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Bell System

TECHNICAL REFERENCE

DATA SET 203-TYPE INTERFACE SPECIFICATION

APRIL 1974

Bell System Data Communications

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Data Set 203 - Type

Interface Specification

April 1974

ENGINEERING MANAGER - DATA SYSTEMS

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This Technical Reference, Interface Specification for Data Set 203-Type, replaces the previous issue, Technical Reference Data Set 203-Type, dated June, 1970. The Technical Reference has been revised to include information on the Automatic Retraining Auxiliary Channel (ARAC), the Multiple Access Interface, the Digital Loopback Switch, and the Permanent Request-to-Send features.

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LIST OF FIGURES

TECHNICAL SPECIFICATION SUMMARY

Modulation: 2-, 4-, or 8-level amplitude modulation with vestigial sideband (VSB) line signal shaping

Data Rate:

SPEED OPTIONS

Modulation Levels	List 2	List 3	List 4	List 5	List 6
2	2400 bps	1800 bps	2400 bps	3200 bps	3600 bps
4	4800 bps	3600 bps	4800 bps	6400 bps	7200 bps
8*	7200 bps	5400 bps	7200 bps	9600 bps	10800 bps

*(8-level operation on a permissive basis on private lines only.)

Operation: Synchronous

Line Requirements: DDD network or 3002 channel with C2 conditioning — L3 and L4. 3002 channel with C2 conditioning — L2, L5, L6.

Attenuation and Delay Distortion Equalization: Adaptive, automatic equalizer

Interface Signals: EIA RS—232-C or MIL STD. 188B

Transmitter Output Level: 0 to -15 dBm adjustable in 1 dB steps

Receiver Input Level: -10 to -34 dBm or -20 to -44 dBm by strapping option.

Line Impedances: 600 or 900 ohms

Operating Modes: Duplex, half-duplex, or simplex

Control Functions:

Request-to-Send — Clear-to-Send Delay

(For Two-Wire Half-Duplex Operation)

List 2	7.9 sec.
List 3	10.5 sec.
List 4	7.9 sec.
List 5	6.0 sec.
List 6	5.2 sec.

Note: For four-wire operation, if Permanent Request-to-Send Option is used, Clear-to-Send Indication is always ON.

TECHNICAL SPECIFICATION SUMMARY (CONT'D)

Receive Line Signal Detector Time:

Operate:	Equal to Request-to-Send — Clear-to-Send Delay
Release:	Nominally 70 msec.

Carrier on Delayed Time:

Operate:	70 msec.
Release (Holdover):	
List 2	1.39 sec.
List 3	1.85 sec.
List 4	1.39 sec.
List 5	1.04 sec.
List 6	0.92 sec.

Connectors:
Business Machine:

L8: 25-pin Cinch or Cannon Type DB-19604-432 Connector with Cinch DB-51-26-1 Hood (or equivalents)

L9: 25-pin connector as above and a 15-pin Cinch DA-19603-403 with a Cinch DA-51225-1 locking hood (or equivalents)

AC Power Requirements: 117 volts $\pm$10% ac at a frequency of 47.5 to 63 Hz. Three-wire outlet not under control of a switch

Environmental Requirements:

Ambient Temperature Range:	40° — 120°F
Relative Humidity:	20% — 95%

Dimensions: "Stand-alone" cabinet is two feet high by two feet wide by one foot deep. Rack mounting is also available.

Weight:

In Cabinet	
Data Set 203A	Approximately 110 lbs.
Data Set 203B	Approximately 72.5 lbs.
Data Set 203C	Approximately 89.5 lbs.

1. GENERAL

The Data Set 203 family is designed to provide transmission and reception of high-speed digital data over the switched telecommunications network and 2- or 4-wire private line facilities. The data sets have the following basic design features:

a. Synchronous data transmission with transmitter bit timing supplied by the data set or by the customer, and receiver bit timing supplied by the data set;

b. 2-, 4- or 8-level* amplitude modulation with suppressed carrier;

* 8-level operation is on a permissive basis on private lines only.

c. vestigial sideband (VSB) line signal shaping;

d. automatic, adaptive equalization.

The data set places no restrictions as to the data format used by the customer. When the data set is used with Data Auxiliary Sets 804A or 804M, alternate voice transmission, unattended answering, and compatibility with automatic calling units (Data Auxiliary Sets 801-type) are available.

1.1 Data Set 203-Type and List Coded Nomenclature

There are three basic types of Data Set 203. Data Set 203A-type is a transmitter-receiver, Data Set 203B-type is a transmitter only, and Data Set 203C-type is a receiver only.

The data set code identifies the basic unit and customer options as (L-) numbers. The list numbers are shown below. Figure 1 illustrates the possible combinations available for ordering Data Set 203.

List-Coded Nomenclature for Data Set 203-Type

Basic Unit Lists

L1C Common apparatus, assembly, wiring and hardware for one Data Set 203.

L1D Same as L1 except Data Set is rack mounted in a 23-inch frame. A 14-inch vertical space is required for mounting Data Set 203B, whereas Data Set 203A or C require 20 inches.

L1E Applies to Data Set 203C only. Same as L1D except only 14 inches is required for mounting Data Set 203C.

Speed Option Lists

L2 4-wire private line operation at a bit rate of 2.4, 4.8, or 7.2* kbps.

L3 DDD, 2- or 4-wire private line operation at a bit rate of 1.8, 3.6, or 5.4* kbps (5.4 kbps only for private line operation).

L4 DDD, 2- or 4-wire private line operation at a bit rate of 2.4, 4.8, or 7.2* kbps (7.2 kbps only for private line operation).

L5 4-wire private line operation at a bit rate of 3.2, 6.4, or 9.6* kbps.

L6 4-wire private line operation at a bit rate of 3.6, 7.2, or 10.8* kbps.

Functional Option Lists

L7 A 0-150 bps nonsynchronous secondary channel. Optional only for Data Set 203A operating on 4-wire facilities.

L8 Provides an EIA Standard RS-232-type customer interface.

L9 Provides a Military Standard 188-type customer interface.

L11 Provides an Automatic Retraining Auxiliary Channel (ARAC) in place of Option L7 only for Data Set 203A only with speed Option L2 on 4-wire private line facility.

L12 Provides an Automatic Retraining Auxiliary Channel (ARAC) in place of Option L7 for Data Set 203A only with speed Option L6 on 4-wire private line facility.

* Operation at these bit speeds is on a permissive basis only for exceptionally high quality lines or for applications tolerant of unusually high error rates.

L13 Provides Data Set 203-type with a multiple-access customer interface by using a 38A-type Data Unit to supply fan-out functions.

1.2 Physical Description

Data Sets of the 203-type may be mounted in a 2" high x 2" wide x 1" deep cabinet as a "stand-alone" unit as shown in Figure 2, or they may be mounted on standard 23-inch relay racks. These different equipment configurations are available as ordering options. Data Sets of the 203-type are designed to operate in an environment where the ambient termperature is in the range of 40 to 120 degrees Fahrenheit and the relative humidity is a maximum of 95 percent.

Physical Characteristics

Data Set List Number	Description	Data Set Size and Weight		
		203A-( )	203B-( )	203C-( )
L1C	Data Set mounted in a cabinet.	2 ft. wide 1 ft. deep 2 ft. high 110 lbs.	2 ft. wide 1 ft. deep 2 ft. high 72.5 lbs.	2 ft. wide 1 ft. deep 2 ft. high 89.5 lbs.
L1D	No cabinet — 23-inch frame.	23 in. wide 9 in. deep 20 in. high 90 lbs.	23 in. wide 9 in. deep 14 in. high 53 lbs.	23 in. wide 9 in. deep 20 in. high 70 lbs.
L1E	No cabinet — 23-inch frame.	(Not applicable)	(Not applicable)	23 in. wide 9 in. deep 14 in. high 65 lbs.

1.3 Power Requirements

Data Sets 203-type operate on 117 (±10 percent) volt ac power at a frequency range of 47.5 to 63 Hz. A fuse, in series with the ac input, is provided at the rear of the power unit. Power consumption ranges between 17 and 55 watts, depending on the list options used. The power cord supplied with the data set requires a standard 3-wire grounding type ac receptacle which should be on a circuit not under control of a switch.

1.4 Grounding

Protective Ground is established for Data Sets 203-type through the ground wire of the power cord. The customer's terminal equipment Protective Ground should be connected to the same ground as the ground wire of the power cord and should not rely on the Protective Ground Circuit (AA) provided in the data terminal interface. A Signal Ground (AB) Circuit is provided to the customer as a common return for control and data interchange circuits. Protective Ground and Signal Ground are normally tied together by means of a strap on the rear of the data set. The strap may be disconnected on request of the customer, subject to local noise conditions, ground potentials, and safety considerations.

1.5 Interface

The interface signals exchanged between the business machines and Data Sets 203-type conform to the Electronic Industries Association Standards RS-232-C and RS-334. However, for special applications, Data Sets 203-type can be optionally equipped to conform to Military Standard 188B.

1.6 Use With Data Auxiliary Set 804-Type

Data Sets 203-type are associated with a Data Auxiliary Set 804A or 804M when voice coordination (telephone set), network control signaling, automatic answer, and compatibility with Data Auxiliary Sets 801-type (Automatic Calling Units) are required. Data Auxiliary Set 804A-type is used when operating on the

switched message network and on various private line configurations where alternate voice is required. Data Auxiliary Set 804M-type is intended for use on a 4-wire switched private line type network or for use with two dial switched message network lines used as a 4-wire facility.

1.6.1 Data Auxiliary Set 804A-Type

Data Auxiliary Set 804A-type, shown in Figure 2 with associated Data Set 203-type, consists of an integrated telephone, a Rotary or TOUCH-TONE ®dial, a six-button key unit, and a line control unit. The line control unit contains the circuitry for transfer between TALK and DATA, unattended answering, disabling echo suppressors, and compatibility with automatic calling units. The overall dimensions are approximately nine inches wide, nine inches deep, and 4-1/2 inches high. The Data Auxiliary Set 804A-type will operate satisfactorily over the same temperature and relative humidity ranges as Data Sets 203-type. It weighs approximately nine pounds.

The Data Auxiliary Set 804A-Type is used in conjunction with Data Sets 203-type when operating over the switched message network, on private lines where alternate voice is desired, and whenever it is desired to switch between private line facilities and the switched message network.

Some of the configurations available when using Data Auxiliary Set 804A-type with Data Sets 203-type and, where required, additional telephone equipment, are listed below:

- 2-wire operation on switched message network.*
- Operation on 2-wire private line with alternate voice.*
- Operation on 2-wire private line with switched message network backup.*
- Operation on 4-wire private line with alternate voice.
- Operation on 4-wire private line with switched message network backup.*
- 4-wire operation using two switched message network lines.*

* L3 (1800 or 3600 bps) and L4 (2400 or 4800 bps) options only.

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1.6.2 Data Auxiliary Set 804M-Type

Data Auxiliary Set 804M-Type consists of an integrated telephone, a Rotary or TOUCH-TONE dial, six-button key unit, and a 4-wire line control unit. The 4-wire line control unit provides the logic for transfer between TALK and DATA, unattended answering, and compatibility with 4-wire Automatic Calling Units (Data Auxiliary Set 801C-type only). The overall dimensions are approximately 9 inches wide, 11-1/2 inches deep, and 4-1/2 inches high. It will operate satisfactorily over the same temperature and relative humidity ranges as Data Sets 203-type. It weighs approximately 4 pounds.

The Data Auxiliary Set 804M-type is used in conjunction with the Data Sets 203-type when operating over a 4-wire switched network. It can also be used on 4-wire private lines requiring alternate voice, or with two dial switched network lines as a 4-wire facility.

1.6.3 Manual Controls of Data Auxiliary Set

The Data Auxiliary Set 804A- or 804M-type is equipped with an integrated six-button control panel for manual control and testing. Figure 3 shows the designation of each button. The purpose of each button is as follows:

1. TEST

   This nonlocking button is provided to permit the Telephone Company to evaluate the condition of the data set from a specially equipped data test center. If the user suspects the data set is operating in a faulty manner, he will place a call to a Repair Service telephone number given to him at the time the data set is installed. He will be contacted by the testing station (Data Test Center) and will be instructed as to when to push the TEST button. Following operation of the TEST button, the TEST lamp will light and the data set will enter the Remote Test mode. It will then be evaluated by the Data Test Center. Upon completion of the tests, the user will be notified of the results. If a fault is indicated, the necessary repair will be undertaken.

2. AUTO

   This button is used if it is desired to automatically answer an incoming call. The button must be depressed (it then stays down) before the data set will be able to automatically answer an incoming call. If desired, the data auxiliary set can be arranged, by wiring option, for permanent automatic answer in which case the AUTO button is not used. With the automatic answer feature, all incoming calls will be automatically answered provided the station is idle and the Data Terminal Ready (CD) Circuit is properly conditioned by the business machine. A lamp is associated with the AUTO button in the 804M only.

3. TALK

   This button stays down when depressed to permit use of the telephone and to allow for manual answer of an incoming call. On the Data Auxiliary Set 804A-type only, the TALK button is lighted at the called station.

4. DATA

   This button places the data set in the Data mode to allow data to be transmitted or received. It does not stay down when depressed and, when released after being depressed, it also releases all other buttons. The DATA button lamp will be lighted to indicate the data set is in the Data mode. Note that the Data Terminal Ready Circuit must be ON before the data set will enter the Data mode.

1.7 Internal Control Panel

The Data Set 203-type has controls provided inside the front cover on an internal panel (see Figure 4). The following controls are supplied.

1.7.1 Speed Select Switch

Data Sets 203-type utilize a 2-, 4- or 8-level amplitude modulation scheme which results in three separate operating speeds in the same data set. The data set is equipped with a switch on the control panel (located behind the front outer cover of the data set) to permit selection of the desired speed (see Figure 4). The switch can be turned to four different positions. The first three positions select one of the three operating speeds of the data set. The fourth position, labeled CC (Customer Control) will allow the business machine to select between the two highest speeds through a control Circuit, Data Signal Rate Selector, (CH), on the interface.

1.7.2 Mode Control Switch

A separate 3-position switch is provided which allows the customer to place the data set in either the Remote Test mode, the Local Test mode, or Line mode for normal operation. When the Local Test mode is selected, the modem is disconnected from the communications circuit and looped back on itself through a pad while the line is terminated toward the other end. When the Remote Test mode is selected, the data set is conditioned to be tested by a Telephone Company Data Test Center. The Line mode position is used for normal operation.

1.7.3 Digital Loopback Switch

A Digital Loopback Switch may be provided which permits the Received Data Circuit of Data Sets 203A-type to be connected to the Transmitted Data Circuit and the Receive Signal Element Timing Circuit to be connected to the Transmit Signal Element Timing External Circuit. With these connections, the data set may be operated as a regenerator which provides the customer with the capability to isolate a trouble condition between his remote terminal and the Telephone Company equipment from his local terminal (see Section 5.2). The capability to test a remote terminal is important for those installations where only one terminal may have testing capabilities.

For Data Sets 203A-Type L1C or L1D, the field installed digital loopback feature may not be used with the L7, L11 or L12 auxiliary channels or with the L13 multiple interface option. The digital loopback feature in Data Sets 203A-type L1C and L1D that have a factory installed digital loopback switch may be used with auxiliary channels L11 or L12 only if the data terminal has control of the Request-to-Send Circuit, or the automatic retrain option is installed in the data

set. There are no restrictions on use of the digital loopback feature with the L7 secondary channel or with the L13 multiple interface option with data sets that have the factory installed switch.

1.8 System Considerations

Data Set 203-type is essentially provided in two varieties. One is for use on private lines (L2, L5, L6) and the other for use on both private lines and the switched message telecommunications network (L3 and L4). The dual purpose variety (L3 and L4) offers considerable flexibility in system applications. The set can be used on a 4-wire private line as the basic facility. Two switched message network lines can be used as a 4-wire back-up facility without a speed reduction (2- and 4-level operation only). In addition, the set can use one or two dial switched network lines as the basic facility. Finally, with the optional L7 secondary channel, two simultaneous data streams are possible over 4-wire line arrangements.

The Data Set 203-type is not specifically designed to operate in a multipoint polling environment. The lengthy turnaround time can result in reduced throughput in those systems with frequent short message transmission. However, secondary channel operation can be effectively used in this type environment. The short polling and acknowledgment messages can be handled by the secondary channel while the remote high-speed transmitter need only be turned ON when there is data to send.

Secondary channel operation can also prove beneficial when the data set is used on 2-wire facilities. For systems with block retransmission, instead of turning around the receiving data set to acknowledge each block transmitted, the secondary channel is used to signal the transmitter to retransmit only those particular blocks that were received in error.

If switched message network operation is contemplated but the Data Set 203-type turnaround time is considered to have a controlling effect on data throughput, two switched network lines can be used as the basic facility. With this arrangement the data sets do not have to be turned around. (Equivalent to 4-wire continuous carrier operation.) Data throughput will approach the data set operating speed.

2. CUSTOMER FEATURES

Data Sets 203-type are provided with a number of customer features or options which may be requested by the user. Some of these features are only available as ordering options, whereas others are supplied as installer strapping options. The desired features and options must be specified when the set is ordered. A description of these features follows:

2.1 Features Available as Ordering Options

To obtain certain features in a Data Set 203-type, different ordering options must be requested. The features provided in this way are listed below:

2.1.1 Data Set 203-Type

The Data Set 203-Type can be ordered as a transmitter and receiver (203A), a transmitter only (203B) or a receiver only (203C). Each of these three arrangements can be ordered in a cabinet or a 23-inch rack mounting assembly (see Section 1.1).

2.1.2 High-Speed Data Rate Options (Lists 2, 3, 4, 5 and 6)

The speed options available with Data Set 203-type are shown below:

Speed Option Lists

L2 4-wire private line operation at a bit rate of 2.4, 4.8, or 7.2* kbps. Simultaneous operation of main and secondary channel is not possible on the same wire pairs.

L3 DDD, 2- or 4-wire private line operation at a bit rate of 1.8, 3.6, or 5.4* kbps (5.4 kbps only for private line operation only). Simultaneous operation of main and secondary channel is possible on any wire pair (secondary channel is required on DDD and 2-wire private line).

L4 DDD, 2- or 4-wire private line operation at a bit rate of 2.4, 4.8, or

* Operation at these bit speeds is on a permissive basis only for exceptionally high quality lines or for applications tolerant of unusually high error rates.

7.2* kbps (7.2 kbps only for private line operation only).

Simultaneous operation of main and secondary channel is possible on any wire pair (secondary channel is required on DDD and 2-wire private line).

L5 4-wire private line operation at a bit rate of 3.2, 6.4, or 9.6* kbps. Simultaneous operation of main and secondary channel is not possible on the same wire pairs.

