely started. If there is no detected garbling of this incoming transmission, it is assumed that an error on-line changed either the ENQ or the CEC of the call-in operation into the control character DC2, which is used to restart an interrupted selected sending station. The fact that there was no detected garbling of the incoming information means that there was no simultaneous response from any called-in receiving station. Therefore, it is suggested that the computer switcher accept the

incoming traffic as a valid part of the traffic pickup, and reinitiate the interruption of the selected sending station by sending ENQ DEL and pausing as it did originally. The computer switcher can then proceed with the call-in operation by sending the sequence ENQ CEC for the intended receiving station again. Any previously selected receiving stations would still be in the selected state and unaffected by what has taken place.

If the invalid response is a SIC ACK response with the wrong SIC and it is deemed that the message cannot be delivered to a wrong station in addition to the proper station(s), the computer switcher can merely de-select this plus any previously selected receiving stations by sending EOT. If an explanation for the selection and almost immediate de-selection is required, the computer switcher can send ENQ DC2 to unblind all selected receiving stations and deliver such a message to all selected receiving stations, ending with the EOT code to return the stations to the "idle" state. No alarm will be invoked at the de-selected receiving stations. If it is desired to activate a local alarm at the receiving stations being de-selected, then the computer switcher should initiate the delivery abort action (see Section 4.13 - Delivery Abort) with an appropriate service message. Anytime an invalid response requires de-selecting selected receiving stations, the computer switcher should start the call-in process over again starting with the first addressee. If call-in is not to be reattempted by the computer switcher, then the DC2 code should be sent following EOT to condition all stations to resume normal system operation.

(4) 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 teletypewriter outlying stations can be expected within 600 milliseconds under most circumstances. It is suggested that in the case of a no response time-out the computer switcher call-in the station again by sending the sequence ENQ CEC for that particular station. Since there was no response of any kind, it is probably not necessary to de-select selected receiving stations as in the case of an invalid response. However, if desired, the delivery abort action can be employed in the case of a no response to call-in. It is assumed that what most likely happened in the case of no response is that when the sequence ENQ CEC was sent the previous time it was affected by noise on the line in such a manner that none of the stations recognized it as its call-in code sequence.

After all of the available addressees have been called-in and after any separate information for each selected receiving station has been delivered during the call-in process, the computer switcher should send the sequence ENQ DC2 to unblind all selected receiving stations. The computer switcher may then send any information that is to be common to all selected receiving stations. The date and time record is a possible example of such common information. The DC2 code will restart any selected sending station transmitter that was interrupted or will allow cocked sending stations to generate their polling request signals. The computer switcher should then send the message starting with the STX code followed by the message text and ETX. All of the selected receiving stations will copy the message.

If the call-in operation is not successful and delivery is not to be reattempted for some period of time, the computer switcher should send the sequence EOT DC2 to define the end of the call-in operation, to de-select any selected receiving stations, and to either restart a selected sending station transmitter that was interrupted or allow cocked sending stations to generate their polling request signals.

#### 4.11 ROLL-CALL OPERATION AND RESPONSES

Roll-call is the performance of a call-in operation of already selected receiving stations at the conclusion of the message delivery. Its primary function is to verify whether or not the selected receiving stations received the information sent to them. 86B stations incorporate the roll-call capability, but it is not mandatory that the computer switcher must implement it.

Roll-call involves calling each selected receiving station individually and getting a response indicating whether or not the message was properly received. When the computer switcher has sent the ETX code defining the end of a message delivery, it initiates a roll-call operation in the same way it initiates a call in operation, by sending the control character ENQ. The code will stop the transmitter at any selected sending station or will inhibit the generation of a polling request signal by any cocked sending stations, will define the beginning of a roll-call function, will blind all selected receiving stations, and will activate the appropriate logic in each outlying receiving station to look for the Call Enquiry Code (CEC).

