

DATA SET 201C
TRANSMITTER-RECEIVER
SUPPLEMENTARY INFORMATION

CONTENTS	PAGE
1. GENERAL	1
2. EQUIPMENT CHARACTERISTICS	2
A. Status Indicators	2
B. Test Switches	2
C. Customer Interface	3
D. Telephone Line Interface	7
E. Customer Options	10
F. Telco Options	11
3. FUNCTIONAL DESCRIPTION	14
A. Data Set	14
B. Self Tests	14
C. Restrictions on Use of Self Tests	16
4. APPLICATIONS	18
A. Switched Network	18
B. Point-to-Point	18
C. Multipoint	20
D. Extended Service	20
E. Digital Data System Off-Net	20
5. MAINTENANCE	20
6. REFERENCES	22

1. GENERAL

1.01 This section covers data set (DS) 201C in greater depth than the description, installation, maintenance, and test sections. Before reading this section, one should be familiar with the contents of all the other sections in this series as listed in Part 6. The information in this section supplements the information in the other sections and is not required for installation, maintenance or testing under normal circumstances.

1.02 Whenever this section is reissued, the reasons for reissue will be listed in this paragraph.

1.03 DS 201C (Fig. 1) is a synchronous, serial binary transmitter-receiver that operates at 2400 bps over 2- or 4-wire private lines and the switched network.



Fig. 1—Data Set 201C—Front View

1.04 DS 201C is line signal compatible with and can be interchanged for DS 201B in most applications. It is not compatible with DS 201A.

NOTICE

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1.05 DS 201C provides the major features (except local copy) of DS 201B and also provides status indicators and self-test operation. A self-contained line control circuit is provided for switched network service.

Note: The line control circuit performs the functions previously performed by data auxiliary set (DAS) 804A-type. Therefore, DAS 804A-type is not required.

2. EQUIPMENT CHARACTERISTICS

2.01 This part provides a description of the data set status indicators and test switches, the customer and telephone line interfaces, and the customer and telephone company (telco) options.

A. Status Indicators

2.02 Eight status indicators are provided on DS 201C to monitor the power unit, certain interface leads, and the test switches. These status indicators consist of light emitting diodes (LEDs) that illuminate translucent designations on the data set front cover.

2.03 **ON:** This indicator is lighted when power is supplied to the data set. The indicator is connected to an unregulated +12 volt supply.

2.04 **TR (Terminal Ready):** Normally this indicator is lighted when the data terminal ready (CD) lead is **on**. However, when the remote test (RT) switch is depressed and the remote test procedure is terminated normally, the TR indicator is off until the RT switch is released. This indicates that the CD lead is clamped **off** by the self-test circuitry, to prevent automatic answering after the remote test is completed.

2.05 **MR (Modem Ready):** Normally this indicator is lighted when the data set ready (CC) lead is **on**. Although the CC lead is **off** in all of the self-test modes, the MR indicator will light when the self-test (ST) switch is depressed, to provide a lamp test.

2.06 **RS (Request to Send):** This indicator is lighted when the request-to-send (CA) lead is turned **on** at the customer interface or is turned **on** by the self-test circuitry. The RS indicator is off when the receive only (RO) switch is depressed, regardless of the condition of the CA lead at the

customer interface or the positions of the other test switches.

2.07 **CS (Clear to Send):** This indicator is lighted when the clear-to-send (CB) lead is **on**, in both normal and test modes.

2.08 **CO (Carrier On):** This indicator is lighted when the received line signal detector (CF) lead is **on**, in both normal and test modes.

2.09 **MC (Modem Check):** This indicator is lighted when the receiver signal element timing (DD) lead is **off**. During normal operation, the MC indicator functions as a no-clock indicator. Since the DD lead is clamped **off** when the received line signal detector (CF) lead is **on**, the MC indicator is off when the CO indicator is lighted, and lighted when the CO indicator is off. During self-test operation (switch ST depressed), the MC indicator functions as an error indicator. Whenever an error in received data is detected by the self-test circuitry, the MC indicator blinks on. Since single bit errors are too short to be detected by the eye, a pulse stretcher is used to provide 100-ms blinks of the MC indicator.

2.10 **TM (Test Mode):** This indicator is lighted when one or more of the AL, ST, RT, and DL test switches are depressed. When the TM indicator is off, the data set is in the normal operating mode.

B. Test Switches

2.11 Five pushbutton switches, accessible through the front cover, provide self-test operation of DS 201C. These test switches are the depress-to-operate and depress-to-release type.

2.12 **RO (Receive Only):** This switch conditions the data set to function as a receiver in an end-to-end self test on 2-wire facilities. The request-to-send (CA) lead is clamped **off** in the data set, regardless of the condition of this lead at the customer interface or the positions of the other test switches.

2.13 **AL (Analog Loop-Back):** This switch loops back the data set transmitter output to the receiver input through an internal attenuator for both 2-wire and 4-wire facilities. The attenuator provides the equivalent of a 4-wire private line input of -16 dBm. The transmitter and receiver

are disconnected from the telephone line interface and the transmit and receive pairs to the telephone line interface are terminated in 600 ohms. The data set ready (CC) lead is clamped *off* and the test mode (TM) indicator is lighted. For 2-wire switched network service, the data set is prevented from entering the data mode manually and automatic answer is inhibited. While the talk mode is not inhibited, any attempt to transfer to the data mode will result in the call being dropped.

2.14 ST (Self Test): This switch conditions the data set for self-test operation on both 2-wire and 4-wire facilities. The transmitted data (BA) lead is disconnected from the customer interface and connected to the output of a 15-bit word generator. The received data (BB) lead is clamped to mark at the customer interface and is connected to a 15-bit word comparator. The data set ready (CC) lead is clamped to *off* and the data terminal ready (CD) lead is clamped to *on*. The request-to-send (CA) lead is also clamped to *on*, if the receive only (RO) switch is not depressed. The modem ready (MR) and test mode (TM) indicators are lighted.

2.15 RT (Remote Test): This switch conditions the data set for remote testing from a data test center on 2-wire switched network service. Automatic answer is enabled before the remote test begins and is disabled after this test is completed. All the functions of the self-test (ST) switch are provided, except lighting the modem ready (MR) indicator.

2.16 DL (Digital Loop-Back): This switch loops back the data set receiver output to the transmitter input to permit the received signal to be retransmitted on 4-wire facilities. The received data (BB), transmitted data (BA), received line signal detector (CF), request-to-send (CA), receiver signal element timing (DD), and transmitter signal element timing (external) (DA) leads are disconnected from the customer interface. The BB lead is connected to the BA lead, the CF lead to the CA lead, and the DD lead to the DA lead, and the data set is conditioned for external timing. Internal gating is enabled to ensure that the transmitter and receiver dibit clocks are synchronized. The data set ready (CC) lead is clamped to *off* and the test mode (TM) indicator is lighted.

C. Customer Interface

2.17 The customer interface is the point of connection between DS 201C and the customer provided equipment (CPE). The customer must supply the plug and cable to connect the CPE to the data set.

2.18 The signals on all but six of the customer interface leads meet the requirements of Electronic Industries Association (EIA) Standard RS-232-C. The distortion of the signal element (bit) timing circuits and the distortion of data circuits conform to EIA Standard RS-334.

2.19 All voltage levels on the customer interface leads are in respect to signal ground. The transmitted and received data leads are in the marking condition when the voltage present is more negative than -3 volts and are in the spacing condition when the voltage is more positive than +3 volts. The control leads are in the *on* condition when their voltage is more positive than +3 volts and are in the *off* condition when their voltage is more negative than -3 volts.

2.20 The terminating impedance of the receiving end of a customer interface circuit has a dc resistance of not less than 3000 ohms and not 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 terminating circuits is less than -2 to +2 volts.

2.21 The operation of terminator circuits in the data set is dependent only on the signal voltage on the interface leads and conforms to EIA Standard RS-232-C with regard to the rise and fall time. On control leads the time required for the signal to pass through the transition region (-3 to +3 volts) during a change in state does not exceed 1 ms. On the received data, receiver signal element timing, and transmitter signal element timing circuits, the rise and fall time through the transition region does not exceed 16.7 μ s. The rise and fall times of the transmitted data and transmitter signal element timing (external) (if used) signals should also conform to the above limits.

2.22 The open circuit driver voltage on any interface lead does not exceed -25 or +25 volts. All terminators will withstand any input signal that is within the -25 to +25 volt limit. The interface driver circuits are such that when

the proper terminating impedance (3000 ohms to 7000 ohms) is provided and the terminator open circuit voltage is 0, the voltage at the point of interface is between +5 and +15 volts or -5 and -15 volts.

2.23 The data set interface connector provides 19 interface leads for connection to the CPE and two additional leads for use with the telco test equipment. Table A contains a summary of the pin assignment, function, data set mnemonic, and EIA designation for the customer interface leads. A detailed description of these leads is contained in the following paragraphs.

2.24 Protective Ground (AA)—Pin 1: This lead is electrically bonded to the data set housing and chassis. It is connected to local power ground through the third wire of the power cord.

2.25 Transmitted Data (BA)—Pin 2: Mark and space signals generated by the CPE are delivered to the data set on this lead. The data set samples the signals on this lead during the negative transition of the transmitter signal element timing (DB) signal or the clock signal provided by the CPE for externally timed data sets. The CPE must be arranged to transmit data on this lead only when an *on* condition is present on both the clear-to-send (CB) and data set ready (CC) leads.

2.26 Received Data (BB)—Pin 3: Mark and space signals generated by the data set in response to data signals received from the distant-end data set are delivered to the CPE on this lead. The data signals are clocked to the CPE and the CPE is timed to sample the data during the negative transitions of the receiver signal element timing (DD) signals. An *off* condition on the received line signal detector (CF) lead causes the received data lead to be clamped in the mark condition. In 2-wire service, an *on* condition on the request-to-send (CA) lead causes the received data lead to be clamped in the mark condition. Therefore, unlike DS 201A and DS 201B, local copy is not provided in 2-wire service.

2.27 Request to Send (CA)—Pin 4: With switched carrier operation, an *on* condition on this lead is an indication to the data set transmitter of the intent of the CPE to transmit data. After turning *on* this lead, the CPE should wait for an *on* condition on the clear-to-send (CB) lead before starting transmission. For a minimum variation in

delay between the *on* conditions of CA and CB, the positive going transition of CA should coincide with a positive transition of the dibit clock transmitter (DCT) lead. When the CA lead is turned *off* at the end of a message, the data set transmitter remains on about 2 ms to allow the last bits of data to clear the transmitter. With continuous carrier operation, the transmitter is kept on at all times. The user may choose, however, to use the CA lead to control timing functions in the CPE that require the CB lead *on* condition. In this case, the data set provides an optional delay of 0 or 7.1 ms between an *on* condition of CA and an *on* condition of CB.

2.28 Clear to Send (CB)—Pin 5: Signals on this lead 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) lead from the CPE. The CA-CB delay is 148.3 ms for the switched network and 2-wire private lines and 7.1 ms for 4-wire private lines. This delay allows the distant data set to get into synchronization. The *on* condition of the CB lead is an indication to the CPE that signals presented on the transmitted data (BA) lead will be transmitted to the communications channel. The *off* condition of this lead is an indication to the CPE that it should not transfer data on the BA lead. The *off* condition of CB will be maintained as long as CA is *off*. CB turns *off* when CA is turned *off* so that another message can be initiated by turning CA *on* again. In continuous carrier operation, the data set provides an optional CA-CB delay of 0 or 7.1 ms.

2.29 Data Set Ready (CC)—Pin 6: Signals on this lead are generated by the data set to indicate to the CPE whether or not the data set is in the data mode. The *on* condition of this lead indicates that the local data set is capable of transmitting and receiving data signals and is not in the test mode or talk mode (if the data set is arranged for alternate voice service). The *on* condition of this lead alone should not be interpreted to mean that a communication channel has been established to a distant data station or should not be used to determine the status of any remote CPE. This lead is used in conjunction with request-to-send and clear-to-send leads when data is being transmitted.

TABLE A
CUSTOMER INTERFACE

PIN NO.	FUNCTION	DATA SET MNEMONIC	EIA DESIGNATION (RS-232-C)
1	Protective Ground	FG	AA
2	Transmitted Data	SD	BA
3	Received Data	RD	BB
4	Request to Send	RS	CA
5	Clear to Send	CS	CB
6	Data Set Ready	DSR	CC
7	Signal Ground	SG	AB
8	Received Line Signal Detector	CO	CF
9	Test Voltage	+12V	—
10	Test Voltage	-12V	—
14	New Sync	NS (Non-EIA)	—
15	Transmitter Signal Element Timing	SCT	DB
16	Dibit Clock Transmitter	DCT (Non-EIA)	—
17	Receiver Signal Element Timing	SCR	DD
18	Dibit Clock Receiver	DCR (Non-EIA)	—
19	Remote Release (+5V)	RR (Non-EIA)	—
20	Data Terminal Ready	DTR	CD
21	Ready	RDY (Non-EIA)	—
22	Ring Indicator	RI	CE
23	Ring Indicator 2	RG2 (Non-EIA)	—
24	Transmitter Signal Element Timing (External)	SCTE	DA

2.30 Signal Ground (AB) —Pin 7: This lead establishes the common ground reference potential for all interface leads except protective (frame) ground (AA). This lead is normally connected to the protective ground lead to minimize the introduction of 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 telco employee.

2.31 Received Line Signal Detector (CF)—Pin 8: The *on* condition of this lead indicates that the data carrier signal has been received for 5 ms or more. This lead will go *off* if the line signal disappears for more than 5 ms due to the end of transmission or to a transmission line interruption. This *off* condition causes the received data (BB) lead to be clamped to the mark condition and the receiver signal element timing (DD) and dibit clock receiver (DCR) leads to be clamped to

the **on** condition. In 2-wire service, the CF lead is clamped **off** when request to send (CA) is **on** and for 100 ms after CA is turned **off** to prevent the receiver from responding to echoes on the line and processing the transmitted data (providing local copy).

2.32 Test Voltages (+12V, -12V)—Pins 9 and 10: These leads are connected to the power unit in the data set for use by telco personnel in data set testing. Pin 9 provides access to the +12 volt dc supply; pin 10 provides access to the -12 volt dc supply. The CPE must not be connected to these leads.

2.33 New Sync (NS—Non-EIA)—Pin 14:

This lead may be used on an optional basis with a data set at the master station of a multistation private line network, such as in a polling operation, to ensure rapid resynchronization 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. The CPE can condition this lead to turn **on** for 1 ms or more to squelch the existing clock after the end of a message is received. At all other times the **off** condition should be applied by the CPE. When the new sync option is not used, the new sync lead is held **off** within the data set.

2.34 Transmitter Signal Element Timing (DB)—Pin 15:

For internally timed data sets, 2400-Hz square-wave signals on this lead are used to provide the CPE with signal element timing information for the transmitted data (BA) lead. The DB signal is present at all times when power is applied to the data set. The first signal element of the transmitted data (BA) signal should be presented by the CPE on the positive (**off** to **on**) transition of DB which coincides with the **off** to **on** transition of the clear-to-send (CB) signal. (The clear-to-send signal turning **on** coincides with a positive transition of DB.) Transmitted data is sampled by the data set on negative transitions of DB. The DB lead provides a timing signal which is phase-locked to the transmitter signal element timing (external) (DA) signal for data sets timed externally by the CPE.

2.35 Dibit Clock Transmitter (DCT—Non-EIA)—Pin 16:

A square-wave signal at one-half the bit rate appears on this lead whenever power is applied to the data set. Positive and negative transitions of this signal coincide with positive and negative transitions of transmitter signal element timing (DB). The DCT lead indicates the rate at which phase changes are made in the transmitted signal. Two serial bits (dibit) from the CPE are used to determine a phase change by the data set modulator, and the grouping of bits is according to the transitions on this lead so that over one cycle of DCT, two serial bits from the CPE are encoded into one phase shift. If the minimum variation in delay between request to send (CA) **on** and clear to send (CB) **on** is desired, the positive transition of request to send from the CPE should coincide with a positive transition of DCT.

2.36 Receiver Signal Element Timing (DD)—Pin 17:

The square-wave signal on this lead at the nominal 2400-Hz rate is used to provide the CPE with receiver signal element timing information. The transition from **on** to **off** indicates the center of each signal element (bit) on the received data (BB) lead. The DD signal is provided when the received line signal detector (CF) lead is **on**. If CF should go **off**, DD is clamped to the **on** condition.

2.37 Dibit Clock Receiver (DCR—Non-EIA)—

Pin 18: A square-wave signal on this lead provides receiver timing information to the CPE at the bit rate. Positive and negative transitions on this lead coincide with positive and negative transitions on the receiver signal element timing (DD) lead. By referring to the DCR lead, the CPE can define the 2-bit (dibit) grouping of the decoded phase shifts of the received line signal. This means that in one cycle of DCR, two serial bits that were originally encoded into a phase shift by the transmitter are decoded into two bits with the same sequential relationship that existed at the transmitter. The DCR signal is provided when the received line signal detector (CF) lead is **on**. If CF should go **off**, DCR is clamped to the **on** condition.

2.38 Remote Release (RR—Non-EIA)—Pin

19: This lead is used only for switched network service when the CPE is equipped with a contact closure interface on the data terminal ready (CD) and/or ready (RDY) leads. In conjunction

with these leads, RR allows for selective automatic answer of incoming calls. With this feature, a call is answered when the CPE responds to signals on the ring indicator (CE) lead (or closures between ring indicator and ring indicator 2) by closing a contact (or by a permanent strap) between RR and RDY and a closure between RR and CD. On call originations, CPE equipped with a contact interface must close RR to CD to go into the data mode. When the CPE is equipped to provide signals conforming to EIA voltage levels on the CD and RDY (if used) leads, RR is not used by the CPE.

2.39 Data Terminal Ready (CD)—Pin 20:

This lead will function with either a contact closure interface or an EIA voltage interface. The lead controls the connection of the data set to the channel in switched network service. With an EIA voltage interface, the CPE must provide an *on* condition on the CD lead to request that the data set enter the data mode. The data set responds by turning *on* the data set ready (CC) lead after entering the data mode. The CD lead should be kept *on* throughout the call. An *off* condition should be maintained by the CPE for nondata modes. With a contact interface, the CPE provides an *on* condition by closing a contact between CD and the remote release (RR) lead. An open between CD and RR is an *off* condition. The closure between CD and RR must be maintained for the duration of the call. The CD and ready (RDY) leads may be kept *on* all the time to answer incoming calls at the end of the first ringing cycle and to go into the data mode. Alternatively, the CPE can wait for a ringing indication on the ring indicator (CE) lead and respond by turning *on* the CD and RDY leads.

2.40 Ready (RDY—Non-EIA)—Pin 21:

This lead is used primarily with a contact closure interface for selective automatic answering on switched network service. The lead can also accept EIA voltage signals. When selective automatic answering is used with a contact closure interface, RDY should be closed to the remote release (RR) lead while the data terminal ready (CD) lead is *on* to answer incoming calls. A contact closure (or a permanent strap) between RDY and RR must be provided by the CPE. Alternatively, an EIA voltage *on* condition on RDY when CD is also *on* will cause the call to be answered. If a closure is provided between RDY and RR (or an EIA *on* condition is applied to RDY) before the ring indicator (CE) lead goes *on*, the call will be answered at

the end of the first full ringing cycle if CD is *on*. Once the call is answered, RDY may be left *on* (closed to RR) or *off* (open to RR).

2.41 Ring Indicator (CE)—Pin 22: Signals on this lead indicate that a ringing signal is being received from a distant data station on the switched network. The lead is provided for automatic answering of calls by the CPE. When ringing is present, a contact closure to the ring indicator 2 (RG2) lead or an EIA voltage *on* condition appears on the CE lead. Between rings and whenever ringing is not occurring, an open contact or an EIA voltage *off* condition is maintained. Ringing continues to be indicated on the CE lead until the call is answered by the CPE.

2.42 Ring Indicator 2 (RG2—Non-EIA)—Pin 23:

This lead is used in data sets that have a contact closure interface on the ring indicator (CE) lead. When ringing is detected, a contact closure within the data set is provided between the RG2 and CE leads. The RG2 lead is not used in data sets that have an EIA voltage interface on the CE lead.

2.43 Transmitter Signal Element Timing (External) (DA)—Pin 24:

For externally timed data sets, this lead is used by the CPE to provide bit rate timing to the transmitter. The *on* to *off* transition of this lead indicates the center of each signal element on the transmitted data (BA) lead. The timing signal from the CPE must have a frequency of 2400 Hz ± 0.005 percent with a peak individual distortion on negative transitions of not more than 0.5 percent. The transmitter signal element timing (DB) lead is phase-locked to this signal and the dibit clock transmitter (DCT) signal is derived from it. Signals should be available on this lead whenever the data set is in service.

D. Telephone Line Interface

2.44 The telephone line interface is the point of connection between DS 201C and the switched network or private lines. Figure 2 shows the telephone line interface between a telephone set and DS 201C for switched network service. Table B contains a summary of the pin assignment, designation, and function for the telephone line interface leads. A detailed description of these leads is contained in the following paragraphs.

TABLE B
TELEPHONE LINE INTERFACE

PIN NO.	DESIGNATION	FUNCTION
1	L	Line status lamp control from data set to telephone set
2	-12V	Test voltage
3	+5V	Test voltage
4	LG	Line status lamp control ground
5	TD	Talk/data control from telephone set to data set
7	T	Telephone line tip
8	R	Telephone line ring
9	DT	Telephone line tip
10	DR	Telephone line ring
11	TEK6	Data set ready control ground
12	RNG	Common ringer control for multiple data sets
13	TEK5	Data set ready control from CIU* to data set
14	C	Data mode status from data set to ACU
16	D1	Data mode control from ACU to data set
20	+12V	Test voltage
21	T1	Telephone set tip
22	R1	Telephone set ring
23	A	Telephone line status from data set to ACU
25	TDG	Talk/data control ground

* Channel interface unit (DAS 828-type, DAS 829-type, or equivalent)

2.45 Transmit and Receive (T, R, DT, DR)—Pins 7, 8, 9, and 10: For 2-wire service, data set and telephone set signals are transmitted and received through leads T (Pin 7) and R (pin 8). For 4-wire service, separate leads are used for transmitting and receiving. Leads T and R are used to transmit only and leads DT (pin 9) and DR (pin 10) are used to receive only.

2.46 Telephone Set Tip and Ring (T1, R1)—Pins 21 and 22: The tip and ring leads associated with one line button of a standard 6-button key telephone set are connected to these pins. The telephone set provides voice communication

over the line and terminates the line during manual origination and answering of data calls.

2.47 Talk/Data Control and Ground (TD, TDG)—Pins 5 and 25: The A and A1 leads associated with the telephone set line button are connected to these pins. Operation of the telephone set data (hold) button controls the TD and TDG leads to put the data set in the data mode in the manual mode of operation.

2.48 Line Status Lamp Control and Ground (L, LG)—Pins 1 and 4: The L and LG leads associated with the telephone set line button are connected to these pins to light the line

button lamp when ringing voltage is detected on the line and when the data set is in the data mode.

2.49 Data Mode Control (D1)—Pin 16:

This lead is used by an automatic calling unit (ACU) to put the data set in the data mode.

2.50 Data Mode Status (C)—Pin 14:

This lead is used by an ACU to detect when the data set is in the data mode.

2.51 Telephone Line Status (A)—Pin 23:

This lead is used by an ACU to detect when the telephone line is in use in either the data or talk mode.

2.52 Common Ringer Control (RNG)—Pin 12:

This lead is used to operate a common ringer for two or more data sets.

2.53 Data Set Ready Control and Ground (TEK5, TEK6)—Pins 13 and 11:

These leads are used by a channel interface unit (CIU) (DAS 828-type, DAS 829-type, or equivalent) to provide an indication to the CPE (on the data set ready lead) when the channel is in the loop-back mode and not available for use.

2.54 Test Voltages (-12V, +5V, +12V)—Pins 2, 3, and 20:

These leads are connected to the power unit in the data set and are provided for test purposes only. Pin 2 provides access to the -12 volt dc supply; pin 3 provides access to the +5 volt dc supply; and pin 20 provides access to the +12 volt dc supply.

E. Customer Options

2.55 DS 201C is provided with several optional features that may be requested by the customer. The desired options must be specified when the data set is ordered. Refer to Table C for a summary of customer and telco options.

2.56 New Sync: New sync is provided for use in a DS 201C at a master station in a multipoint network to ensure rapid resynchronization on a series of messages from different remote transmitters. New sync is required when the interval between successive messages is less than 10 ms, 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

CPE, after detection of an end-of-message code and after the received line signal detector lead goes *off*, should apply a 1-ms (or longer) *on* condition to the new sync lead (pin 14) to squelch the existing clock. If new sync is not required, the new sync lead can be inhibited by installing the new sync not used option.

2.57 Transmitter Timing: Internal or external timing can be provided.

(a) With internal timing, the data set provides serial clock to the CPE on the transmitter signal element timing lead (pin 15).

(b) With external timing, the CPE provides serial clock to the data set on the transmitter signal element timing (external) lead (pin 24). The serial clock signal must conform to the distortion accuracy of EIA Standard RS-334, which requires peak individual distortion of no more than 0.5 percent. Frequency accuracy is required to be within ± 0.005 percent of the bit rate. The internal timing of the data set is phase-locked to the serial clock signal provided by the CPE and also appears on the lead (pin 15) that usually provides internal timing to the CPE. This allows the CPE to properly time the transmitted data at the 2400-bps rate.

2.58 Automatic Answer: Two options provide three types of operation.

(a) With option YE, automatic answer is either not provided or provided on a selective basis. If provided, it is controlled by the CPE through the ready lead (pin 21) and the data terminal ready lead (pin 20). Both leads must be *on* for automatic answer to occur. This can be accomplished by an EIA voltage, by a contact closure to the remote release lead (pin 19), or by a combination of these methods.

(b) With option YF, permanent automatic answer is provided. It is controlled by the CPE through the data terminal ready lead (pin 20) only. The required *on* condition can be accomplished by an EIA voltage or by a contact closure to the remote release lead (pin 19).

2.59 Ring Indication. EIA or contact interface can be provided.

(a) With EIA interface, the ring indicator lead (pin 22) indicates to the CPE that a ringing signal is present on the telephone line.

(b) With contact interface, a contact closure between the ring indicator lead (pin 22) and the ring indicator 2 lead (pin 23) occurs during ringing.

2.60 Grounding: Signal ground (pin 7) is normally connected to protective (frame) ground (pin 1) to minimize the introduction of power line noise into the data circuits. However, local conditions may require that signal ground *not* be connected to protective ground.

2.61 Type of Operation: 4-wire private line, 2-wire switched network, or 2-wire private line service can be provided. With 4-wire service, duplex operation is possible. With 2-wire service, half-duplex operation is required.

(a) With 4-wire private line service, switched carrier or continuous carrier options are available.

- With the switched carrier, 7-ms clear-to-send delay option (XA), the data set can transmit (carrier is on) when request to send is *on*. The data set transmitter is off when request to send is *off*.
- With the continuous carrier, 7-ms clear-to-send delay option (XB), the data set transmitter remains *on* continuously to maintain synchronization; however, when request to send is *off*, the data set transmitter sends an idle code of steady marks.
- With the continuous carrier, 0-ms clear-to-send delay option (XC), data set operation is identical to option XB except that there is no delay between request-to-send and clear-to-send.

(b) With 2-wire switched network service, the only option available is switched carrier with 150 ms of delay between request to send and clear to send (option XD). This delay allows time for echo suppressors in the telephone line to turn around and for the distant receiver to establish synchronization. In addition, the receiver is clamped for 100 ms after the transmitter is turned off to permit line echoes to decay.

(c) With 2-wire private line service, the only option available is switched carrier with 150 ms of delay between request to send and clear to send (option XE). Data set operation is identical to option XD.

F. Telco Options

2.62 The following options provided with DS 201C are to be selected and installed by the telco. Refer to Table C for a summary of telco and customer options.

2.63 Transmit Line Signal Level: This option allows selection of the transmitted signal level. Signal levels of 0 to -15 dBm can be provided in steps of 1 dBm. For private line service, the signal level is set for 0 dBm. For switched network service, the signal level is set so that the level of the signal reaching the central office does not exceed -12 dBm.

2.64 Line Impedance: The data set can be equipped with a 600-ohm or a 900-ohm line impedance. The 600-ohm impedance is for use on private lines. The 900-ohm impedance is for use on the switched network.

2.65 Compromise Equalizer: This option provides a fixed 4-dB slope and symmetrical delay equalizer to compensate for distortion on the telephone line. The option should be provided for all installations.

2.66 Carrier on Sensitivity: This option determines the minimum line signal level at which the data set reliably detects the carrier signal. For private line service, the carrier on sensitivity is set for -24 dBm. For switched network service, -44 dBm is used.

2.67 External Control of DSR (Use With DAS 828-Type): