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PRELIMINARY

Bell System Communications

TECHNICAL REFERENCE

Data Set 212A
Interface Specification

October 1976

DIRECTOR–DATA AND SPECIAL SERVICES

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******** I N D E X ********

LIST OF FIGURES

TECHNICAL SPECIFICATION SUMMARY FOR DATA SET 212A

Data Rates:
- Low-Speed Mode:
  - 0 to 300 Bits Per Second (BPS) Asynchronous Format
- High-Speed Mode:
  - 1200 BPS +1.0% -2.5% Character-Asynchronous Format
  - 1200 BPS Synchronous Format

Operation:
- Low-Speed Mode:
  - Asynchronous, Binary, Serial
- High-Speed Mode:
  - Character-Asynchronous Format or
  - Bit-Synchronous Format, Binary, Serial

Operating Mode:
- Full-Duplex at all speeds

Line Requirement:
- 2-wire switched network

Data Set Compatibility:
- Low-Speed Mode:
  - Existing 300 Baud FSK switched-network data sets
- High-Speed Mode:
  - 212A data set only

Interface Voltages:
- Per EIA RS-232-C

Interface Compatibility:
- Same as 100-series switched-network data sets with additional timing and control functions

Special Interface Control Functions:
- Speed Mode indication through EIA interface
- Local Analog Loop Test and/or make busy mode activation through EIA interface

Received Line Signal Detector Operation:
- Turn ON 155 ± 50 milliseconds after receiving line signal
- Turn OFF 17 ± 7 milliseconds after loss of line signal

Interface Connector And Cable:

Customer equipment must provide a 25-pin Cinch or Cannon Type DB-19604-432 (male) connector plug with Cinch Type DB-51226-1 hood (or equivalents). Interface cable provided by customer should conform to EIA Standards.

AC Power:

117 volts ± 10 percent, 60 Hz ± 5 percent. Single data set consumes 9 watts maximum. Power outlet should be a conventional three-wire type not under switch control.

Environmental Requirements:

Ambient Temperature Range: from 40° to 120° F.
Relative Humidity: from 20 to 95 percent at 70° F
from 20 to 40 percent at 120° F
with no condensation

Dimensions of Single Data Set Housing:

Height: 2.2 inches
Width: 5.8 inches
Depth: 10.8 inches

Dimensions of Multiple Set Housing for 8 Data Sets:

Height: 7 inches
Width: 19 inches
Depth: 13 inches

Weight of Data Set in Single Housing not including Power Transformer:

4 pounds

Weight of Multiple Housing with 8 Data Sets:

33 pounds

1. General

1.1 Functional Description

Data set 212A provides full-duplex transmission and reception of serial binary data at two distinct bit rates over the Switched Network. In the low-speed mode of operation, the data set is compatible with existing switched network low-speed data sets such as the 103 and 113 types. The maximum bit rate in that mode is 300 BPS, and the format of the data is not restricted to any particular code or data patterns. If the 212A data set is called by any low-speed data set with the proper handshaking sequence, the 212A will automatically adapt to the low-speed mode.

The 212A data set can be operated in the high-speed mode, at 1200 BPS. In the high-speed mode, the operation can be in the bit-synchronous format or character-oriented asynchronous format (for a description of this data format, see Sec. 4.8.2). Timing signals are provided on the customer interface for bit-synchronous operation. For character-asynchronous operation at 1200 BPS the data set is optioned for a particular character format, either a 9- or 10-bit-length character, and buffering is provided to allow for transmitting terminal bit rates which are slightly above 1200 BPS.

Speed selection is done by the data station that is originating the connection; the answering 212A automatically adapts to the speed of the originating station.

Included in the standard features of the 212A data set are self tests, analog loopbacks, digital loopbacks, and remote tests which aid in the diagnosis of communication problems by either the customer or Telephone Company personnel. The Analog Loop test can be electronically controlled through the customer interface. The customer interface can be conditioned to provide an indication of the speed mode of the data set. The 212A features eight LED status lamps on the front panel to aid in interpreting system operation and diagnosis.

Data set 212A is used with a standard six-button telephone set, can be optioned for automatic answer, and can be used with an 801 type Data Auxiliary Set for automatic calling.

1.2 Compatability With Existing Data Sets And Terminal Equipment

The 212A is essentially a bilingual data set; that is, it has the capability of transmitting and receiving two different line signals. One of the line signals is an FSK format which allows the 212A to communicate with existing 300-baud data sets such as the 113A, 113B, 103A, and 103J.

Other data sets, including acoustically coupled versions, that use the same signaling as these data sets and have the same handshaking sequence outlined in Sec. 4.5.2 should be able to operate with the 212A. When these other data sets call the 212A, the answering 212A will automatically adapt its line signal to the low-speed mode. If a 212A is conditioned for low-speed operation, it can originate a data call to other 300 baud data sets if they can operate in the answer mode. At the customer interface, the signals appear similar to the signals on the interface of Bell System 100-series data sets in that the sequence of events is the same, but certain time intervals may be different due to the circuit implementations. These time interval differences are not expected to be of concern to data terminals.

The other line signal is unique to the 212A; therefore in the 1200 BPS speed mode, the 212A can operate only with another 212A. The signals on the customer interface, however, will still follow the sequence of the low-speed mode, but the time intervals will be different. Sec. 4.5.1 contains information on the handshaking sequence for high-speed operation.

At 1200 BPS, the Data Set 212A is not compatible with 202-type data sets.

1.3 Customer Interface

The electrical specifications of the customer interface circuits conform to the Electronics Industries Association Standard RS-232-C. The functional description of each customer interface circuit is given in Sec. 3.4.

1.4 Speed Mode Determination

The 212A data set is capable of data communication at two distinct bit rates which are nominally called 300 BPS and 1200 BPS. Both directions of communication are at the same bit rate.

The bit rate of a given communication link between 212A data sets is completely controlled by the data station that originates the connection. At the originating (calling) station, the speed mode is controlled by the speed-select button (HS) on the front panel. The speed mode must be selected before the data mode is entered, and cannot be changed once the data set is in the data mode. The speed mode of the answering (called) station is automatically determined from the received line signal, and the local customer speed selection circuits are ignored.

When the Speed Mode High option is selected, the speed select control of the data set is still functional, and the data set will enter the appropriate speed mode when the data mode is entered. If the low-speed mode is entered, however,

the transmission and reception of customer data are blocked at the customer interface. When the high speed mode is entered, the interface acts normally.

The speed mode of a data call can be changed by simultaneously transferring both data sets to the talk mode, changing the originating speed selector to the new speed, and re-entering the data mode. This method can be used only when there are attendants at both stations.

1.5 Status Lamps

The 212A data set front panel displays eight status indications with LED (Light Emitting Diode) lamps. The meaning of each status lamp is described below:

MB-MAKE BUSY- The ON condition of this lamp indicates that the internal make busy circuit is activated and/or that the data set is ready for an analog loop test.

TR-TERMINAL READY- The ON condition of this lamp indicates that the customer terminal equipment is applying an ON condition to the CD interface circuit.

MR-MODEM READY- The ON condition of this lamp indicates that the data set has turned ON the CC interface circuit except when the data set is in the Self Test or Digital Loop modes. In these modes, the MR lamp monitors the status of the internal Modem Ready circuit (see Sec. 5).

SD-SEND DATA- This lamp indicates the state of the customer interface circuit BA (Transmitted Data) whenever the data set is conditioned to transmit data. The lamp is ON when the BA circuit is positive (space).

RD-RECEIVED DATA- This lamp indicates the state of the data set interface circuit BB (Received Data) except when the data set is in Self Test, Digital Loop, or in the low-speed mode with the Speed Mode High option installed. During these modes, the lamp displays the state of the internal received data. The lamp is ON when the received data is positive (space).

HS-HIGH SPEED- This lamp monitors the status of the speed mode detection circuit. The lamp is ON whenever the data set is transmitting and

receiving at 1200 BPS, including the high-speed analog loop test mode.

MC-MODEM CHECK- This lamp provides indications for two distinct conditions. In the data mode whenever the received carrier energy is below the carrier detector threshold, the lamp will be ON. Whenever the data set is in the Self Test mode, and the Self Test Receiver circuit detects an error in the received data pattern, this lamp blinks ON for 300ms. The Modem Check lamp is ON whenever the data set is in the idle condition, or talk mode.

TM-TEST MODE- This lamp is ON whenever the data set is put in a test mode, either locally or remotely.

1.6 Test Buttons

Four of the five front panel pushbuttons are for system testing. The fifth button, HS, is referred to in Sec. 1.4. The four testing buttons are listed and described below:

AL-ANALOG LOOP- This button conditions the data set to permit local testing by customer terminal equipment through the customer interface.

ST-SELF TEST- This button overrides the customer interface Send Data (BA) circuit, forcing the transmission of a test pattern. The button also activates the error detection circuit which monitors the received data, and provides an indication of bit errors.

RDL-REMOTE DIGITAL LOOP- This button allows testing of local and far-end data sets in the high-speed mode and the intervening channels with the local customer terminal equipment. The far-end data set is automatically put in the digital locp mode when the local RDL button is depressed.

DL- DIGITAL LOOP- This button allows testing of the local data set from a far-end location such as a data test center without local customer terminal equipment.

Detailed descriptions of the possible test button combinations are given in Sec. 5.

1.7 Physical Description

A pictorial view of the 212A data set in the single housing is shown in Figure 1. The data set in its single set housing measures 5.8 inches wide, 2.2 inches high and 10.8 inches deep, and will operate over an ambient temperature range of 40° to 120° Fahrenheit with relative humidity in the range from 20 to 95 percent. The 212A in a single set housing weighs approximately 4 pounds. The wall-mounted power transformer weighs approximately one pound. A standard six button telephone is normally provided to serve up to five data sets on five switched network lines. In addition, multiple arrangements are available which allow up to eight data sets or other data equipment to operate in a common housing. Figure 2 shows the 212A mounted in a 40A2 multiple housing. This arrangement measures 19 inches wide, 7 inches high, and 13 inches deep, and may be used in a standard 19 inch or 23 inch relay rack or a cabinet mounting. With these arrangements, 10 or 20 button telephone sets are available.

1.8 Power Requirements

Electrical power is supplied to the single data set mounting by an external transformer which mounts on the customer provided nonswitched three-prong AC outlet and is internally protected against overload. The 212A is designed to operate with a supply voltage of 105 to 129VAC, 60±3 Hz. Multiple data set installations are powered by an internal power supply which connects to the customer provided nonswitched three-prong AC outlet.

2. Customer Options

In addition to the option descriptions given below, Figure 3 shows a summary of available customer options.

2.1 CC (Data Set Ready) Indication For Analog Loop

If the customer terminal equipment requires an ON condition of the Data Set Ready (CC) circuit to transmit and receive test data during an Analog Loop test, the CC Indication For Analog Loop On option is installed.

2.2 CN (Make Busy/Analog Loop) Circuit

When the CN Circuit In option is installed, the customer interface circuit CN (Make Busy/Analog Loop) is connected to the 212A data set, enabling the customer terminal equipment to electronically make the telephone line appear busy and/or to condition the 212A for an Analog Loop

test. The CN circuit is kept in a permanent OFF state if the CN Circuit Out option is installed. When the make busy feature is used, a Telephone Company selected option is installed to insure that the make busy implementation is compatible with telephone equipment.

2.3 Transmitter Timing

This option selects one of three possible sources for the high-speed transmitter timing signal:

INTERNAL- The 212A data set uses the internally generated 1200Hz clock as a transmitter reference.

EXTERNAL- The data set derives its transmitter clock from the customer interface circuit DA (Transmit Signal Element Timing - Data Terminal Equipment Source).

SLAVE- The transmitter clock is derived from the local received timing signal.

2.4 1200 BPS Operation

The 1200 BPS Operation Asychronous Start-Stop option is installed when the 212A data set is used in the 1200 BPS character-asynchronous format of operation. The state of this option should be the same between any pair of 212A data sets which will communicate with each other in a communication system. If synchronous 1200 BPS operation is implemented, the 1200 BPS Operation Synchronous option should be installed at each data set. The state of this option and the Character Length option do not affect the low-speed mode of the 212A. When the 1200 BPS Operation Synchronous option is installed, the data set provides clocks on the interface for transmitter and receiver timing at all times that power is supplied to the data set.

2.5 Character Length

This option is only effective when the 212A data set is used in the 1200 BPS character-asynchronous format. When the Character Length 10 Bit option is installed, the 212A will accept start-stop characters with one start bit, eight data bits (including a parity bit, if used), and at least one stop bit with a total number of 10 bits per character. The bits between the start and stop bits do not have to follow any particular coding system, but must meet the distortion limits specified in Sec. 4.8. When the Character Length 9 Bit option is installed, the total number of bits

per character must be 9 including one start bit and at least one stop bit. The setting of this option should be the same for any pair of 212A data sets that are required to communicate with each other in a particular installation. If the 1200 BPS Operation Synchronous option is installed, or if the data set is operating in the low-speed mode, the Character Length option has no effect on the operation of the data set.

2.6 Receiver Responds To Digital Loop

This option is active only when the 212A data set is in the high-speed data mode. When the option is set for Receiver Responds to Digital Loop In, the data set will respond to a request for a remote digital loop from the far end station as long as CD is ON and the Automatic Answer option is installed. When the Receiver Responds to Digital Loop Out option is installed, the 212A data set cannot be put into the Digital Loop test mode remotely. This option does not affect the operation of the DL front panel pushbutton, or low-speed operation (see Sec. 5.6).

2.7 Loss Of Carrier Disconnect

The installation of the Loss of Carrier Disconnect In option causes the 212A data set to terminate a data call when a loss of received carrier energy is detected for approximately 350 milliseconds.

2.8 Receive Space Disconnect

When the Receive Space Disconnect In option is installed, the 212A data set will disconnect a data call after receiving approximately 1.6 seconds of continuous spacing.

2.9 CB (Clear To Send) and CF (Received Line Signal Detector) Indications

When the CB and CF Indications Common option is installed, the customer interface circuit CB (Clear To Send) will be forced to the OFF state whenever the customer interface circuit CF (Received Line Signal Detector) is OFF. When the CB and CF Indications Separate option is installed, the CF circuit has no effect on the CB circuit.

2.10 Send Space Disconnect

The Send Space Disconnect In option is used to transmit approximately 4 seconds of spacing signal to the far-end data set before disconnecting . This could cause the far-

end data set to go on hook if the Receive Space Disconnect feature is installed at that end.

2.11 Automatic Answer

The Automatic Answer option enables the 212A data set to answer a telephone call unattended, if the Terminal Ready (CD) circuit is ON at the customer interface. The automatic answer feature can be temporarily disabled manually with the AL front panel pushbutton or electrically through the CN circuit of the customer interface. The override using AL is only possible if the Make Busy feature is not implemented.

2.12 Answer Mode Indication

The Answer Mode Indication option provides an indication of whether the 212A data set was the originating or answering station during a data call. This indication is provided on the CE customer interface circuit, which without this option will only follow the ringing signal of an answering station. When the On option is installed, the CE circuit will still indicate the ringing cycles, but will also remain in the ON condition when the telephone call is answered, either manually or automatically. For the originating data set, the CE circuit remains OFF regardless of the state of the option.

2.13 Speed Mode

When the Speed Mode High option is installed, the 212A will only pass customer data through the customer interface when it is in the high-speed data mode. When the Speed Mode Dual option is installed, the customer interface is active in both speed modes (see Sec. 1.4).

2.14 Interface Speed Indication

When the Interface Speed Indication Out option is installed the customer interface circuit CI (Speed Mode Indicator) is disconnected from the interface. If the terminal equipment is configured to use the speed mode indication, the Interface Speed Indication In option should be installed.

2.15 Signal Ground To Frame Ground Connection

A protective (frame) ground circuit is provided on the 212A data set by means of the ground wire of the power cord. This also provides grounding of the data set housing and chassis. The Signal Ground circuit on the customer interface is the common reference potential for all

circuits on the interface. The Signal Ground and protective ground circuits are tied together by means of a strap option in the data set housing, installed as the Signal Ground To Frame Ground Connection In option. This arrangement is intended to provide additional margin against longitudinal power line noise. The strap may be disconnected with due consideration given to possible noise conditions, ground potential differences, safety conditions, local electrical codes, and the data terminal manufacturer's recommendations. Protective ground does not appear as a circuit at the customer interface.

3.0 Customer Interface

3.1 Pin Assignments

The pin assignments for the customer interface connector are shown in Table 1.

3.2 Electrical Specifications

The electrical characteristics of the customer interface circuits of the 212A data set are in conformance with Section Two of the Electronic Industries Association Standard RS-232-C. Customer terminal equipment interface circuitry should also follow the recommendations of standard RS-232-C.

3.2.1 Signal States

The Transmitted and Received data signals are considered in the marking state when the voltage on the circuit is more negative than minus three volts with respect to signal ground, and in the spacing condition when the voltage on the circuit is more positive than plus three volts with respect to signal ground. All control and timing functions are considered ON when the voltage on the circuit is more positive than plus three volts with respect to signal ground, and is considered OFF when the voltage on the circuit is more negative than minus three volts with respect to signal ground. The Data Terminal Ready (CD) circuit is "fail-safe" in that a power off condition in the terminal equipment or a disconnection of the customer interface cable is interpreted as an OFF condition by the data set. The data,timing, and control functions are defined below:

VOLTAGE	NEGATIVE	POSITIVE
BINARY STATE	ONE	ZERO
SIGNAL CONDITION	MARK	SPACE
CONTROL AND TIMING FUNCTICN	OFF	ON

3.2.2 Terminator Impedance

The terminating impedance of the receiving end of customer interface circuits has a resistive component of not less than 3000 ohms nor greater than 7000 ohms over the range of voltages for the which the signal is defined. When the interface plug is disconnected, the interface voltage on terminator circuits is less than ±2 volts.

3.2.3 Rise And Fall Times

For control interchange circuits driven by the 212A data set, the time required for the signal to pass through the transition region of minus three to plus three volts during a change of state does not exceed one millisecond. For the Received Data (BB) , Transmit Signal Element Timing (DB), and Received Signal Element Timing (DD), the time required for the signal to pass through the transition region is greater than one microsecond but does not exceed 20 microseconds.

3.2.4 Open Circuit Voltages

The open circuit driver voltage on any customer interface circuit does not exceed ±18 volts with respect to signal ground. When the terminating impedance is between 3000 and 7000 ohms, and the terminator open circuit voltage is zero, the potential at the point of interface is not less than ±5 volts or greater than ±15 volts. The terminator on an interface circuit is designed to withstand any input signal within the ±25 volt limit.

3.3 Mechanical

Each 212A data set is equipped with a 25 pin female connector. The user must supply the plug and necessary cable to connect terminal equipment to the data set. For the male connector, a plug such as the DB-19604-432 plug manufactured by Cannon [ITT-Cannon Electric, Division of IT&T Corporation,3208 Humboldt Street, Los Angeles, California 90031] or Cinch [Cinch Manufacturing Company, 1026 S.Homan Avenue, Chicago, Illinois 60624] is required.

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 of removal, and provide a positive screw-in locking arrangement to prevent the connector from being pulled out inadvertently.

3.4 Functional Description of Interface Circuits

A description of the operation of each customer interface circuit and the signals appearing on it is given below. The circuit numbers refer to pin assignments of the customer interface connector.

3.4.1 Transmitted Data (BA) - Circuit 2

Signals on this circuit are generated by the terminal equipment and transferred to the transmitter of the 212A data set. A positive signal is considered a binary "0" or SPACE and a negative signal is considered a binary "1" or MARK. The transmitting terminal should hold circuit BA in the marking state when no data are transmitted, including intervals between characters or words.

When the 212A data set is used in the 1200 BPS synchronous format, the data transitions must conform to EIA standard RS-334. When the 212A data set is in the low-speed mode, or is operating at 1200 BPS in the character-asynchronous format, no restriction is made on the time of data transitions providing the transitions do not exceed the distortion limits set forth in Sec. 4.8.

The data terminal should not transmit data unless the CB (Clear To Send) circuit is ON.

3.4.2 Received Data (BB) - Circuit 3

Signals on the BB interface circuit are generated by the 212A data set receiver in response to signals transmitted by the remote data set, except when the 212A data set is in the Analog Loop test mode (see Sec. 5.1).

When the 212A data set is operated in the 1200 BPS synchronous format, timing information is provided by the data set on interface circuit DD (Receiver Signal Element Timing, Data Communications Equipment Source), in accordance with EIA standard RS-334. Figure 5 illustrates the relationship between circuits BB and DD for synchronous operation.

When the 212A is operated in the 1200 BPS character-asynchronous format, the clock signals DD and DB are disconnected from the interface.

The received data circuit is clamped to the marking state whenever the customer interface circuit CF (Received Line Signal Detector) is OFF. The Received Data circuit is also clamped to marking if the Speed Mode High option is installed and the data set enters the low-speed data mode.

3.4.3 Clear To Send (CB) - Circuit 5

An ON condition of the Clear To Send circuit indicates to the terminal equipment that the 212A will transmit any data which are present on the Transmit Data (BA) circuit. If CS is OFF, the data set will internally clamp BA to mark, and ignore the customer Transmitted Data circuit. If a Remote Digital Loop test is initiated, the local CB circuit will turn OFF until the remote data set is in the digital loop test mode. The CB circuit is always turned OFF when the 212A is in the Self Test mode or in the Digital Loop mode (locally or remotely activated). If the CB and CF Indications Common option is installed, circuit CB will turn OFF whenever circuit CF (Received Line Signal Detector) is OFF.

3.4.4 Data Set Ready (CC) - Circuit 6

Signals on this circuit originate from the data set to indicate its local status. The ON condition of circuit CC indicates that the 212A is in the data mode and is connected to the communication channel, or in Analog Loop if the CC Indication For Analog Loop On option is installed. The ON condition of this circuit alone should not be interpreted to mean that a communication channel has been completely established or used to determine the status of any remote terminal equipment. The CC circuit will be OFF in all test modes (except optionally Analog Loop), and when the channel is being used for voice communication (Talk mode).

3.4.5 Signal Ground (AB) - Circuit 7

This circuit establishes the common ground reference for all customer interface circuits. This circuit is normally connected to protective ground by the grounding option to minimize the introduction of longitudinal power line noise into electronic circuitry through the power transformer. Depending on local electrical codes and conditions, this connection to protective ground can be removed by the Telephone Company Installer (See Sec. 2.4).

3.4.6 Received Line Signal Detector (CF) - Circuit 8

The ON condition of this circuit indicates that data carrier is being received and has been received for at least

155±50 milliseconds. This circuit will not normally turn ON in the presence of message circuit noise or out-of-band signals. The CF circuit will go OFF if the received data carrier falls below the receiver threshold for more than 17±7 milliseconds. During the time that CF is OFF, the received data circuit (BB) is clamped to the Marking state. If the 212A is transmitting the space disconnect signal, its CF circuit will be held OFF.

When the 212A is put in the Analog Loop test mode, the CF circuit functions in the same way as described above, except that the carrier signal of the local data set is monitored, since that is the signal being looped.

3.4.7 Speed Mode Indication (CI) - circuit 12

This circuit is connected to the customer interface when the Interface Speed Indication In option is installed. The CI circuit will be in the ON state when the 212A is in the high-speed data mode or the high-speed Analog Loop test mode. At all other times, the CI circuit is in the OFF state. The state of the CI interface circuit does not necessarily correspond with the state of the front panel Speed Select (HS) button. This is true particularly in the answering data set, which automatically adapts to the speed of the originating station each time the data mode is entered, ignoring its own speed selector (see Sec. 1.4).

3.4.8 Transmit Signal Element Timing (Data Communication Equipment Source) (DB) - Circuit 15

This interface circuit is associated with the high-speed synchronous format. For 1200 BPS character-asynchronous operation, the signal on circuit DB is not provided. If synchronous 1200 BPS operation is optioned, this clock will be on the interface at all times that power is applied to the data set including the times that the data set is in the low-speed mode. When the Transmit Timing option is set for Internal timing, signals on the DB circuit are a square wave at the nominal 1200Hz rate and are used to provide the data terminal equipment with signal element timing information for the Transmitted Data (BA) circuit. The first signal element of the Transmitted Data signal should be presented by the data terminal equipment on the first positive (OFF to ON) transition of DB which occurs after the Clear To Send circuit (CB) has turned ON. The transmitted data is sampled by the data set on negative transitions of DB.

When the Transmit Timing option is set for External or Slave, the signals on DB will be phase-locked to the external transmit clock from the data terminal, or the received timing clock, respectively. When external transmit

timing is used, the transmitted data transitions should follow the specifications for circuit DA (see Sec. 3.4.14).

3.4.9 Receiver Signal Element Timing (Data Communication Equipment Source) (DD) - Circuit 17

This interface circuit is associated only with the synchronous format in the high-speed mode, and is not provided when the data set is optioned for the 1200 BPS character-asynchronous format in the high-speed mode. If the 1200 BPS Operation Synchronous option is installed, this signal will be active during the low-speed mode also, and should not be used for timing purposes.

The square wave signal on this circuit at the nominal 1200Hz rate is used to provide the data terminal equipment with receiver timing information for the Received Data (BB) circuit. The ON to OFF (negative-going) transition on circuit DD nominally indicates the center of each signal element on the BB circuit.

3.4.10 Data Terminal Ready (CD) - Circuit 20

This circuit provides a means for the customer terminal equipment to control the connection of the 212A onto the communication channel, and to control the Analog Loop test mode. The ON condition of the CD circuit is necessary to maintain the connection of the 212A to the communication channel. The ON condition must also be present before the 212A will enter the data mode either manually or automatically. The CD circuit must be ON in conjunction with the interface CN lead or the front panel AL pushbutton depressed to establish the Analog Loop test mode. If the CD circuit is turned OFF for more than 50 milliseconds during a data call, the 212A will enter an irreversible disconnect sequence (see Sec. 4.7). For automatic answering applications, the presence of an OFF condition on circuit CD does not inhibit the operation of the CE (Ringing Indication) circuit. The CD circuit must be turned ON in order for the 212A to automatically answer an incoming call (see Sec. 4.4).

3.4.11 Ring Indicator (CE) - Circuit 22

The ON condition of this circuit normally indicates that a ringing signal is being received by the 212A. The ON condition is approximately coincident with the ON segment of the ringing cycle. If the Answer Mode Indication CE On option is installed, the CE circuit will be in the ON condition also after the incoming call has been answered, either manually or automatically. The CE circuit will remain ON in this case as long as the 212A detects an off

hook condition of the telephone line. When the call is terminated and the telephone line is on hook, the CE circuit will turn OFF.

3.4.12 Transmit Signal Element Timing (Data Terminal Equipment Source) (DA) - Circuit 24

Signals on this circuit are used to provide the 212A transmitter with signal element timing information when the Transmitter Timing External option is selected and the high-speed mode with the synchronous format is used. The timing signal must have a frequency of 1200±0.01% Hz with peak individual distortion of negative transitions no greater than 0.5% and a duty cycle of 40% to 60% as per EIA standard RS-334. The ON to OFF transition of this circuit should nominally indicate the center of each signal element on the Transmitted Data (BA) circuit. When the data terminal provides timing information, signals should be available on this circuit at all times that the 212A is in the data mode at 1200 BPS.

3.4.13 Make Busy/Analog Loop (CN) - Circuit 25

This interface circuit is not defined in EIA standard RS-232-C and is used on an optional basis to allow customer terminal equipment to electronically make the telephone line appear busy (off hook) or to implement the Analog Loop test mode. When the CN Circuit In option is installed, the CN interface circuit is controlled by the connected terminal equipment. An On condition (positive) causes the 212A to make the telephone line busy (if the data set is so configured by a telephone company option). If the data set is not so configured, the line remains in the on hook condition. The ON condition of CN together with an ON condition of Data Terminal Ready (CD) causes the data set to assume the Analog Loop test mode, and make busy. The front panel AL pushbutton overrides the CN lead so that if the CN circuit is OFF, the AL pushbutton, when depressed, will causes a make busy condition and condition the 212A for Analog Loop. The open or grounded conditions of the CN circuit are interpreted as ON conditions. When the CN Circuit Out option is installed, the CN circuit is internally forced to the OFF state.

4.0 Operating With Terminal Equipment (System Operation)

4.1 General Call Setup Procedures

A call may be originated either automatically (with an Automatic Calling Unit-ACU) or manually (with an associated telephone set). Either manual or automatic answer may be used to receive a call, however, when a call is manually answered, it should be originated manually. The call set up procedures are the same for operation in the high- or low-speed modes.

4.2 Manual Call / Manual Answer

In this case the calling attendant picks up the telephone handset, depresses the telephone line key associated with the line to which the data set is connected, and after hearing dial tone, dials the telephone number of the distant data station. At the called data set, the Ring Indicator (CE) circuit will turn ON, and the line lamp under the line key corresponding to the line being called will turn ON when ringing voltage is present (ringing is heard). The attendant at the called station answers the telephone call by depressing the appropriate line key and picking up the handset, establishing voice contact with the originating attendant. The attendants at both stations should verify that the Data Terminal Ready (CD) circuit is ON (TR lamp on 212A lighted), and the calling attendant should verify that the proper speed mode has been selected. Both attendants can then transfer to the data mode by momentarily depressing fully the nonlocking "DATA" key on the telephone so that the line key releases and the lamp under the line key turns ON. The telephone handset may then be placed on hook. Either attendant can depress the DATA key first. If the called data set enters the data mode first, the calling station DATA key must be depressed within approximately 15 seconds, or the called data set may abort the call and disconnect. When the data mode is entered, the lamp under the line key on the telephone set turns ON, the MR lamp on the 212A turns ON, and the Data Set Ready (CC) circuit turns ON. The sequence of events which follows (handshaking) depends on the speed mode selected (see Sec. 4.5).

4.3 Manual Call / Automatic Answer

The calling attendant picks up the telephone handset, depresses the appropriate line key, and after hearing dial tone, dials the telephone number of the distant station. At the called station, the Ring Indicator circuit (CE) will turn ON, and the line lamp under the line key corresponding to the line being called will turn ON when ringing voltage

is present. The distant 212A will automatically answer the call at the end of a ringing cycle if the Data Terminal Ready (CD) circuit is ON and the Automatic Answer In option is installed, turn ON the Data Set Ready (CC) circuit, light the MR lamp on the 212A, and light the line lamp on its associated telephone. After a two second silent interval, the calling attendant will hear a high-pitched tone which is the answertone transmitted by the called 212A data set. The Data Terminal Ready (CD) circuit must be ON, and the speed mode must be selected at the originating 212A before the transfer to the data mode. After the tone begins, the calling attendant must transfer to the data mode within 15 seconds by momentarily depressing fully the "DATA" key on the telephone. The lamp under the line key will go on and the Data Set Ready (CC) circuit will go ON when the transfer is made. The calling attendant can then release the data key and may place the telephone handset on hook. The sequence of events which follows (handshaking) depends on the speed mode selected (see Sec. 4.5).

4.4 Automatic Calling / Automatic Answering

When an automatic calling unit is used, the call is originated by the ACU, and the answertone is detected by the ACU. The ACU causes the 212A to transfer to the data mode (providing the CD circuit is ON) at the beginning of the answertone. When the transfer is complete, the line lamp on the telephone will turn ON, and the Data Set Ready (CC) circuit of the 212A will turn ON. The handshaking sequence which follows depends on the speed mode selected (see Sec.4.5).

4.5 Handshaking Sequences

The handshaking procedures take place after the transfer to the data mode is accomplished (after CC has turned ON). There are five basic sequences which can be followed, depending on the selection of speed and the kind of data sets which are connected. The possible combinations are listed below:

1) The originating data set is a 212A with the High-Speed Mode selected and the answering data set is a 212A.

2) The originating data set is a 212A with the Low-Speed Mode selected and the answering data set is a 212A with the Speed Mode Dual Speed option selected.

3) The originating data set is a 212A with the Low-Speed Mode selected and the answering data set is a 300 BPS FSK data set other than a 212A (such as a 113B or 103A).

4) The originating data set is a 300 BPS FSK data set other than a 212A and the answering data set is a 212A with the Speed Mode Dual option installed.

5) The originating data set is either a 212A with the Low-Speed Mode selected or another 300 BPS data set and the answering data set is a 212A with the Speed Mode High option installed.

The sequence for the first combination is given in Sec. 4.5.1. The handshaking sequence for combination 2 is given in Sec. 4.5.2. The handshaking for combinations 3 and 4 are essentially the same as that for combination 2, but the time intervals will not in general match those shown. If a data set is compatible with the 100-series type handshaking, then in general it will be compatible with the 212A in the Low-Speed Mode. The last combination is discussed in Sec.4.5.3.

4.5.1 High-Speed Mode Handshaking Sequence

After the answering 212A has transferred to the data mode, the channel is kept silent for two seconds. When the silent interval has elapsed, the answering 212A begins transmitting the answertone. The originating 212A requires approximately 155±50 milliseconds to detect the answertone. The originating 212A will begin to transmit 456±10 milliseconds after answertone is detected. The answering 212A requires 270±40 milliseconds for its carrier detection process, after which it transmits a marking signal. The originating 212A also requires 270±40 milliseconds to acquire the carrier, then its CF circuit turns ON. The answering data set delays 765±10 milliseconds after it began transmitting the mark signal, then turns on the CF and CB circuits. The originating data set delays 765±10 milliseconds after the CF circuit turned ON, then turns ON the CB circuit. The handshaking is complete at this point, and 1200 BPS data can be transmitted in both directions.

After the answering 212A is transferred into the data mode, it begins to time the abort interval. If the CF circuit does not turn ON within approximately 18 seconds, the data set will abort the call and go on hook. Figure 6 shows the high-speed handshaking sequence with manual calling and manual answering.

4.5.2 Low-Speed Mode Handshaking Sequence

After the answering data set has been transferred into the data mode, the data set times the two second silent interval before it begins to transmit the answertone. The originating data set carrier detector turns on after 155±50 milliseconds, and the CF circuit turns ON. 456±10 milliseconds after the CF circuit has turned on, the originate data set begins transmitting a mark signal. The carrier detector at the answering data set also requires 155±50 milliseconds to detect the carrier, then the CF and CB circuits turn ON. The originate data set turns on its CB circuit 765±10 milliseconds after the CF circuit turns ON. Customer data can be transmitted in both directions at this point. Figure 7 shows the low-speed handshaking with manual calling and automatic answering.

4.5.3 Attempted Low Speed Operation With Speed Mode High Option

If the Speed Mode High option is installed in the 212A, the internal operation of the data set during the handshaking remains the same, but certain customer interface circuits are affected by the option. Interface circuits CB and CF will not turn ON and circuit BB will be held in the marking state if the low-speed data mode is entered. As a consequence, the customer can neither transmit nor receive any data. All disconnect features of the 212A will still be in effect, and the interface circuits CC,CI,DD, and DB will still be operational. If the far end data set is not a 212A, that data set will only receive a steady marking signal from the 212A, and any data transmitted by the far end data set will not be present at the BB circuit of the 212A. If the high-speed mode is entered, the normal handshaking sequence is followed, as described in Sec. 4.5.1.

4.6 Data To Talk Transfer

Transferring the telephone line back to the telephone handset can be accomplished by depressing the line key for the appropriate telephone line and lifting the handset. The 212A will immediately terminate the data mode, which includes removing carrier from the channel. If the far end data set is equipped to disconnect on a loss of carrier energy, this transfer could cause the far end data set to disconnect and go on hook.

When the transfer to the talk mode is made, the data set will have the originate/answer mode internally stored so a transfer back to the data mode can be initiated in the correct mode.

4.7 Data Call Termination

4.7.1 Data Terminal Ready Control

The local 212A enters an irreversible disconnect sequence when the Data Terminal Ready circuit is turned OFF during the data mode for more than 50 milliseconds, unless the data set is in certain test modes (see Sec. 5). If the Send Space Disconnect Out option is installed, the Data Set Ready circuit will turn OFF 68±10 milliseconds after the CD circuit turns OFF. If the Send Space Disconnect In option is installed, then the data set enters the space transmit sequence which is detailed in Sec. 4.7.3. The CD circuit can be turned ON any time after the 50 milliseconds required for the OFF interval.

4.7.2 Carrier Fail Disconnect

The installation of the Loss of Carrier Disconnect In option causes the 212A to terminate a data call when a substantial loss of received carrier energy is detected. The customer interface circuits CC and CB will turn OFF 433±17 milliseconds after the carrier falls below the carrier detector threshold, disconnecting the telephone line. If the carrier is interrupted for less than 175 milliseconds, a disconnect will not occur; if a carrier interrupt lasts for more than 307 milliseconds, a disconnect will always occur. The CF circuit turns OFF 17±7 milliseconds after the loss of carrier, and turns ON 155±50 milliseconds after the carrier turns ON. If the 212A is put into the Digital Loop test mode by a remote 212A, the Loss of Carrier Disconnect option is forced to the In condition electronically for the remainder of the data call.

4.7.3 Long Space Transmit

If the Send Space Disconnect In option is installed, the space transmit sequence is initiated by either of two conditions:

1) Customer interface circuit CD is turned OFF for at least 50 milliseconds.

2) The Loss of Carrier Disconnect In option is installed and the carrier detector has turned off for at least 307 milliseconds.

The space transmit sequence begins after one of the above events has occurred. The transmit data is clamped to the spacing condition and the CF circuit is turned OFF. After 3.95±0.15 seconds has elapsed, the 212A disconnects

from the telephone line, and CC turns OFF. The sequence cannot be interrupted by any condition of the CD circuit or a restoration of received carrier energy. It is possible to transfer to the talk mode before the 4 second time interval has elapsed, and not lose the telephone connection. Figure 8 shows the sequence for disconnecting using the send space disconnect option with interface circuit CD being turned OFF.

4.7.4 Long Space Disconnect

When the Receive Space Disconnect In option is installed, the 212A will disconnect the data call when the received data circuit remains in a spacing condition for 1.6±0.15 seconds. At the time of disconnect, the CC,CB and CF circuits will turn OFF and the data set will go on hook. If the Remote Digital Loop feature is activated in the 212A by the RDL front panel pushbutton, the Receive Space Disconnect option is forced to the Out state internally. At the 212A which is put into the Digital Loop test mode, the option is also forced to the Out condition. These overrides exist only as long as the 212A is in the test mode.

4.7.5 Abort

The Abort disconnect feature is not optional, but is always activated when the 212A is transferred to the data mode as an answering data set. From the time that the CC circuit turns ON, received carrier must be detected within 17.87±0.15 seconds or the data set will go on hook.

4.7.6 Manual

A manual disconnect can be forced by the attendant by first transferring to the talk mode, then placing the handset on hook. This method of disconnecting overrides all of the others, and works for either the originating or answering data sets.

4.8 Character Oriented Operation / Data Distortion

In order for the 212A to transmit and receive customer data without errors, the transitions of the data must conform to certain specifications which are detailed in this section. The requirements are different for the different speed modes and for synchronous operation. Synchronous operation is discussed in Sec. 4.9.

The Electronic Industries Association Standard RS-404 (Standard For Start-Stop Signal Quality Between Data Terminal Equipment and Non-Synchronous Data Communication

Equipment) can be consulted for additional information on character-asynchronous operation.

4.8.1 Low-Speed Mode

The transitions of the data signal on the customer interface circuit BA (Transmitted Data) do not have to be synchronized with any clock signals on the interface, nor do the bit patterns have to conform to any particular code. To insure good performance, the average bit interval should not be shorter than 1/300 second. Distortion of the transmitted data, as measured by the displacement of a transition from the nominal transition instant, will add to the distortion introduced by the communication channel and data sets.

4.8.2 High-Speed Mode Character-Asynchronous Format

When the 1200 BPS Operation Asynchronous Start-Stop option is installed in the 212A, character formatted data must be used when the high-speed mode is established. Character-asynchronous implies that although the individual characters must contain controlled bit intervals, the characters, as blocks of bits, can be presented to the customer interface at random intervals (asynchronously). The character length can be either 9 or 10 bits, and the length selection must be the same at each pair of 212A data sets that will be connected in the high-speed mode.

The transmitting terminal equipment must have a gross start-stop distortion no greater than 45% (see RS-404 for the definition of gross distortion). Gross distortion has two sources; a speed difference between the terminal and the data set, and displacements of the data transitions from the nominal due to circuit variations and noise. If the transmitting terminal equipment is capable of transmitting characters consecutively, the bit rate in the characters must not differ from the nominal (1200.00) by more than +1.0% or -2.5%. In this case, since the highest possible speed difference (nominal -2.5%) contributes 22% distortion, the data distortion due to circuit and cable variations and noise should not exceed 23%, to insure acceptable performance.

At the data set receiver, the data signal on the BB circuit will have an intracharacter bit rate of 1219 BPS. This is equivalent to a gross start-stop distortion of 14%, which should be well below the receiving margin of terminal equipment. It is therefore possible for the distortion at the output of the data set to be less than the distortion at the output of the transmitting terminal.

Special consideration should be given to systems that use a steady space signal as an interrupt or "break" command, if the break signal is timed by the transmitting

terminal equipment to be less than 23 bits long (19 milliseconds). The 212A system will extend the break signal to 23 or 24 bits (10 bit length option) or 21 or 22 bits (9 bit length option) if the break at the transmitting end is shorter than 23 bits. Any data which are transmitted immediately after a short break will be lost, since the data set overwrites 13 bits of spacing on the data. At the end of the 23 bit break, the data set attempts to synchronize on the next mark to space transition, interpreting it as a start transition. If data were transmitted immediately after the short break, the resynchronization could take place in the middle of a character, causing loss of synchronization for a short time, and errors. If the break signal is longer than 23 bits, the 212A will reproduce the length at the receiver and correctly resynchronize on the next character.

4.9 Synchronous Operation

The 212A data sets can be optioned for synchronous operation at 1200 BPS. With this option, the synchronous format will be implemented whenever the data set is in the high-speed data mode. The 1200 BPS Operation Synchronous option must be installed at both ends of transmission. The transitions of the customer interface circuit BA must conform with the requirements given in Sec. 3.4.

Both directions of transmission can be locked to the same frequency by installation of the Transmitter Timing Slave option in one data set. The other data set will then control the exact frequency of the channel in both directions (the frequency must always conform with the requirements given in Sec. 3.4). If the Slave option is installed at a data set, the Remote Digital Loop test cannot be performed from that end, since that test loops the timing signal at the far end data set and this would result in both data sets looping the timing signal to each other, with no reference. The Analog Loop test is also prohibited at the data set with the Slave option, in the high-speed mode, for the same reason. The above tests can be done if the Self Test feature is also used at the data set with the Slave option, since the timing source is always internal in the Self Test mode, overriding the Slave option.

When the data set is optioned for synchronous operation, it can still respond to a low-speed data call and behave normally. The Analog Loop test is allowed for low-speed operation even if the Slave option is installed. The Digital Loop test is also allowed (using the DL pushbutton at the far end) for low-speed operation.

There is no restriction on the format or code pattern of the data for synchronous formatted data in the high-speed mode.

5. Data Set Testing

The following tests can be used by the customer to isolate a trouble condition in the data connection or to verify the correct operation of the data set, terminal equipment, and data set/terminal interfaces. In the tests where two data sets are involved, they are referred to as the local and far-end data sets. The states of the customer interface circuits during the test modes are shown in Figure 9.

5.1 Analog Loop

The Analog Loop test mode is used to verify the operation of the 212A modulation/demodulation functions, the terminal receive/transmit functions and the data set/terminal interface. To condition the 212A for an Analog Loop test, the Data Terminal Ready circuit must be ON. The speed mode of the test is selected by the front panel HS pushbutton. The test is initiated by depressing the locking AL front panel pushbutton, or if the CN Circuit In option is installed, by turning ON the CN circuit. The 212A follows a "handshaking" sequence which resembles the data mode sequence, except that there is no far end data set, and no answertone sequence. If the 212A is in the originate mode, the transmitter is activated as soon as the test mode is entered. When the carrier detector acquires the signal, the CF circuit turns ON, and 765±10 milliseconds later, the CB circuit turns ON, allowing transmission and reception of data by the local terminal equipment. If the 212A is in the answering mode, both CF and CB turn ON when the carrier detector turns on. The speed mode of the test can be changed during the test, in which case the 212A will turn OFF CB and CF and reinitialize the test sequence in the new speed mode. The Ring Indicator (CE) circuit is operational during the Analog Loop test if the data set is not configured for making the telephone line busy.

If the 212A is configured to operate in the 1200 BPS mode synchronously and the Transmitter Timing Slave option is installed, the Analog Loop test in the high-speed mode is not allowed.

If the CC Indication For Analog Loop On option is installed, the customer interface Data Set Ready (CC) circuit will be ON whenever the AL front panel pushbutton is depressed or the CN circuit is ON.

The TM lamp on the front panel of the 212A will be illuminated whenever the front panel AL pushbutton is depressed or the CN circuit is ON.

If the data set is configured for make busy, the telephone line will be placed in the busy state during the

Analog Loop test. Figure 10 shows the internal configuration of the data set during the test.

5.2 Analog Loop - Self Test

The test is initiated by depressing both the AL and ST front panel pushbuttons, in any order. Internal to the data set, an analog loopback is established in the same way as the Analog Loop test mode, except that the customer interface circuits remain OFF. The 212A generates a test pattern which is applied to the transmitter being tested, and an error detection circuit is placed on the received data circuit. If the AL/ST test is performed in the low-speed mode, the error detection circuit causes the MC lamp on the front panel to blink ON if the bit length of a received data bit is outside the nominal length by more than 25% of a nominal bit length. If the 212A is in the high-speed mode, the MC lamp will blink ON if a bit error is detected in the received data. For either kind of detected error, the MC lamp remains ON for approximately 300 milliseconds. Figure 11 shows the internal configuration of the data set during the test mode.

5.3 End To End Self Test

This test can be used to check the operation of the local modulator/ demodulator, the far-end modulator/ demodulator, and the integrity of the communication channel in each direction independently. No terminal equipment is needed at either data station. The Self Test mode in the 212A overrides the condition of the Data Terminal Ready circuit from the terminal, forcing it to the ON condition internal to the data set. The ST front panel pushbuttons can be depressed before or during the data mode establishment except if the terminals are not connected, or if circuit CD is not ON, in which case the ST buttons would have to be depressed before the data mode. The error detection circuit at each end monitors the received data signal, and illuminates the MC lamp at that end if an error is detected, or the distortion threshold is exceeded. Each data set sends the test pattern through the communication channel to the other data set, with both directions of transmission occurring simultaneously. Either speed mode can be checked with the End To End Self Test. Figure 12 shows the internal configuration of the data sets during the test.

5.4 Remote Digital Loop

This test is used to remotely condition the far-end 212A to act as a repeater for the data being transmitted by

the local 212A. The test is only effective when the 212A is in the high-speed mode. The Remote Digital Loop test can be initiated at the local 212A by manually depressing the RDL front panel pushbutton. The digital loop will take place at the far-end data set only if the Receiver Responds to Digital Loop Yes option is installed at that end. To digitally loop an unattended data set, that station must be optioned for Automatic Answer In and have the CD circuit ON. When the test is initiated, the local 212A turns OFF the CB circuit until the digital loop through the far-end is established. At the far-end data set, the interface circuits CB, CF, and CC are turned OFF for the duration of the test. The TM lamp is illuminated at both ends during the test. The space disconnect feature is disabled, overriding the Receive Space Disconnect option in both 212A's. At the far-end data set, the Loss of Carrier Disconnect In option is forced during the test mode and for the remainder of the time that the data set is in the data mode. Also at the far-end data set, the customer interface circuit Data Terminal Ready is overridden internally to the ON state during the test, and reverts back to customer control when the test mode is terminated.

During the Remote Digital Loop test, the local terminal equipment can transmit data to the far-end and monitor the local received data, which should be a duplicate except for a delay time equal to the total round trip delay.

A Remote Digital Loop test is not allowed if the Transmit Timing Slave option is installed. Figure 13 shows the internal configuration of the data sets during the test mode.

5.5 Remote Digital Loop - Self Test

This test allows the local attendant to verify the operation of both local and far-end 212A data sets and both directions of the connecting communications channel without local terminal equipment. The data path from the local 212A to the far-end 212A and back again is the same as in the Remote Digital Loop test, except that in this test the data pattern is provided by the local 212A and is checked for accuracy by the local 212A. The customer send data circuit is ignored at both of the 212A data sets. To condition the 212A for this test, both the ST and RDL front panel pushbuttons must be depressed, either before or during the data mode (high-speed only), in either order. The far-end data set must have the Receiver Responds to Digital Loop Yes option installed, have CD ON and the Automatic Answer option installed. At the local 212A, the interface circuits CC, CB, and CF are turned CFF for the duratien of the test. These same circuits are also turned OFF at the far-end data set. At both data sets, the Data Terminal Ready circuit is

forced to the ON state internally, and the customer CD circuit is ignored. At the local data set, the MC lamp indicates an error in the looped test pattern by flashing ON for approximately 300 milliseconds. When the RDL-ST test is completed, the ST and RDL buttons are released and the data sets are returned to the normal high-speed data mode (CC,CB,CF ON). At the far-end data set, the Loss of Carrier Disconnect In option is in effect for the duration of the test and the remainder of the time that the data set is in the data mode. Figure 14 shows the internal configuration of the data sets during the test mode.

5.6 Digital Loop

The 212A can be manually conditioned to loop the received data back to the transmitter circuits in all data formats by depressing the DL front panel pushbutton. This test is used to test the 212A from a remote location such as a data test center. The DL button can be depressed either before or during the data mode for single mountings. For multiple mountings, DL should be depressed before the call is established. If the 212A is installed in a multiple mounting, the data set will be transferred to the local service telephone line for the test if that option is installed in the mounting. When the button is depressed, the 212A will be optioned for Automatic Answer In with customer circuit CD internally forced to the ON state, and will loop the received data back to the transmitted data circuit, and connect the received timing to the transmit timing when in the data mode. Also, the interface circuits CC, CB, and CF will turn OFF. The TM lamp will turn ON indicating that the data set is in a test mode. The local data set can then be tested from the far-end by using terminal equipment at the far-end to transmit a test pattern and examine the looped data. At the far-end data set, all interface circuits will behave normally as in the data mode. At the conclusion of the test, the DL button is released, and the local data set is returned to the normal data mode automatically with control reverting to the customer CD circuit. At the local data set, the Loss of Carrier Disconnect Yes option is forced for the duration of the test and the remainder of the time that the data set is in the data mode.

The Digital Loop test cannot be used in the high-speed mode if the far-end 212A has the Transmitter Timing Slave option installed.

At the end of the test, the far-end station can cause the local 212A to disconnect by hanging up the telephone connection after transferring to the talk mode, causing a loss of carrier. The local 212A is conditioned to disconnect on the loss of carrier by the DL pushbutton.

When the DL button is released, the data set is transferred back to the normal telephone line if the installation is a multiple mounting. Figure 15 shows the internal configuration of each data set during the test mode.

5.7 Digital Loop - Self Test

This test is the same as the Digital Loop test except that the test pattern is supplied by the far-end 212A internally, and the looped data are checked by the far-end data set. At the far-end 212A, the front panel ST button is depressed to activate these functions, and turn OFF the customer circuits CC, CB, and CF for the duration of the test. At the far-end, The customer CD circuit is forced ON internally, and the interface CD circuit is ignored. The MC lamp at the far-end acts as an indicator for the quality of the looped data by flashing ON whenever a received error occurs (high-speed) or the distortion of a received data bit exceeds 25% (low-speed). At the end of the test, the ST and DL buttons are released and both data sets revert to the normal data mode if the customer CD circuits are ON. At the local 212A, the Loss of Carrier Disconnect Yes option is forced ON for the duration of the data call. Figure 16 shows the configuration of each data set during the test mode.

6. Performance Objectives

The 212A data set is designed for a long term average bit error rate objective of less than 1 error in 10^5 bits for the bit-synchronous format in the high-speed mode for 80% of all dialed connections. For 1000-bit blocks, less than 1 block in 100 will be in error for 80% of all dialed connections.

When the data set is operating in the high-speed mode with character-asynchronous format, parity errors will occur at the rate of less than 1 error in 10^4 characters for 80% of the dialed connections. The gross start stop distortion in this format will normally be equal to 14% for all connections; however, line impairments encountered for some dialed connections may cause the distortion to momentarily exceed this value.

In the low-speed mode of operation, Data Set 212A will provide performance comparable to that of the Bell System 100-series switched network data sets.

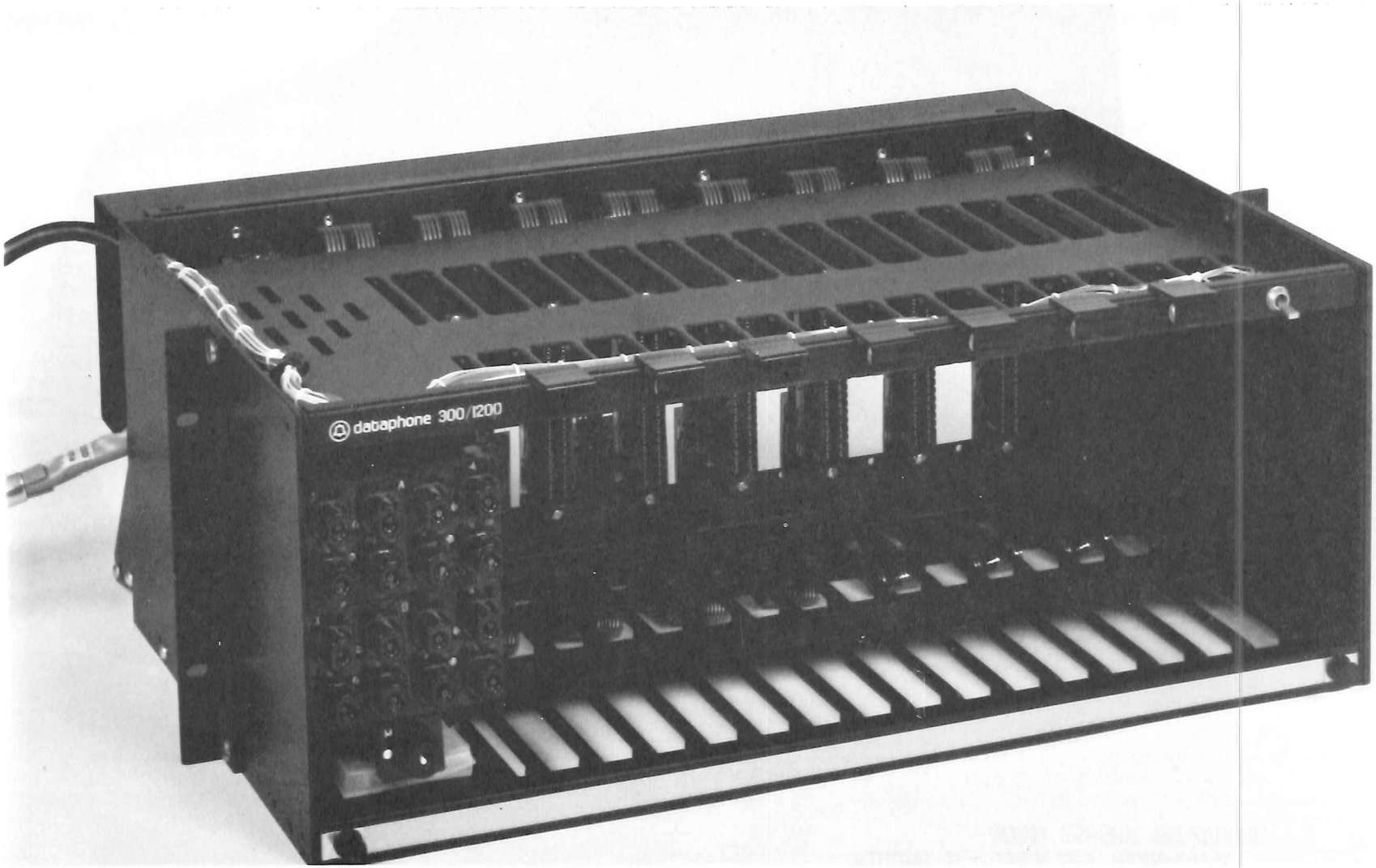
TABLE 1 EIA CONNECTOR PIN ASSIGNMENTS

PIN NO	NAME	DIRECTION	FUNCTION
1	-	-	NO CONNECTION (NC) [1]
2	BA	TO DATA SET	TRANSMITTED DATA
3	BB	FROM DATA SET	RECEIVED DATA
4	-	-	NC
5	CB	FROM DATA SET	CLEAR TO SEND
6	CC	FROM DATA SET	DATA SET READY
7	AB	-	SIGNAL GROUND
8	CF	FROM DATA SET	RECEIVED LINE SIGNAL DETECTOR
9	-	-	NC
10	-	-	NC
11	-	-	NC
12	CI	FROM DATA SET	SPEED MODE INDICATION
13	-	-	NC
14	-	-	NC
15	DB	FROM DATA SET	TRANSMIT SIGNAL ELEMENT TIMING-DATA COMMUNICATION EQUIPMENT SOURCE
16	-	-	NC
17	DD	FROM DATA SET	RECEIVED SIGNAL ELEMENT TIMING-DATA COMMUNICATION EQUIPMENT SOURCE
18	-	-	NC
19	-	-	NC
20	CD	TO DATA SET	DATA TERMINAL READY
21	-	-	NC
22	CE	FROM DATA SET	RING INDICATOR
23	-	-	NC
24	DA	TO DATA SET	TRANSMIT SIGNAL ELEMENT TIMING-DATA TERMINAL EQUIPMENT SOURCE
25	CN	TO DATA SET	MAKE BUSY/ANALOG LOOP

[1] protective ground is provided on a screw terminal

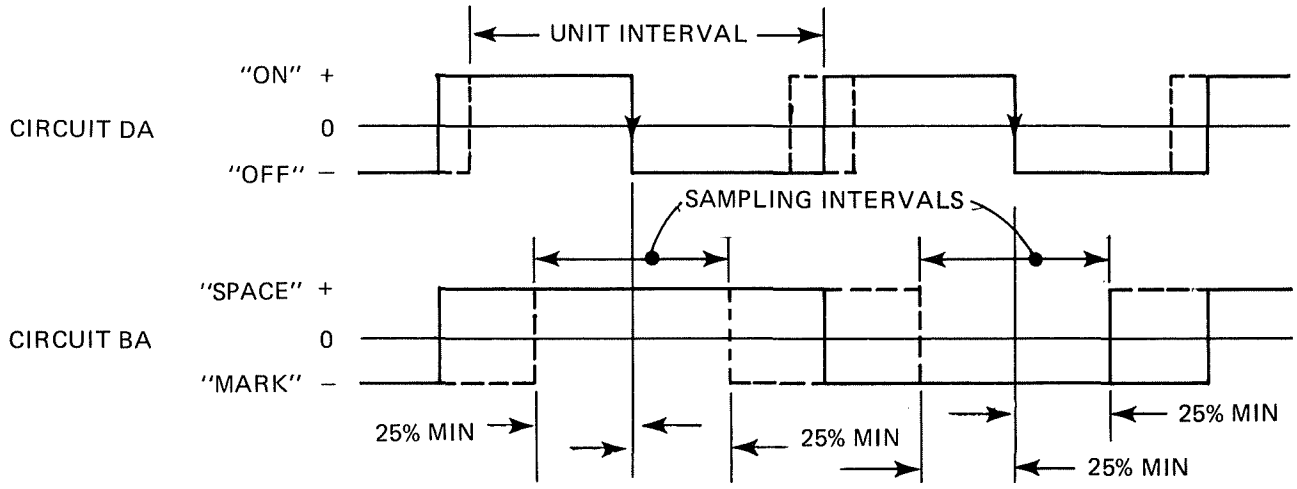
FIGURE 1 - DATA SET 212A-L1/2
WITH 2565HK TELEPHONE

FIGURE 2 - 40A2 DATA MOUNTING FOR EIGHT DATA SETS

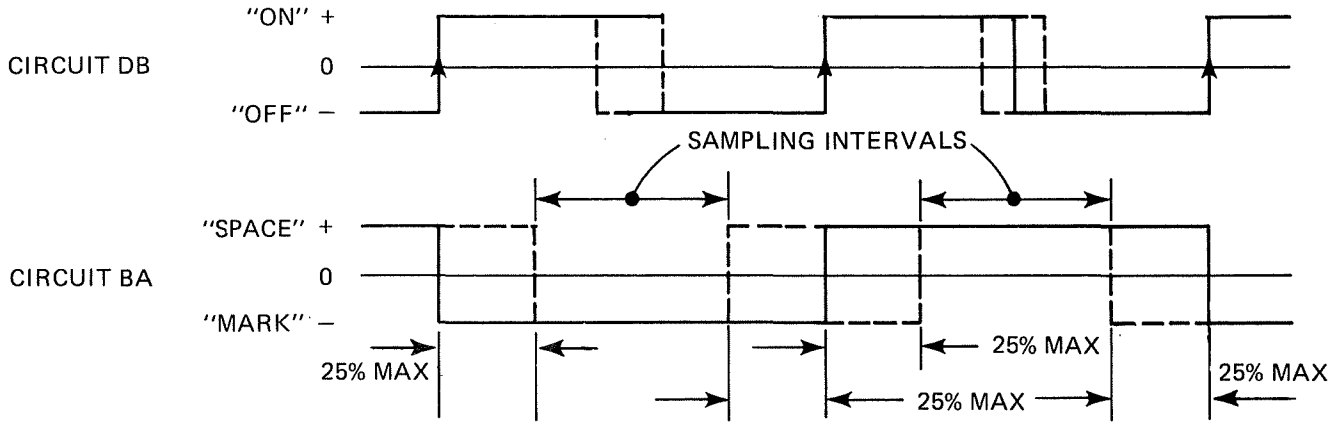


FEATURE	CHOICE	DESCRIPTION
CC INDICATION FOR ANALOG LOOP	ON	CC CIRCUIT ON DURING AL TEST
	OFF	CC CIRCUIT OFF DURING AL TEST
CN CIRCUIT	IN	AL/MAKE BUSY CONTROLLED BY CN CIRCUIT OR AL BUTTON
	OUT	AL/MAKE BUSY CONTROLLED ONLY BY AL BUTTON, CN INTERNALLY HELD OFF
TRANSMITTER TIMING	INTERNAL	1200 BPS TRANSMITTER DRIVEN BY INTERNAL CLOCK
	EXTERNAL	1200 BPS TRANSMITTER DRIVEN BY DA CIRCUIT
	SLAVE	1200 BPS TRANSMITTER DRIVEN BY RECEIVE CLOCK (DD)
1200 BPS OPERATION	ASYNCHRONOUS/ START STOP	CHARACTER-ORIENTED OPERATION IN THE HIGH-SPEED MODE
	SYNCHRONOUS	BIT-SYNCHRONOUS OPERATION IN THE HIGH-SPEED MODE
CHARACTER LENGTH	9 BIT	CHARACTER FORMAT IS 9 BIT FOR 1200 BPS ASYNCHRONOUS/START STOP OPERATION
	10 BIT	CHARACTER FORMAT IS 10 BIT FOR 1200 BPS ASYNCHRONOUS/START STOP OPERATION
RECEIVER RESPONDS TO DIGITAL LOOP	IN	DIGITAL LOOP CAN BE REMOTELY ACTIVATED IN THE HIGH-SPEED MODE
	OUT	NO RESPONSE TO REMOTE REQUEST FOR A DIGITAL LOOP
LOSS OF CARRIER DISCONNECT	IN	CALL IS DROPPED IF LOSS OF CARRIER OCCURS
	OUT	LOSS OF CARRIER DOES NOT DROP CALL
RECEIVE SPACE DISCONNECT	IN	CALL IS DROPPED IF STEADY SPACE IS RECEIVED
	OUT	SPACE SIGNAL HAS NO EFFECT ON DATA SET
CB AND CF INDICATIONS	COMMON	CB CIRCUIT IS TURNED OFF WHENEVER CF CIRCUIT GOES OFF
	SEPARATE	CB CIRCUIT IS NOT AFFECTED BY CF CIRCUIT
SEND SPACE DISCONNECT	IN	STEADY SPACE TRANSMITTED BEFORE DISCONNECTING
	OUT	NO SPACE TRANSMITTED BEFORE DISCONNECTING
AUTOMATIC ANSWER	IN	UNATTENDED ANSWER IF CD CIRCUIT IS ON
	OUT	NO RESPONSE TO RINGING INDICATION
ANSWER MODE INDICATION-CE	ON	CIRCUIT CE REMAINS ON AFTER CALL IS ANSWERED
	OFF	CIRCUIT CE TURNS OFF AFTER CALL IS ANSWERED
SPEED MODE	HIGH	DATA CAN CROSS INTERFACE ONLY IN THE HIGH-SPEED MODE
	DUAL	DATA CAN CROSS INTERFACE IN BOTH SPEED MODES
INTERFACE SPEED INDICATION	IN	CIRCUIT CI INDICATES SPEED MODE
	OUT	CIRCUIT CI DISCONNECTED FROM CPE INTERFACE
SIGNAL GROUND TO FRAME GROUND CONNECTION	IN	PROTECTIVE GROUND AND SIGNAL GROUND TIED TOGETHER
	OUT	NO CONNECTION BETWEEN PROTECTIVE GROUND AND SIGNAL GROUND

FIGURE 3 - DATA SET 212A CUSTOMER OPTIONS

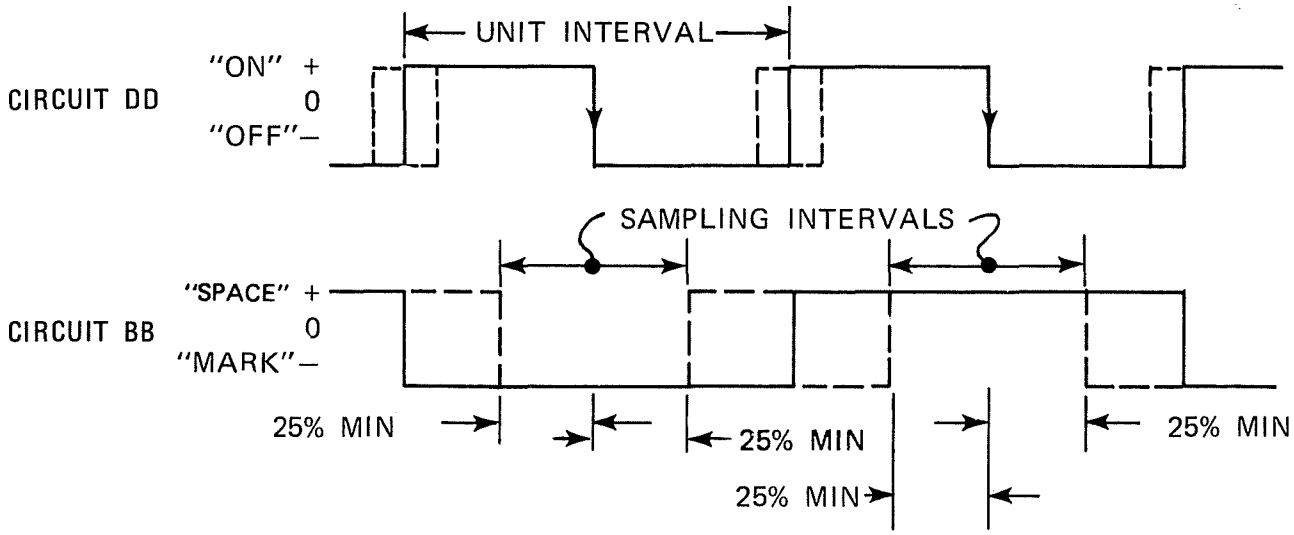


RELATIONSHIP BETWEEN CIRCUITS BA AND DA FOR EXTERNAL TIMING, SYNCHRONOUS

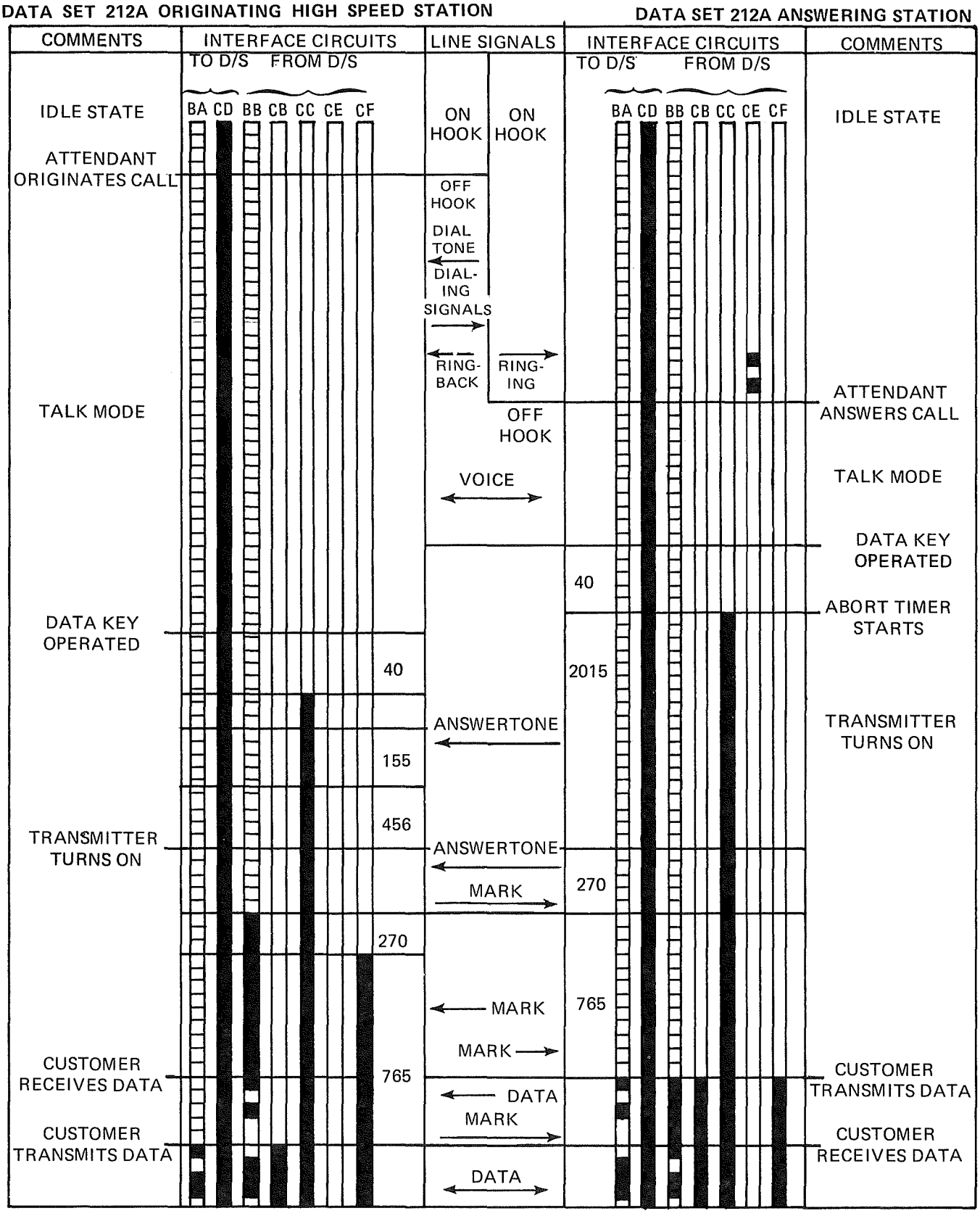


RELATIONSHIP BETWEEN CIRCUITS BA AND DB FOR INTERNAL TIMING, SYNCHRONOUS

FIGURE 4 – TIMING FOR SYNCHRONOUS TRANSMISSION



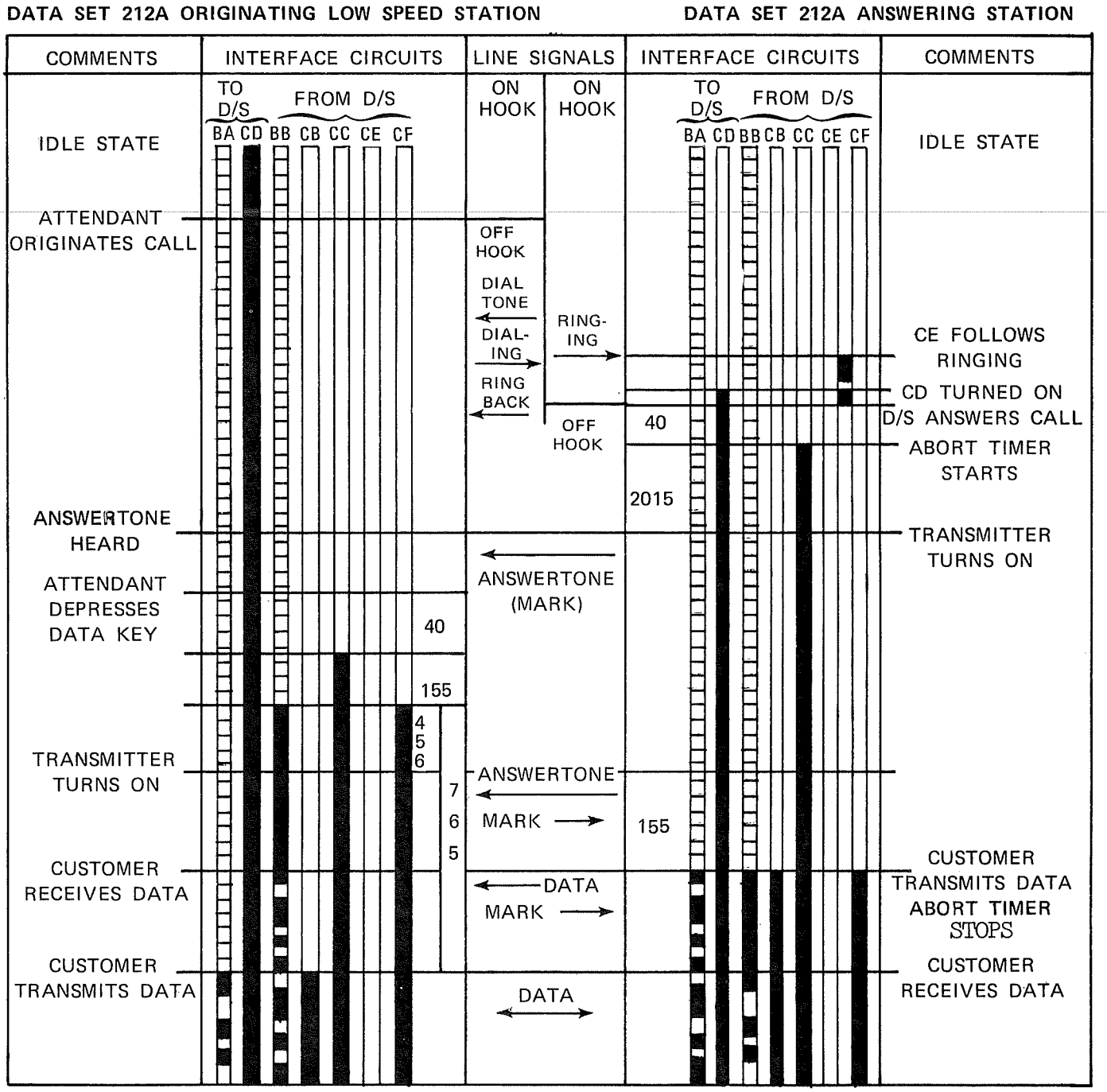
TIMING FOR SYNCHRONOUS RECEPTION
FIGURE 5



NOTE: INTERVALS SHOWN ARE TYPICAL AND IN MILLISECONDS

SEQUENCE CHART FOR A HIGH SPEED CALL
ORIGINATED MANUALLY AND ANSWERED MANUALLY

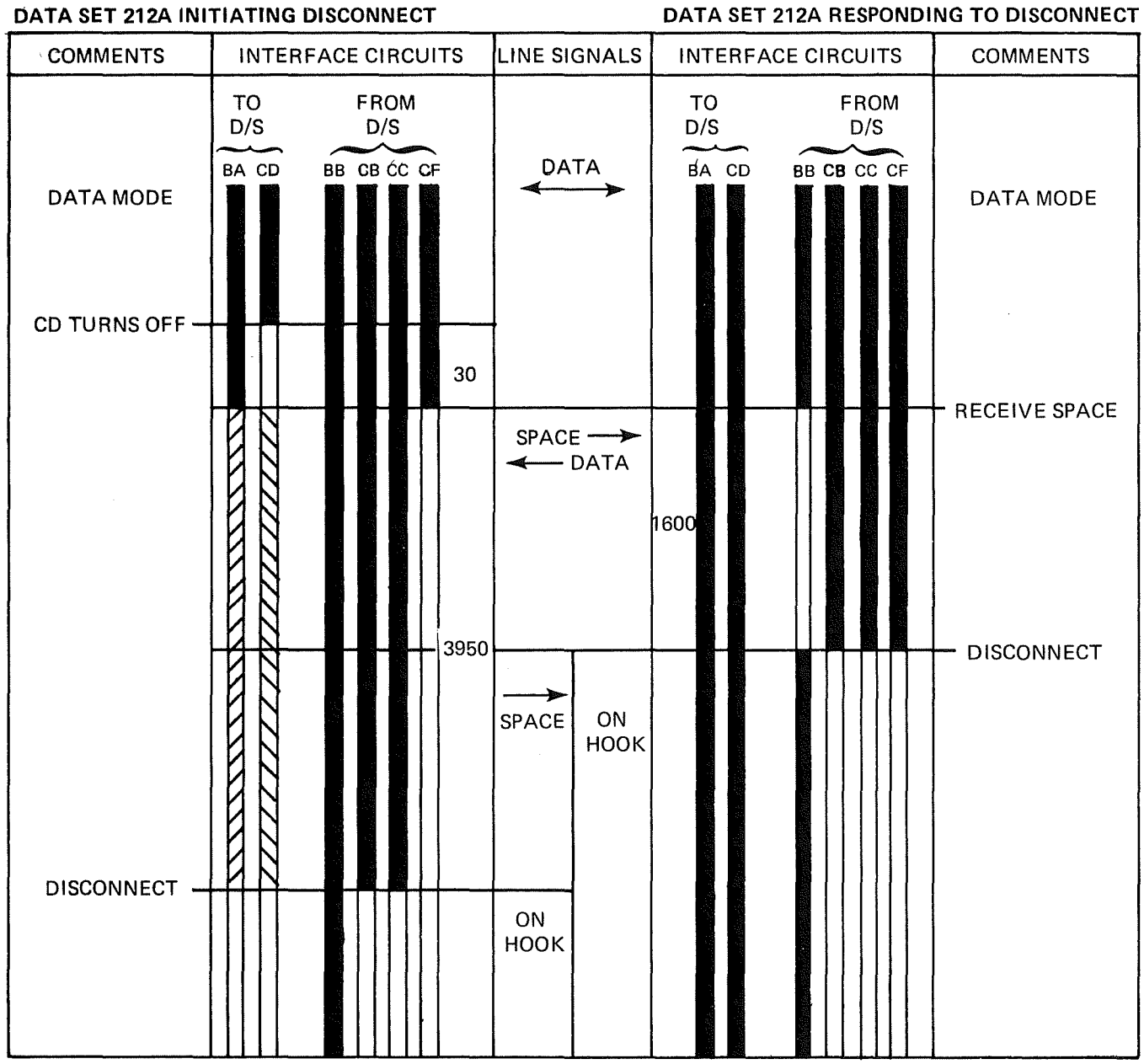
FIGURE 6



NOTE: INTERVALS SHOWN ARE TYPICAL AND IN MILLISECONDS.

SEQUENCE CHART FOR A LOW SPEED CALL ORIGINATED MANUALLY AND ANSWERED AUTOMATICALLY

FIGURE 7



NOTE: INTERVALS SHOWN ARE TYPICAL AND IN MILLISECONDS

SEQUENCE CHART FOR LONG SPACE DISCONNECT

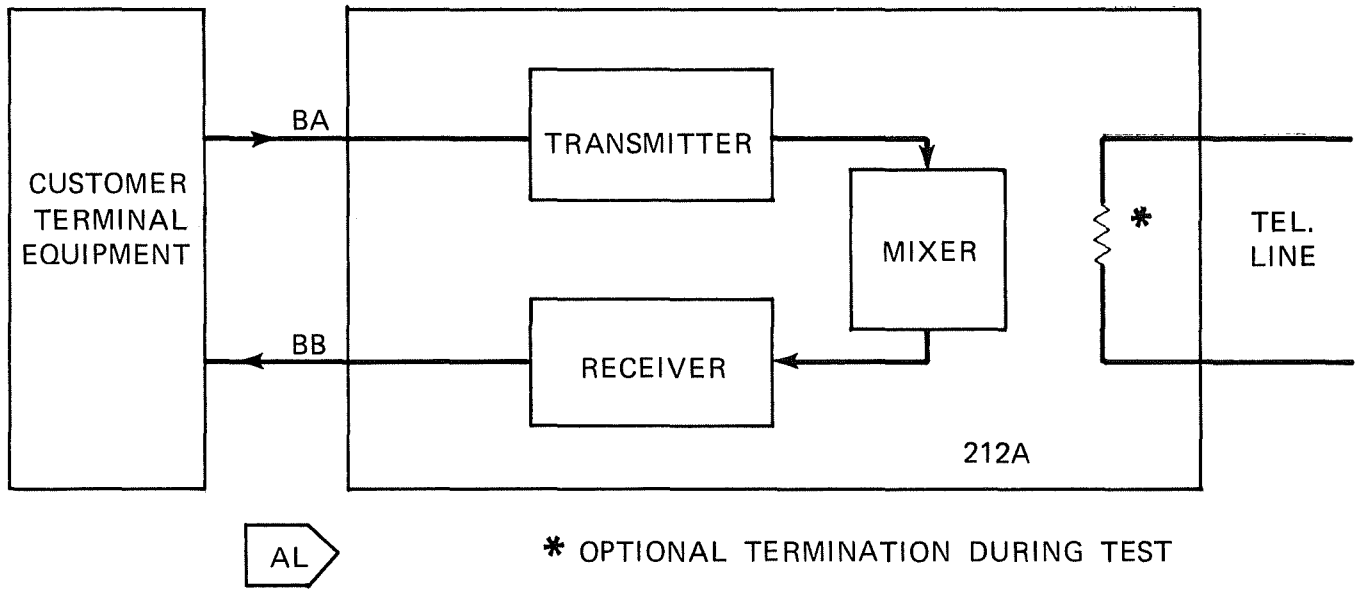
FIGURE 8

			DL[1] OR RDL[1]		ST/ST[2]		DL/ST[3] OR RDL/ST[3]	
	AL	AL/ST	LOCAL	REMOTE	LOCAL	REMOTE	LOCAL	REMOTE
CC	–[4]	–	+	–	–	–	–	–
CB	+	–	+	–	–	–	–	–
CF	+	–	+	–	–	–	–	–
BA	DATA	5	DATA	5	5	5	5	5
BB	DATA	–	DATA	–	–	–	–	–
CD	+	5	+	5	5	5	5	5

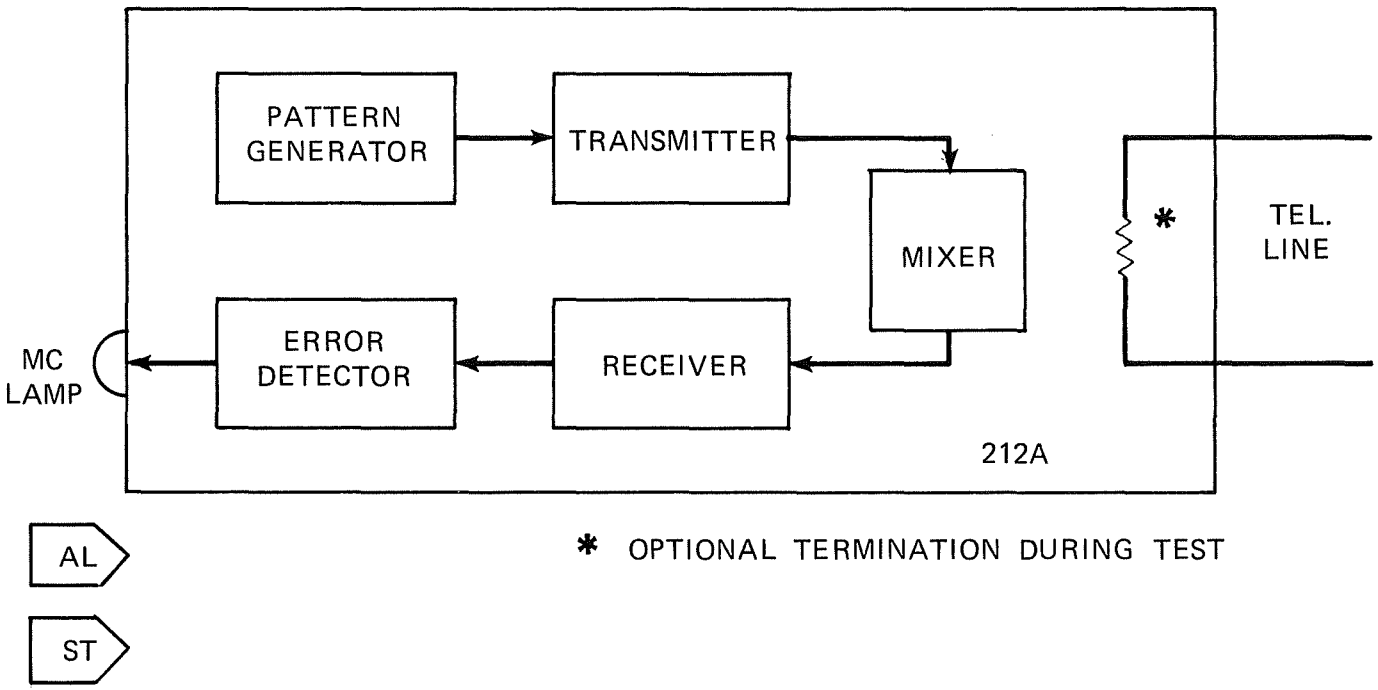
+	ON	–	OFF OR MARK

NOTES:
1. DL DEPRESSED AT REMOTE OR RDL DEPRESSED AT LOCAL
2. ST DEPRESSED AT BOTH LOCAL AND REMOTE
3. EITHER DL AT REMOTE, ST LOCAL OR RDL AND ST LOCAL
4. OPTIONALLY ON
5. IGNORED BY 212A

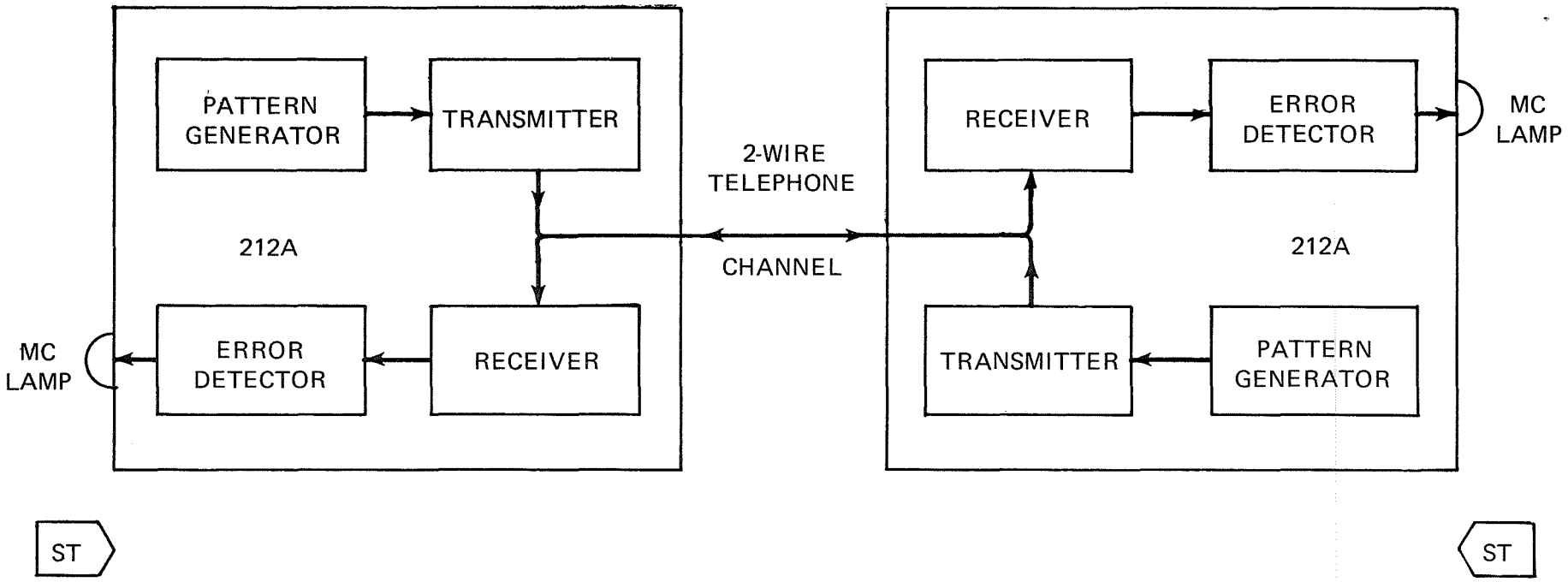
CONDITION OF CUSTOMER INTERFACE DURING TESTS
FIGURE 9



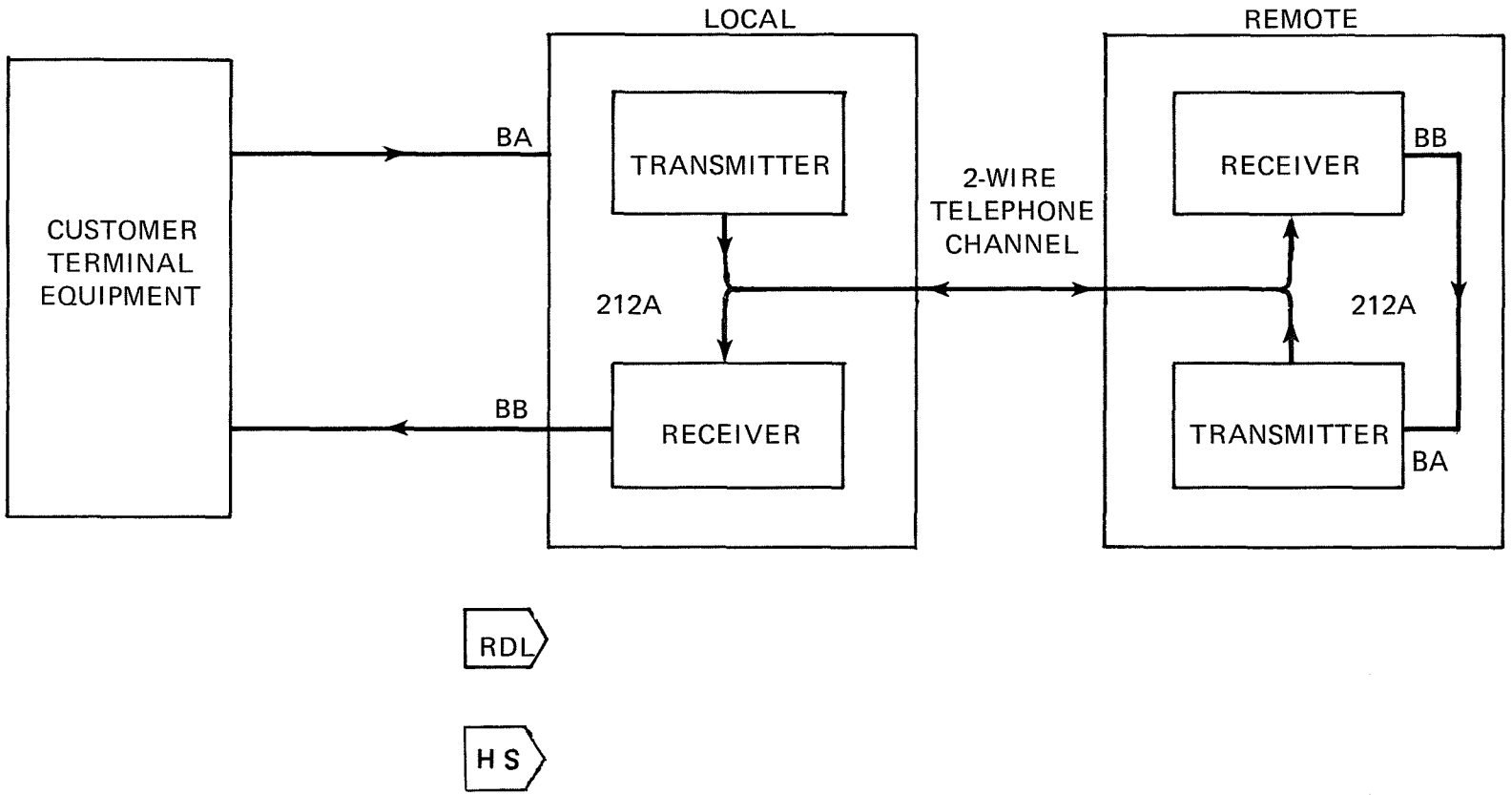
ANALOG LOOP TEST
FIGURE 10



SELF-TEST ANALOG LOOP
FIGURE 11

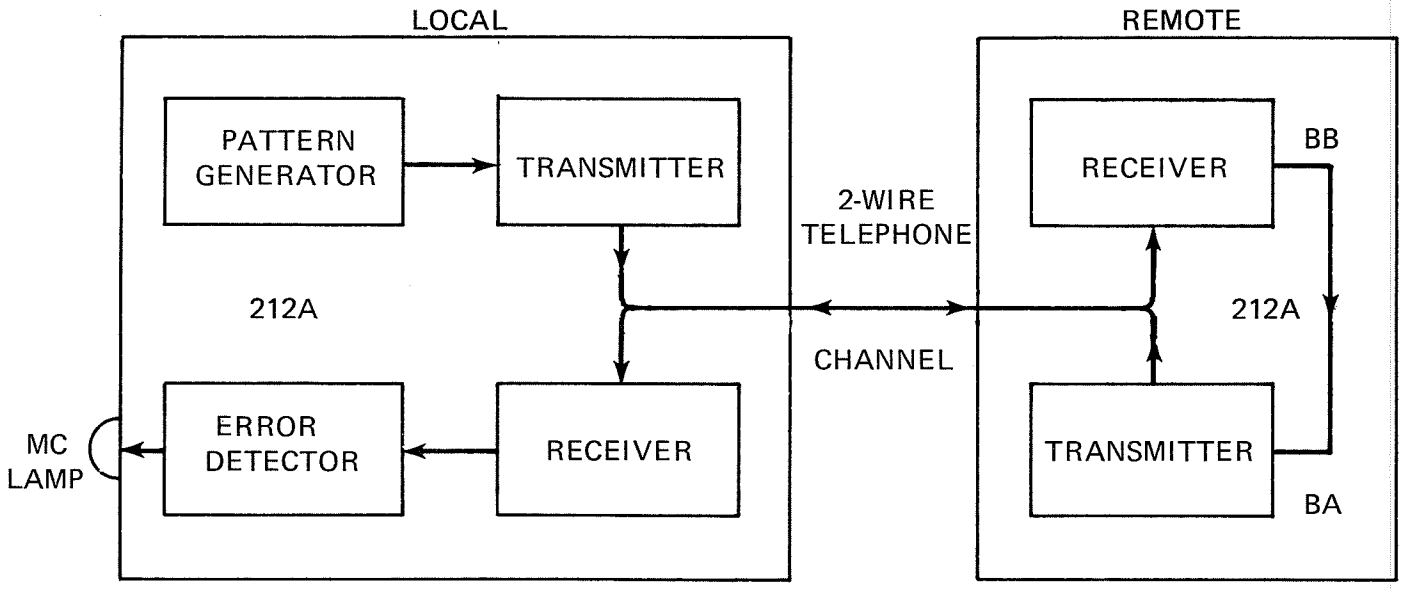


END TO END SELF-TEST
FIGURE 12



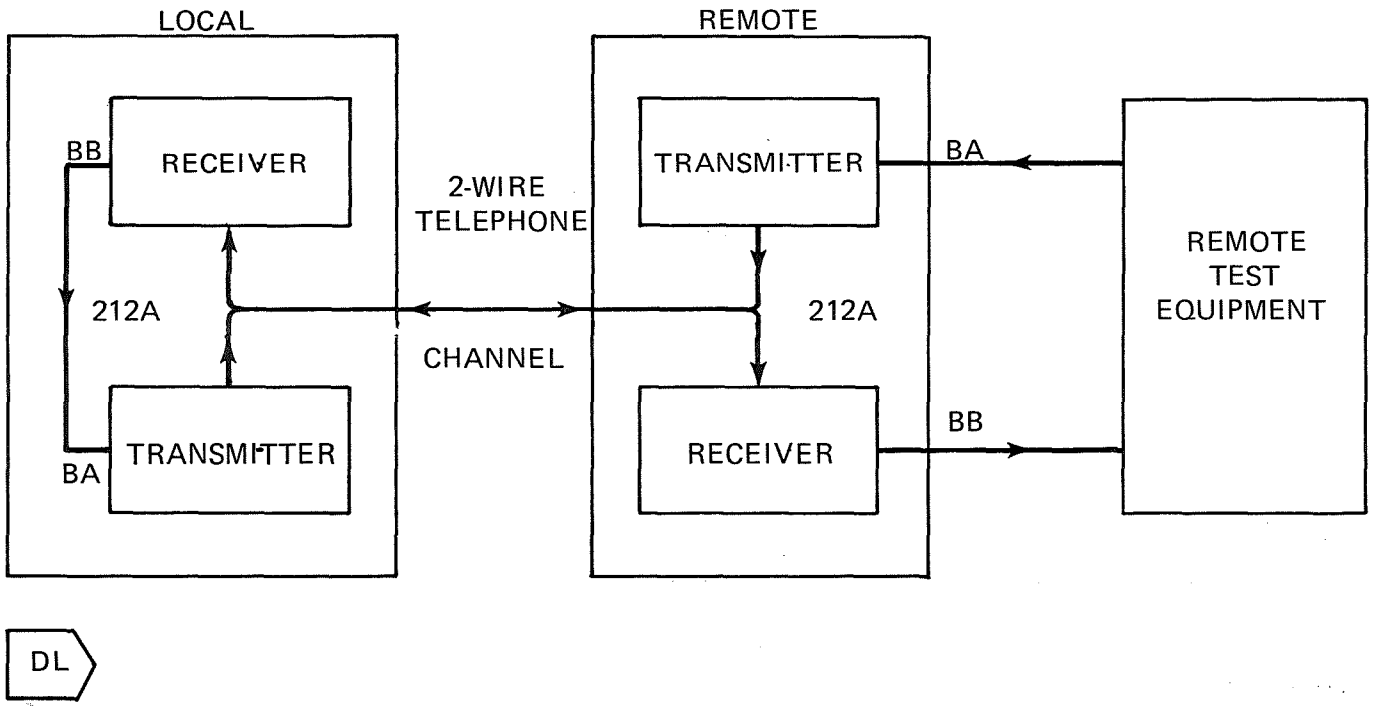
NOTE: HIGH SPEED ONLY

REMOTE DIGITAL LOOP
FIGURE 13

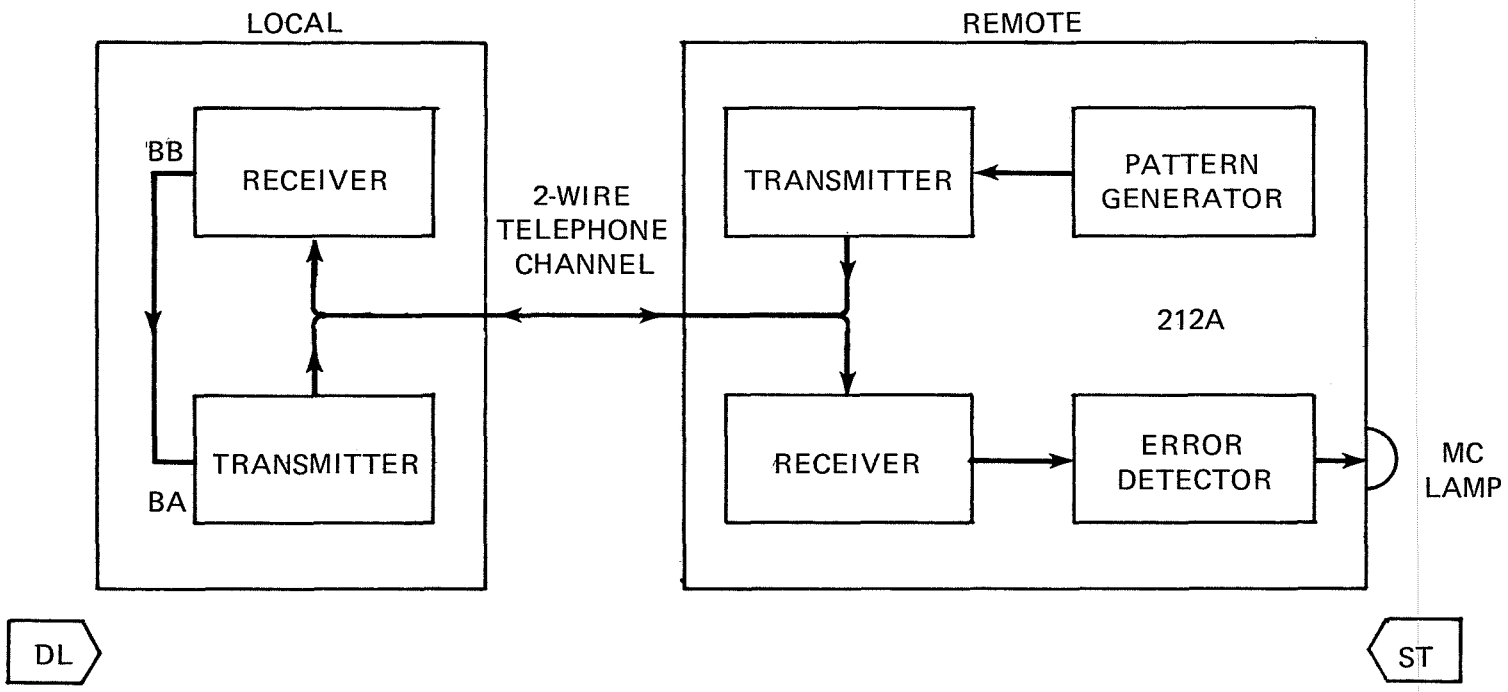


NOTE: HIGH SPEED ONLY

SELF-TEST REMOTE DIGITAL LOOP
FIGURE 14



DIGITAL LOOP
FIGURE 15



SELF-TEST DIGITAL LOOP
FIGURE 16