When an interruption of incoming traffic is required or when the generation of a polling request signal is being inhibited at cocked sending stations, the computer switcher must wait for a sufficient period of time to insure that the incoming line is idle and that all inbound traffic has been received before soliciting responses from selected receiving stations. A pause of 600 milliseconds is recommended for almost all system configurations. However, since the roll-call operation involves the detection of a contiguous two character sequence starting with ENQ, it is recommended that as in the case of a call-in operation, when this pause is required, the computer switcher send the character DEL (Delete) immediately following the ENQ that initiates the roll-call function. This will satisfy the ENQ sequence logic at the 86B stations and will avoid the possibility of having noise or hits that may occur during the pause from erroneously satisfying the ENQ sequence at some station and causing a response before the incoming line is idle. The length of the pause required can then be shortened by the transmission time of the DEL character--100 milliseconds at 100 wpm and 67 milliseconds at 150 wpm.

After the required pause the computer switcher should send the ENQ code again, this time followed immediately by the CEC of a selected receiving station and wait for a response from the station. The CEC for each station should be the same as for call-in. Since the 86B stations require detection of the sequence ENQ CEC in order to respond, the computer switcher should send the ENQ with each CEC generated.

When no interruption of incoming traffic is required and the sending stations are not cocked, the computer switcher does not need to pause before proceeding with the roll-call function, and so, may send the CEC of a selected receiving station immediately after the initial ENQ code sent to define the beginning of the roll-call function.

The response received as a result of a roll-call operation may be any of the following four types:

- (1) a message-correctly-received response,
- (2) a message - improperly - received response,
- (3) an invalid response, or
- (4) no response at all.

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

(1) Message-Correctly-Received Response

The message-correctly-received response is the two character sequence SIC CAN, consisting of a Station Identity Code (SIC) followed by the control character Cancel (CAN). The receipt of a message-correctly-received response means that during the delivery of the message the various checks made by the receiving 86B station were satisfied (see Section 4.12 - Causes for Message-Improperly-Received Response).

Station Identity Codes can be chosen from the set of graphic characters in ASCII. As explained in the case of the call-in function, by choosing a different CEC and a different SIC for each station in a given system, the comput-

er switcher can verify that the proper stations are responding for each message delivery by matching the received SIC with the one that the computer switcher has stored as being paired with the CEC that was sent.

Because the roll-call and call-in functions employ the same ENQ CEC sequence to request responses, the affirmative station responses have been designed to be different - SIC ACK for call-in and SIC CAN for roll-call. This then provides protection against a situation in which a selected receiving station fails to see the ETX code ending the message delivery and, hence, interprets the roll-call operation as another call-in. It also protects against situations where a temporary loss-of-carrier or commercial power failure caused the station to reinitialize in the "idle" state so that again a roll-call function would appear to the station as a call-in. Under such circumstances, the computer switcher should consider a SIC ACK response as an invalid response to roll-call (See Section 4.11 (3) - Invalid Response).

(2) Message - Improperly-Received Response

The message-improperly-received response is the two character sequence SIC NAK. This response means that during the delivery of a message one or more of the various checks made by the receiving 86B station were not satisfied (See Section 4.12 - Causes for Message-Improperly-Received Response). The computer switcher can record the receipt of this response and deal with the redelivery of the message to this station in the fashion prescribed for by the particular system application.

The inclusion of SIC as a part of the message-improperly-received response allows the computer switcher to verify that the response received actually came from the station roll-called.

Even though the SIC NAK response means not-ready-to-receive to call-in and message-improperly-received to roll-call, there is no ambiguity concerning interpretation of a SIC NAK response to roll-call because whatever condition would cause a not-ready-to-receive response to a call-in function should be interpreted as a condition that would mean that the message was not received properly.

### (3) Invalid Response

An invalid response to roll-call is any response that is not SIC CAN or SIC NAK, with the SIC being the proper SIC. Since the roll-call is intended to provide a receiving station interrogation function, it is suggested that the following procedures be followed when an invalid response is received.

If the invalid response takes the form of an undetectable one or two character sequence, it is suggested that the computer switcher roll-call the intended selected receiving station again by sending the sequence ENQ CEC for that particular situation. 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 means that an interrupted selected sending station has been falsely started. If there is no detected garbling of this incoming transmission, it is assumed that an error on-line changed either the ENQ or the CEC of the roll-call operation into the control DC2, which is used to restart an interrupted selected sending station. The fact that there was no detected garbling of the incoming information means that there was no simultaneous response from any roll-called selected receiving station. Therefore, it is suggested that the computer switcher accept the incoming traffic as a valid part of the traffic

pickup, and reinitiate the interruption of the selected sending station by sending ENQ DEL and pausing, as it did originally. The computer switcher can then proceed with the roll-call operation by sending the sequence ENQ CEC for intended selected receiving station again. The previously selected receiving stations would still be in the selected state and unaffected by what has taken place.

If the invalid response is a SIC CAN, SIC ACK, or SIC NAK response with the wrong SIC, it is suggested that the computer switcher ignore the response and send the sequence ENQ CEC for the intended selected receiving station again.

If the invalid response is a SIC ACK response with the proper SIC, it means the station has interpreted the roll-call function as a call-in function and has become a selected receiving station. As mentioned above, this can happen if the selected receiving station did not detect the ETX code or is in the "idle" state when the roll-call operation takes place. The computer switcher should treat such a SIC ACK response as a SIC NAK response (message-improperly-received) and deal with the redelivery of the message to this station in the fashion prescribed for by the particular system application. Since only this station is unblinded at this time, the computer switcher could send a statement indicating the condition that has occurred and advising the station that the message in question will be redelivered at some future time.

### (4) 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 teletypewriter outlying stations can be expected within 600 milliseconds under most circumstances. It is suggested that in the case of a

no-response time-out the computer switcher roll-call the station again by sending the sequence ENQ CEC for that particular station. It is assumed that what most likely happened in the case of no response is that when the sequence ENQ CEC 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.

After all of the selected receiving stations have been roll-called, the computer switcher can send the sequence ENQ DC2 to unblind all selected receiving stations. The computer switcher may then send any information that is to be common to all selected receiving stations. A date and time record is a possible example of such common information. The DC2 code will restart any selected sending station transmitter that was interrupted or will allow cocked sending stations to generate their polling request signals.

To terminate the message delivery the computer switcher should send the sequence EOT DC2. The EOT code will cause all selected receiving stations to go to the "idle" state. The DC2 code will restart any selected sending station transmitter that was interrupted or will allow cocked sending stations to generate their polling request signals.

#### 4.12 CAUSES FOR MESSAGE-IMPROPERLY-RECEIVED RESPONSE

The 86B station will respond to the roll-call function with the message-improperly-received response SIC NAK if any of the following conditions have occurred since the station was selected.

- A. A paper-out condition was detected on a sprocket-feed machine that resulted in part of the delivery being lost, or
- B. The terminal device failed to respond to the received signals during delivery, or
- C. Two ETX codes were detected.

The computer switcher should be programmed to cope with the condition in which a selected receiving station repeatedly responds "ready-to-receive" to call-in but then responds "message-improperly-received" to roll-call. This situation can be the result of a station malfunction

such that one of the checks performed during message delivery (e.g., check to see that terminal device responds to received signals) is not satisfied. Such a condition would not affect the ready-to-receive status of the station, but would affect the validity status of messages received.

#### 4.13 DELIVERY ABORT

A delivery abort function is available with 86B stations so the computer switcher can interrupt a message delivery in progress and return selected receiving stations to the "idle" state in case a preempt is required or a system irregularity is detected during the normal system operation.

The complete message format for the delivery abort function is:

D	D	ED
L	W C	Service Message OC
E	2	T2

The computer switcher interrupts the message delivery in progress and sends the control character DLE followed by the uppercase alpha character W. The DLE code blinds the selected receiving stations, stops any selected sending transmitter or uncocks the sending stations, and defines the beginning of a polling function. The character W acts as a special SPC that causes a MESSAGE RECEPTION ALARM lamp to light at all of the selected receiving stations that receive the W while in the polling state.

With 86B stations there is a capability to include a service message as a part of the delivery abort action. In general, service messages can be quite helpful to the outlying station attendant in clarifying the reason for the interruption, what action is being taken, and what to expect next. If a service message is to be sent as part of the delivery abort action, the computer switcher should send the control character DC2 after the DLE W sequence, to unblind all selected receiving stations, and then send the service message. The DC2 code defines the end of the polling function as far as all stations on the line are concerned so that the information in the service message will not be mistaken for SPCs. The DC2 code also serves to restart any selected sending station transmitter that was interrupted by the DLE code.

If the sending stations were cocked at the time the delivery abort action took place, the

DLE code would have nullified the cocked state at all sending stations. If the DC2 code was sent before a possible service message, the DC2 code would not recock the sending stations but would negate the polling state. Consequently, the sequence EOT DC2 sent after the service message to return selected receiving stations to the "idle" state would no longer satisfy the DLE EOT DC2 combination required to recock the sending stations. Thus, if a service message is delivered as part of a delivery abort function (DC2 sent after DLE W), then to recock the sending stations

the computer switcher should send DLE EOT DC2, instead of EOT DC2, to end the service message. DLE EOT DC2 cocks the sending stations and EOT received while in the delivery abort state returns all selected receiving stations to the "idle" state. If, on the other hand, there is no service message delivered as a part of the delivery abort function (no DC2 after DLE W), then the computer switcher can just send EOT DC2 to both cock the sending stations and return the selected receiving stations to the "idle" state.

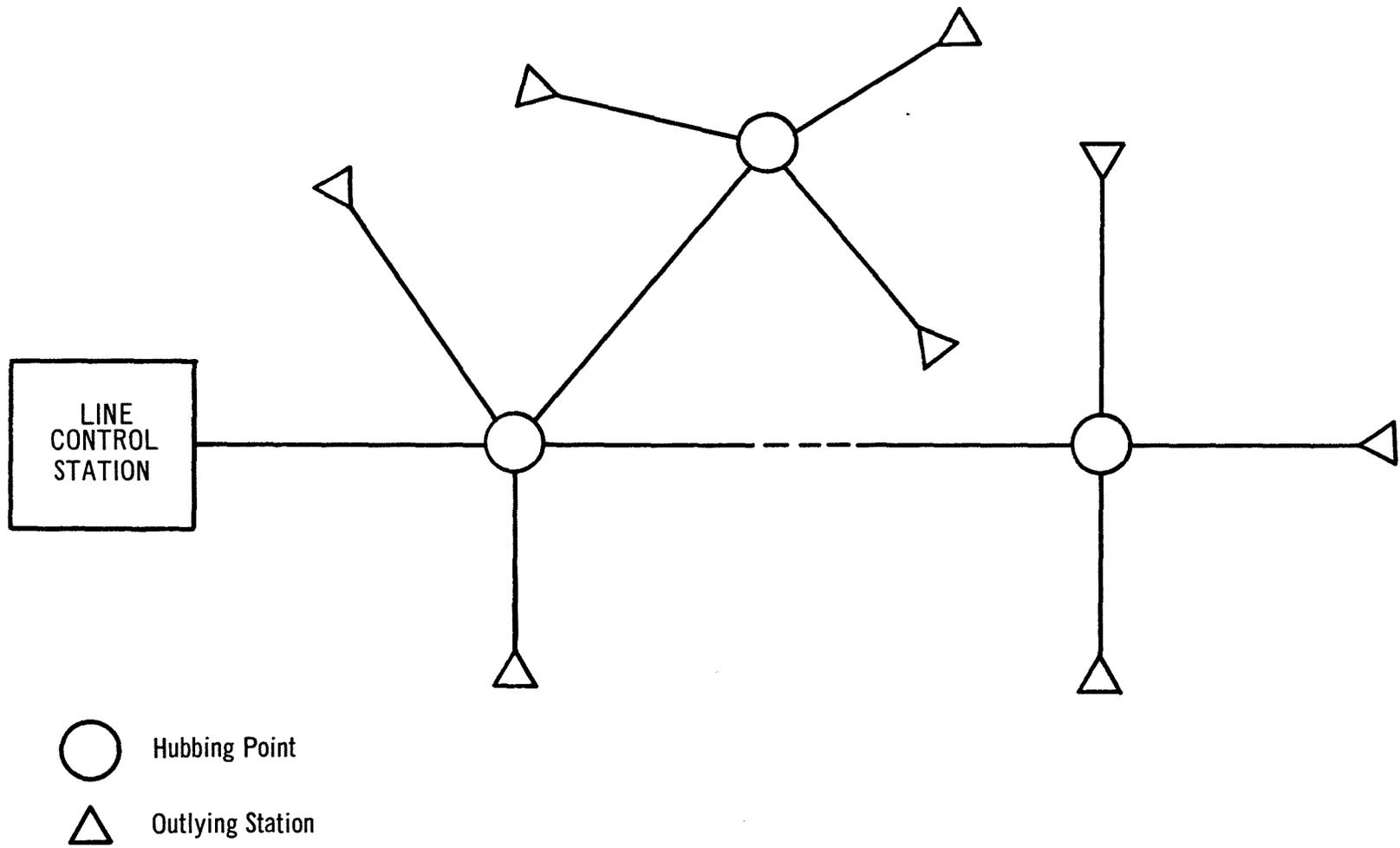


FIGURE 1 - BLOCK DIAGRAM REPRESENTATION OF TYPICAL 86B SYSTEM LINE

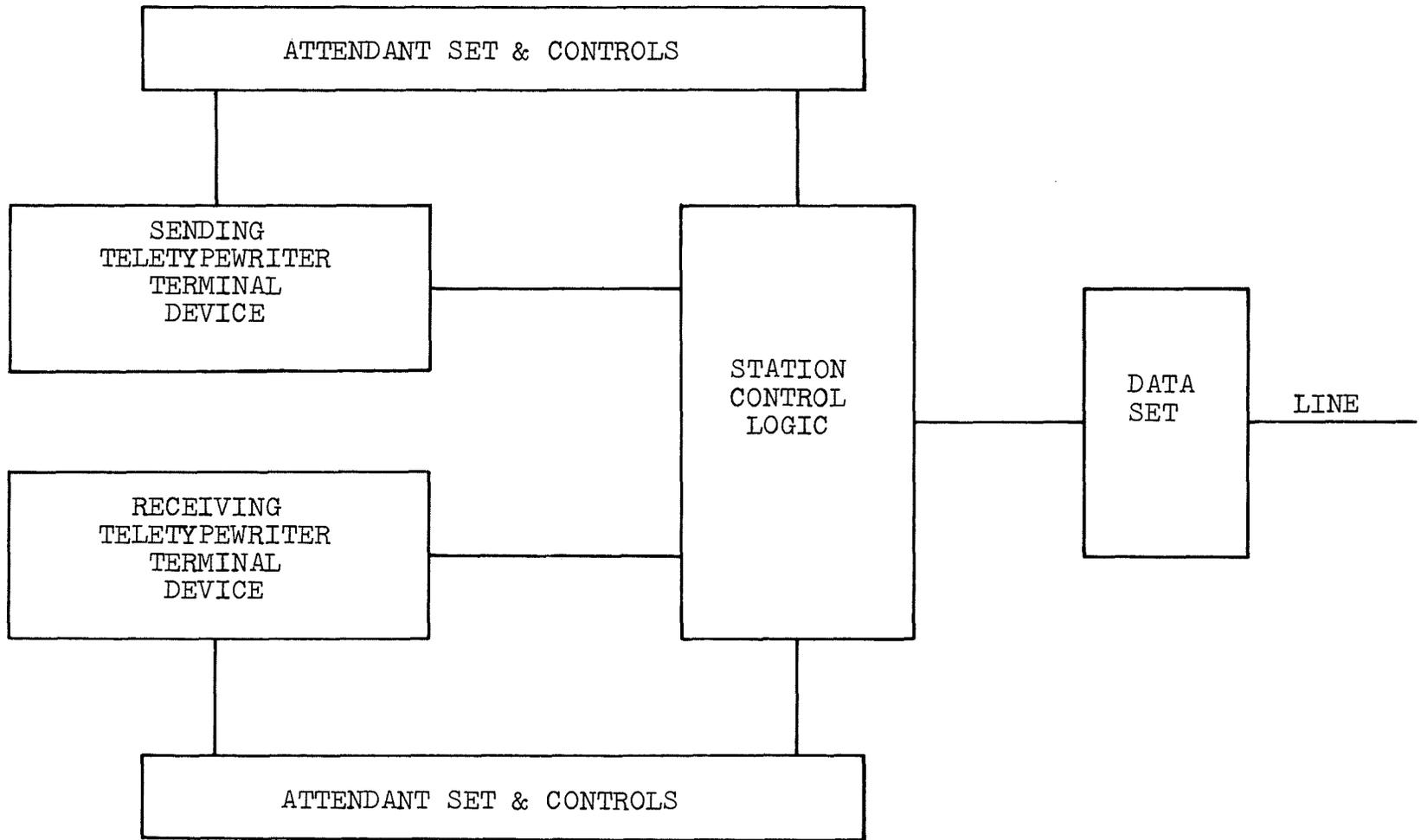


FIGURE 2 - BLOCK DIAGRAM REPRESENTATION OF TYPICAL 86B STATION

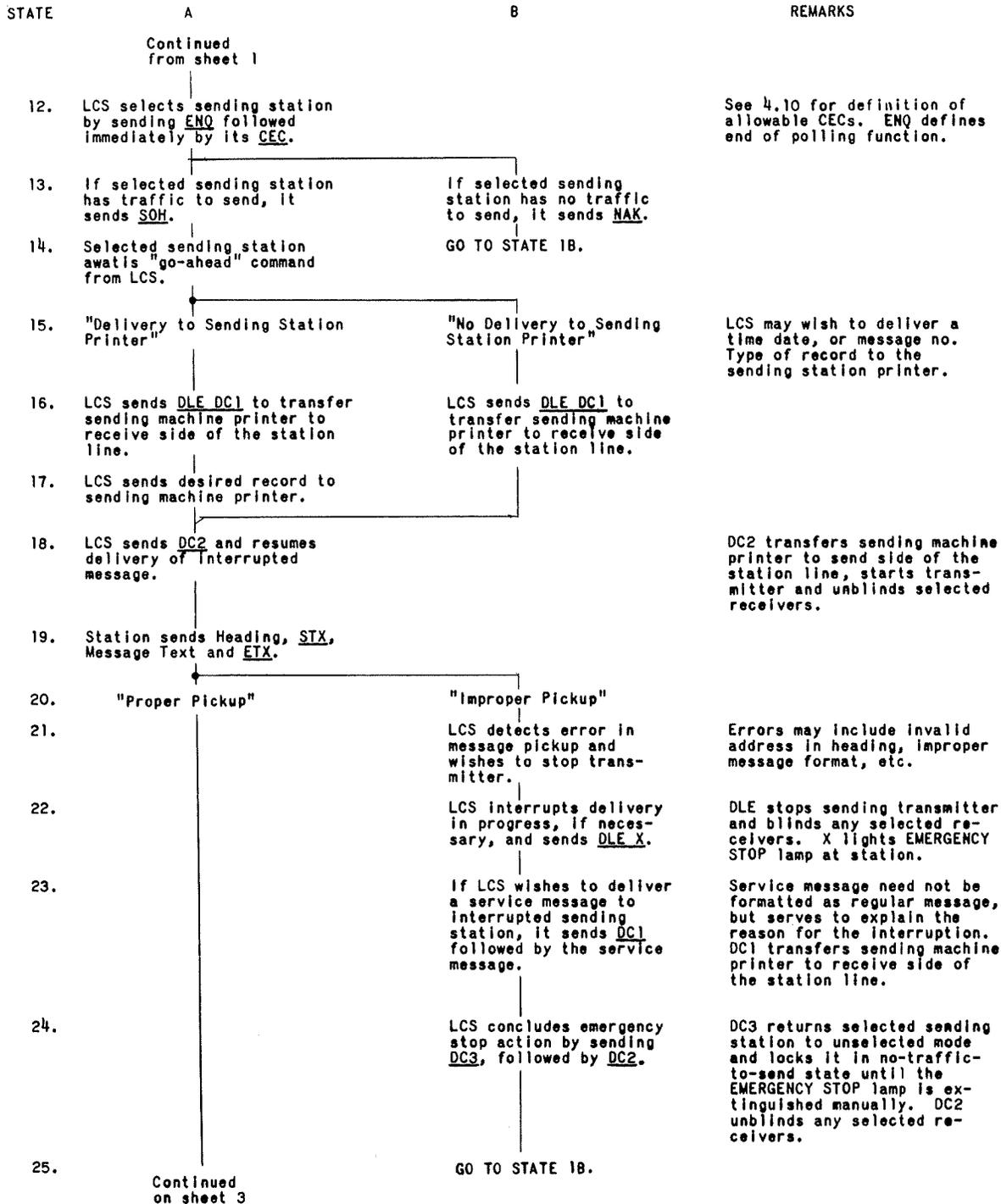
USA STANDARD CODE FOR  
INFORMATION INTERCHANGE  
USAS X3.4 - 1967

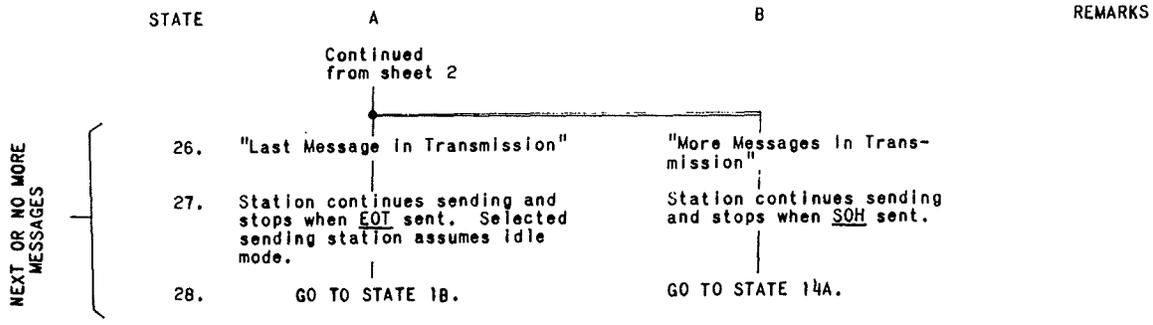
Bits					0	0	0	0	1	1	1	1			
					0	0	1	1	0	0	1	1			
b <sub>7</sub>	b <sub>6</sub>	b <sub>5</sub>	b <sub>4</sub>	b <sub>3</sub>	b <sub>2</sub>	b <sub>1</sub>	Column	0	1	2	3	4	5	6	7
					0	1	2	3	4	5	6	7			
					0	1	2	3	4	5	6	7			
0	0	0	0	0	0	0	0	NUL	DLE	SP	0	@	P	\	p
0	0	0	1	1	1	1	1	SOH	DC1	!	1	A	Q	a	q
0	0	1	0	2	2	2	2	STX	DC2	"	2	B	R	b	r
0	0	1	1	3	3	3	3	ETX	DC3	#	3	C	S	c	s
0	1	0	0	4	4	4	4	EOT	DC4	\$	4	D	T	d	t
0	1	0	1	5	5	5	5	ENQ	NAK	%	5	E	U	e	u
0	1	1	0	6	6	6	6	ACK	SYN	&	6	F	V	f	v
0	1	1	1	7	7	7	7	BEL	ETB	/	7	G	W	g	w
1	0	0	0	8	8	8	8	BS	CAN	(	8	H	X	h	x
1	0	0	1	9	9	9	9	HT	EM	)	9	I	Y	i	y
1	0	1	0	10	10	10	10	LF	SUB	*	:	J	Z	j	z
1	0	1	1	11	11	11	11	VT	ESC	+	;	K	[	K	{
1	1	0	0	12	12	12	12	FF	FS	,	<	L	\	l	
1	1	0	1	13	13	13	13	CR	GS	-	=	M	]	m	}
1	1	1	0	14	14	14	14	SO	RS	.	>	N	^	n	~
1	1	1	1	15	15	15	15	SI	US	/	?	O	-	o	DEL

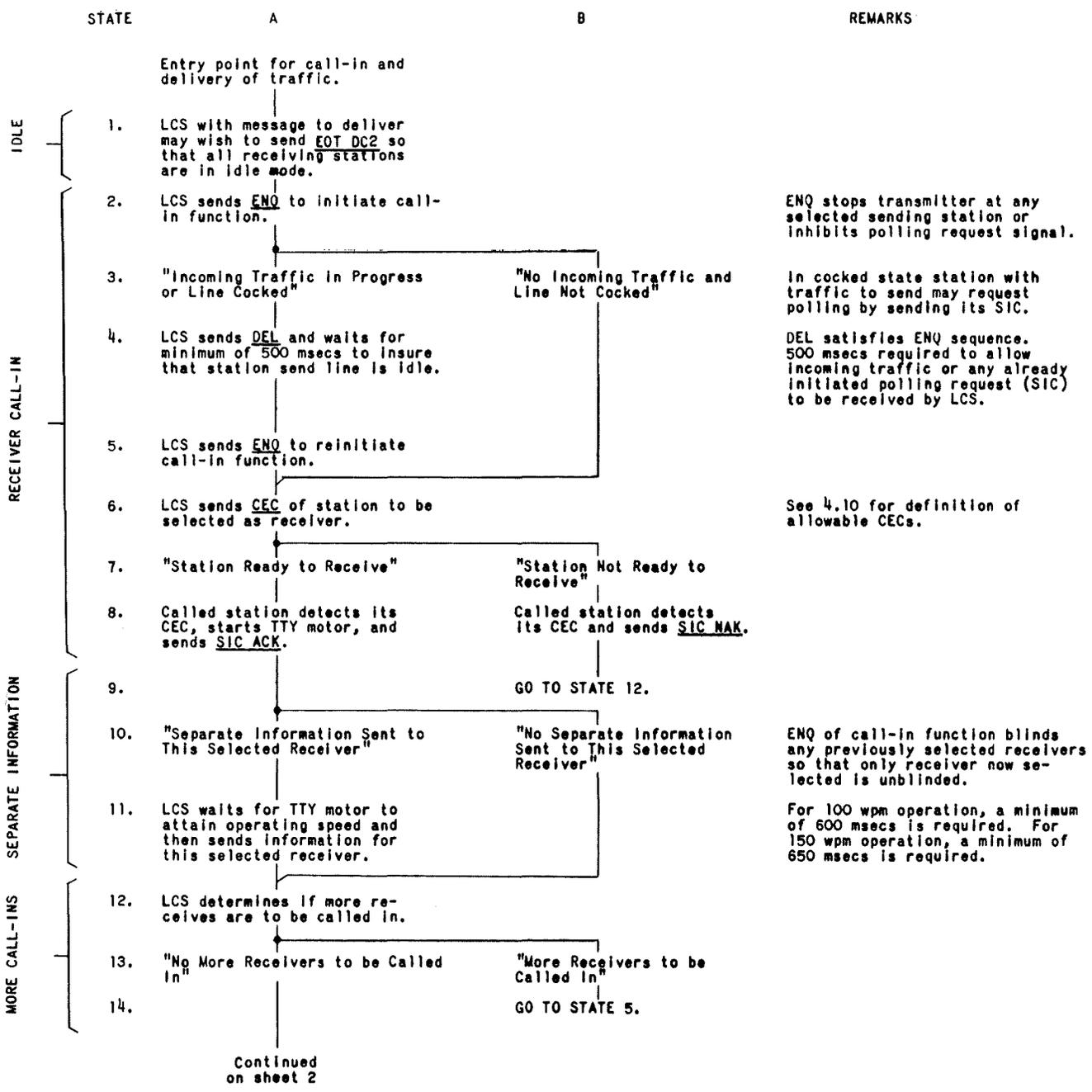
\*Only columns 2 to 7 are normally printed with the exception of SP (space) and DEL (delete).

FIGURE 3









Continued on sheet 2

