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TECHNICAL REFERENCE

DATA SET 208A INTERFACE SPECIFICATION

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Data Set 208A

Interface Specification

November 1973

Engineering Manager - Data Systems

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If further information is required, please contact:

Engineering Manager — Data Systems
American Telephone and Telegraph Company
195 Broadway
New York, New York 10007

This Technical Reference supersedes the following Technical References:

"Data Set 208A — Interface Specification — Preliminary — June 1972"

"Data Set 208A — Interface Specification — October 1972"

TABLE OF CONTENTS

TABLE OF CONTENTS (Cont'd)

LIST OF FIGURES

TECHNICAL SPECIFICATION SUMMARY

Data Rate:	4800 bps
Modulation:	Phase Shift Keyed (PSK)
Operation:	Synchronous, Binary, Serial
Line Requirements:	Basic (Unconditioned) 4-Wire private line Type 3002 channel
Interface Voltages:	Per EIA RS-232-C
Operating Modes:	Simplex, Half-duplex or Duplex

Interface Control Functions:

Request-to-Send — Clear-to-Send Delay:

48.5 ±0.5 milliseconds (switched carrier option), 8 ±0.5 milliseconds (continuous carrier operation with switched Request-to-Send option)

Received Line Signal Detector Operation:

Turn ON	41 ±0.5 milliseconds after Signal Quality Detector turns ON
Turn OFF	Less than one millisecond after Signal Quality Detector turns OFF (without one second holdover option)

Signal Quality Detector Operation:

Turn ON	If data carrier signal is present for 4 milliseconds or longer
Turn OFF	If data carrier signal is absent for 2 milliseconds or longer

Interface Connector and Cable:

Business machine 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 is recommended to be no more than 50 feet long in conformance with EIA Standard RS-232-C.

AC Power:

117 volt ±10% ac, 60 Hz ±5% Consumes about 26 watts

TECHNICAL SPECIFICATION SUMMARY (Cont'd)

Power cord provided by Telephone Company. Power outlet should be a conventional 3-wire type not under switch control.

Environmental Requirements:

Ambient temperature range: 40° — 120° F
Relative Humidity: From 20 to 95%

Dimensions: 16 inches wide, 4-1/4-inches high, and 11-1/2-inches deep

Weight: Approximately 20 pounds

1. GENERAL

1.1 Data Set 208A Type

Data Set 208A is a 4-wire data set designed for transmission and reception of synchronous 4800 bps serial, binary data on basic (unconditioned) 3002-type 4-wire channels. The data set uses Phase Shift Keyed (PSK) modulation and features a fast start-up (less than 50 milliseconds) automatic adaptive equalizer for quick turnaround operation.

The Data Set 208A can provide 4800 bps duplex service which, depending upon the need of the data terminal, can be operated to yield one-way, two-way nonsimultaneous (half-duplex) or two-way simultaneous (duplex) transmission for point-to-point or multipoint private line applications. The data set places no restriction on the coding of customer data as the transmitter contains a scrambler circuit to randomize the signal applied to the channel. There is a feature which provides for automatic retraining of the adaptive equalizer without restarting the transmitter when error performance is degraded. It also has an optional New Sync feature similar to that used in Data Set 201-type for squelching the receiver clock at the end of a message and permitting quick resynchronization on the following message. Other optional features are described in Section 2. Transmitter timing is provided by the data set (or from customer equipment as an option), and receiver timing is provided by the data set.

1.2 Interface

The interface signals exchanged between the data set and the data terminal equipment conform electrically to the Electronics Industries Association (EIA) Standard RS-232-C. The interface circuits provided in Data Set 208A include those listed in the Type D Interface of RS-232-C for Dedicated Line Service. Five additional interface circuits are also provided. On an optional basis, the data set can be strapped for continuous carrier operation as in the Type E Interface of RS-232-C. Section 3 provides descriptive information on the function and operation of the interface circuits.

1.3 Physical Description

The data set housing, shown in Figures 1 and 2, measures 16-inches wide, 4-1/4-inches high, and 11-1/2-inches deep. The data set will operate normally over a temperature range from 40° to 120°F and with a relative humidity from 20 to 95 percent. The data set weighs approximately 20 pounds.

Note that Figure 1 depicts the updated version of the data set. The original version had a somewhat different front panel that included seven indicator lamps and a three-position slide switch for testing.

1.4 Power Requirements

Electrical power is supplied to the data set through a 3-wire shielded power cord attached via a twist lock connector on the back of the data set. The plug should be connected to a conventional 117 volt $\pm$10 percent, 60 Hz $\pm$ 5 percent, nonswitched three-prong ac outlet. The data set consumes approximately 26 watts of ac power.

1.5 Grounding

The Protective Ground circuit on the interface of Data Set 208A is established through the ground wire of the power cord. This also provides grounding of the data set housing and chassis to the local building power ground. It is recommended that the data terminal equipment be tied to the same building power ground as the data set to avoid differences in ground potentials which may affect data performance or damage electronic circuitry. The Signal Ground circuit on the interface is the common reference potential for all the other circuits on the interface. The Protective and Signal Ground circuits are tied together by means of a strap in the data set as provided from the factory. This is intended to provide additional margin to longitudinal power line noise. The strap may, however, be disconnected at the request of the customer with due consideration given to possible noise conditions, ground potential differences, safety conditions, local electrical codes, and data terminal manufacturer recommendations.

1.6 Location and Mounting of Data Set

The data set should be located in the vicinity of the data terminal equipment on a nearby desk, table, stand, or for multiple arrangements in Bell System provided data set cabinets or equipment

racks. The room or cabinets in which it is located should preferably provide some ventilation to prevent heat build-up which may occur with stagnant air. The customer-provided interface cable from the data terminal should not exceed 50 feet in length in accordance with recommendations in EIA Standard RS-232-C. This recommendation is intended to minimize cross-talk coupling among the unbalanced interface circuits and reduce the chance of noise pickup from outside sources. The data set will be installed in a location to permit compliance with this recommendation.

1.7 Test Switches and Self-Testing Features

The present version of Data Set 208A has four push-button test switches accessible on the right side of the front cover. There are two additional buttons that are not operational for the 208A, but are used only on Data Set 208B. The position of these buttons has no effect on Data Set 208A. The test buttons permit comprehensive local and remote testing of the data set and facilities. All of the buttons, shown in Figure 1, are a push-to-operate and push-to-release type with the exception of the LP button which is nonlocking. The four buttons are identified as follows with their respective functions:

1. LP (Lamp Test): This is a nonlocking button which when held depressed will light all of the status lamps except the ON lamp (which is lit whenever the data set is powered) to check that they are working. Depressing this button does not affect data set operation.
2. AL (Analog Loopback): The AL button is used to connect the transmitter output to the receiver input through an internal attenuation network. This permits the testing of the local data set with either self-contained test circuitry activated by the ST button or with external test equipment or the data terminal equipment through the data set interface.
3. ST (Self-Test): The ST button is used to condition the data set to operate with a built-in test word generator and word comparator to check for errors. This switch internally turns the Request-to-Send signal ON and lights the RS lamp. The Data Set Ready circuit and the MR lamp are both turned OFF. The ER lamp will blink on to indicate the occurrence of errors.
4. DL (Digital Loopback): The DL button is used to internally connect together the Received Data (BA) and the Transmitted Data (BB) circuits, the Receiver Signal Element Timing (DD) and Transmitter Signal Element Timing External (DA) circuits, and the Signal Quality (CG) and Request-to-Send (CA) circuits at the customer interface. This permits a round-trip test of the facilities and the two data sets with either the self-contained test circuitry activated by the ST button or with external test equipment or the data terminal equipment through the data set interface. It also permits a looparound test to be made from a Telephone Company test center.

   NOTE: The DL button will not function properly unless the AL button is released.

The four test switches permit the following types of tests to be made (see Figures 3, 4 and 5).

Self-Tests

1. Analog loopback self-test (data set alone).
2. End-to-end self-test (one data set transmitter, one data set receiver, and the interconnecting private line facilities).
3. Digital loopback self-test (two data sets plus the 4-wire private line facilities).

Tests With Data Terminal Through Data Set Interface

4. Analog loopback test (data terminal equipment and local data set; requires full-duplex data terminal operation).
5. Digital loopback test (data terminal equipment, 2 data sets and 4-wire facilities; requires full-duplex data terminal operation).

Test From Telephone Company Test Center

6. Telephone Company Remote Test (local data set and 4-wire facilities to the Telephone Company test center).

Any of the first three self-tests can be made by the customer, prior to calling Telephone Company repair service, without any auxiliary test equipment. Tests 4 and 5 permit testing through the data set interface with external test equipment as well as with the data terminal. Procedures for all of these tests are covered in Section 5 of this document.

The original version of the 208A had a slide switch for testing instead of push buttons, and the Self-Test (ST) and Lamp Test (LP) functions were not available.

1.8 Status Lamp Indications

Six LED status lamps are provided on the front of the data set. They indicate a power on condition, the status of four interface control circuits, and the mode of the automatic equalizer in the DATA mode or error indication when making a self-test. The following is the list of lamp indications giving abbreviated mnemonics and corresponding functions (see Figure 6(a) for a diagram of the lamp positions):

- ON — Power Indication
- MR — Data Set Ready (Modem Ready)
- RS — Request-to-Send
- CS — Clear-to-Send
- CO — Received Line Signal Detector (Carrier On)
- ER — Equalizer Retrain in Normal Mode or Error Indication in Self-Test Mode

The LP (Lamp Test) button when depressed will turn on all the lamps, except the power indicator (which is lit whenever the data set is powered), to check that they are working. Otherwise, the lamps operate as follows:

The ON lamp will light when ac power is supplied to the data set. If for any reason the power supply voltages in the data set rise excessively, the ON lamp will extinguish. When this occurs, the power unit can be reset by unplugging and replugging the power cord in the ac outlet. If the condition persists, the customer should verify that the correct ac voltage is being supplied to the data set and, if such is the case, notify the Telephone Company Repair Service for correction of the problem.

The MR, CS, and CO lamps light in accordance with the ON condition of the respective interface circuits CC, CB, and CF (see Section 3.2 for description of the operation of these circuits). The RS lamp lights whenever the CA circuit is ON and the data set is in the DATA mode. In the TEST mode, the RS lamp lights when the data set is to transmit. Depending upon the particular test being performed, the RS lamp may be controlled by internal test circuitry or through the customer interface (CA circuit).

The ER lamp indicates the mode of the adaptive equalizer when the data set is in the DATA mode. It is normally on when the CO lamp is off. When the CO lamp is on and the ER lamp is flashing, the automatic adaptive equalizer is retraining. After retraining ER will go off. If ER continuously flashes when the CO lamp is on, marginal performance is indicated (i.e., channel impairments are excessive or the data set is faulty). If this condition should arise, it is recommended that the testing procedures discussed in Section 5 be employed. The ER lamp is also used when the data set is in one of the three self-test modes (analog loopback, end-to-end, or digital loopback). The ER lamp will flash whenever errors are detected in the received data signal during these tests.

Section 5 outlines several tests that can be made. Verification of proper data set operation is by means of these lamp indications.

The original version of the 208A had seven status indicator lamps as depicted in Figure 6(b) instead of the present six. In this original version, indication that the Analog Loopback (AL) or Digital Loopback (DL) test was in progress was given and the MR indication was not given. In the present version, indication that a test is in progress is given by the depressed push buttons.

1.9 Alternate-Voice Service

A data station equipped with Data Set 208A can be provided with a telephone set for alternate-voice private line service. When this service is ordered, the telephone will be connected to the line through the channel terminating equipment.

1.10 Dial Backup Service

A dial backup capability that employs two dialed connections as a substitute for the 4-wire private line is available for use with Data Set 208A. The switching of the data set between the private line and the two backup channels is controlled by means of a key telephone set. The two dialed connections must be manually dialed by the customer. Consult the local Telephone Company for further details if this service is desired.

1.11 Automatic Retraining of Adaptive Equalizer

The start-up procedure of the Data Set 208A receiver involves a training interval of less than 50 milliseconds during which a special sequence of signals from an associated transmitter is sent to the receiver. Once the receiver has been properly trained and data transmission is in progress, there is a chance that the receiver may require retraining due to interfering phenomena on the transmission channel. In the past, the degradation in error performance of the received data has prompted the data terminal equipment to halt the transmission and cause the transmitting data set to go through a new training sequence. However, the 208A receiver's adaptive equalizer will retrain itself automatically on the incoming data signal when the error rate approaches one error in 100 bits. This feature eliminates the need for restarting transmission from the remote transmitter using switched carrier operation. When the adaptive equalizer retrains itself, the data set turns the Equalizer Mode interface circuit OFF to notify the local data terminal equipment that the Received Data signals may not be valid. At the same time the ER lamp will be illuminated.

2. OPTIONAL CUSTOMER FEATURES

Data Set 208A is provided with several optional features which must be specified by the customer when the data set is ordered to ensure compatibility with the data terminal equipment and system operation. A description of each of these features is provided in this section. See Figure 7 for a summary of the customer options.

2.1 Transmitter Timing Provided by Data Terminal

The data set transmitter normally provides a transmit clock signal on the Transmitter Signal Element Timing (DB) interface circuit (see Section 3.2) to allow the data terminal equipment to properly time the transmit data at the 4800 bps rate. As an option, the data terminal can provide an EIA compatible transmit clock signal to the data set on the Transmitter Signal Element Timing, External (DA) interface circuit to perform the same function. This signal must conform to the distortion and frequency accuracy of EIA Standard RS-334, which requires peak individual distortion of no more than 0.5 percent and frequency accuracy within $\pm$.01 percent of the bit rate. * With this option the internal timing of the data set will be phase-locked to the external clock signal provided by the data terminal equipment and will also appear on the interface circuits that usually provide internal transmitter timing.

2.2 Continuous Carrier With Switched or Continuous Request-to-Send

With data sets on point-to-point circuits and with master station data sets on multipoint circuits, it is advantageous to transmit a carrier signal all the time to eliminate the training sequence inherent in starting up the distant receiver (for detecting carrier and training the adaptive equalizer). A feature is available which will keep the transmitter on permanently when the data set is powered. When this feature is employed, the Request-to-Send circuit may be used in one of two ways. If the data terminal requires the use of the Request-to-Send and Clear-to-Send circuits, a strapping option in the data set provides a delay of 8 $\pm$0.5 milliseconds between these signals. When Clear-to-Send is OFF, the data set will transmit a MARK signal to the distant end.

* When the one-second holdover option is used in the distant data set, the frequency accuracy of this signal should be $\pm$.005 percent.

If switched Request-to-Send control is not needed, it will be strapped ON permanently in the data set, and the Clear-to-Send circuit will always be ON indicating that signals applied to the Transmitted Data (BA) circuit will be transmitted at all times. This latter option removes the control of the Request-to-Send circuit from the data terminal equipment so that no signal is required for this circuit in the data terminal.

The continuous carrier option should not be used in those data sets at outlying (remote) locations of a multipoint circuit since it will interfere with signals from other remote data sets. In addition, those data sets communicating to a distant terminal which requires that the Received Line Signal Detector (CF) circuit turns ON and OFF to signal the beginning and end of a transmission should not be optioned for continuous carrier. For these applications the switched carrier option should be selected.

2.3 One-Second Holdover

The One-Second Holdover option is recommended for use in data sets receiving continuous carrier from a distant transmitter. This option permits the receiving data set to maintain timing synchronization during periods of momentary line dropouts not exceeding one second. With this option the Received Line Signal Detector (CF) circuit is kept ON up to one second beyond the time that carrier signal is lost. Received Data during the interval of data carrier signal loss will be provided to the data terminal equipment although it will probably not be valid. The loss of received data carrier will be indicated on the Signal Quality Detector circuit if the signal is absent for more than two milliseconds. When the carrier signal reappears, the Signal Quality Detector circuit will turn ON after receiving this signal for four milliseconds or longer.

Without the use of this option the loss of received line signal due to a transmission line interruption or dropout will result in the turning OFF of the Received Line Signal Detector circuit if the line signal is absent for longer than two milliseconds. When this occurs, the data set will clamp the Received Data circuit to the MARK state.

2.4 New Sync

The New Sync option is recommended for use in the 208A receiver at a master station on a multipoint circuit to ensure rapid resynchronization on a series of incoming messages from different remote transmitters. This option, which is recommended when the interval between successive messages is less than 100 milliseconds, is necessary because of clock holdover in the receiver after the end of a message. This holdover may interfere with the start of synchronization on receipt of the following message. To use this option, the data terminal, after the detection of an end of message code and after the Received Line Signal Detector circuit goes OFF at the completion of the message, should apply an ON condition (see Section 3.1 for definition) to the New Sync interface circuit for at least one millisecond, but no longer than the intermessage interval, to squelch the existing receiver clock. At all other times the New Sync circuit should be held OFF by the data terminal since an ON condition will prevent the receiver from responding to any data signals. When this option is not used, the New Sync circuit is held OFF within the data set. Also, in the Digital Loopback and Self-Test modes, the New Sync feature is disabled.

2.5 Data Set Ready Circuit Option for Analog Loopback Testing by Data Terminals*

The current EIA Standard RS-232-C, which defines operation of the data terminal/data set interface, requires the data set to place the Data Set Ready (CC) circuit in the OFF condition when the data set is in the TEST mode or other non-DATA mode. When this occurs the data terminal by hardware or software design ignores any signals on all of the other interface circuits. In the case that the 208A is placed in the analog loopback test mode, the CC circuit will normally turn OFF (see Sections 3.2.6 and 5.2). Since the analog loopback test is intended to permit the data terminal to verify transmission through the local data set, the normal operation of CC may defeat this test feature.

* This option is added to the new version of the 208A. The older version of the 208A placed CC to OFF in all TEST and non-DATA modes.

If the data terminal equipment manufacturer provides the hardware and software capability in the terminal to perform an analog loopback test with the local data set and recommends such a test be used to isolate transmission problems with the local data set, the data terminal may require the CC circuit to be held ON during this test. An option is provided in the 208A to permit this condition of the Data Set Ready (CC) circuit. Although this option is in violation with the current RS-232-C Standard, the analog loopback test is among several fault isolation tests defined in a recently published document by EIA on fault isolation between data sets and data terminals+ (see Section 3.3.2, Local Test Line, in that document).

Without specific knowledge of the test capability and requirements of the data terminal, the CC circuit option should be set OFF (CC will be OFF in the analog loopback test mode). This does not prohibit the use of external test equipment to make an analog loopback test through the data set interface.

3. INTERFACE DESCRIPTION

The interface is the point of connection between the data set and the data terminal. Each data set is equipped with a 25-pin (female) connector on the back of the data set for connection to the data terminal (see Figure 2). The user must supply the plug and necessary cable to connect his equipment to the data set. For the male connector, a plug such as the DB-19604-432 Plug manufactured by Cannon* or Cinch** is required. This type of 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.

+ "Fault Isolation Methods for Data Communications Systems," Industrial Electronics Bulletin No. 11, November 1972. Available from Electronic Industries Association, 2001 Eye Street, N.W., Washington, D.C. 20006; Price $1.40 each.

* 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.

3.1 Electrical Considerations

Data Set 208A is equipped to follow the recommendations of Electronic Industries Association Standard RS-232-C with regard to interface circuit function and operation (except as noted in Section 2.5 on an optional basis on the CC circuit). However, the data set provides five additional interface circuits which are not described by that standard. In addition, pin 25 (which is unassigned in the standard) is reserved for data set testing. The peak individual distortion of the timing circuits and the isochronous distortion of the data circuits are in conformance with EIA Standard RS-334.

3.1.1 Signal States

For the Transmitted and Received Data circuits, the signal is considered in the MARK condition when the voltage on the circuit is more negative than −3 volts with respect to Signal Ground, and in the SPACE condition when the voltage on the circuit is more positive than +3 volts with respect to Signal Ground. When no voltage is applied to the Transmitted Data circuit, it will be held to the MARK condition.

For all control circuits, the control function is considered ON when the voltage on the circuit is more positive than +3 volts with respect to Signal Ground, and is considered OFF when the voltage on the circuit is more negative than −3 volts with respect to Signal Ground.

TABLE 1

Summary of Data and Control Circuit Interface Terminology

Voltage	Negative	Positive
Binary State	ONE	ZERO
Signal Condition	MARK	SPACE
Control Function	OFF	ON

3.1.2 Impedance of Terminator

The terminating impedance of the receiving end of the interface circuits has a dc resistance of not less than 3000 ohms nor more than 7000

ohms over the range of voltages for which the signal is defined. When the interface plug is disconnected, the interface voltage on terminator circuits is less than ±2 volts.

3.1.3 Rise and Fall Time

The operation of the circuitry that receives signals from an interface circuit is dependent only on the signal voltage and conforms to RS-232-C with regard to the rise time and the fall time. For control interface circuits, the time required for the signal to pass through the transition region (−3 volts to +3 volts) during a change in state does not exceed one millisecond. For the Received Data, Receive Signal Element Timing and Transmitter Signal Element Timing circuits, the rise time and the fall time does not exceed 8 microseconds through the 6-volt range (−3 volts to +3 volts) in which the signal condition is not defined. The Transmitted Data and Transmitter Signal Element Timing, External signals from the data terminal should also meet this limit.

3.1.4 Open Circuit Voltages

The open circuit driver voltage with respect to Signal Ground on any interface circuit does not exceed ±25 volts. The terminator on an interface circuit is designed to withstand any input signal within the ±25 volt limit. The driver design is such that when the terminating impedance is in the proper range (3000 ohms to 7000 ohms) and the terminator open-circuit voltage is zero, the potential at the point of interface is not less than ±5 volts nor more than ±15 volts.

3.2 Purpose and Use of Interface Circuits

Data Set 208A is provided with 16 interface circuits for connection to the customer's data terminal equipment and three additional circuits for connection to Telephone Company test equipment. All interface circuits are physically terminated in a 25-pin (female) receptacle mounted on the back of the data set (see Figure 2). Figure 8 shows the pin assignments that are applicable for data set operation. Note that six of the pins are not used for any function. These are pins 12, 13, 19, 20, 22, and 23. A description of the operation of each circuit and the signals appearing on them follows. Circuit names and the mnemonics are in accordance with EIA Standard RS-232-C, except as noted. Circuit numbers correspond to pin assignments on the 25-pin receptacle.

3.2.1 Protective Ground (AA) — Circuit 1

This conductor is electrically bonded to the equipment frame. It is further connected to external grounds through the third wire of the power cord.

3.2.2 Transmitted Data (BA) — Circuit 2

Direction: TO Data Set

Signals on this circuit are generated by the data terminal equipment and are sent to the data set for transmission to remote data terminal equipment. A positive polarity signal is a binary "0" or SPACE, and a negative polarity signal is a binary "1" or MARK. The data set samples signals on this circuit on the negative transition (ON to OFF) of the Transmitter Signal Element Timing (DB) signal or the clock signal provided by the data terminal (circuit DA) on externally timed data sets.

The data terminal should not transmit data on this circuit unless an ON condition is present on the Clear-to-Send (CB) interface circuit from the data set. When CB is OFF signals applied to BA are ignored by the data set. Except for Analog Loopback testing with the data terminal, the Data Set Ready (CC) circuit should also be ON before data is presented to the BA circuit. When the continuous Request-to-Send option is used, the data set continually transmits signals applied to BA.

3.2.3 Received Data (BB) — Circuit 3

Direction: FROM Data Set

Signals on this circuit are generated by the receiving data set in response to data signals received from a remote transmitting data set. The data terminal equipment should sample the Received Data signal on the negative transition (ON to OFF) of the Receiver Signal Element Timing (DD) signal. A positive polarity represents a binary "0" or SPACE, and a negative polarity is a binary "1" or MARK.

This circuit is always held in the MARK ("1") condition when the Received Line Signal Detector circuit (CF) is OFF.

3.2.4 Request-to-Send (CA) — Circuit 4

Direction: TO Data Set

With switched carrier operation, an ON condition on this circuit is an indication to the local data set transmitter of the intent of the data terminal equipment to transmit data. After turning this circuit ON, the data terminal should wait for an ON condition on the Clear-to-Send (CB) circuit before starting transmission. When the CA circuit is turned OFF at the end of a message, the data set transmitter remains on about another two milliseconds to clear the last few bits from the transmitter. Then the transmitter will turn off.

With continuous carrier operation, the transmitter is kept on at all times. The customer may choose, however, to use the CA circuit to control timing functions in the data terminal which require the CB circuit ON indication. In this case, the data set will provide a delay of 8 $\pm$0.5 milliseconds between an ON condition on CA and the ON condition of CB. If the data terminal does not require this feature, it may be disabled. As a result, the Request-to-Send circuit will be strapped in the data set in the ON condition at all times and will not be under the control of the data terminal. In either case, continuous carrier operation inhibits the data set from initiating a start-up training sequence which eliminates the 48.5 ms delay between Request-to-Send and Clear-to-Send.

When switched Request-to-Send operation is used, this circuit will assume the OFF condition within the data set if the connection to the customer interface is broken. This circuit is a fail safe circuit as defined in RS-232-C.

3.2.5 Clear-to-Send (CB) — Circuit 5

Direction: FROM Data Set

Signals on this circuit are generated by the data set to indicate whether or not the data set is ready to transmit data. In switched carrier operation, CB is turned ON in response to an ON condition of the Request-to-Send (CA) circuit from the data terminal equipment, delayed by 48.5 $\pm$0.5 milliseconds. This is done to allow the adaptive equalizer in the remote data set to train itself and get into synchronization. The ON condition of the Clear-to-Send circuit means that signals presented on the Transmitted Data (BA) circuit will be transmitted to the communications channel. The OFF condition on this circuit is an indication to the data terminal equipment that it should not transfer data on the BA circuit. CB will turn OFF when CA is turned OFF and will remain OFF as long as CA is OFF.

In continuous carrier operation with the switched Request-to-Send option, the Clear-to-Send circuit turns ON 8 $\pm$0.5 milliseconds after the Request-to-Send circuit is turned ON. This is to provide a time delay on the Clear-to-Send circuit for use by the data terminal, if this feature is desired. The transmitter is always transmitting carrier signal, but the data terminal must wait for the Clear-to-Send circuit to go ON before transmitting data on circuit BA. If the data terminal equipment does not require switched Request-to-Send control, this option will be disabled and Clear-to-Send will be ON all the time, indicating availability of the data set to transmit data.

The operation of CB with either the switched carrier or the switched Request-to-Send option is such that it turns ON coincident with a positive transition of both the Divided Clock, Transmitter (DCT) and Transmitter Signal Element Timing (DB) circuits.

3.2.6 Data Set Ready (CC) — Circuit 6

Direction: FROM Data Set

Signals on this circuit originate from the data set to indicate its local status. The ON condition on this circuit indicates that the local data set is capable of transmitting and receiving data signals and is not in the TEST Mode (except when the CC ON option has been selected and analog loopback testing is activated — see Section 2.5). The ON condition of this circuit alone should not be interpreted that a communication channel has been established to a remote data station or used to determine the status of any remote terminal equipment. This circuit is used in conjunction with the Request-to-Send and Clear-to-Send circuits when transmitting data. The OFF condition on this circuit will appear when the local data set is in the TEST mode (except when the CC ON option has been selected and analog loopback testing is activated), when the channel is being used for voice communications (if the alternate-voice

feature is provided), or when the channel is being tested.

3.2.7 Signal Ground (AB) — Circuit 7

This circuit establishes the common ground reference potential for all interface circuits except Protective Ground (AA). This circuit is normally connected to the Protective Ground circuit to minimize the introduction of longitudinal power line noise into electronic circuitry through the power transformer. Depending on local procedures and conditions, this connection to Protective Ground can be removed by the Telephone Company installer.

3.2.8 Received Line Signal Detector (CF) — Circuit 8

Direction: FROM Data Set

The ON condition of this circuit indicates that the data carrier signal has been received for 45 milliseconds or more. This circuit is timed to turn ON approximately 41 milliseconds after the Signal Quality Detector circuit turns ON. The turn ON of this circuit occurs before the first data bit from a remote transmitter is received. Normal levels of message circuit noise, impulse noise, and out-of-band signals as prescribed for private line channels*should not turn ON this circuit.

Without the one-second holdover option, this circuit will go OFF if the line signal drops below the receiver threshold for more than two milliseconds due to the end of transmission or to a transmission line interruption. This OFF condition causes the Received Data (BB) circuit to be clamped to the MARK condition.

With the one-second holdover option installed, the CF circuit will remain ON for one-second beyond the time that data carrier signal is lost (if it does not reappear in the interim). During this one second, Received Data will not be clamped to MARK. Instead, the Received Data circuit will pass all signals to the data terminal equipment that are demodulated in this one-second interval even though they may not be valid.

* See Technical Reference "Data Communications Using Voiceband Private Line Channels" PUB 41004.

3.2.9 Circuits 9 and 10

These circuits are used for testing purposes by Telephone Company personnel. The data terminal must not be connected to them.

3.2.10 Equalizer Mode (QM, non-EIA) — Circuit 11

Direction: FROM Data Set

This circuit is used to indicate to the data terminal equipment that the adaptive equalizer in the receiver is reset or is retraining itself automatically when error performance is poor. In the self-test mode QM also indicates data bit errors.

When the Received Line Signal Detector (CF) is ON and QM is OFF, the data being provided on the Received Data circuit has a "high" probability of error. When QM is ON, the automatic equalizer is in its normal trained mode and the signals on the Received Data circuit should have a "low" probability of error. QM will turn OFF while CF is ON if the adaptive equalizer requires retraining in the local data set. This is done automatically without a command signal or interruption of the customer data from the transmitting data set. This feature is particularly useful in multipoint broadcast networks with a common transmitter or whenever continuous carrier operation is used in a remote transmitter. See Section 1.11 for more information on this feature.

3.2.11 New Sync (NS, non-EIA) — Circuit 14

Direction: TO Data Set

This circuit may be used on an optional basis, and is intended for use with a data set at the master station of a multistation private line network, such as in a polling operation, to ensure rapid resychronization of the receiver on a sequence of messages from many different remote transmitters. This feature is necessary because the receiver clock maintains the timing information of the previous message for some interval after it has ended. This may interfere with resynchronization on receipt of the next message. An ON condition should be applied to this circuit for at least one millisecond, but no longer than the intermessage interval, to squelch the existing timing information after the

end of a message is received. At all other times the OFF condition should be applied by the data terminal equipment.

When the New Sync option is selected and the data set is in the DATA mode, an ON signal applied to New Sync forces the Received Line Signal Detector (CF) circuit OFF and, consequently, clamps Received Data (BB) to MARK. In the Digital Loopback and Self-Test modes, signals on the New Sync circuit are ignored. In addition, when this option is not used, the circuit will be strapped OFF within the data set.

3.2.12 Transmitter Signal Element Timing (DB) — Circuit 15

Direction: FROM Data Set

For internally timed data sets, square-wave signals on this circuit at the nominal 4800 Hz rate are used to provide the data terminal equipment with signal element timing information for the Transmitted Data (BA) circuit. This signal will be present on circuit 15 at all times when power is on in the data set. 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 is coincident with the ON condition of the Clear-to-Send (CB) signal. The Clear-to-Send circuit will turn ON coincident with a positive transition of circuit DB. Since BA is sampled on negative transitions of DB, signals on circuit BA should be presented such that the nominal center of each bit is indicated by the ON to OFF transition of DB.

Circuit DB will provide a timing signal which is phase-locked to the signal on circuit 24 (Transmitter Signal Element Timing External) for data sets timed by the data terminal equipment.

3.2.13 Divided Clock, Transmitter (DCT, non-EIA) — Circuit 16

Direction: FROM Data Set

A square-wave signal at 1600 Hz (one-third the nominal bit rate) appears on this circuit whenever power is supplied to the data set. Positive transitions on this circuit are coincident with positive transitions of Transmitter Signal Element Timing (DB), and negative transitions are coincident with negative transitions of DB. This circuit indicates the rate at which phase changes are made in the transmitted signal. Three customer bits are used to determine a phase change by the modulator, and the grouping of bits is according to the transitions on this circuit so that over one cycle of DCT three customer bits are encoded into one phase shift.

3.2.14 Receiver Signal Element Timing (DD) — Circuit 17

Direction: FROM Data Set

The square-wave signal on this circuit at the nominal 4800 Hz rate is used to provide the data terminal equipment with receiver signal element timing information. The transition from ON to OFF nominally indicates the center of each signal element on the Received Data (BB) circuit. This signal is provided at all times when the data set is powered except when the data set is in the Digital Loopback TEST mode.

3.2.15 Divided Clock, Receiver (DCR, non-EIA) — Circuit 18

Direction: FROM Data Set

A square-wave signal on this circuit provides the receiver timing information at 1600 Hz (one-third the nominal bit rate). Positive and negative transitions on this circuit are coincident with positive and negative transitions on Receiver Signal Element Timing (DD), respectively.

By referring to the transitions on this circuit, the data terminal equipment can define the 3-bit grouping of the decoded phase shifts of the received line signal. This means that in one cycle of DCR, three customer bits that were originally encoded into a phase shift by the transmitter are decoded into three bits with the same sequential relationship that existed at the transmitter. This signal is provided at all times when the data set is powered.

3.2.16 Signal Quality Detector (CG) — Circuit 21

Direction: FROM Data Set

This circuit is used to give an indication similar to Received Line Signal Detector (CF). Circuit CG will go ON if data carrier signal is received for approximately four milliseconds or longer. It

will go OFF if there is a loss of data carrier signal for two milliseconds or longer. After Signal Quality Detector goes ON, there is a delay of about 41 milliseconds until CF goes ON, indicating that equalization has been achieved and that signals on the Received Data circuit are valid. The Signal Quality Detector provides a fast-responding indication of the presence or absence of data carrier signal from a remote transmitter.

3.2.17 Transmitter Signal Element Timing, External (DA) — Circuit 24

Direction: TO Data Set

On data sets with the external timing option, this circuit is used by the data terminal equipment to provide bit rate timing to the transmitter. The ON to OFF transition on this circuit should nominally indicate the center of each signal element on the Transmitted Data (BA) circuit. The timing signal must have a frequency of 4800 Hz $\pm$.01 percent with peak individual distortion of negative transitions no greater than 0.5 percent per EIA Standard RS-334.* The Transmitter Signal Element Timing, (DB) circuit will be phase-locked to this signal, and Divided Clock Transmitter is derived from it similarly. When the data terminal provides bit timing, signals should be available on this circuit at all times except when the data set is not in service.

3.2.18 Circuit 25 (non-EIA)

This circuit is used for testing purposes by Telephone Company personnel. The data terminal equipment must not be connected to it.

4. OPERATION WITH DATA TERMINAL EQUIPMENT

4.1 Half-Duplex Operation — Turnaround Sequence

Data Set 208A can be operated half-duplex if the data terminal equipment has this capability. With this type of operation, the data set will be transmitting part of the time and receiving part of the time, perhaps in a pattern of acknowledgment/retransmission of the transmitted messages. The flowchart in Figure 9 depicts the operation of the interface control circuits of two data sets involved in this type of communications on a point-to-point private line channel.

4.2 Polling Operation on 4-Wire Multipoint Private Lines

For broadcast polling applications on multipoint private lines, a split bridge technique is employed. The bridge is arranged so that a signal input from any station on the bridge is not transmitted back to the originating station. Figure 10 shows this type of multipoint private line arrangement, which is attractive where all transmissions are between a master station and associated remote stations (i.e., remote stations cannot intercommunicate directly).

This system permits the master station to operate with the Continuous Carrier option, thereby eliminating the start-up sequence each time a new transmission is initiated by the master station. This will shorten the polling cycle of the system. For remote stations, the turnaround time is controlled by the training sequence delay at the master station receiver.

For multipoint split bridge arrangements, it is recommended that the remote data terminals use a multibit start-of-message code and end-of-message code to protect the master data set receiver and associated data terminal from spurious data due to interference on the channel. If messages from different remote stations occur within 100 milliseconds, the master data set should use the New Sync option to permit the data terminal to squelch the received signal timing information in the master data set after each message from the remote stations. A sequence of interface control circuit operations at the master and remote data sets is shown in Figure 11 for this type of polling operation. This sequence indicates when the New Sync circuit may be used.

5. TESTING OF THE DATA SET

As indicated in Section 1.7, Data Set 208A has built-in comprehensive test capabilities which can readily be used by a customer to isolate

* When the one-second holdover option is used in the far end data set, the frequency accuracy of this signal should be $\pm$.005 percent.

transmission problems to the data set, the transmission facilities, or the data terminal equipment. These test features may be used either prior to calling the Telephone Company Repair Service or when the Telephone Company Test Center requests assistance with certain remote tests. The use of the test buttons and status lamps on the 208A is described in this section.

5.1 Data Set Self-Test Procedures

Tests 1, 2 and 3 described below can be conducted by customer personnel to isolate a transmission problem to the data set or transmission facilities. The testing configurations for these tests are depicted in Figures 3(b), 4 and 5(b), respectively. Test 1 is quite simple to perform and allows a quick test of a particular data set independent of connection to the customer or channel interface. Test 2 or 3 allows the transmission facilities and the remote data set to be included in the test. If Test 2 or 3 should indicate complete failure to transmit and receive data, then the data sets or transmission facilities are definitely suspect.

Initially the status lamps on the suspect data set(s) should be checked by holding the LP button depressed to see that all lamps are working. Once it is confirmed that all lamps are working, the LP button can be released. Before proceeding with the tests, the data terminal equipment associated with the data set under test should be in an idle mode so that data transmission is not interrupted by these tests.

TEST 1) Analog Loopback Self-Test

Step 1 — Depress the AL button.

Step 2 — Depress the ST button to place the data set in self-test. Ignore flashes on ER while the ST button is being operated.

Step 3 — At this point the ON, RS, CS, and CO lamps should be ON and the MR and ER lamps should be OFF.

Step 4 — If the ER lamp flashes one or more times or remains ON or if any of the other lamps do not agree with the conditions in Step 3, the data set is defective. The lamps should be observed for at least 30 seconds to be confident that the data set is or is not working.

Step 5 — To return the data set to normal operation, release the ST and AL buttons.

TEST 2) End-to-End Self-Test

Step 1 — With an attendant at each station, manually establish a voice link between them by means of a separate voice channel. (If alternate voice service is provided, the private line to be tested can serve as the initial voice link as long as no discussion is desired during the test interval.)

Step 2 — Have the attendants agree on when to start the test and when to end it, then transfer from the TALK to the DATA mode (if necessary).

Step 3 — Depress the ST button on both data sets. Note that the data set whose ST button is depressed first may show error indications until the ST button on the other set is depressed.

Step 4 — After a few seconds have the attendant at each data set check that ON, RS, CS, and CO lamps are ON and that the MR and ER lamps are OFF.

Step 5 — The ER lamp at each data set will flash if errors occur. Satisfactory operation is indicated by an average of three flashes per minute or less. At either end, if the number of flashes of ER exceeds an average of three per minute, or if the ER lamp is on continuously, or if the status of any of the lamps on either data set is not correct per Step 4, the receiver of that data set, the transmitter of the other data set, or the interconnecting facilities is not providing proper performance. Each data set may be tested using TEST 1 to isolate the trouble further.

Step 6 — To return the data sets to normal operation, release the ST button on each data set to release them from the TEST mode.

TEST 3) Digital Loopback Self-Test

Step 1 — Depress the DL button on the remote data set. (Insure that the AL button is released).

Step 2 — Depress the ST button on the local data set to place it in the self-test condition. The test is controlled from this data set.

Step 3 — At this point the ON, RS, CS, and CO lamps on the local data set should be ON and the MR and ER lamps should be OFF. On the remote data set, the lamps should be in the same state except it should be noted that the ER

lamp indicates equalizer retrain periods and not errors.

Step 4 — At the local data set the ER lamp will flash if errors occur. Satisfactory operation is indicated by an average of three flashes per minute or less. If the number of flashes of ER exceeds an average of three per minute, or if the ER lamp is ON continuously, or if the status of any of the lamps on either data set is not correct per Step 3, then the data sets or the transmission facilities are not providing proper performance.

Step 5 — To return to normal operation, release the DL button on the remote data set and the ST button on the local data set.

The results of TEST 3 can be combined with those of TEST 1 to isolate a trouble to the 4-wire transmission facilities or to one of the data sets. TEST 2 allows further isolation of the trouble to the receive or transmit side of the circuit. Problems with telephone equipment or facilities should be reported to the local Telephone Company. The Telephone Company Test Center may decide to check the telephone facilities and perform a Remote Test of the data set as described in Section 5.3.

5.2 Customer Test Procedures Using the Data Terminal

Besides the self-test capability of the Data Set 208A, it is possible to test the data terminal (or other customer-provided equipment connected to the customer interface) and the data set together in an analog loopback mode similar to TEST 1 above, or to test the data terminal, two data sets, and transmission facilities together in a digital loopback mode similar to TEST 3 above. As mentioned in Section 2.5, if the data terminal manufacturer provides the hardware and software capability for a full-duplex analog loopback test through the data set interface and requires the Data Set Ready (CC) circuit to be ON, the CC circuit should be optioned for the ON condition when the AL switch is depressed. Then the following tests, depicted in Figures 3 (a) and 5 (a), can be made.

TEST 4) Analog Loopback Test Using the Data Terminal

Step 1 — Depress the AL button.

Step 2 — Condition the data terminal to simultaneously transmit and receive a test signal through the local data set. A delay of about 7 milliseconds occurs between signals on the Transmitted Data circuit and the Received Data circuit because of propagation delays in the data set circuitry. A steady MARK or SPACE signal is sufficient for a test signal since the data set has a built-in scrambler circuit to randomize the data. The data terminal, operating full-duplex, should be able to verify that the test signal is being sent through the local data set and back to the data terminal without an error. If errors should occur, either the data set or data terminal may be in trouble. To isolate the problem, an analog loopback self-test (TEST 1) should be made (if not already done) to check the data set by itself.

Step 3 — To return the data set to normal operation, release the AL button.

TEST 5) Digital Loopback Test Using the Data Terminal

Step 1 — Depress the DL button at the remote data set.

Step 2 — Have the data terminal transmit and receive a test signal through the local data set in the manner described in Step 2 of TEST 4 above. If the 1000 bit block error rate is greater than 1 per 100 blocks (see Section 6), either the data terminal, the transmission facilities, or one of the data sets may be in trouble. Further isolation can be accomplished by performing TEST 1, TEST 2, or TEST 3 as described previously.

Step 3 — To return to normal operation, release the DL button on the remote data set.

5.3 Telephone Company Remote Test Procedures

Besides the three self-tests and the two tests using the data terminal (or external test equipment) which can be made by customer personnel, there is a remote test which can be made from the Telephone Company Test Center with the assistance of customer personnel at the data set. The Telephone Company Repair Service should be notified of any problems

which have been isolated to the data set or transmission facilities. When the Test Center calls in response to a trouble report, the customer will be requested to assist with the test features of the data set. They may also ask the customer to make self-tests of the data set(s).

TEST 6) Four-Wire Digital Loopback Remote Test

Before initiating this test the data terminal should be placed in an idle mode. When instructed by the Test Center personnel, the DL button should be depressed on the data set.

The Test Center will then make a series of programmed transmissions with the local data set. After completing these test transmissions, the Test Center will call the customer location and ask that the data set be removed from the TEST mode by releasing the DL button. Results of the test and any further action by the Telephone Company will be indicated by Test Center personnel.

NOTE: The six tests described above apply to two-point private line connections. The tests can also be applied to multipoint polling systems as long as the test is restricted to one master-to-remote link at a time. However, coordination with the master station is required before depressing a test button at a remote location to ensure that the network is released for testing.

The original version of the 208A did not contain the self-test feature and hence Tests 1, 2 and 3 were not available in that version. Tests 4 through 6 were available as described above except that the analog and digital loopbacks were activated by a slide switch instead of by push buttons. However, Data Set Ready (CC) was always held OFF in the analog loopback mode in accordance with EIA Standard RS-232-C.

6. PERFORMANCE

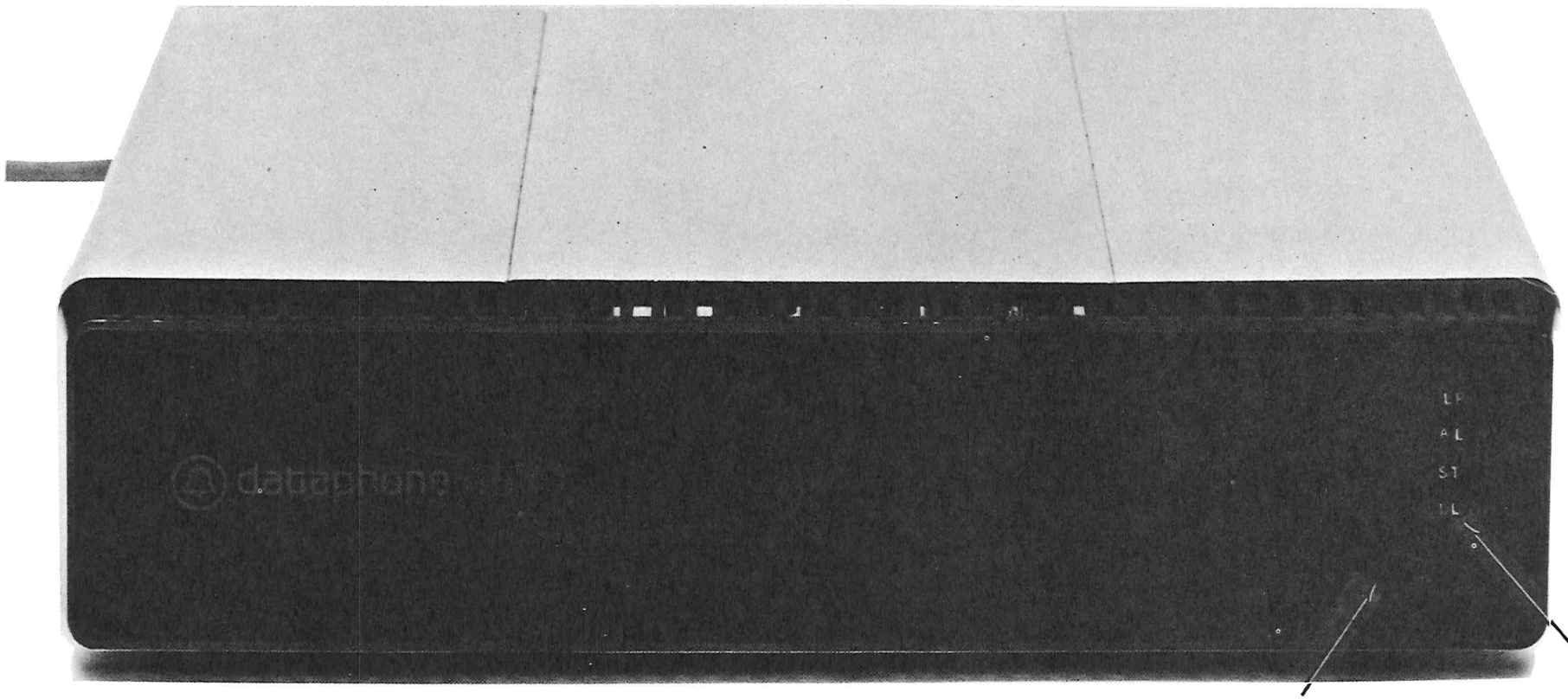
The performance of Data Set 208A is specified in terms of block error rate because this measure is more meaningful than the conventional bit error rate specification for most users. Many data communications systems send data in a blocked format and consequently block error rate can be related to thruput, an important measure of system performance. A "block error" is defined as a block of data which contains one or more bit errors. A block transmission system generally forms data into blocks of a specific number of bits. This block of data usually contains redundant bits for the purpose of error detection at the receiving terminal. If one or more bit errors are detected in a received block of data, a message requesting retransmission of the entire block is returned to the source. In this sense, the block error rate is the ratio of the number of retransmissions required to the total number of blocks received.

Data Set 208A, operating at 4800 bps on 2-point or multipoint basic 3002-type private line channels, has a long-term 1000-bit block error rate objective of 10^{-2} or better. The 1000-bit block size selected as part of the specification is not meant to imply that customer systems should be operated using this size block. Many factors determine the optimum block size for a specific data system. The choice of 1000 bits was made because it is in the range of block sizes normally used in data systems operating at this speed, and it is a convenient block size for measurement purposes.

Data Set 208A can be used in a switched or in a continuous carrier mode. The continuous carrier mode should be used for 2-point operation and, in the case of multipoint operation, should be used from the central computer location to the remote stations. For operation in the continuous carrier mode, the block error statement applies to a continuous stream of data that is divided into 1000-bit blocks. Thus the statement implies that, on the average, no more than one block in a hundred should have one or more bit errors. It has been our experience that, to a good approximation, block error rate is directly related to block size for block sizes in the 500- to 10,000-bit range. Thus, if block size is reduced by a factor of two, the block error rate improves by approximately a factor or two. In this manner, the performance measured for 1000-bit blocks can be related to any particular block size with relatively good precision.

For operation in the switched carrier mode, such as from a remote station to a central computer in a polling system, the block error specification applies to the individual blocks transmitted. For blocks of sizes of 1000 bits or less, block error rates of 10^{-2} or better should be expected. For messages longer than 1000 bits, the block error rate increases proportional to length.

FIGURE 1 — Front View of Data Set 208A



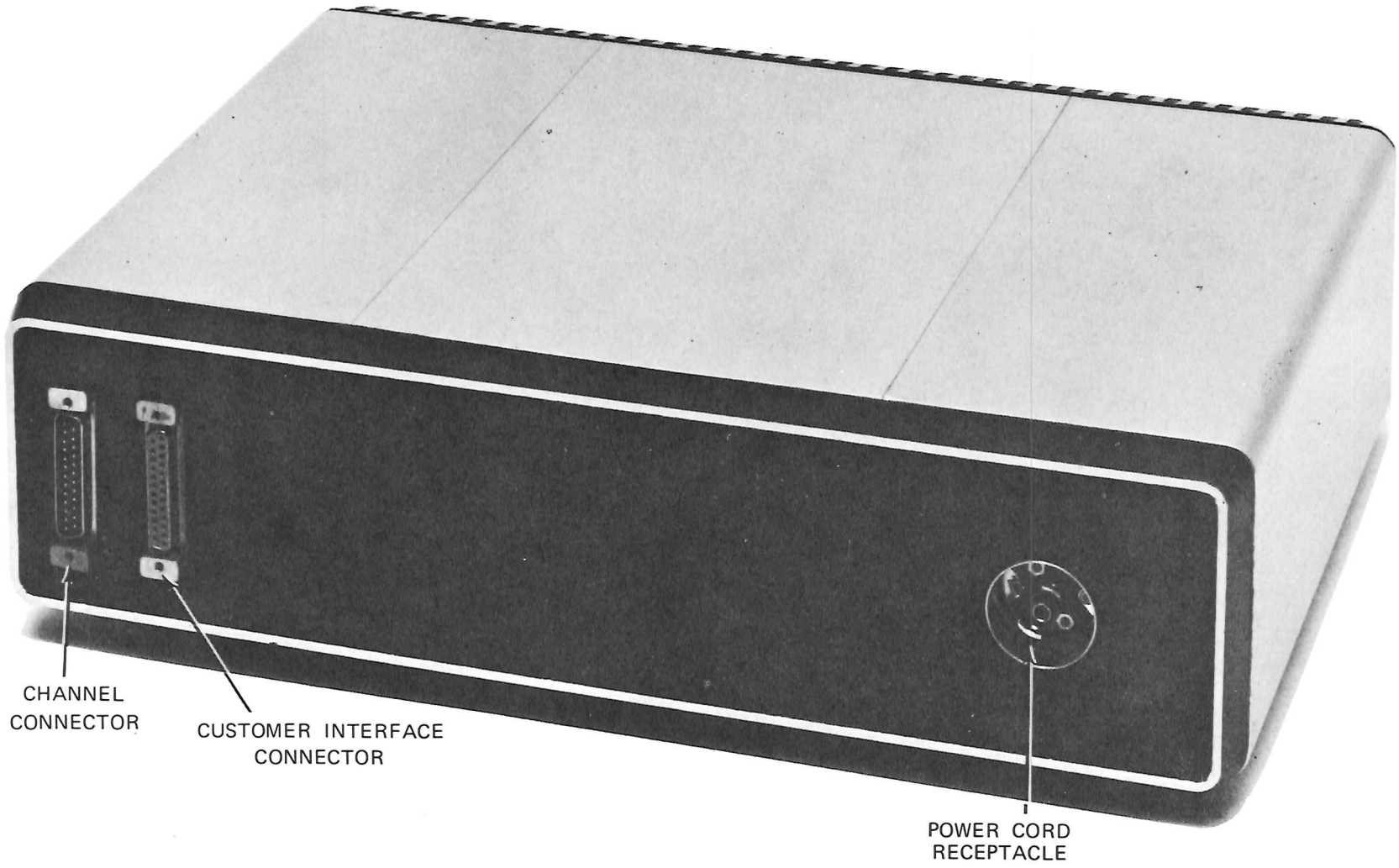
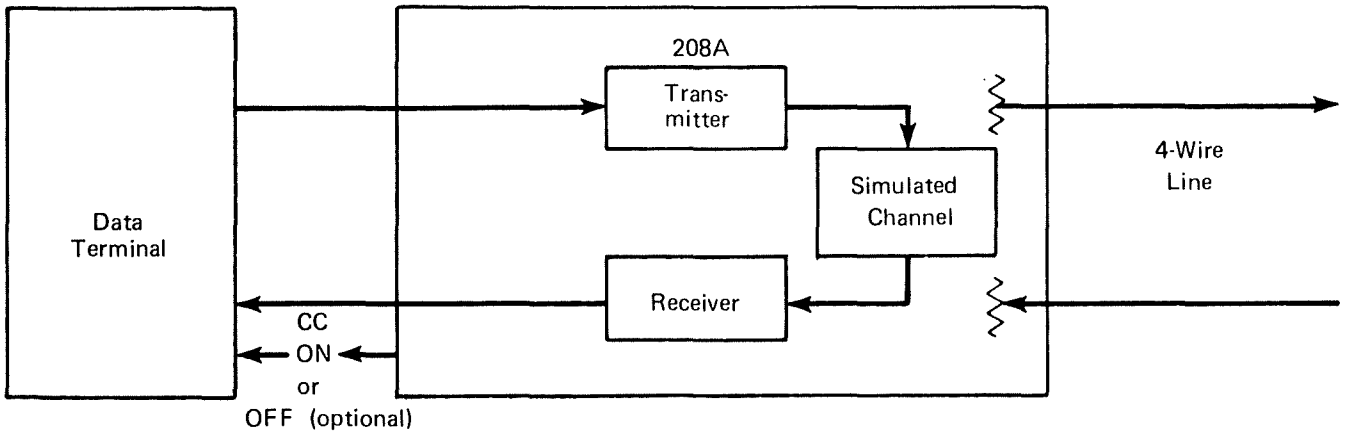


FIGURE 2

REAR VIEW OF DATA SET 208A



NOTE: Data Terminal Should Control the Data Set Through the Interface and Verify Transmission in a Full-Duplex Mode

FIGURE 3(a) – Analog Loopback

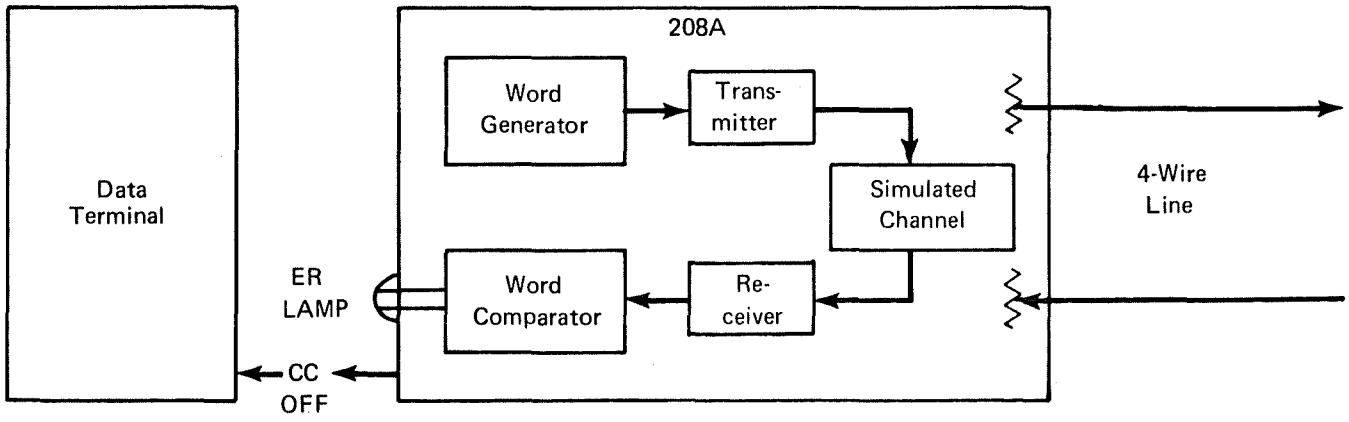


FIGURE 3(b) – Analog Loopback Self-Test

Figure 3 – Analog Loopback Test Configurations of Data Set 208A

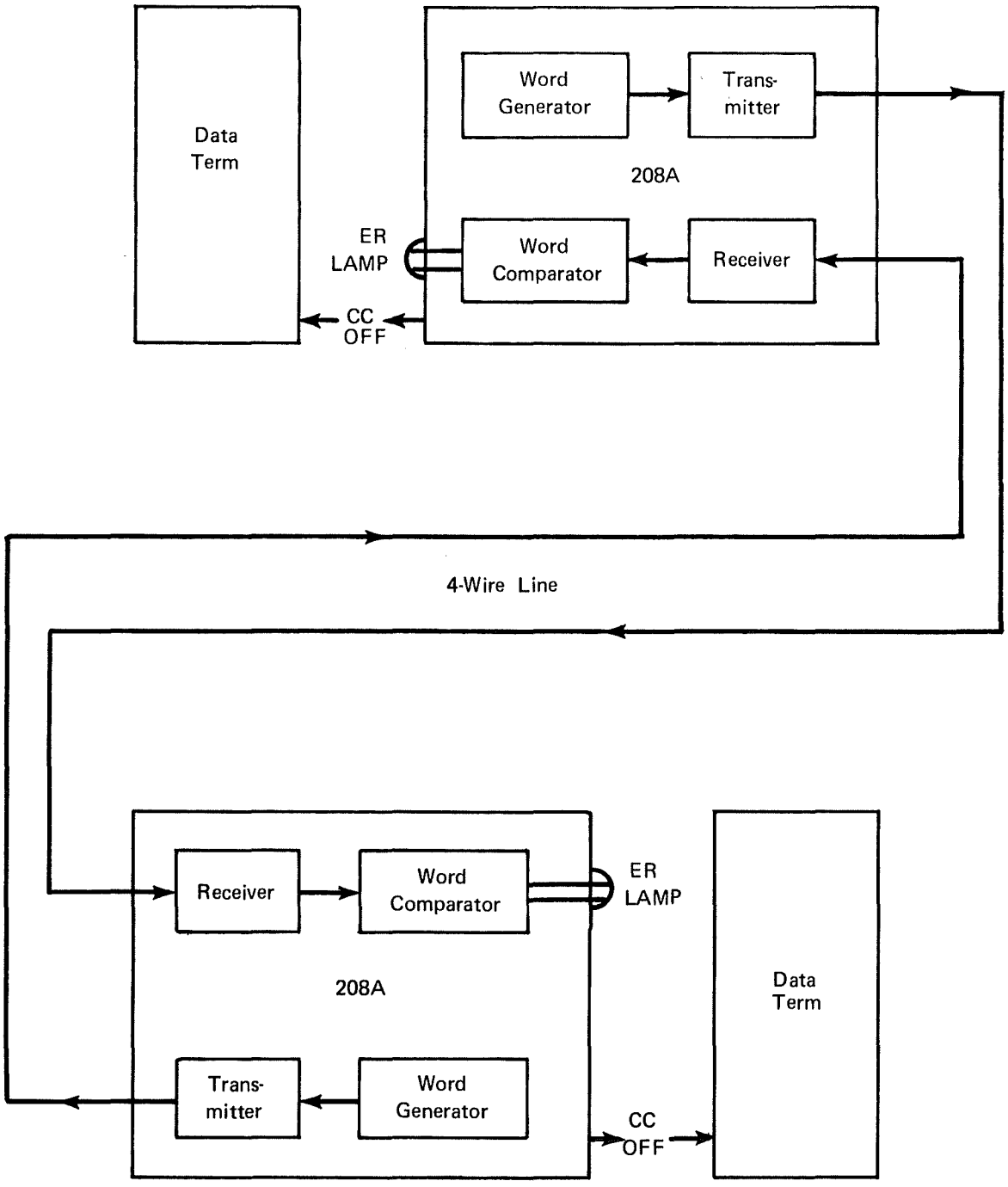
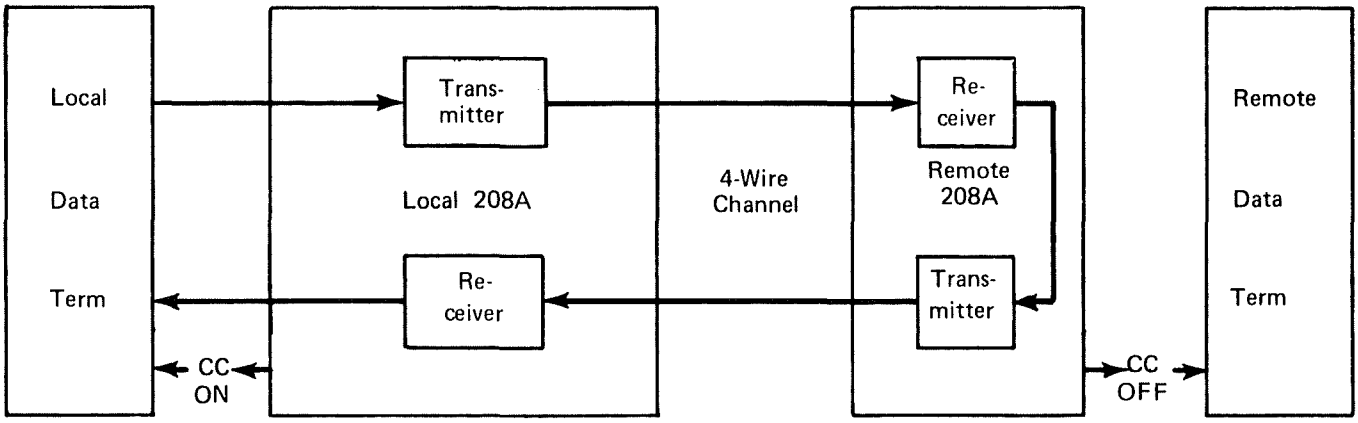


Figure 4 — End-to-End Self-Test Configuration of Data Set 208A



NOTE: The Local Data Terminal Should Control the Data Set Through the Interface and Verify Transmission in a Full-Duplex Mode

Figure 5(a) — Digital Loopback

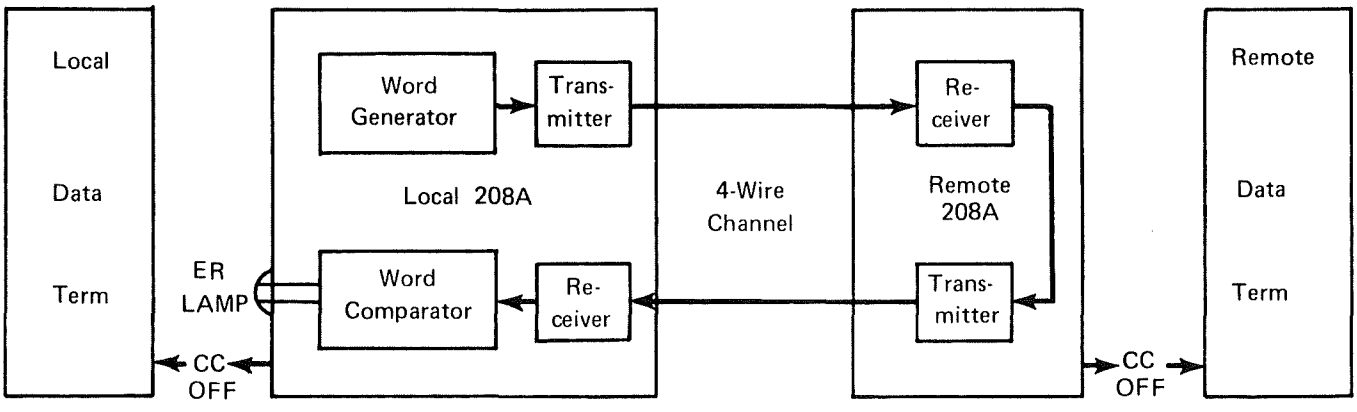


Figure 5(b) — Digital Loopback Self-Test

Figure 5 — Digital Loopback Test Configurations of Data Set 208A

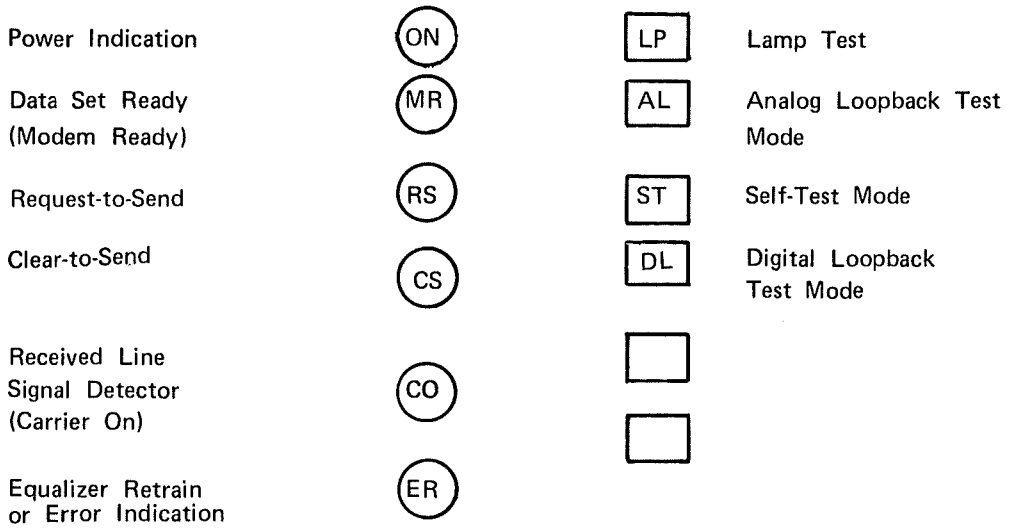


Figure 6(a) – Present Version of Front Panel Layout

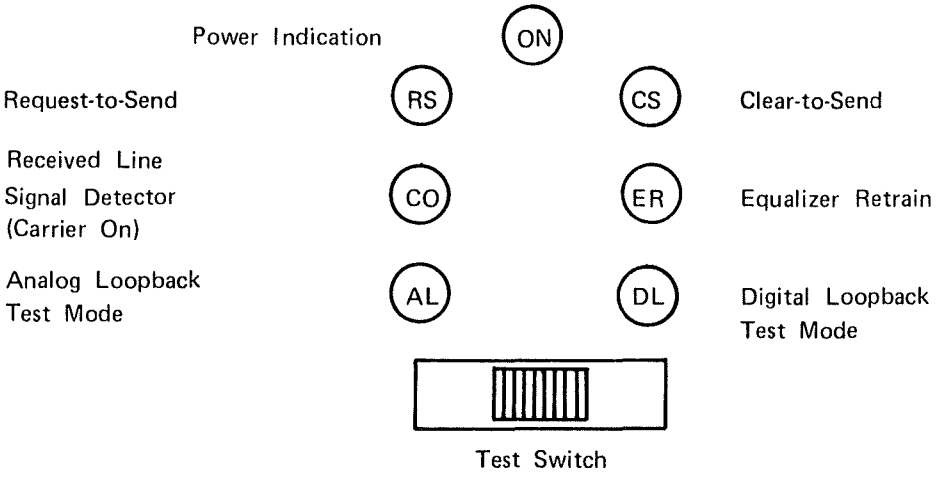


Figure 6(b) – Original Version of Front Panel Layout

Figure 6 -- Layout of Lamps and Switches on Front Panel of Data Set 208A

Optional Customer Features of Data Set 208A

DATA SET OPTIONS	SELECT ONE OR OTHER FOR EACH OPTION
Transmitter Timing Provided by	Data Set (Internal) Data Terminal (External)
Carrier Control	Switched (Switched Request-to-Send Option Required) Continuous
Request-to-Send Operation in Continuous Carrier Mode	Continuous (CB Constantly ON) Switched (8±.5 msec CA-CB Delay)
One Second Holdover at Receiver on Line Dropouts	Not Provided Provided
New Sync Option to Squelch Receiver Clock	Not Used – NS is Strapped OFF Within the Data Set Used – Data Terminal Turns ON New Sync for 1 msec or Longer
Data Set Ready Lead Option for Analog Loopback Testing by Data Terminal	CC is OFF When the AL Button is Depressed CC is ON When the AL Button (only) is Depressed
Grounding Option	AB Connected to AA AB Not Connected to AA

Additional Features Available with Data Set 208A

Alternate Voice Service
Dial Backup Service
Rack Mounting

Figure 7

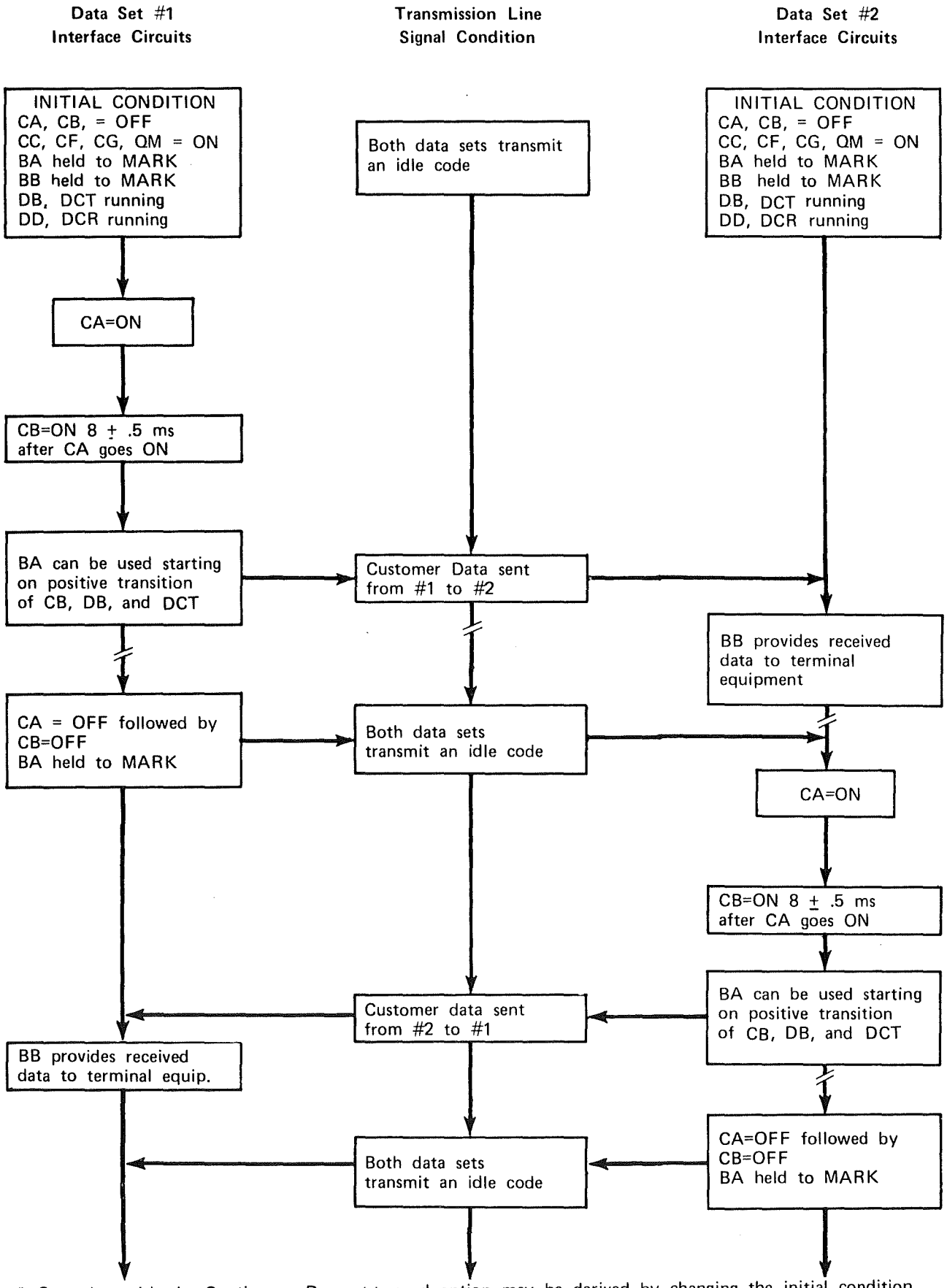
FIGURE 8

Customer Interface Pin Assignments and Circuit Designations

Pin No.	EIA RS-232-C Nomenclature
1	Protective Ground (AA)
2	Transmitted Data (BA)
3	Received Data (BB)
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	Reserved for Data Set Testing
10	Reserved for Data Set Testing
11	Equalizer Mode (QM, non-EIA)
12	Not Used
13	Not Used
14	New Sync (NS, non-EIA)
15	Transmitter Signal Element Timing (DB)
16	Divided Clock, Transmitter (DCT, non-EIA)
17	Receiver Signal Element Timing (DD)
18	Divided Clock, Receiver (DCR, non-EIA)
19	Not Used
20	Not Used
21	Signal Quality Detector (CG)
22	Not Used
23	Not Used
24	Transmitter Signal Element Timing External (DA)
25	Reserved for Data Set Testing

FIGURE 9

4-Wire Private Line Service Turnaround Sequence of Data Set 208A For Half-Duplex Operation (Switched Request-to-Send Option*)



* Operation with the Continuous Request-to-send option may be derived by changing the initial condition of CB to ON and removing all further references to CB and CA.

FIGURE 10

4-Wire Multipoint Private Line Service
With One Master Station and Several Remote Stations

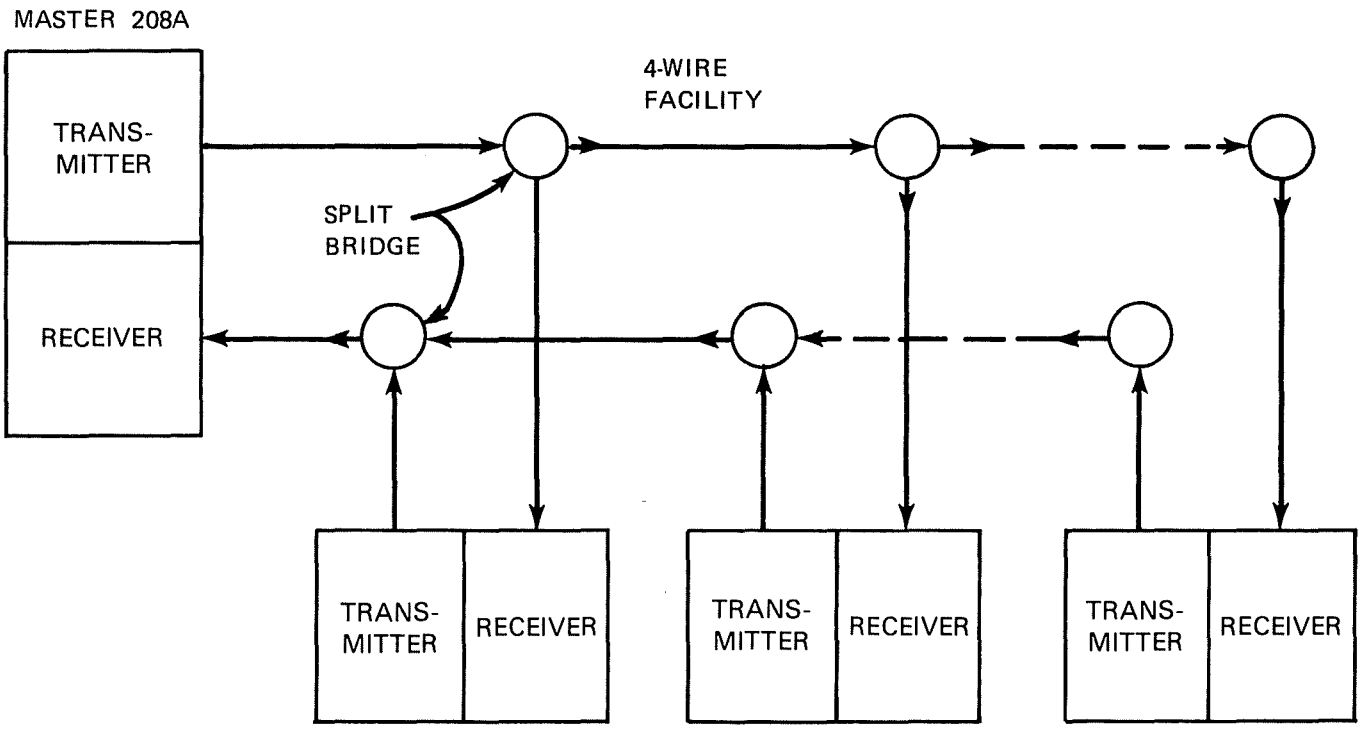


FIGURE 11

4-Wire Multipoint Private Line Service
Operation of Master and Remote
Data Sets in a Polling Application
(Continuous Carrier Operation in Master Data Set)