L6 4-wire private line operation at a bit rate of 3.6, 7.2, or 10.8* kbps. Simultaneous operation of main and secondary channel is not possible on the same wire pairs.

2.1.3 Secondary Channel (List 7)

Data Sets 203-type may contain, as standard or in some cases optional equipment, a low-speed secondary transmitter-receiver (also referred to as auxiliary, supervisory or reverse channel).

The low-speed secondary channel is designed to provide up to 150 bits per second nonsynchronous data transmission primarily for acknowledgment of high-speed data, data set control without turnaround, or for systems where only low-speed, low-volume data is to be transmitted in the opposite direction to the high-speed data.

On the switched message network or 2-wire private line facilities (List 3 or List 4 configurations only), the low-speed secondary channel is required equipment. On the switched message network, the secondary channel is intended to operate simultaneously in the reverse direction to the transmission of high-speed data (that is, as a backward secondary channel). On 2-wire private lines, the secondary channel may operate as a reverse channel, or it may be connected to operate as an auxiliary channel with independent controls to allow simultaneous or nonsimultaneous transmission in the same direction as the high-speed data.

* Operation at these bit speeds is on a permissive basis only for exceptionally high quality lines or for applications tolerant of unusually high error rates.

On 4-wire facilities (any speed option), the low-speed secondary channel is optional equipment since simultaneous transmission of high-speed data is possible in both directions. When the secondary channel is used, it can operate simultaneously on the same pair of wires only with the List 3 speed option (1.8, 3.6, or 5.4 kbps) or the List 4 option (2.4, 4.8 or 7.2 kbps). For the List 2 (2.4, 4.8, 7.2 kbps), the List 5 (3.2, 6.4, 9.6 kbps), or the List 6 (3.6, 7.2, 10.8 kbps) speed options, the high-speed and low-speed channels have overlapping spectra and, therefore, precludes simultaneous use of the high-speed and secondary channels in both directions simultaneously. (See Section 4.3.2.)

It should be noted that at most two 2-wire pairs can be connected to the data set line connector, i.e., the high-speed and low-speed channels cannot be separated and operated independently on two 4-wire circuits.

The low-speed secondary channel is required equipment on all Data Sets 203B (transmitter-only) and Data Sets 203C (receiver-only) type. The operation of the Secondary channel with these data sets is the same as mentioned above.

2.1.4 Unattended Automatic Answer

When a Data Auxiliary Set 804A- or M-Type is ordered to control Data Set 203, an unattended answer feature is available for most applications which permits automatic answering of incoming calls. A 2025 Hz answer tone is transmitted to the calling station when the unattended station answers.

This feature may be provided on a permanent basis which allows the data set to automatically answer an incoming call when the Data Terminal Ready (CD) Circuit is turned ON by the associated business machine. Or, it may be under control of the AUTO button, which means that automatic answer can only be accomplished if the AUTO button is depressed (Paragraph 2.4.2) and the Data Terminal Ready (CD) Circuit is turned ON by the business machine. Selection of permanent or key-controlled automatic answer is an installer strapping option.

2.1.5 Compatibility with Automatic Calling Units (Data Auxiliary Sets 801A- or C-Type)

Data Sets 203-Type, when used in conjunction

with Data Auxiliary Sets 804A- or M-Type are compatible with Automatic Calling Units (Data Auxiliary Sets 801A- or C-Type). Automatic Calling Units (ACU) permit a business machine to call any number in the switched message network and transfer the circuit to the associated data set for the automatic transmission of data. The ACU, under control of the business machine, will perform all the functions usually performed by an attendant in originating a data call. For information about ACU's please refer to the following Bell System Technical References:

PUB 41601 — Data Auxiliary Set 801A
PUB 41602 — Data Auxiliary Set 801C

2.1.6. Interface

Two interface arrangements are available. One is an EIA interface per RS-232-C and is coded L8. The other is a MIL STD 188B-Type interface and is coded L9. Both are described in detail in Section 3.

2.1.7 Automatic Retraining Auxiliary Channel (ARAC)

All 203A data sets can be provided with automatic retraining by an installer option (see Section 4.1.4). The Automatic Retraining Auxiliary Channel, L11 or L12, is a special option for customers who have independent outbound and inbound data flow.

With this option, Data Set 203A/L2 or L6 is designed to retrain on half of a duplex 4-wire facility. The retraining is initiated by the ARAC circuitry in response to (1) poor line signal quality, (2) restoral of a line after a line drop-out that exceeded the data set holdover time, and/or (3) simultaneous recovery of both channels of the full-duplex line. (See Section 4.1.5.)

2.1.8 Multiple Access Interface (List 13)

The Multiple Access Interface Option provides six customer interface ports and provides the capability of serving up to six data terminals with one 203 data set. With this option each data terminal can receive data simultaneously from a remote terminal. However, only one data terminal can transmit data at a time. There are six interface ports, one of which incorporates all the standard 203 interface circuits. The remaining five ports include only the six output and two input circuits discussed below. The output circuits are:

1. Received Data (BB)
2. Transmit Signal Element Timing (DB)
3. Clear-to-Send (CB)
4. Receive Signal Element Timing (DD)
5. Data Set Ready (CC)
6. Received Line Signal Detector (CF)

The two input circuits for each port are the Request-to-Send Circuit (CA) and the Transmitted Data Circuit (BA). The arrangement requires that only one Request-to-Send Circuit be ON at any given time. All six ports will have Circuit CB ON if any port has Circuit CA ON and the data set Circuit CB is ON.

Both drivers and terminators at the multiple access interface provide and require electrical signals which meet EIA Standard RS-232-C.

A continuous carrier option is available with the multiple access interface. With this option the data set transmits carrier continuously. This may be used to prevent retraining of the data set each time one of the customer Request-to-Send Circuits is turned ON. The Transmitted Data Circuit (BA) is controlled by its Request-to-Send Circuit (CA) making it necessary for the customer to utilize Circuit CA at each port. With the continuous carrier option, the Clear-to-Send Circuit (CB) is ON at the six ports all the time that the data set is in the data mode, independent of the status of the Request-to-Send Circuits.

2.1.9 Permanent Request-to-Send

With the Permanent Request-to-Send Option, the Clear-to-Send Circuit is always ON and data set carrier is on-line continuously (except in the training modes). This option may be used to prevent data set retraining each time the customer terminal equipment turns its Request-to-Send Circuit ON.

This option is incorporated in a 5-foot cord (M23A-51) which provides connectors which mate with both the data set customer interface and the customer data terminal equipment interface.

2.2 Features Provided as Installer Strapping Options

In addition to the features that can only be provided by ordering special equipment, Data Sets 203-Type have other optional features that may be provided by the addition or deletion of certain installer options. The features provided this way are described below:

2.2.1 Clamp Disable Options

If desired by the customer, the clamp circuitry associated with the high-speed Received Data (BB) and the Receiver Signal Element Timing (DD) Circuits can be disabled. With the SCR unclamped option, Circuit DD will constantly supply the associated business machine with bit timing that will only be in synchronism with the data when the receiver has been trained (Section 3.3.15). This option is primarily intended to allow Data Set 203A-Type to be used as a regenerative repeater but may be used for other purposes if desired. With the RD unclamped option, signals on Circuit BB will only be valid when the Received Line Signal Detector (CF) Circuit is ON (Section 3.3.3).

2.2.2 Data Set Timing

The data set transmitter accepts serial binary data at the selected data rate synchronous with a bit rate timing signal which may be obtained from the business machine or internally from the data set. When the customer elects to supply the bit rate timing signal, it will be accepted by the transmitter in accordance with the interface standards. However, to achieve satisfactory performance of the data set, the external timing furnished by the business machine must be accurate to at least 0.001 percent.

2.2.3 Training Options

The Data Sets 203-Type require a start-up or training period of the high-speed channel to enable the data transmitter to condition the data receiver prior to actual transmission of high-speed customer data. The total time required for this training period is given in Figure 5. There are three different ways in which Data Set 203-Type can be arranged to enter and complete the training period. These are:

1. Exclusive Transmitter Control — The training interval can only be initiated under customer terminal control by turning ON the high-speed Request-to-Send (CA) Circuit at the transmitter. This option assumes the data receiver is on-line prior to the initiation of the training sequence.
2. Receiver Inhibit Using Secondary Channel — This option is provided to insure that the receiver is on-line and ready for training. Essentially, the initiation of the training sequence is triggered by turning ON the high-speed Request-to-Send (CA) Circuit at the transmitter. However, with this option, the completion of training is delayed until the reception of secondary channel energy from the station with the high-speed receiver.
3. Automatic Training — This training option is one which allows the transmitter to automatically train the receiver whenever needed. It is available only when full modems (Data Sets 203A) are used on 4-wire lines. Basically, the high-speed receiver decides when it needs to be trained and signals the appropriate transmitter using the other side of the 4-wire line. This process cycles until both sides of the 4-wire connection are ready for data transmission. This cycling will take place only when both high-speed Request-to-Send (CA) Circuits are held ON. With this option, the Clear-to-Send (CB) Circuit can be arranged to be either inhibited by the Carrier On Delayed (COD) Circuit or be independent of the Carrier ON Delayed (COD) Circuit. The Automatic Training option must be used when the Permanent Request-to-Send Option is employed.

Option 2 (Receiver Inhibit Using Secondary Channel) described above is intended for use on 2-wire half-duplex data services. Option 3 (Automatic Training) or Option 1 (Exclusive Transmitter Control) is suggested for use on 4-

wire full-duplex services. The basic start-up sequence and various optional modes are described in detail in Section 4.

2.2.4 Secondary Channel Carrier Control

To support the training options described in Section 2.2.3, three different strapping options have been provided to control the transmission of secondary channel carrier. These are:

1. Exclusive High-Speed Channel Control — This option allows no independent control of the secondary channel. Whenever the high-speed Request-to-Send (CA) Circuit is OFF, the secondary channel signal will be transmitted and the high-speed receiver will be placed on-line. Similarly, an ON condition on the high-speed Request-to-Send (CA) Circuit will cause the high-speed channel signal to be transmitted and the secondary channel receiver will be placed on-line. The additional Secondary Request-to-Send (SCA) Circuit associated with the secondary channel will have no effect on Data Set 203-Type when this option is used.
2. Independent Secondary Channel Control — This option allows the business machine to control the state of the secondary channel exclusively through the use of the Secondary Request-to-Send (SCA) Circuit. The state of the high-speed channel will have no effect on the secondary channel operation when this option is selected.
3. Semi-Independent Control of Secondary Channel — When the List 2, List 5 or List 6 speed options are selected, the spectrum of the main data channel overlaps with that produced by the secondary channel. Consequently, this option has been provided to insure that both signals are not transmitted over the same line pair at the same time (i.e., a single modem cannot transmit the carriers of both the high- and low-speed channels simultaneously). To achieve this, the state of the high-speed Request-to-Send (CA) Circuit is given priority over the state of the Secondary Request-to-Send (SCA) Circuit. Consequently, the table below is followed regarding the transmission of carrier (4-wire operation is assumed).

State of High-Speed Request-to-Send	State of Secondary Request-to-Send	High-Speed		Secondary	
		Transmitter	Receiver	Transmitter	Receiver
ON	ON	ON	ON	OFF	ON
ON	OFF	ON	ON	OFF	ON
OFF	ON	OFF	ON	ON	ON
OFF	OFF	OFF	ON	OFF	ON

The recommended use of the above strapping options is as follows:

Option	Type of Service
Exclusive High-Speed Channel Control	List 3 or List 4 speed option on switched message network or 2-wire private line.
Independent Secondary Channel Control	List 3 or List 4 speed option on 2- or 4-wire private line.
Semi-Independent Control of Secondary Channel	List 2, List 5 or List 6 speed options on 4-wire private line.

3. INTERFACE

The interface is the point of connection between the data set and the business machine. Each data set is equipped with a 25-pin female connector. The user must supply the plug and necessary cable to connect his equipment to the data set. As the male connector, a plug such as the DB-19604-432 plug manufactured by Cannon* or Cinch, is suggested. This type plug provides a reliable, low-resistance contact.

In addition, a DB-51226-1 Hood manufactured by Cinch or equivalent is recommended to protect the connections, anchor the cable to the plug, provide a finger grip for easy insertion or removal, and provide a positive screw-in locking arrangement to prevent the connector from being pulled out inadvertently.

For Data Set 203-Type with list code L9, a special applique is provided which permits connection to all the high-speed data and clock signals through a 15-pin connector. The mating connector (Cinch DA-19603-403 or equivalent), locking hood (Cinch DA-51225-1 or equivalent) and connecting cable must be supplied by the customer. A standard 25-pin connector is also provided for interfacing with all the provided circuits. The data and clock circuits in the 15-pin connector are paired with separate ground leads.

3.1 Electrical Considerations

3.1.1 EIA — RS-232-C

Data Sets 203-Type when ordered with the List 8 option are equipped to follow the recommendations of the Electronic Industries Association for digital data sets as described in the published Standards RS-232-C and RS-334.

3.1.2 MIL STD 188B

A summary of the electrical characteristics provided by the List 9 option for MIL STD 188B drivers and terminators is presented below.

Driver Characteristics

a. Open Circuit Output Voltage:

   6.1 volts $\pm$7 percent for both positive and negative voltages.

b. Source Impedance:

   Less than 90 ohms.

c. Output Waveforms:

   Rise and fall times of 11.7 microseconds $\pm$ 2.0 microseconds with a load impedance of 5000 ohms or more.

d. Short Circuit Current:

   Between 50 and 90 milliamperes.

Terminator Characteristics

a. Input Impedance:

   Greater than 8000 ohms for input levels less than or equal to an 18.5 volts absolute value.

b. Input Capacitance:

   Less than 1000 picofarads.

c. Maximum Operating Current:

   Less than 100 microamperes.

3.2 Interface Circuit Connections

3.2.1 EIA RS-232-C

All interchange leads for Data Sets 203-Type are terminated in a 25-pin receptacle mounted on the front of the data set. The following pin assignments are applicable to the various Data Sets 203-Type.

DATA SET 203A

Pin No.	EIA RS-232-C Nomenclature
1	Protective Ground (AA)
2	Transmitted Data (BA)
3	Received Data (BB)

* ITT — Cannon Electric,
Division of IT&T Corp.,
3208 Humboldt St.,
Los Angeles, California 90031

Cinch Manufacturing Co.,
1026 S. Homan Avenue,
Chicago, Illinois 60624

DATA SET 203A (Cont'd)

Pin No.	EIA RS 232-C Nomenclature
4	Request-to-Send (CA)
5	Clear-to-Send (CB)
6	Data Set Ready (CC)
7	Signal Ground (AB)
8	Received Line Signal Detector (CF)
9	For Telephone Company Use Only
10	For Telephone Company Use Only
11	Unassigned
12	Secondary Received Line Signal Detector (SCF)
13	Secondary Clear-to-Send (SCB)
14	Secondary Transmitted Data (SBA)
15	Transmitter Signal Element Timing (Internal) (DB)
16	Secondary Received Data (SBB)
17	Receiver Signal Element Timing (DD)
18	Carrier On Delayed (COD)*
19	Secondary Request-to-Send (SCA)
20	Data Terminal Ready (CD)
21	Signal Quality Detector (CG)
22	Ring Indicator (CE)
23	Data Signal Rate Selector (CH)
24	Transmitter Signal Element Timing (External) (DA)
25	Unassigned

* Pin No. 18 is unassigned and this circuit is not defined in EIA RS-232-C.

DATA SET 203B

Pin No.	EIA RS-232-C Nomenclature
1	Protective Ground (AA)
2	Transmitted Data (BA)
3	Not Applicable
4	Request-to-Send (CA)
5	Clear-to-Send (CB)
6	Data Set Ready (CC)
7	Signal Ground (AB)
8	Not Applicable

DATA SET 203B (Cont'd)

Pin No.	EAI RS 232-C Nomenclature
9	For Telephone Company Use Only
10	For Telephone Company Use Only
11	Unassigned
12	Secondary Received Line Signal Detector (SCF)
13	Secondary Clear-to-Send (SCB)
14	Secondary Transmitted Data (SBA)
15	Transmitter Signal Element Timing (DB)
16	Secondary Received Data (SBB)
17	Not Applicable
18	Unassigned
19	Secondary Request-to-Send (SCA)
20	Data Terminal Ready (CD)
21	Not Applicable
22	Ring Indicator (CE)
23	Data Signal Rate Selector (CH)
24	Transmitter Signal Element Timing (DA)
25	Unassigned

DATA SET 203C

Pin No.	EIA RS-232-C Nomenclature
1	Protective Ground (AA)
2	Not Applicable
3	Received Data (BB)
4	Not Applicable
5	Not Applicable
6	Data Set Ready (CC)
7	Signal Ground (AB)
8	Received Line Signal Detector (CF)
9	For Telephone Company Use Only
10	For Telephone Company Use Only
11	Unassigned
12	Secondary Received Line Signal Detector (SCF)
13	Secondary Clear-to-Send (SCB)

DATA SET 203C (Cont'd)

Pin No.	EIA RS 232-C Nomenclature
14	Secondary Transmitted Data (SBA)
15	Not Applicable
16	Secondary Received Data (SBB)
17	Receiver Signal Element Timing (DD)
18	Carrier ON Delayed (COD)*
19	Secondary Request-to-Send (SCA)
20	Data Terminal Ready (CD)
21	Signal Quality Detector (CG)
22	Ring Indicator (CE)
23	Data Signal Rate Selector (CH)
24	Not Applicable
25	Unassigned

*Pin No. 18 is unassigned and this circuit is not defined in EIA RS-232-C.

3.2.2 MIL STD 188B

For MIL STD 188B (L9) the listing of both the 15- and 25-pin connector is provided below.

15-PIN CONNECTOR

Signal Pin	Ground Pin	Data Set 203-Type Nomenclature
—	1	AA (Protective Ground)
2	9	BA (Transmitted Data)
3	10	BB (Received Data)
13	6	DD (Receiver Signal Element Timing)
15	8	DB (Transmitter Signal Element Timing)
4	11	DA (Transmitter Signal Element Timing External)
5,7, 12,14	—	Unassigned

25-PIN CONNECTOR

Pin No.	Data Set 203-Type Nomenclature
1	AA (Protective Ground)
2	BA (Transmitted Data)
3	BB (Received Data)
4	*CA (Request-to-Send)

*These leads conform to EIA RS-232C.

25-PIN CONNECTOR (Cont'd)

Pin No.	Data Set 203-Type Nomenclature
5	CB (Clear-to-Send)
6	CC (Data Set Ready)
7	AB (Signal Ground)
8	CF (Received Line Signal Detector)
9	For Telephone Company Use Only
10	For Telephone Company Use Only
11	Unassigned
12	SCF (Secondary Received Line Signal Detector)
13	SCB (Secondary Clear-to-Send)
14	SBA (Secondary Transmitted Data)
15	DB (Transmitter Signal Element Timing)
16	SBB (Secondary Received Data)
17	DD (Receive Signal Element Timing)
18	COD (Carrier ON Delayed)
19	*SCA (Secondary Request-to-Send)
20	*CD (Data Terminal Ready)
21	CG (Signal Quality Detector)
22	CE (Ring Indicator)
23	*CH (Data Signal Rate Selector)
24	DA (Transmitter Signal Element Timing External)
25	Unassigned

***These leads conform to EIA RS-232C.**

3.3 Purpose and Use of Interface Circuits

Data Set 203-Type is provided with at most twenty-three (23) interface circuits for connection to the customer's data equipment or associated installer test equipment. A description of the operation of each and the signals appearing on each follows for Data Set 203-Type with an EIA RS-232-C interface.

3.3.1 Protective Ground (AA)

This conductor is electrically bonded to the equipment frame. It is further connected to Local power grounds through the power cord.

3.3.2 Transmitted Data (BA)

Direction: TO Data Set

Signals on this circuit are generated by the transmitting business machine at the bit rate supplied by the data set or by the customer's own clock. The transitions of the data shall be coincident with the positive transitions of the bit clock DA or DB (Transmitter Signal Element Timing External or Internal). A positive signal is a binary "0" or SPACE and negative is a binary "1" or MARK.

The transmitting business machine equipment should hold Transmitted Data Circuit in the

"MARK" condition when no signals are to be transmitted. This lead is not used in Data Set 203C. No attempt should be made to transmit data until the Clear-to-Send (CB) Circuit is in the ON state.

3.3.3 Received Data (BB)

Direction: FROM Data Set

Received Data is supplied by the data set receiver in synchronism with the serial clock in the receiver (Circuit DD). The data transitions are coincident with the positive transitions of Circuit DD. A positive signal is a binary "0" or SPACE, and negative signal is a binary "1" or MARK. RD is normally clamped to "MARK" whenever the Received Line Signal Detector (CF) lead is OFF. However, when the Clamp Disable Option is provided (Section 2.2.1), data on this lead will only be valid when Circuit CF (Received Line Signal Detector) is ON. With this option provided and no signal being received, Circuit BB (Received Data) consists of one of two possible codes for each of the three bit rates. At the lowest bit rate (2-level operation), Circuit BB will be either a steady MARK or steady SPACE. At mid-range bit rate (4-level operation), Circuit BB will be either a dotting or steady SPACE. At the highest bit rate (8-level operation), RD will be either a "MARK-SPACE-MARK" or a "SPACE-SPACE-MARK" code.

This circuit is clamped marking in Data Set 203B.

3.3.4 Request-to-Send (CA)

Direction: TO Data Set

The Request-to-Send signal is supplied by the customer and is used by the Data Set 203 to turn on high-speed carrier and subsequently, condition the data set for transmission of high-speed data (initiate training). On 2-wire facilities, an ON condition on Circuit CA (Request-to-Send) will condition the data set as a high-speed transmitter. An OFF condition will condition the data set as a high-speed receiver. On 4-wire facilities, the data set is always conditioned for high-speed reception, and Circuit CA (Request-to-Send) is used only to turn ON the high-speed transmitter to enable the training of the distant receiver.

As described in Section 2.2.5, installer option straps may be provided for control of the low-speed channel with Circuit CA (Request-to-Send). When the secondary channel is used and installer option Exclusive High-Speed channel Control is provided, the Request-to-Send signal exclusively controls the low-speed channel. With Circuit CA (Request-to-Send) ON, the low-speed channel is conditioned to receive and with Circuit CA OFF, the low-speed channel is conditioned to transmit. With installer option Semi-Independent Control of Secondary Channel provided, both Circuit CA and Circuit SCA (Secondary Request-to-Send) control the low-speed channel. With this option, the low-speed channel is conditioned to transmit only when Circuit CA is OFF and Circuit SCA (Secondary Request-to-Send) is ON. Otherwise, the low-speed channel is conditioned to receive. With installer option Independent Secondary Channel Control provided, only the Secondary Request-to-Send signal controls the low-speed channel.

The Request-to-Send Circuit (CA) is internally clamped OFF in Data Set 203C.

Data terminal equipment designed for either transmit-only or duplex operation may hold the Request-to-Send Circuit ON all the time or use the Permanent Request-to-Send Option.

3.3.5 Clear-to-Send (CB)

Direction: FROM Data Set

The Clear-to-Send (CB) Circuit is supplied by the data set and indicates when data can be sent over the high-speed channel. Its state is primarily controlled by the operation of the Request-to-Send Circuit. However, the various data set speed and timing options somewhat affect the operation of this lead.

When the training of the distant receiver is under exclusive transmitter control, there is a fixed time interval between the placement of the ON condition on the Request-to-Send (CA) Circuit and the appearance of an ON signal on the Clear-to-Send (CB) Circuit, provided that the Data Set Ready (CC) Circuit is ON. This time interval for the available data set speed options is shown below.

Data Set Speed Option	Request-to-Send Clear-to-Send Delay
1800 baud (List 3)	10.5 seconds
2400 baud (List 2)	7.9 seconds
2400 baud (List 4)	7.9 seconds
3200 baud (List 5)	6.0 seconds
3600 baud (List 6)	5.2 seconds

When the training of the distant receiver is controlled by both the state of the Request-to-Send Circuit and the presence of secondary channel energy, the time interval between Request-to-Send ON and Clear-to-Send ON may be variable inasmuch as it depends on how rapidly the data set receiver enters the Data mode. This variable time, however, can be no shorter than that encountered under exclusive transmitter control. Once again, an ON condition on the Clear-to-Send (CB) Circuit will only occur if the Data Set Ready (CC) Circuit is ON.

When the Automatic Training with Clear-to-Send (CB) independent of Carrier On-Delayed (COD) option is selected (4-wire operation), the timing between the initial ON of Request-to-Send the the Clear-to-Send ON indication will be the same as that described for the exclusive transmitter control option. If the receiver decides it needs to be retrained, it will signal the transmitter and the Clear-to-Send (CA) Circuit will automatically be turned OFF even though the business machine is holding the Request-to-Send (CA) Circuit in the ON state. After retraining, the Clear-to-Send Circuit will again turn ON to indicate when data transmission can take place.

When the Automatic Training with Circuit CB inhibit by Circuit COD-OFF option is selected (4-wire operation) the operation of Circuit CB is the same as above except that Circuit CB will be clamped OFF whenever Circuit COD is OFF.

In addition to independently switching to the OFF state for automatic retraining, the Clear-to-Send (CB) Circuit will switch from ON to OFF immediately after Request-to-Send or Data Set Ready is switched OFF.

This lead is clamped OFF in Data Set 203C.

3.3.6 Data Set Ready (CC)

Direction: FROM Data Set

Signals on this circuit are generated by the local data set to indicate that it is ready to operate. A Data Set Ready ON indication is given when the associated Data Auxiliary Set 804-Type line control unit is switched to the Data mode, after a call has been established and the business machine is supplying a Data Terminal Ready ON indication to the data set. If the Data Auxiliary Set 804-Type is switched to the TALK mode, or if the call is terminated by the business machine switching Data Terminal Ready OFF, a Data Set Ready OFF indication is given. The Data Set Ready (CC) Circuit will also be held in the OFF condition when the data set is in the Remote or Local TEST modes.

The OFF condition on Circuit CC indicates one of the following:

a. Any abnormal or test condition exists which disables or impairs the service furnished.

b. That the communications channel is switched to the voice mode.

c. That the local data set is not connected to a communications channel (i.e., the data set is on-hook).

When no Data Auxiliary Set 804-Type line control unit is used, the Data Set Ready (CC) Circuit is permanently clamped ON except when the data set is in a test mode.

3.3.7 Signal Ground (AB)

This conductor establishes the common ground reference potential for all interchange circuits except Protective Ground. It is strapped to Protective Ground on the data set side of the interface to minimize the introduction of noise into electronic circuitry. However, this strap can be removed, if consistent with local electrical code regulations.

3.3.8 Received Line Signal Detector (CF)

Direction: FROM Data Set

This signal is provided by the data set to indicate when the signals appearing on the Received Data Circuit should be valid data. The Received Line Signal Detector (CF) Circuit initially switches from OFF to ON immediately after the data set receiver has been completely trained.

Circuit CF will immediately switch from ON to OFF if high-speed carrier is lost for more than 70 milliseconds.

Once trained, Circuit CF will switch from OFF to ON within 70 milliseconds when line signal is again received following a dropout of less than the holdover time shown in Section 4.3.17 (COD has not gone OFF).

This lead is clamped OFF in Data Set 203B.

3.3.9 Circuits 9 and 10

These circuits are for use by Telephone Company personnel only. The business machine should not be connected to these circuits.

3.3.10 Secondary Received Line Signal Detector (SCF)

Direction: FROM Data Set

This signal is provided by the data set to indicate when energy, within the bandwidth of the secondary channel and greater than -48 dBm, is being received by the secondary channel receiver. The Secondary Received Line Signal Detector (SCF) Circuit will switch from OFF to ON upon receipt of sufficient signal energy within 0.9 to 1.1 seconds for Data Set 203-Type List 1C, List 1D or List 1E. When the energy level drops below -48 dBm, Circuit SC will switch from ON to OFF within 130 milliseconds following the loss of signal energy.

This interface circuit will be clamped in the OFF state whenever the secondary channel receiver is not connected to the telephone line (see Section 4.3.11). When the secondary channel is not ordered (List 7 not requested), this interface signal will be clamped OFF.

3.3.11 Secondary Clear-to-Send (SCB)

Direction: FROM Data Set

This signal is provided by the data set to indicate when low-speed data can be transmitted assuming the remote low-speed receiver is on-line. A Secondary Clear-to-Send ON indication can only be given when the Data Set Ready Circuit is ON. With either the Data Set Ready Circuit OFF or the low-speed channel not in the transmit mode, the Secondary Clear-to-Send Circuit will be clamped in the OFF state.

When the data set is strapped to allow control of the low-speed transmitter by the Secondary Request-to-Send Circuit, the Secondary Clear-to-Send Circuit will turn ON 1.4 to 2.3 seconds for Data Set 203-Type List 1C, 1D or 1E after the Secondary Request-to-Send Circuit is switched from the OFF to ON state. When option Secondary Transmitter Controlled by Request-to-Send is in the data set (Exclusive High-Speed Channel Control), the Secondary Clear-to-Send Circuit will turn ON 1.4 to 2.3 seconds for Data Set 203-Type List 1C, 1D or 1E after the Request-to-Send Circuit is switched from ON to OFF.

After the business machine either turns OFF the Secondary Request-to-Send Circuit or turns ON the Request-to-Send Circuit (depends on the option), the Secondary Clear-to-Send Circuit will switch to the OFF state in 70 to 140 milliseconds for Data Set 203-Type List 1C, 1D, or 1E.

When the secondary channel is not ordered in Data Set 203A (List 7 is not requested), this interface signal will be clamped OFF.

3.3.12 Secondary Transmitted Data (SBA)

Direction: TO Data Set

Low-speed nonsynchronous data may be transmitted by the business machine at data rates of up to 150 bits per second. A positive voltage on this lead is treated as a binary "0" or SPACE signal and a negative voltage is a binary "1" or MARK.

The business machine should clamp the Secondary Transmitted Data (SBA) Circuit in a MARK condition whenever the Secondary Clear-to-Send interface circuit is in the OFF state. When the Secondary Clear-to-Send Circuit switches to the ON state, low-speed data may be presented on the Secondary Transmitted Data Circuit for transmission to the remote secondary channel receiver.

This interface lead is not used on Data Set 203A when ordered without the secondary channel (List 7 not requested).

3.3.13 Transmitter Signal Element Timing-Internal (DB)

Direction: FROM Data Set

The Transmitter Signal Element Timing (DB) Circuit is supplied by the data set to synchronize the business machine with the data set. This signal is a square wave at a frequency equal to the bit rate selected for data transmission. Consequently, the frequency of this CLOCK signal can be either equal to the baud rate,

twice the baud rate, or three times the baud rate, depending on the speed selected. Speed selection is accomplished by the proper manual operation of the BIT RATE switch in conjunction with the Data Signal Rate Selector (CH) interface circuit. As long as power is supplied to the data set, the Transmitter Signal Element Timing [Serial Clock (DB)] Circuit will continue to supply a CLOCK signal independent of the transmitter timing option selected (see Section 3.2.2).

This interface circuit is clamped marking in Data Set 203C.

3.3.14 Secondary Received Data (SBB)

Direction: FROM Data Set

This interface circuit passes the nonsynchronous data received by the secondary channel to the business machine. A positive voltage on this lead represents a binary "0" or SPACE signal, whereas a negative voltage is a binary "1" or MARK. The Secondary Received Data (SBB) Circuit will be clamped in a MARK condition when the Secondary Received Line Signal Detector (SCF) Circuit is in the OFF state. Whenever Circuit SCF switches from OFF to ON, the Secondary Received Data Circuit will immediately pass the received low-speed data to the business machine.

This interface circuit is clamped marking in Data Set 203A when the secondary channel is not ordered (List 7 is not requested).

3.3.15 Receiver Signal Element Timing (DD)

Direction: FROM Data Set

This signal provided by the data set is used to synchronize the receiving business machine to the received data and is a square wave at a frequency equal to the bit rate selected for data transmission. Consequently, the frequency of this clock signal can be either equal to, twice, or three times the baud rate, depending on the speed selected using the BIT RATE switch in conjunction with the Data Signal Rate Selector (CH) Circuit.

When the data set is on-line in the Receive mode and high-speed carrier is not being received, Circuit DD will be clamped in the MARK condition. Once the remote transmitter begins to train the receiver, Circuit DD will stay clamped in the MARK condition until the end of the Binary mode (see Section 4). At this point, Circuit DD will be unclamped and properly phased received timing will be passed to the business machine. If the Carrier On Delayed (COD) Circuit switches from ON to OFF at any time, Circuit DD will be once again clamped in the MARK condition. However, this clamp circuit can be disabled with a strapping option (Section 3.2.1) for operation as a regenerative repeater.

This interface lead is clamped spacing in data set 203B.

3.3.16 Carrier On Delayed (COD)

Direction: FROM Data Set

This signal is provided by the data set and is essentially a high-speed carrier detector. When the high-speed receiver is on-line and the remote transmitter is quiet, the Carrier On Delayed (COD) Circuit will be clamped in the OFF state. Once the high-speed transmitter is activated, the Carrier ON Delayed Circuit will switch from OFF to ON within 70 milliseconds following the reception of carrier. If high-speed carrier disappears, Circuit COD will switch from ON to OFF after the following holdover intervals have elapsed:

Speed Option	Hold-Over (Seconds)
2400 baud (List 2)	1.39
1800 baud (List 3)	1.85
2400 baud (List 4)	1.39
3200 baud (List 5)	1.04
3600 baud (List 6)	0.92

This interface signal is clamped ON in Data Set 203B, List 1C or 1D.

The importance of this carrier detector is that the data set maintains the receive timing phase in the absence of carrier for any period less than the hold-over time, and therefore does not have to be retrained.

3.3.17 Secondary Request-to-Send (SCA)

Direction: TO Data Set

This interface lead is provided to enable the

business machine to independently control the low-speed secondary channel.

On 2-wire facilities, an ON state on the Secondary Request-to-Send (SCA) Circuit will cause the data set to place the secondary channel transmitter on-line allowing for the transmission of low-speed data. An OFF state will correspondingly cause the data set to place the secondary channel receiver on-line. On 4-wire facilities, the secondary channel receiver will always be connected to the receive pair. Consequently, the state of the Secondary Request-to-Send Circuit will only control the low-speed transmitter.

As long as the data set is strapped for independent control (Section 2.4) of the secondary channel, the preceding description holds. If the data set is strapped for semi-independent control (Section 2.4), the Request-to-Send Circuit must be OFF to allow an ON condition on the Secondary Request-to-Send Circuit to activate the low-speed transmitter.

If the data set is strapped for control of secondary channel by Request-to-Send only, the Secondary Request-to-Send Circuit will not be recognized by the data sets.

When the secondary channel is not ordered with Data Set 203A (List 7 not requested), this interface signal will not be recognized by the data set.

3.3.18 Data Terminal Ready (CD)

Direction: TO Data Set

This signal is supplied by the business machine equipment and is only used by the data set when equipped with a Data Auxiliary Set 804-Type.

When the data set is in the "Automatic Answer" mode, a Data Terminal Ready (CD) ON will permit the data set to automatically answer a call on detection of ringing. After a call has been established, a Data Terminal Ready (CD) ON signal enables the data set to be switched between the "TALK" and "DATA" modes. Placing Data Terminal Ready OFF after a call has been established while in the DATA mode will immediately put the station "on-hook." To put the station "on-hook" while in the DATA mode, the Data Terminal Ready Circuit must be switched to the OFF state for a minimum of 50 milliseconds.

3.3.19 Signal Quality Detector (CG)

Direction: FROM Data Set

This signal is supplied by the data set to indicate when the high-speed receiver is presenting good data. When the high-speed receiver has not been trained, the Signal Quality Detector (CG) Circuit will be clamped in the OFF state. Once the training period begins, Circuit CG will normally come ON at the end of the Binary mode (Section 4). A Signal Quality Detector ON indication is given providing: a) carrier recovery is successfully maintained, b) receiver bit timing is successfully recovered and, c) the number of data crossings occurring near the center of the received "eye pattern" has not exceeded a predetermined threshold. After a Signal Quality Detector (CG) ON indication has been initially given, Circuit CG will switch OFF if the data crossings exceed a threshold corresponding roughly to an error performance of one error per hundred bits. For the Signal Quality Detector Circuit to switch back ON, the data crossings must be reduced to roughly correspond to an error performance of one error or less per thousand bits. Circuit CG will be clamped in the OFF state when the Carrier ON Delayed (COD) Circuit is OFF.

This interface signal is clamped OFF in Data Set 203B.

3.3.20 Ring Indicator (CE)

Direction: FROM Data Set

Signals on this circuit indicate to the business machine that a ringing signal is being received. A Ring Indication ON is given to the business machine equipment whenever ringing occurs. When Data Auxiliary Set 804-Type is not provided, the Ring Indicator (CE) Circuit is clamped in the OFF state.

3.3.21 Data Signal Rate Selector (CH)

Direction: TO Data Set

This interface lead is furnished to allow the business machine to switch between the two highest bit rates of the data set when the BIT RATE (Figure 4) switch of the data set is placed in the CC (Customer Control) position. When

the Data Signal Rate Selector (CH) Circuit is ON, the highest bit rate of the speed option provided is selected. With Circuit CH in the OFF state, the next to the highest bit rate of the speed option provided is selected.

Note: The data set should be retrained whenever the data set speed is switched. This rules out the use of the Permanent Request-to-Send Option when Circuit CH is used.

3.3.22 Transmitted Signal Element Timing-External (DA)

Direction: TO Data Set

This interface circuit is provided to allow the business machine to supply the bit timing for the high-speed transmitter. The Transmitter Signal Element Timing — External (DA) signal must be a rectangular wave with a duty cycle of 50 $\pm$10 percent at a fundamental frequency equal to the bit rate selected for data transmission. Consequently, the frequency of this clock signal will be either equal to, twice, or three times the baud rate, depending on the setting of the BIT RATE switch and, if applicable, the state of the Data Signal Rate Selector interface circuit. The frequency of Circuit DA must be accurate to within 0.001 percent of the required bit rate.

This interface lead is not used in Data Set 203C and has no effect on the data set when the strapping option for internal timing is provided.

4. OPERATION

4.1 Training Sequence — General

To provide proper operation, Data Set 203-Type requires:

1. To linear distortion characteristics (delay and slope) of every connection to be precisely compensated for to allow higher data rates.
2. Different receiver carrier phase adjustments to be made for each connection used for transmission since the demodulation scheme is coherent.

To achieve this, Data Set 203-Type utilizes a training or start-up period to condition the receiving data set prior to actual transmission of customer data. In the training period, the high-speed transmitter sends a fixed sequence of signals which is used by the receiver to make the necessary adjustment for the channel.

4.1.1 Modes of Training Sequence

The training period is broken down into four different modes. These are the Operator Tone mode, the Steady Carrier mode, the Binary Data mode, and the Multilevel Data mode. (See Figure 5.) These modes follow the sequences involved in establishing the voiceband channel (see Section 4.2.1).

When in the Operator Tone mode, the transmitting data set sends a single tone whose frequency is half the baud rate (i.e., 900 Hz for the 1800 baud speed option — List 3). This tone lasts for nominally either 2.3 seconds (List 3), 1.7 seconds (List 2 or List 4), 1.3 seconds (List 5) and 1.1 seconds (List 6). The purpose of this tone is:

1. To trigger the data receiver to recognize that the training sequence is starting.
2. To give the operator of the data receiver some time to transfer the data set from TALK to DATA when using a Data Auxiliary Set 804A- or M-Type.

After the Operator Tone mode, the transmitting data set sends only the carrier signal and two pilot tones. During this Steady Carrier mode, the data receiver adjusts the phase of the recovered carrier. The Steady Carrier mode lasts for nominally either 1.4 seconds (List 3), 1.1 seconds (List 2 and List 4), 0.8 second (List 5) or 0.7 second (List 6).

Following the Steady Carrier mode, the transmitting data set sends the carrier modulated with the outermost levels of the quasi-random baseband signal generated internally by the scrambler. As this binary data (Binary Data mode) is being received, the receiver bit timing is properly synchronized with the zero crossings of the data and the automatic equalizer is coarsely adjusted to compensate for the line. The Binary Data mode lasts for nominally either 3.1 seconds (List 3), 2.3 seconds (List 2 and List 4), 1.8 seconds (List 5) and 1.6 seconds (List 6).

The next mode of the training period is the Multilevel Data mode where the transmitting data set sends the carrier modulated with all levels generated by the quasi-random word of the data set scrambler. Using this multilevel signal, the receiver fine-adjusts the automatic equalizer to complete the line compensation process, and the descrambler of the receiver synchronizes itself. The Multilevel Data mode lasts for nominally either 3.7 seconds (List 3), 2.8 seconds (List 2 and List 4), 2.1 seconds (List 5) or 1.8 seconds (List 6).

When the training period is executed without interruption (Section 2.2.3), the total time required is nominally 10.5 seconds (List 3), 7.9 seconds (List 2 and List 4), 6.0 seconds (List 5) and 5.2 seconds (List 6).

4.1.2 Training Under Exclusive Transmitter Control

This option allows the Data Set 203-Type to transmit the entire training sequence whenever the business machine turns ON the Request-to-Send Circuit (see Figure 6). In this mode, the business machine at the transmitting station has exclusive control over when the receiver is to be trained. As Figure 6 indicates, with this exclusive mode of control, the transmitting business machine must be sure that the remote data receiver is on-line before turning ON Request-to-Send. If this is not done, a portion of the training signal may not be received and consequently, proper training will not occur. In particular, the data receiver must be on-line before the steady carrier portion of the training sequence is transmitted. Because of this restriction, this method of Training Sequence Control should not be used when manually calling a data transmitter arranged for automatic answer. This option can be used in private line arrangements or in dial switched network arrangements where a transmitter always calls a receiver and turnaround operation is not used.

4.1.3 Training with Secondary Channel Inhibit

To reliably insure that the data receiver is on-line before training begins, a Telephone Company installer option (Section 2.2.3) is available which uses the secondary channel provided in Data Set 203. This option arranges the data transmitter to begin transmitting the training sequence when the Request-to-Send (CA) Circuit is turned ON but inhibits the completion of the training until reverse secondary channel energy is detected at the transmitter (see Figure 7). This option is recommended for 2-wire dial switched network operation.

When this option is provided, the training sequence will be initiated by the transmission of operator tone as soon as the Request-to-Send (CA) Circuit of the transmitter is turned ON. Operator tone will be continuously transmitted, however, until the receiving data set goes on-line and sends secondary channel carrier back to the transmitter. When the transmitting data set detects the secondary channel carrier, the training sequence will continue with the transmission of the rest of the training modes.

4.1.4 Automatic Retraining (4-Wire Operation Only)

When Data Set 203-Type is provided on a 4-wire circuit to supply full-duplex high-speed data service, a third mode of training sequence control can be supplied on a Telephone Company installer option basis. This option is one that will provide automatic retraining of the data receivers in addition to the usual training sequence control via the Request-to-Send interface circuit (Section 4.1.2).

The automatic retrain feature is operational only when the Request-to-Send (CA) Circuits of both modems are held in the ON state. In this configuration, the data receivers will look for either an excessive line dropout or the Signal Quality Detector (CG) turning OFF as an indicator that a retrain is required. When either condition is observed in a receiver, that receiver's companion transmitter will be automatically triggered to send the training sequence to the distant modem. When the remote modem detects the Operator Tone mode of the training sequence it will appear to be an excessive line dropout. Consequently, the remote receiver will trigger its associated transmitter to send the training signals to the near-end receiver that initially originated the retrain sequence.

When the high-speed transmitters are triggered to automatically send the training sequence, the appropriate Clear-to-Send (CB) interface

circuits will be switched to the OFF state. With option "Clear-to-Send inhibited by COD" installed, the Clear-to-Send (CB) ON indication will only reappear after the sequence of training signals has been sent and high-speed carrier is being received by the modem. In this case, both transmit and receive channels must be operational before a Clear-to-Send ON is given. With option "Clear-to-Send not inhibited by COD" installed, the Clear-to-Send ON indication will reappear after the sequence of training signals has been sent. In this case, the transmit channel is not inhibited by a loss of the received line signal. An additional feature of the automatic retrain option is that it provides remote control of the far-end transmitter via the Request-to-Send Circuit on the local data set.

Figure 8 is a timing diagram which depicts the interface operation that will take place when a temporary line dropout occurs on one side of the 4-wire circuit. If a complete collapse of one of the sides of the 4-wire facility occurs, the data set will respond as shown in Figure 9. When the circuit is restored, another retrain will take place (Figure 10). If the 4-wire circuit remains intact but for some reason signal quality is lost, a retrain will occur automatically as depicted in Figure 11.

4.1.5 Automatic Retraining Auxiliary Channel (ARAC) Operation (4-Wire Operation Only)

The Automatic Retraining Channel is a special option intended for customers who have independent outbound and inbound data flow. With this option, the Data Set 203A/L2 or L6 can be retrained using only half of a duplex 4-wire facility. The retraining is initiated by the ARAC circuitry in the data set in response to (1) poor line signal quality, (2) restoral of a line after a line drop-out that exceeded the data set holdover time, and/or (3) simultaneous recovery of both channels of the full-duplex line.

When a local Data Set 203A receiver requires retraining, it initiates a timed sequence in the local ARAC transmitter and the resulting signal is transmitted through the outbound data link to the remote ARAC receiver. The remote ARAC receiver detects the signal and, in turn, initiates a training sequence in the remote Data Set 203A transmitter. At this point the training sequence proceeds as shown in Figure 5. The ARAC signals do not interfere with the primary high-speed data stream.

To achieve the ARAC functions, the customer terminal must provide the proper cross connections at the CUSTOMER interface connector. The Request-to-Send (CA, pin 4) Circuit must be connected to the Secondary Received Data (SBB, pin 16) Circuit, and the Signal Quality Detector (CG, pin 21) circuit must be connected to the Secondary Transmitted Data (SBA, pin 14) Circuit. No other connections must be made to these circuits. These cross connections must be provided for every Data Set 203A using the ARAC function.

4.2 Switched Message Network Operation

As indicated in Section 2.1.2, the List 3 and List 4 speed options of Data Set 203-Type can be used for operation on the switched message network. For this service, the following operations should be followed to insure proper operation of the data set.

4.2.1. General Call Set-Up Procedure

Attendant depresses the "TALK" button on the Data Auxiliary Set 804A, lifts the handset, and dials the number of the distant data set.

The calling operation could also have been performed by the business machine using an Automatic Calling Unit (Data Auxiliary Set 801-Type) if the called data set is arranged for unattended answering.

If the call is answered manually, after the attendants have decided to enter the Data mode, the attendant at the called end depresses the "DATA" button. The attendant at the calling (originating) end then listens for a high-pitched (2025 Hz) tone, and when the tone changes to a lower pitch, he will then depress and release the nonlocking "DATA" button and place the handset on-hook.

If the call is answered automatically, the attendant at the calling (originating) end will hear a high-pitched (2025 Hz) tone, and when that tone changes to a lower pitch, he will then depress and release the nonlocking "DATA" button and place the handset on-hook. If the call was originated by an ACU, the ACU will detect the end of the high-pitched (2025 Hz) tone and place the originating data set in the Data mode.

The call will be terminated when the "TALK" button is pushed and the telephone handset is momentarily lifted off-hook and then replaced on-hook or when the DTR (Data Terminal Ready) interface lead is turned OFF for 50 milliseconds or more while the data set is in the DATA mode.

4.2.2 Transmitter Calling Receiver

Figure 12 depicts the call set-up procedure that will be encountered when a high-speed transmitter calls a high-speed receiver. As shown in the figure, the receiver will enter the Data mode first and disable echo suppressors. For this call set-up arrangement, the high-speed receiver will be on-line before the high-speed transmitter.

As Figure 12 shows, the time required at the transmitter to enter the Data mode will be typically less than 92 milliseconds when an Automatic Calling Unit originates the call. If the call is manually originated, the response time may be lengthened quite a bit. As a result, the receiving business machine should delay the transmission of low-speed data until the COD (Data Carrier Detector Delayed) interface circuit turns ON. This additional delay will insure that the low-speed receiver is unclamped and ready to receive data.

4.2.3 Receiver Calls Transmitter

The call set-up procedure that will be followed when a high-speed receiver calls a high-speed transmitter is shown in Figure 13. In this situation, the transmitter will enter the Data mode first and subsequently disable echo suppressors.

As indicated in Figure 13, the time required for the receiver to enter the Data mode will be typically less than 92 milliseconds when an Automatic Call Unit originates the call. If the call is manually originated, this response time may be lengthened quite a bit.

4.2.4 Turnaround Sequence

One method that can be used to turn around Data Set 203A is shown in Figure 14. This procedure is based on having the high-speed transmitter request the turnaround.

As Figure 14 clearly shows, the total time required to turnaround will be at least the duration of the training interval. (See Figure 5.)

4.3 Private Line Operation

Private line operation differs from dial switched network operation in that private line facilities are dedicated between local station locations and may or may not have alternate voice capability. If alternate voice capability is provided, the Data mode is entered by the pushing of the "DATA" button on the associated Data Auxiliary Set 804-Type. If the service is data-only (no voice capability required), the data sets are continuously in the Data mode and the training sequence can be initiated by business machine control of the Request-to-Send interface circuit or automatically (4-wire).

A number of the possible private line configurations are described in the following sections.

4.3.1 Two-Wire Private Line

Due to the amount of time required to train Data Sets 203-Type, it is recommended that the data set only be operated when some reverse transmission channel is available. As a result, the only 2-wire private line configurations available for service are ones employing the List 3 or List 4 speed options with the simultaneous secondary channel (List 7).

When the List 3 or List 4 speed options are used with a secondary channel for data-only service on a 2-wire private line, Telephone Company installer options (Sections 2.3 and 2.4) should be provided to insure that the initiation of the training sequence is controlled by the secondary channel and the secondary channel is controlled only by Request-to-Send. Figure 15 depicts the start-up procedure that would take place with this 2-wire configuration. When turnaround is required, the sequence depicted in Figure 14 could be employed.

4.3.2 Four-Wire Private Line

Since the 4-wire configuration always insures that both forward and reverse signaling channels are available, any speed option of Data Set 203-Type may be used on 4-wire lines without a secondary channel. When the List 2, List 5 or List 6 speed options are used, the secondary channel cannot be transmitted simultaneously with the primary data signal due to spectrum overlap between the high and low-speed channels. To prevent this, an installer strapping option to control the secondary

channel by either Request-to-Send or both Request-to-Send and Secondary Request-to-Send (Section 2.4) should be installed. When either strapping option is selected, the 4-wire configuration will be capable of:

1. Half-duplex high-speed operation using the low-speed acknowledgment channel.
2. Duplex high-speed operation, or
3. Duplex low-speed operation.

In addition, with the List 3 or List 4 speed option and installer option to control the secondary channel by the Secondary Request-to-Send only, the 4-wire configuration is capable of simultaneous duplex high-speed and low-speed operation.

When the List 3 or List 4 speed option is provided on a 4-wire private line, any one of the optional training sequence control modes (Section 4.1) can be supplied together with the appropriate secondary channel control. Consequently, this creates quite a bit of flexibility in controlling the operation of the 4-wire service.

One of the more important Data Set 203-Type 4-wire configurations will be the one offering duplex high-speed operation. The initial start-up of this mode of operation is shown in Figure 16. For this mode of operation, it is recommended that the automatic retrain option be used (Section 4.1).

4.3.3 Use with Data Auxiliary Set

In addition to the above, the Data Auxiliary Set 804-Type may be used in conjunction with Data Set 203-Type to provide the following: (See Section 1.6)

1. Operation on two-wire or four-wire private line with switched message network backup
2. Operation on a four-wire switched network
3. Four-wire operation using two switched message network lines

5. TESTING

5.1 Local Test

The Local Test feature allows the customer with a duplex terminal to test the back-to-back performance of his local data terminal equipment and data set. To enter the Local Test mode the customer should place the Mode Control Switch (see Section 1.7.2 to Local Test. The data set is then disconnected from the communications channel (see Figure 17) and looped back on itself through a pad, while the line is terminated toward the other end. In this test mode the Data Set Ready Circuit is OFF, but the other control interface circuits, Request-to-Send, Clear-to-Send, and Received Line Signal Detector operate as though the data set is in the Line mode for normal operation.

5.2 Remote Test

A remote test feature, (see Figure 17) which permits a Bell System Data Test Center, to determine whether the data set is in working condition is contained in the Data Set 203-Type.

The data set to be tested is placed in the Remote Test mode using a Data Auxiliary Set 804-Type or by a switch on the data set. When using a Data Auxiliary Set 804-Type, the procedure for entering the Remote Test mode after establishing a call with the test center is to push and release the TEST and other related buttons that the attendant at the data test center may request. The handset may then be replaced on its cradle. Successful entry into the remote test is indicated by the lighting of the TEST lamp on the Data Auxiliary Set 804-Type and the REMOTE TEST lamp (Figure 4) on the data set. Without the Data Auxiliary Set 804-Type, entry into the Remote Test mode is made by momentarily placing the Mode Control Switch (Figure 4) on the data set to REMOTE TEST and then back to LINE.

The Data Test Center will normally release the data set from the Remote Test mode. The release will be indicated by an OFF condition of the TEST lamp on the Data Auxiliary Set 804A or 804M and the REMOTE TEST lamp on the data set. The remote test may also be released at the data set by:

a. Pushing and releasing the TEST button on the Data Auxiliary Set 804A while on-hook, or

b. Going off-hook (lifting the handset) and going into the TALK mode (pushing the TALK button) on the Data Auxiliary Set 804M, or

c. Momentarily placing the LOCAL TEST — LINE — REMOTE TEST Key on the data set to LOCAL TEST and then back to the LINE position.

5.3 Digital Loopback Test

Operation of the Digital Loop-Back switch in conjunction with the Mode Control Switch on Data Set 203A-Type connects the data set as a regenerator (see Figure 17); that is, it conditions the data set transmitter to accept external timing, connects the Received Data Circuit (BB) to the transmitted Data Circuit (BA), connects the Receiver Signal Element Timing Circuit (DD) to the Transmitter Signal Element Timing — External (DA) Circuit and disconnects the control circuits to and from the customer's data terminal. Furthermore, it puts the Request-to-Send Circuit under the control of the Carrier on Delayed Circuit in order to initiate the training sequence from the data set. With this feature, a customer with testing capabilities in his local terminal has the capability to isolate a trouble condition between his remote terminal and the Telephone Company equipment.

To place the data set in the Digital Loop-Back mode the customer first operates the Mode Control Switch to the Remote Test or C position, returns it to the Line or D position (Remote Test lamp remains lighted) and then places the Digital Loop-Back switch to the In or A position. The data set is then looped at the interface and may be controlled by the testing data set as follows.

The testing terminal turns ON its Request-to-Send Circuit, causing the startup of the receiver in the remote data set. In response to the Carrier On Delayed Circuit turning ON, the remote data set initiates the training sequence to start-up the receiver in the testing data set.

If the testing data terminal does not have control of the Request-to-Send Circuit, then the automatic training option should be installed. Testing may begin as soon as the Received Line Signal Detector turns ON.

At the conclusions of the test, the attendant at the data set being tested restores the data set to normal by placing the Digital Loop-Back switch in the OUT or B position, then operates the Mode Control Switch first to the Local Test or E position and then to the Line or D position and observe that the Remote Test lamp is out.

6. PERFORMANCE

This section is included to provide the data terminal designer and the customer with some insight into the performance that can be expected from systems employing Data Sets 203-Type.

6.1 DATA-PHONE® Service

Results of Data Set 203-Type performance at 3600 bps and 4800 bps on the switched telecommunications network are given in an article by Balkovic, Klancer, Klare, and McGruther, entitled "1969-70 Connection Survey — High-Speed Voiceband Data Transmissions Performance on the Switched Telecommunications Network." Bell System Technical Journal, Vol. 50, No. 4, (April, 1971), pp. 1349-1384. Figures 18 to 20 show the bit and block error rates for Data Sets 203-Type based on data from that survey report. Note that this data is taken from a number of calls from a number of locations across the country. Performance from any one location may deviate substantially from that shown in the figures.

Data Sets 203-Type employ a self-synchronizing scrambler. As a result, single bit transmission errors will be presented as a sequence of three bits in error that occur within 23 bits of the original transmission error. However, error bursts will mask this effect whereas relatively quiet lines will exhibit average error rates that are higher by a factor of three. Although the bit error rate is higher the block error rate should not be significantly affected by the scrambler. Consequently, for systems with error detections and block retransmission, the system throughput will not be decreased.

6.2 Private Line Service

It is recommended that, for 4-level operations, Data Sets 203-Type should use C2 conditioned private lines. Since Data Sets 203-Type use automatic adaptive equalization which compensates for slope and delay whether on

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the switched message network or on private line, it is anticipated that the performance of 4-level operation (3600 bps, 4800 bps, 6400 bps or 7200 bps) over C2 conditioned private line facilities will be comparable to the performance at 3600 bits per second (4-level) over the switched message network indicated in Section 6.1 above.

Note: The performance at 8-level operation (5400 bps, 7200 bps, 9600 bps or 10,800 bps) will be substantially less than that achieved at the corresponding 4-level operation in the majority of the cases. Operation at 8-level is not permitted over the switched message network. It is of a permissive nature over private lines. It should only be used in systems capable of operating with reduced performance. If a choice is available between list options to attain a required speed (e.g., 7200 bps with L2 at 8-levels or with L6 at 4-levels), the option utilizing fewer levels is generally superior.

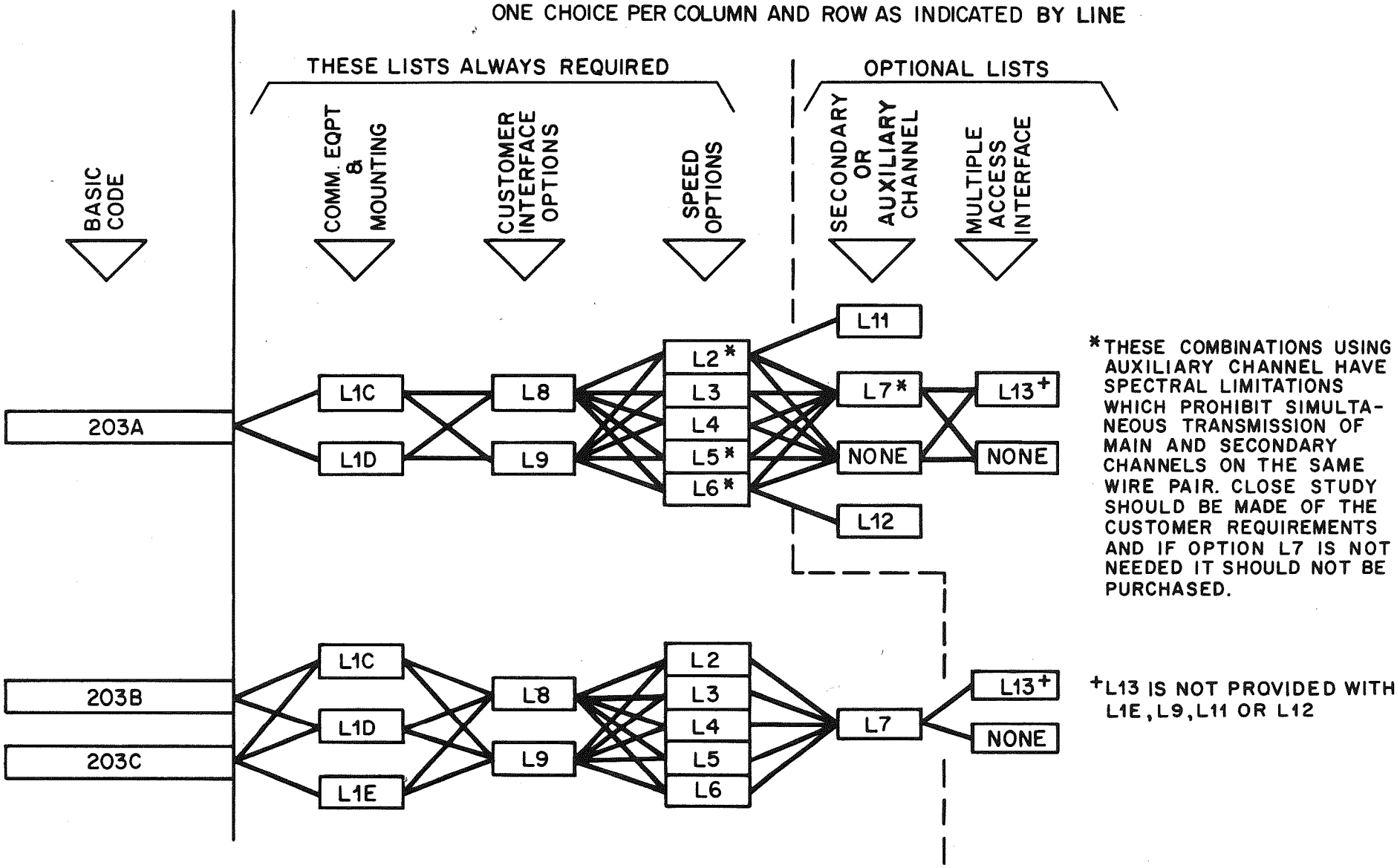


FIGURE 1 – DATA SET 203 LIST COMBINATIONS

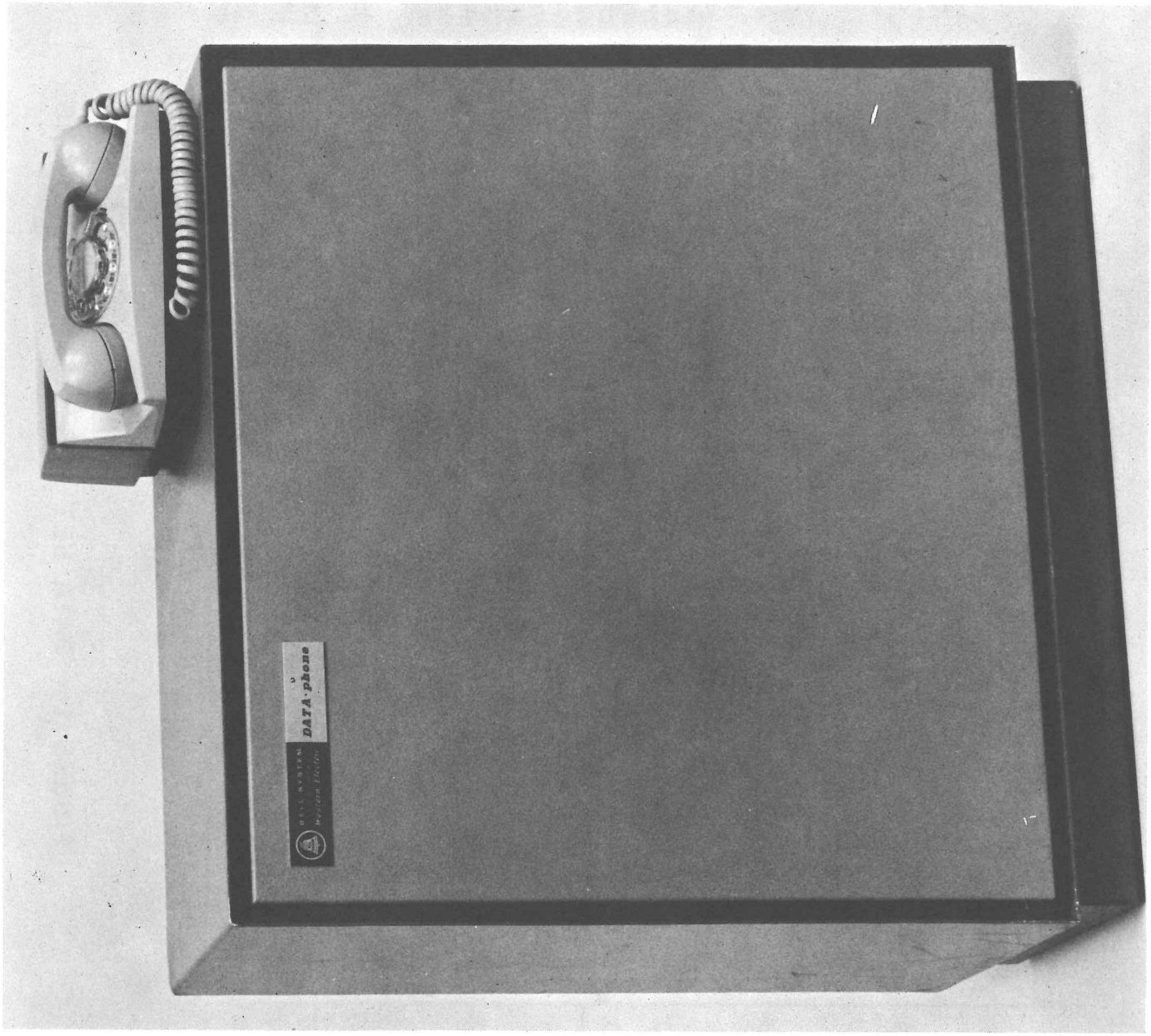


FIGURE 2
DATA SET 203A-TYPE WITH
ASSOCIATED DATA AUXILIARY
SET 804A OR M TYPE

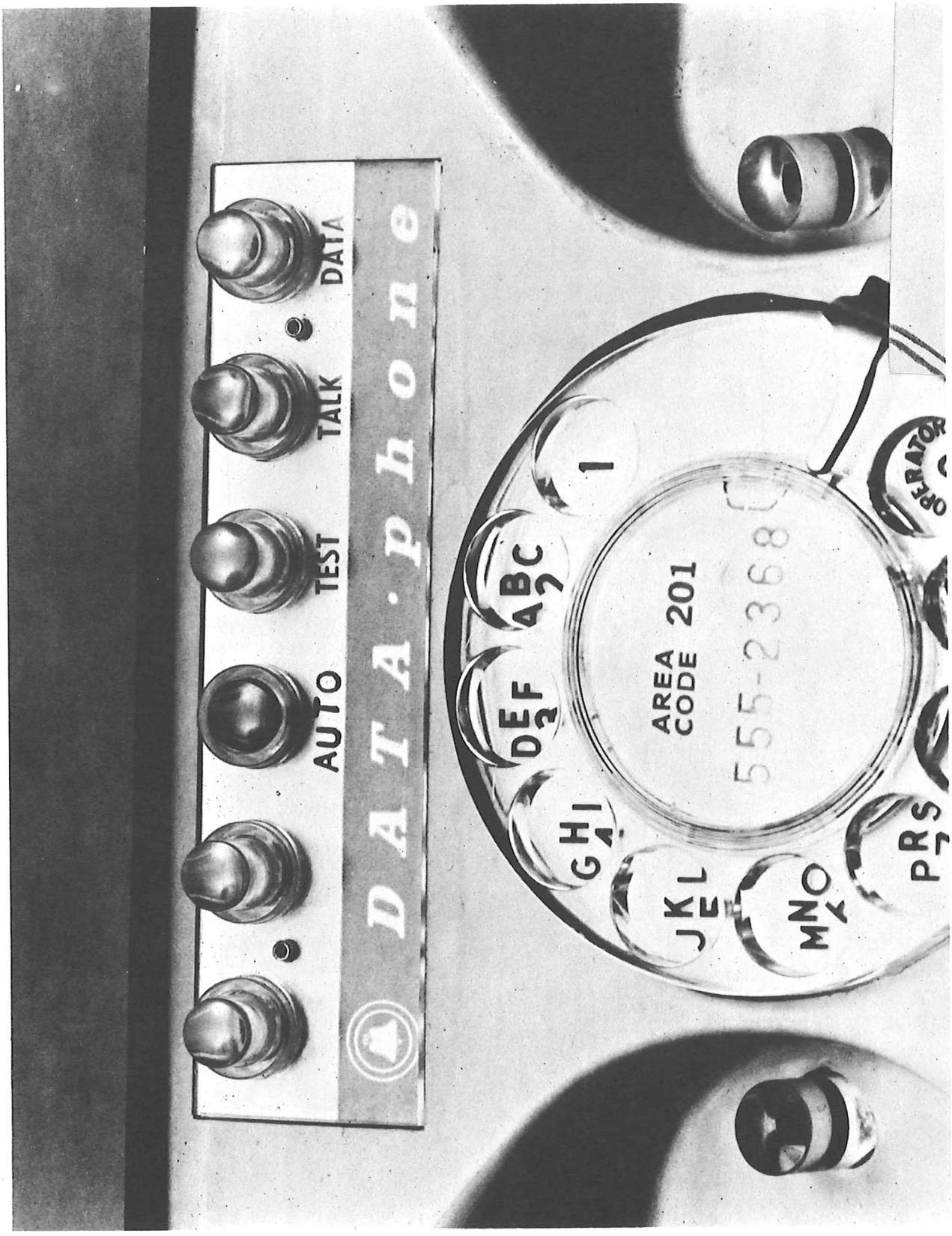
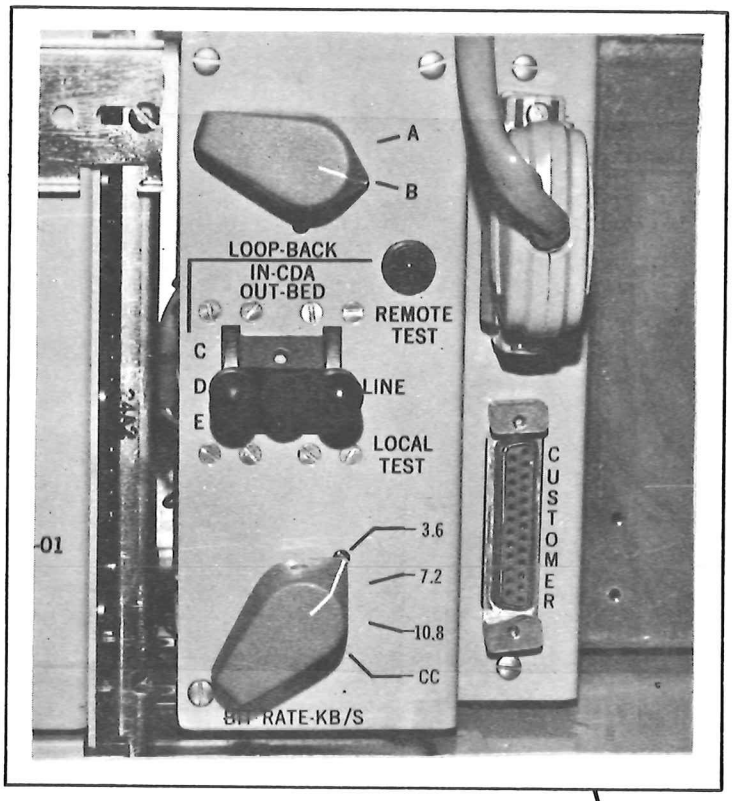


FIGURE 3
DATA AUXILIARY SET
804-TYPE PUSHBUTTONS



INSERT "A"
CONTROL PANEL

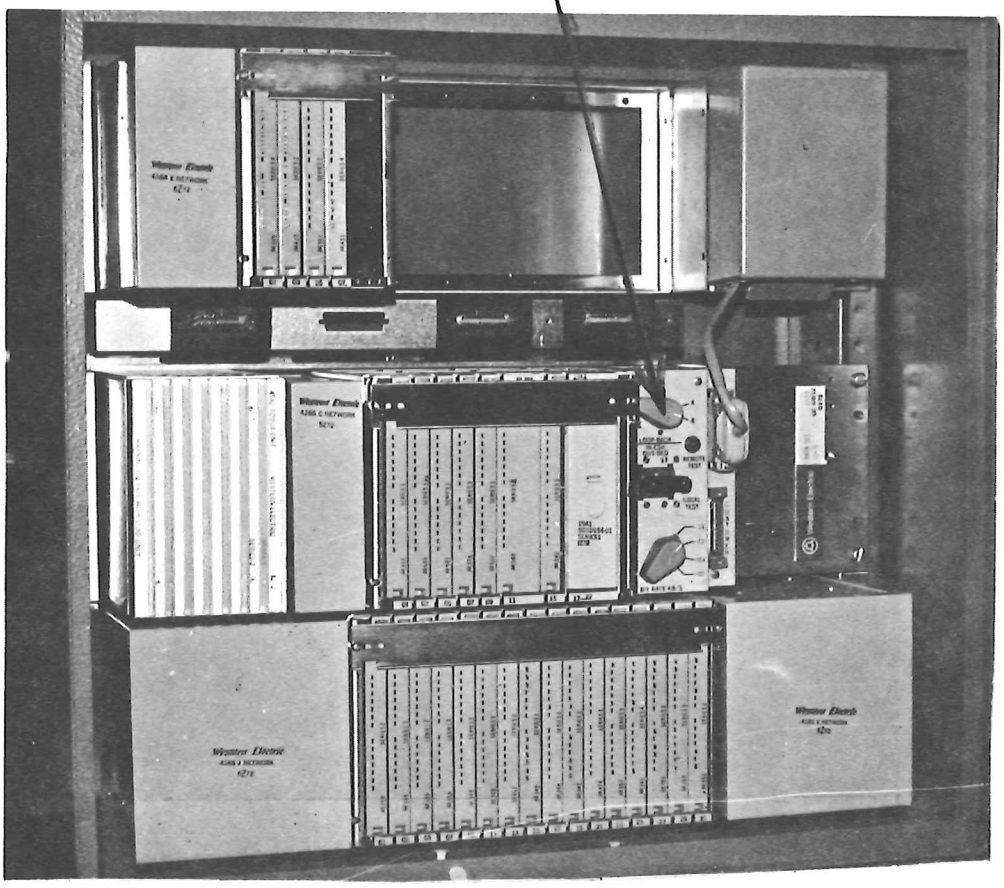
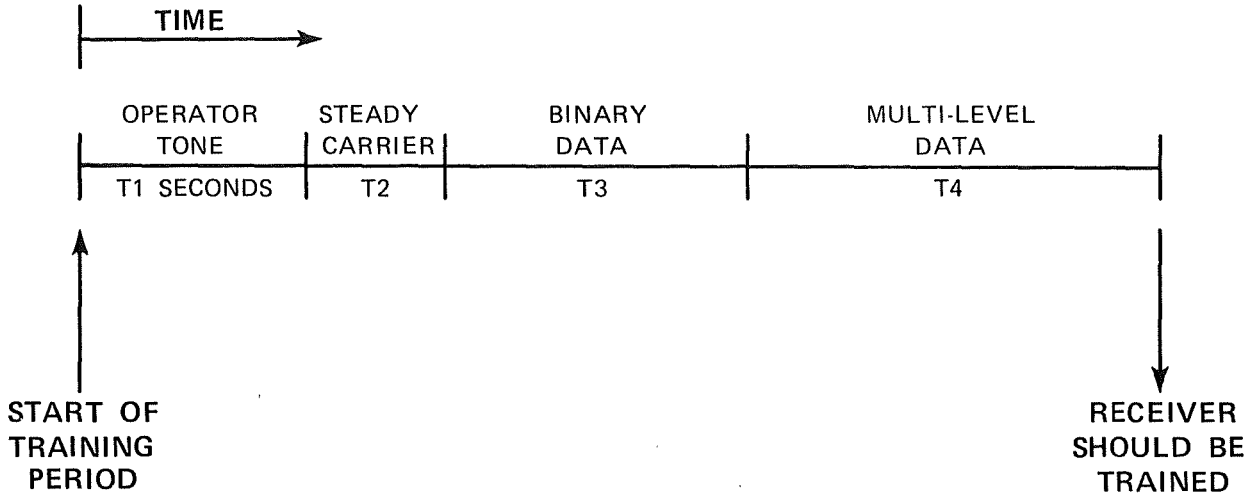


FIGURE 4
DATA SET 203
CONTROL PANEL



TIME IN SECONDS	SPEED OPTION			
	LIST 3 1800 BAUD	LIST 2 or 4 2400 BAUD	LIST 5 3200 BAUD	LIST 6 3600 BAUD
T1	2.3	1.7	1.3	1.1
T2	1.4	1.1	0.8	0.7
T3	3.1	2.3	1.8	1.6
T4	3.7	2.8	2.1	1.8
TOTAL	10.5	7.9	6.0	5.2

FIGURE 5
DATA SET 203
TRANSMITTER START-UP SEQUENCE

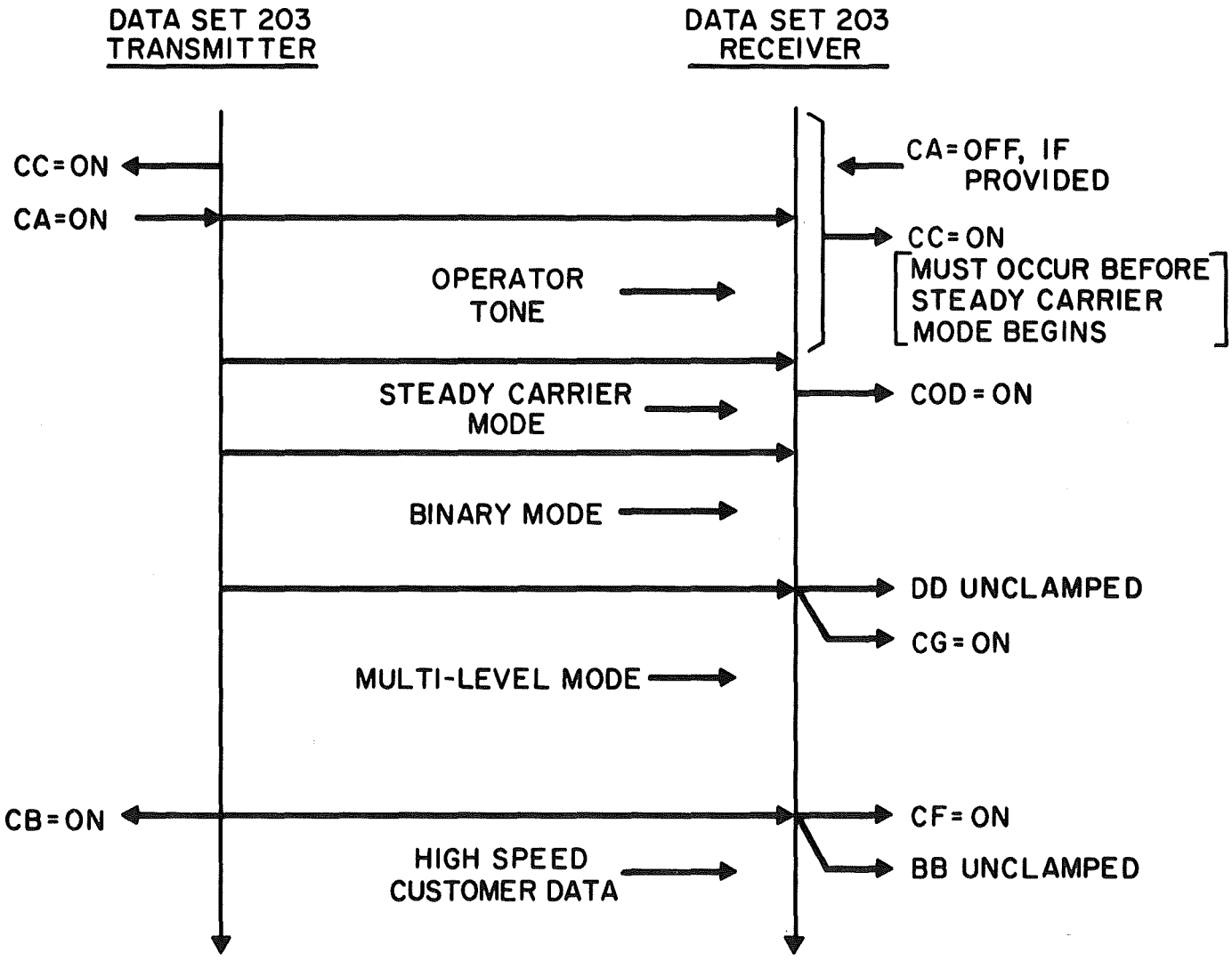


FIGURE 6 - TRAINING UNDER EXCLUSIVE
TRANSMITTER CONTROL

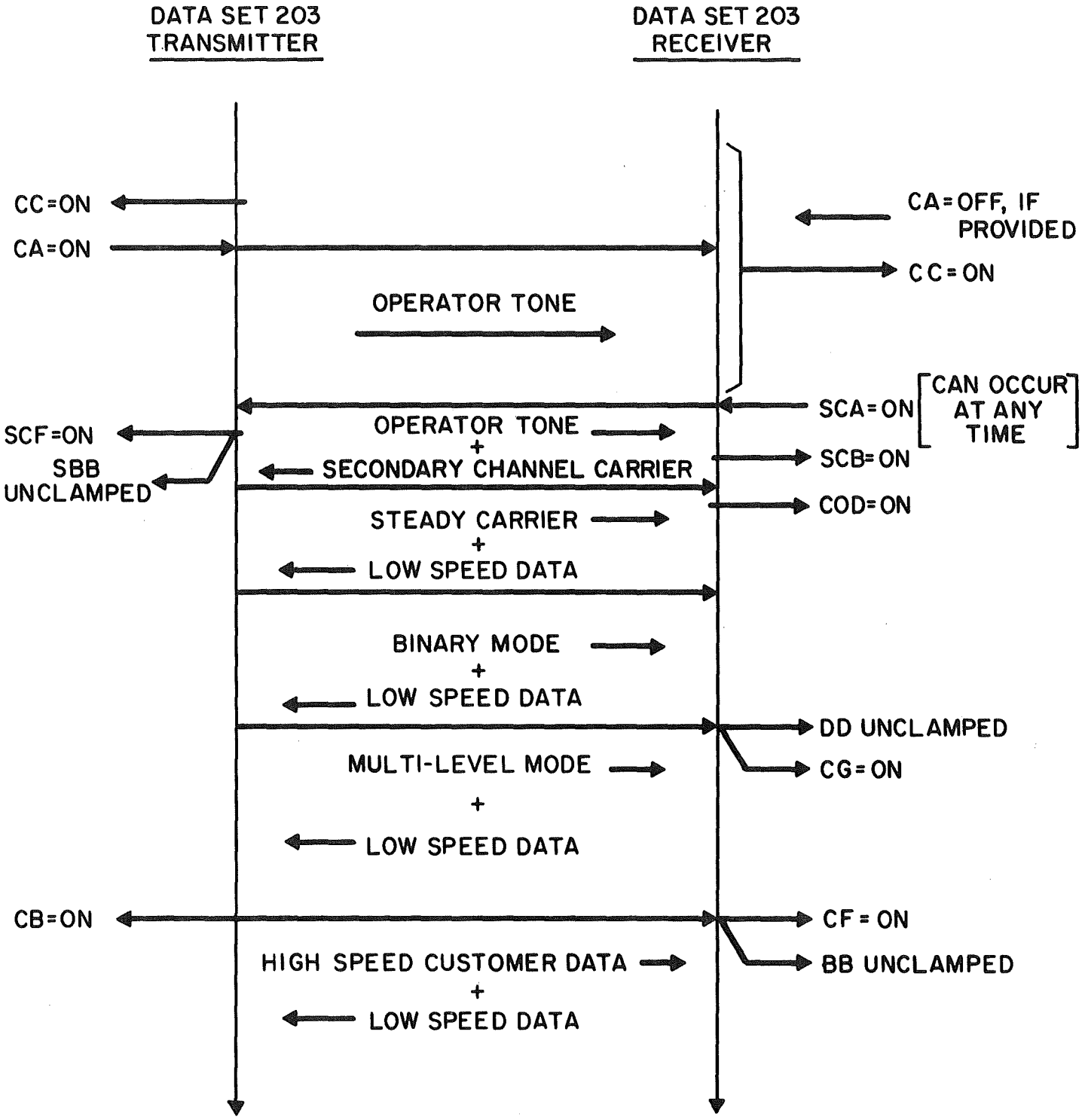
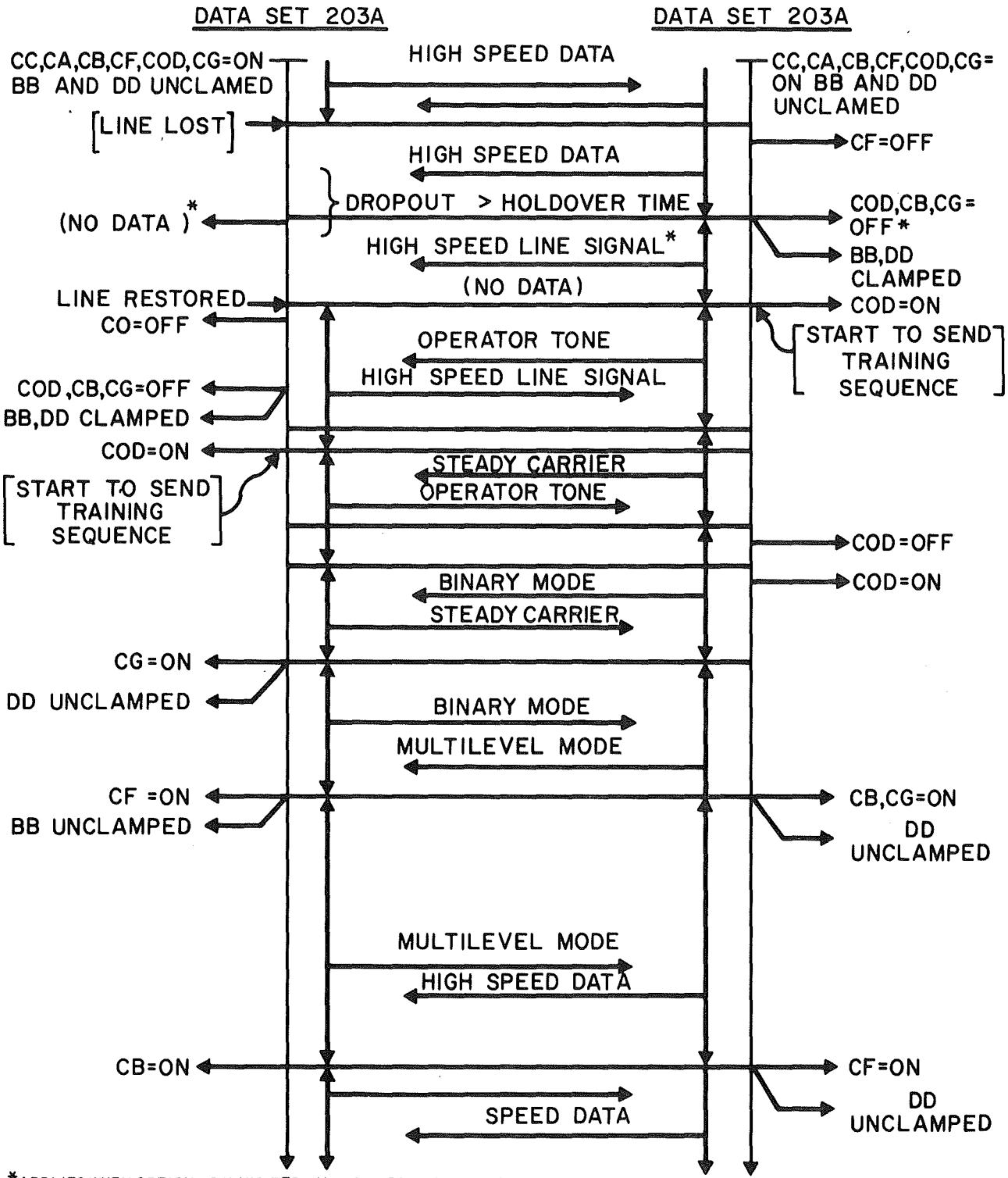
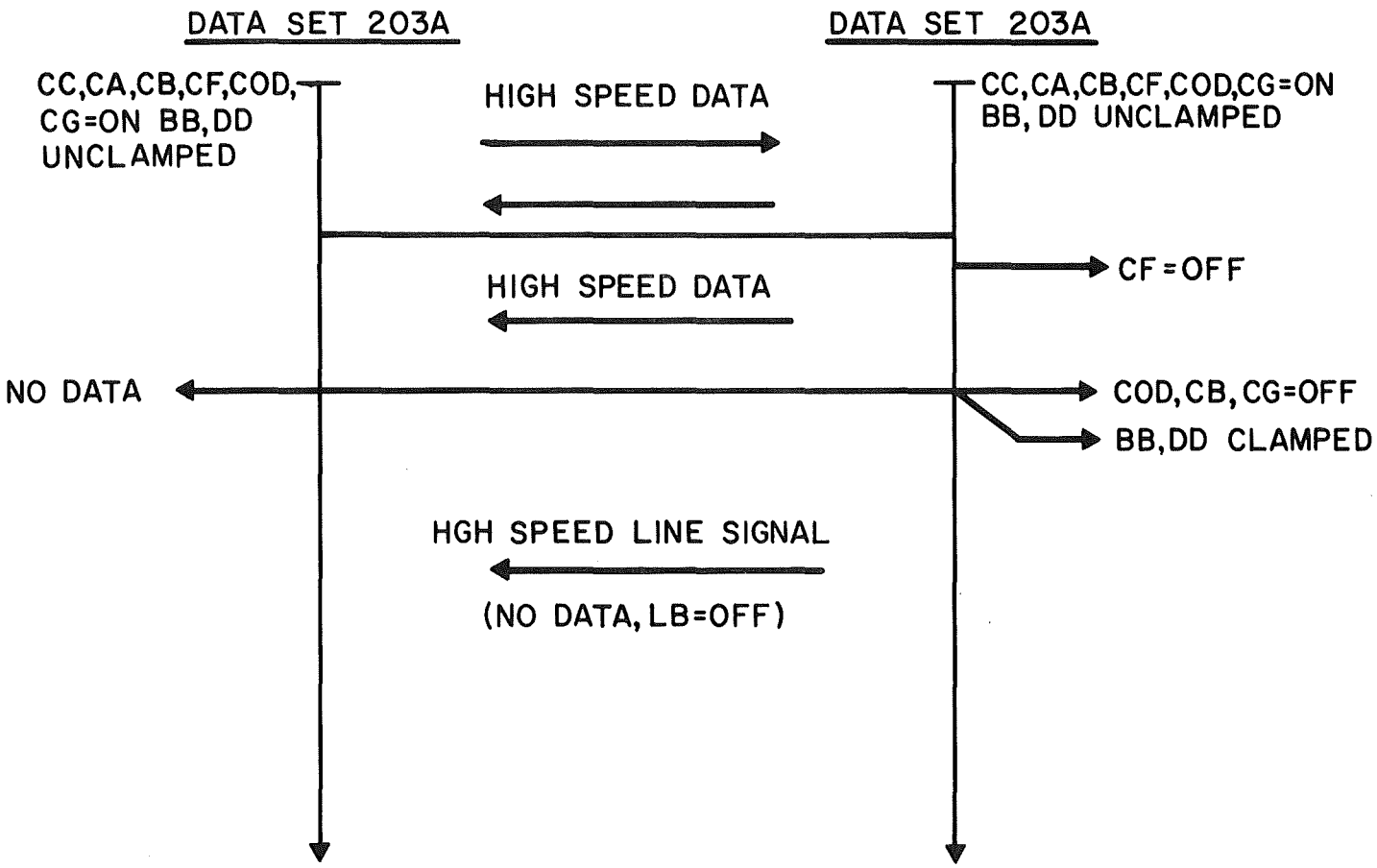


FIGURE 7 - TRAINING WITH SECONDARY CHANNEL INHIBIT



*APPLIES WHEN OPTION CS INHIBITED BY COD IS PROVIDED – WHEN OPTION CB NOT INHIBITED BY COD IS PROVIDED CLEAR-TO-SEND (CB) IS NOT INHIBITED BY CARRIER-ON-DELAYED (COD) AND HIGH SPEED DATA MAY CONTINUE FROM RIGHT TO LEFT WHEN THE LEFT TO RIGHT PATH IS LOST

FIGURE 8-AUTOMATIC RETRAINING (TEMPORARY DROPOUT OF LINE FROM LEFT TRANSMITTER TO RIGHT RECEIVER)



*APPLIES WHEN OPTION CS INHIBITED BY COD IS PROVIDED – WHEN OPTION CB NOT INHIBITED BY COD IS PROVIDED CLEAR-TO-SEND (CB) IS NOT INHIBITED BY CARRIER-ON-DELAYED (COD) AND HIGH SPEED DATA MAY CONTINUE FROM RIGHT TO LEFT WHEN THE LEFT TO RIGHT PATH IS LOST

FIGURE 9–AUTOMATIC RETRAINING (COMPLETE LOSS)

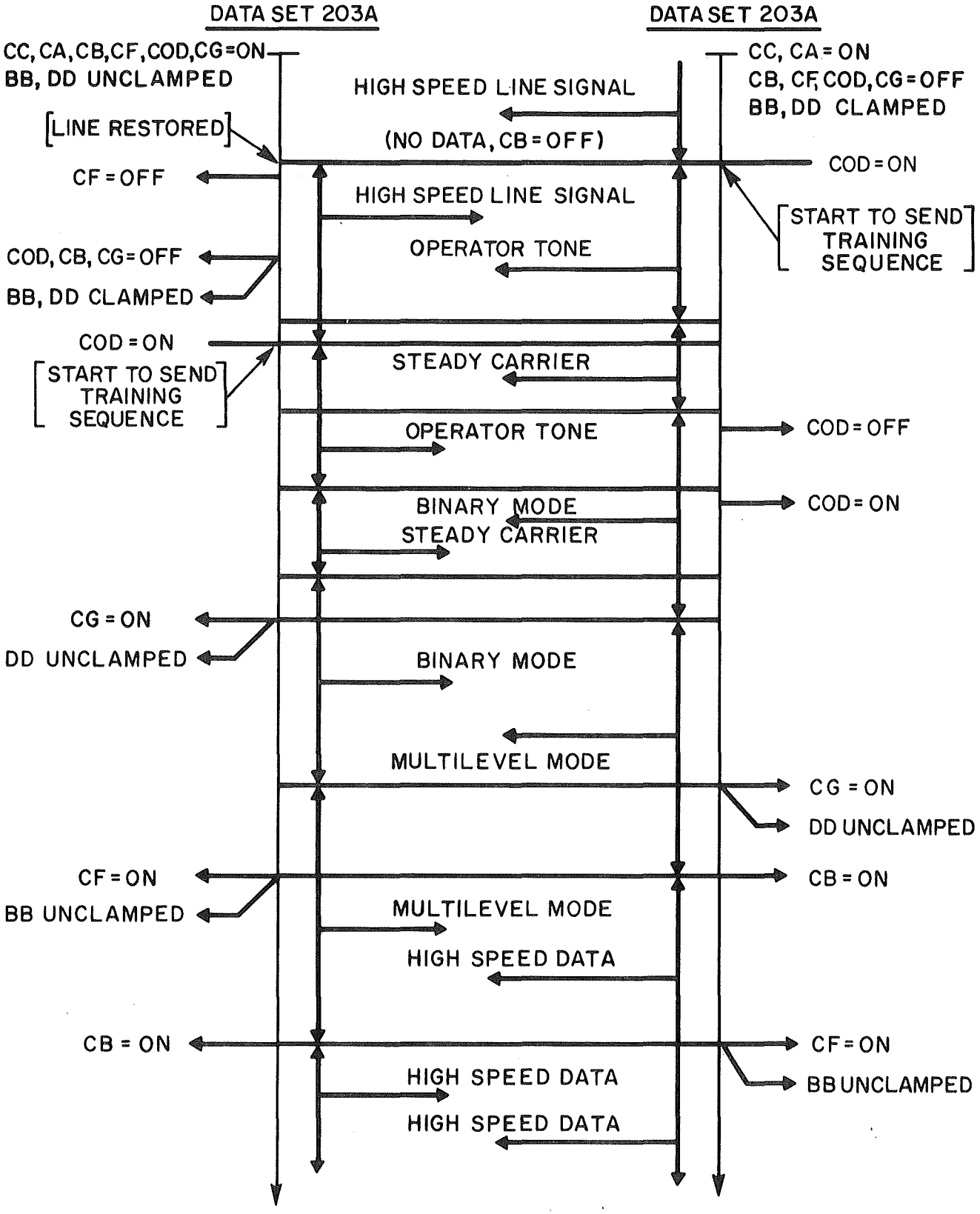


FIGURE 10-AUTOMATIC RETRAINING UPON CIRCUIT RESTORAL

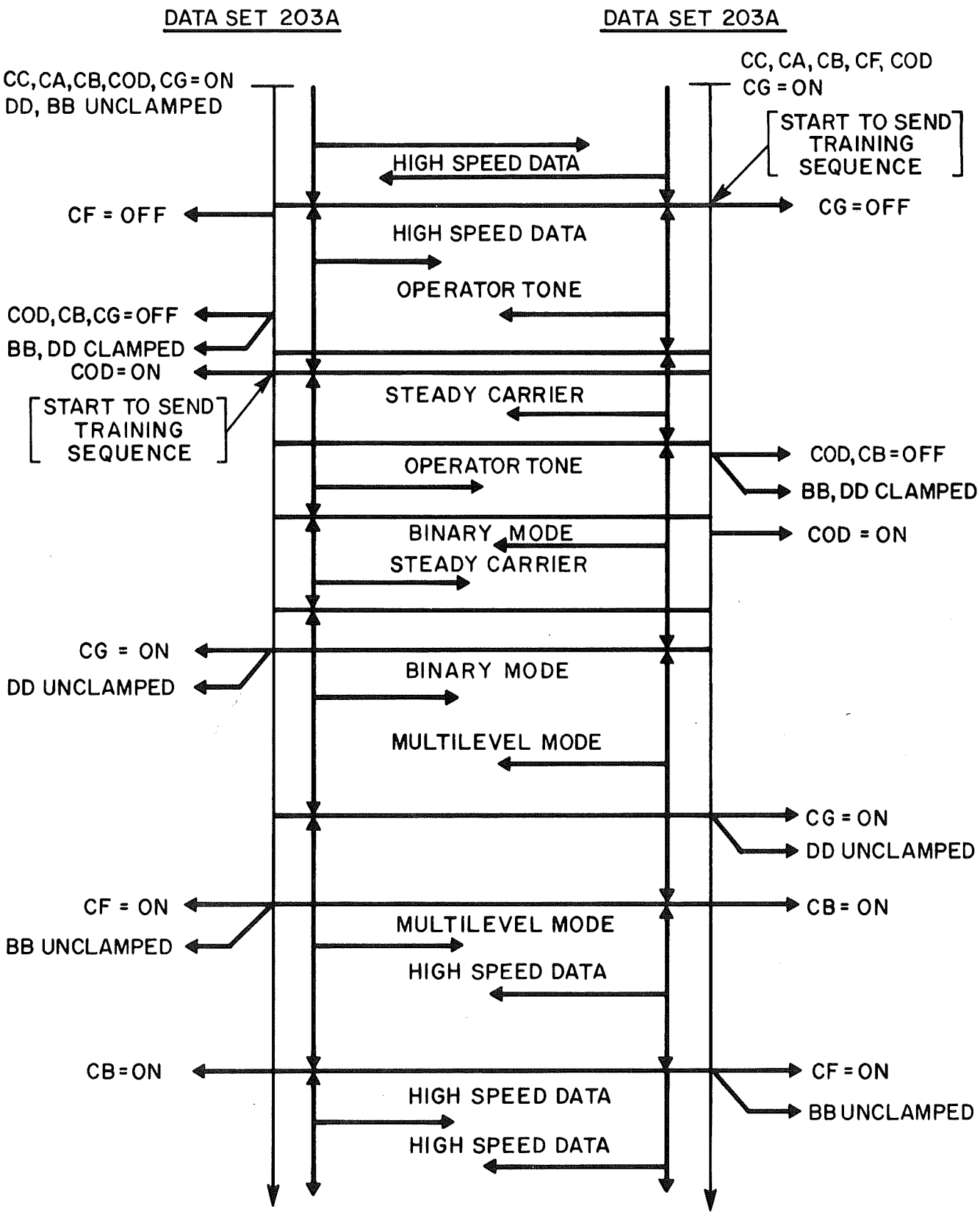
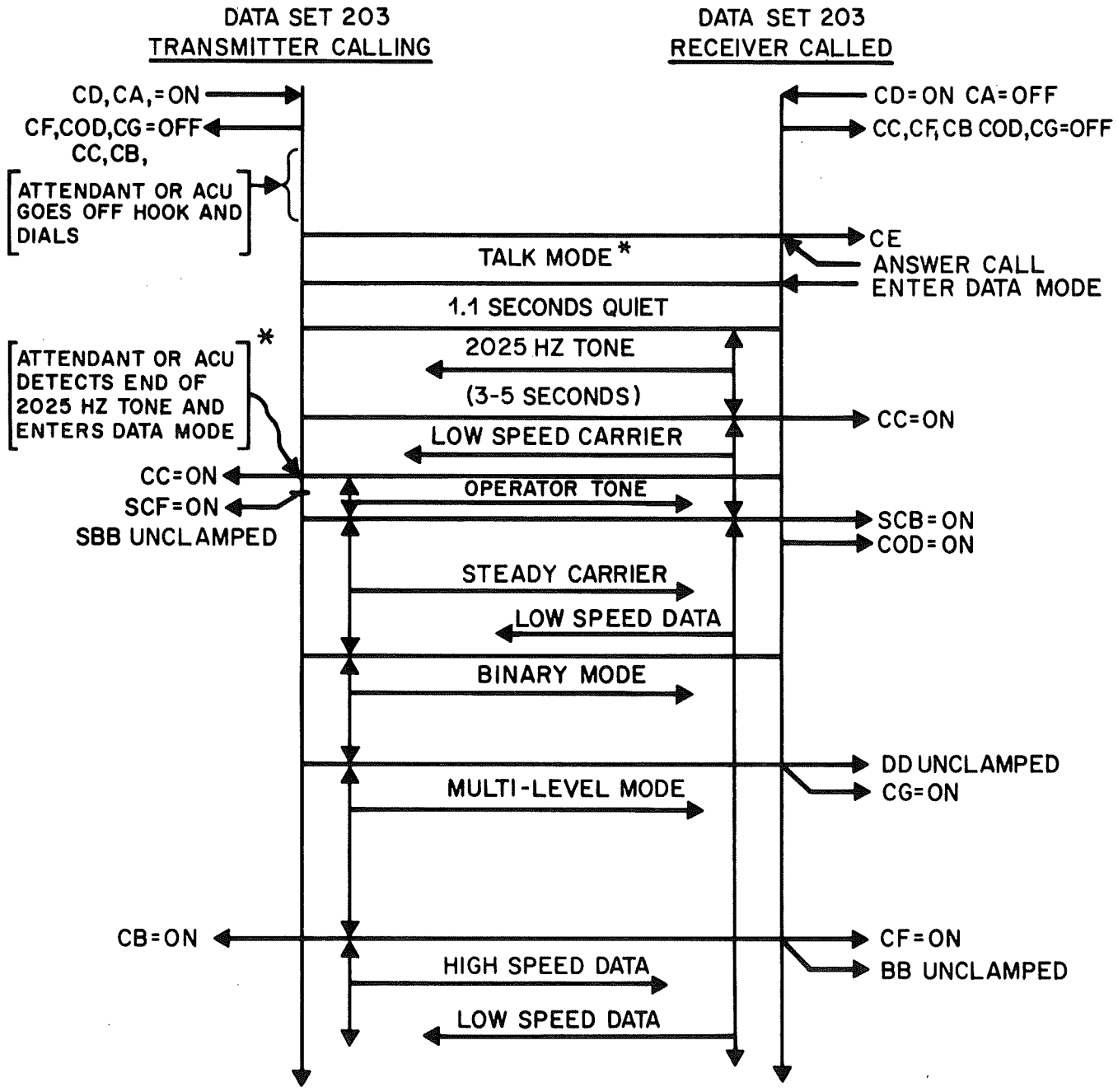


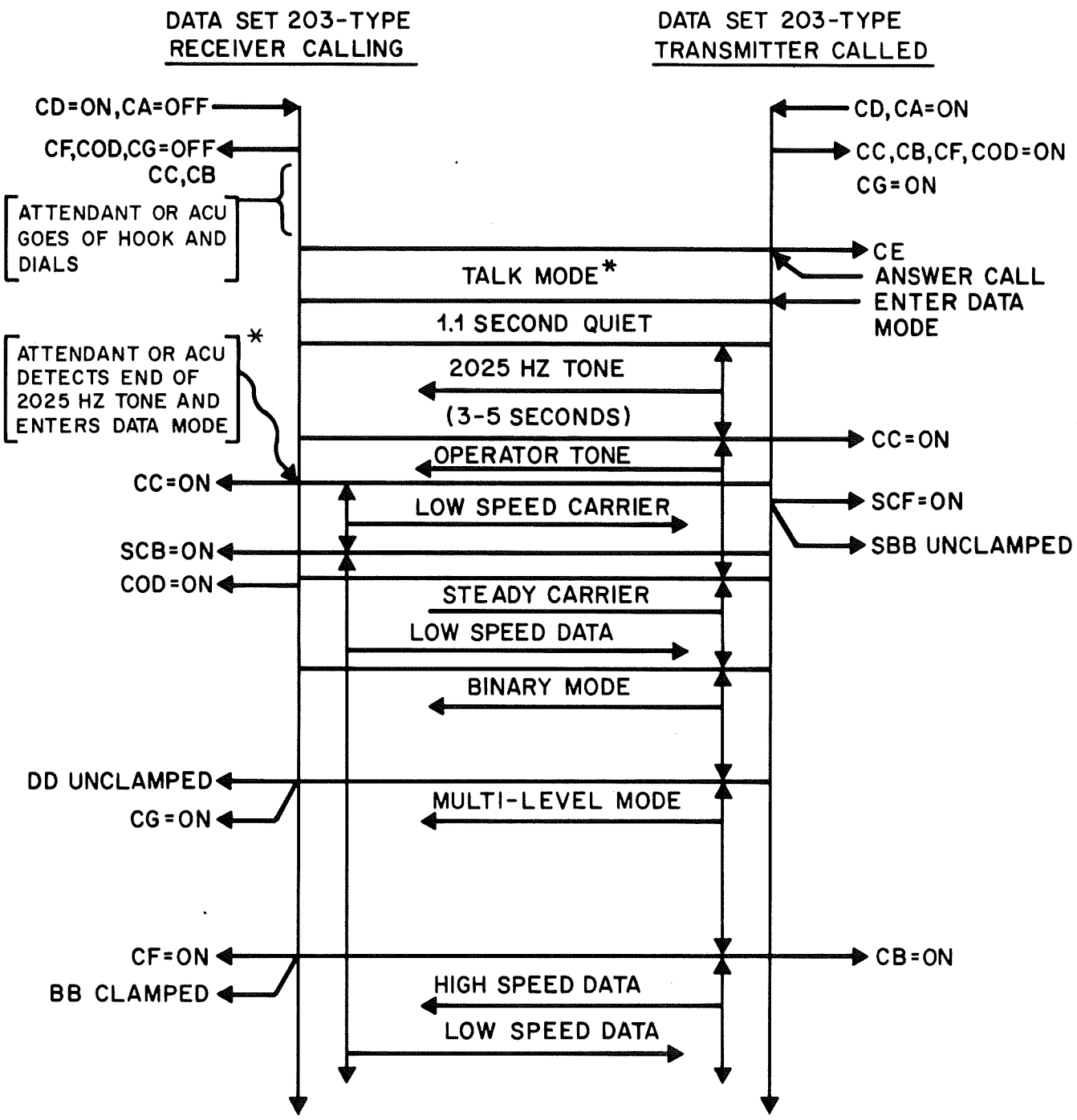
FIGURE 11–AUTOMATIC RETRAINING UPON LOSS OF SIGNAL QUALITY



* WHEN RECEIVER AUTOMATICALLY ANSWERS TALK MODE IS ELIMINATED.

* THIS RESPONSE TIME IS TYPICALLY LESS THAN 92 MILLISECONDS WHEN USING AN ACU (AUTOMATIC CALLING UNIT).

FIGURE 12 - SWITCHED MESSAGE NETWORK OPERATION—TRANSMITTER CALLING RECEIVER



* WHEN TRANSMITTER AUTOMATICALLY ANSWERS, TALK MODE IS ELIMINATED.

⁎ THIS RESPONSE TIME IS TYPICALLY LESS THAN 92 MILLISECONDS WHEN USING AN ACU (AUTOMATIC CALLING UNIT).

FIGURE 13-SWITCHED MESSAGE NETWORK OPERATION RECEIVER CALLING A TRANSMITTER

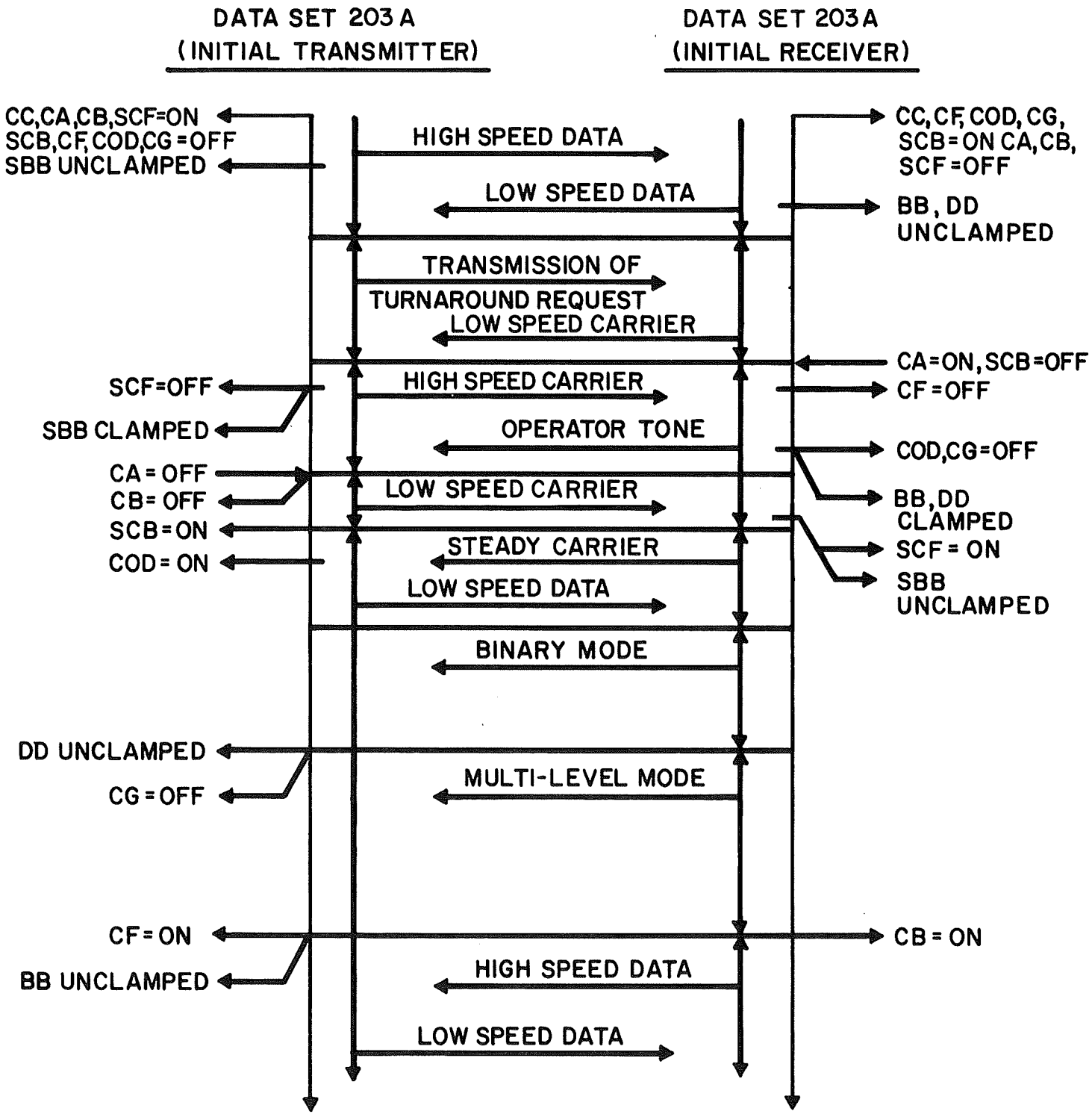


FIGURE 14 – SWITCHED MESSAGE NETWORK OPERATION TURNAROUND SEQUENCE

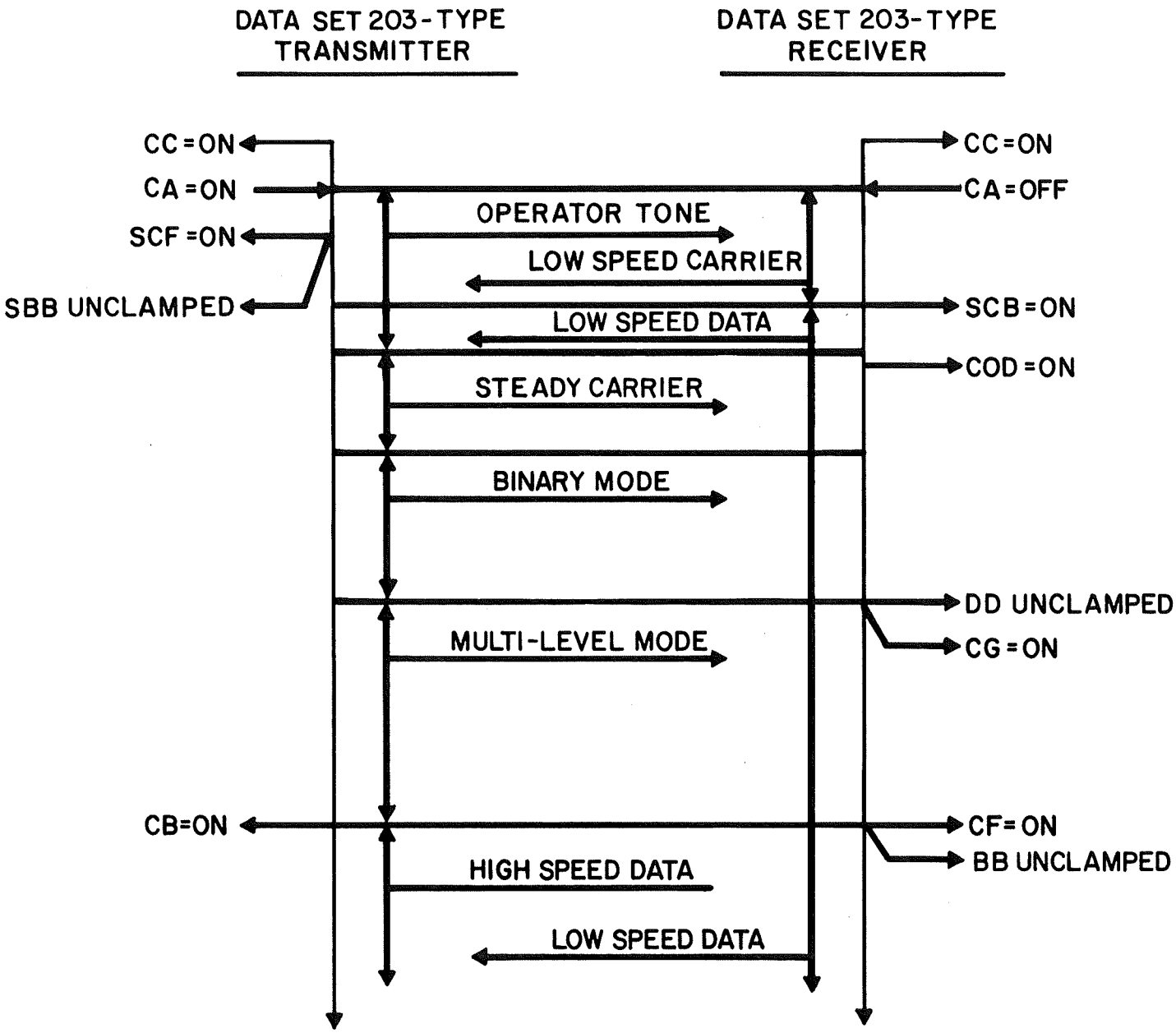


FIGURE 15–2-WIRE PRIVATE LINE – TRAINING SEQUENCE (DATA ONLY)

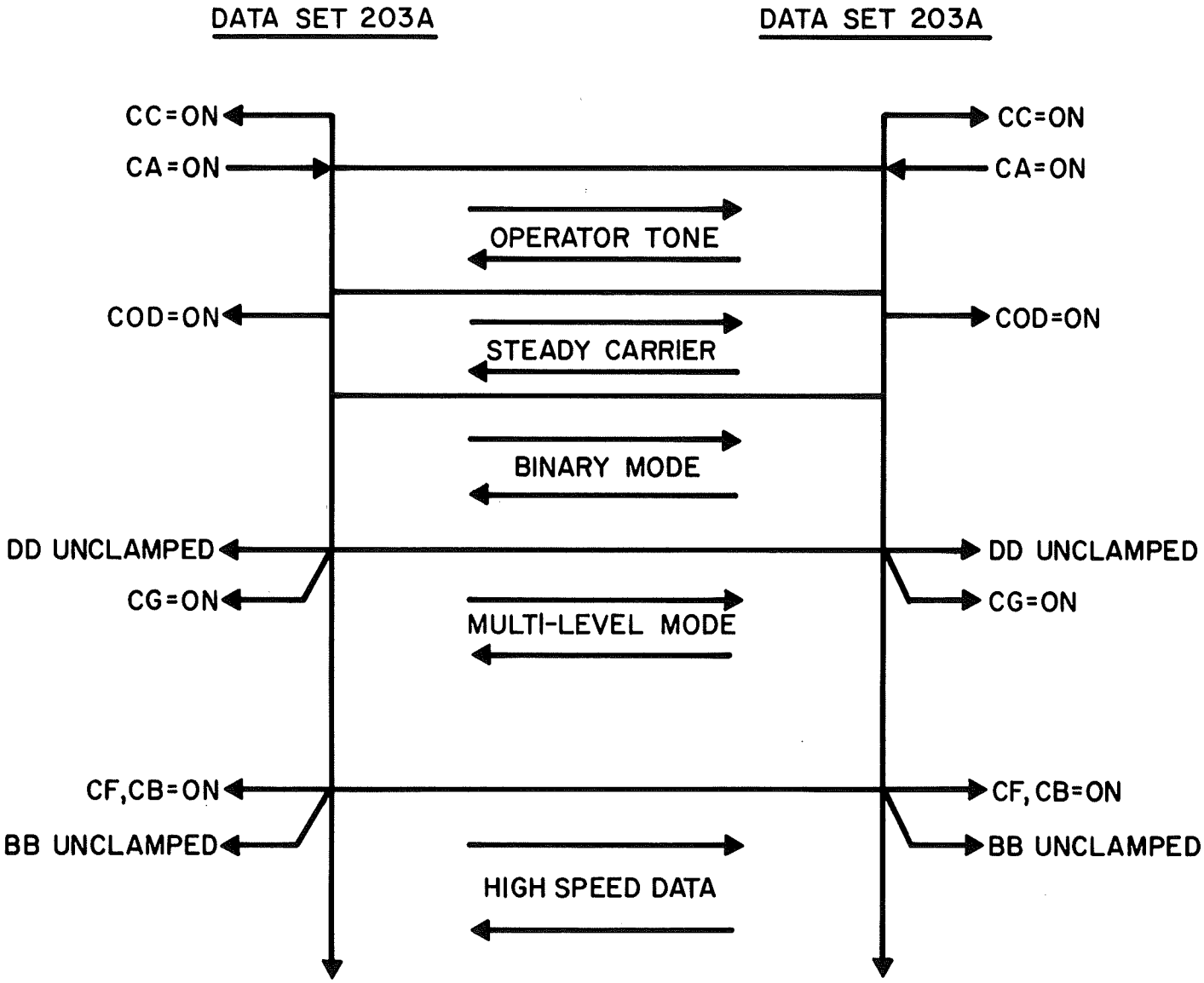
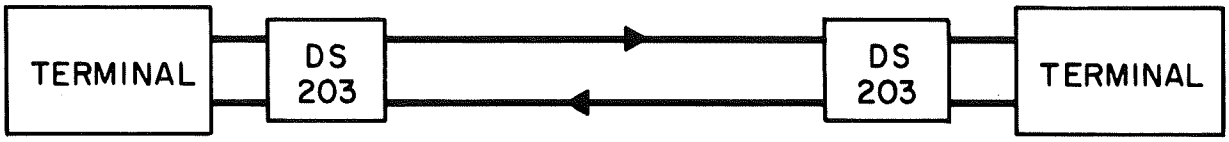
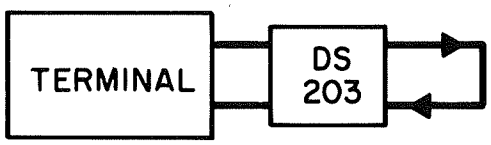


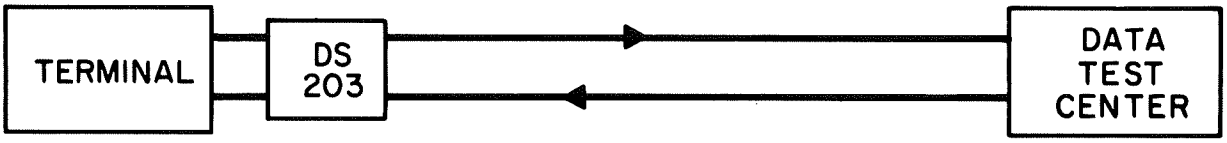
FIGURE 16 4-WIRE PRIVATE LINE TRAINING SEQUENCE (DATA ONLY)



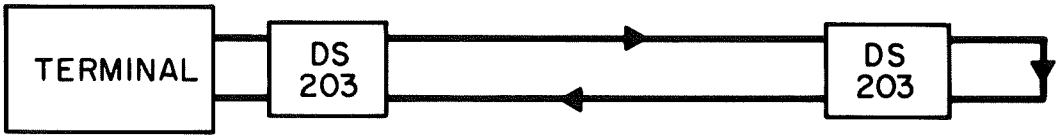
LINE MODE - NORMAL DATA TRANSMISSION



LOCAL TEST



REMOTE TEST



DIGITAL LOOP-BACK TEST

FIGURE 17 - TEST CONFIGURATIONS

FIGURE 18
BIT ERROR RATE DISTRIBUTIONS BY MILEAGE STRATA AT 3600 BPS

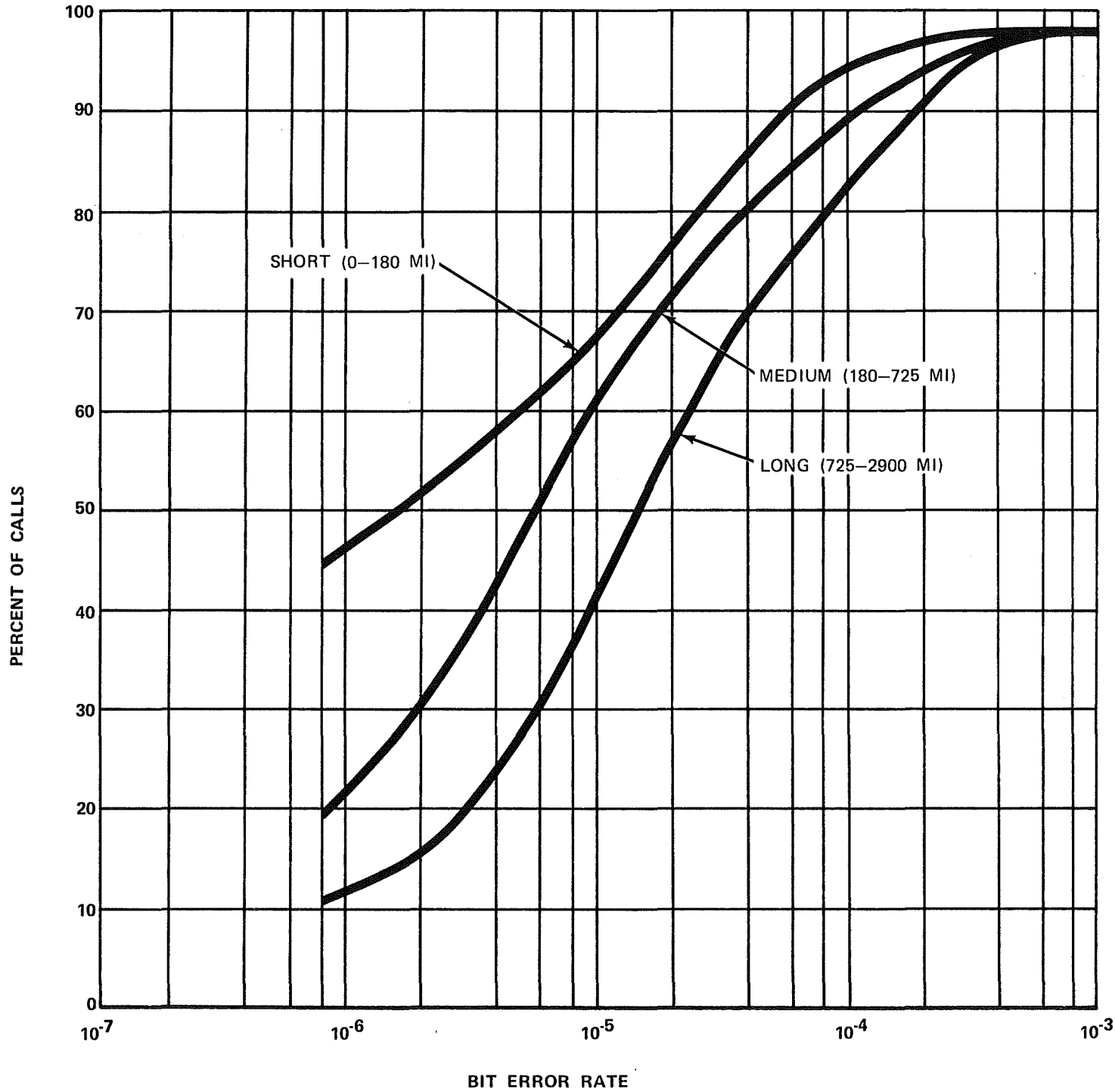


FIGURE 19
BIT AND BLOCK ERROR RATE DISTRIBUTIONS AT 3600 BPS

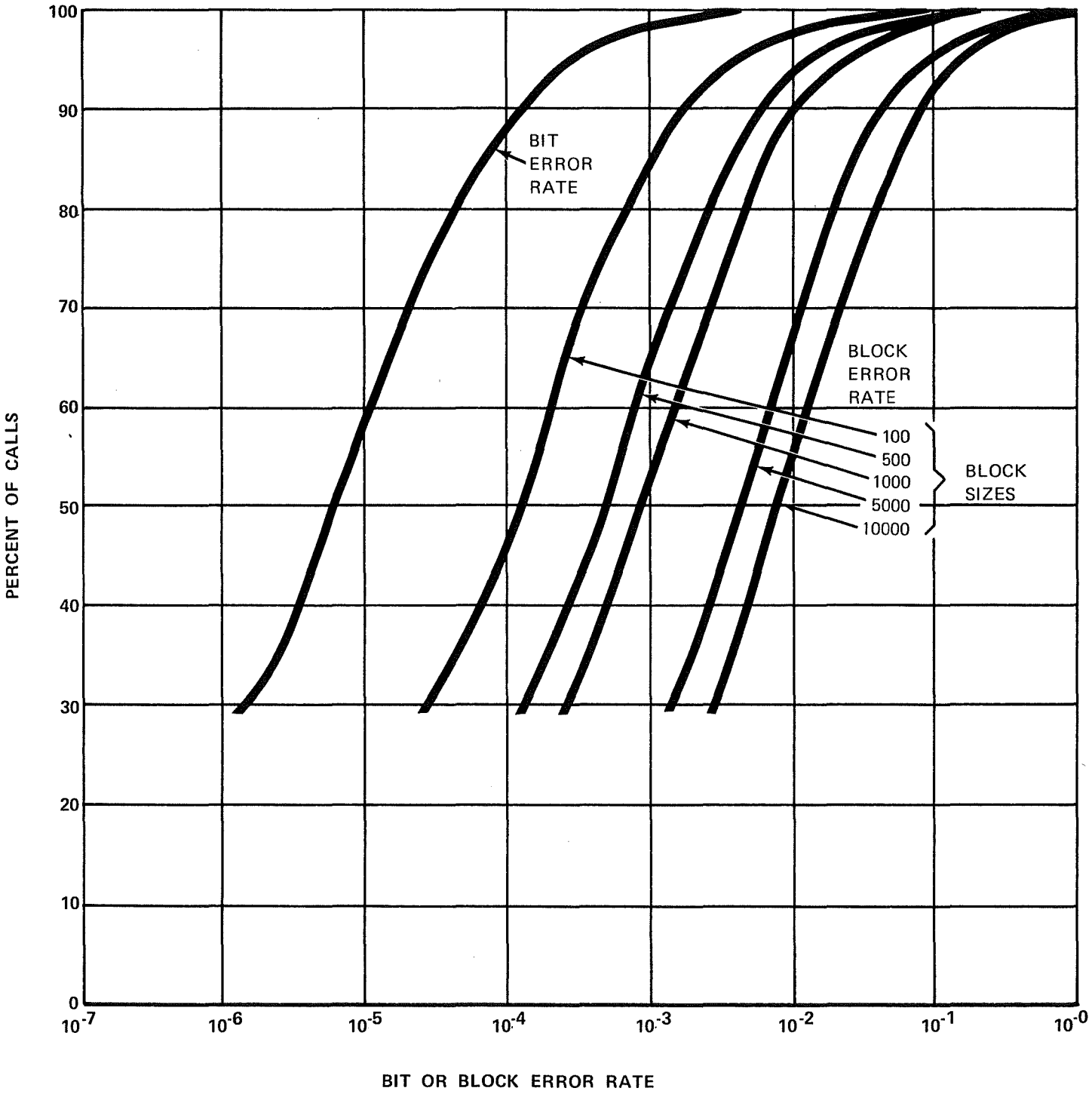


FIGURE 20
BIT AND BLOCK ERROR RATE DISTRIBUTIONS AT 4800 BPS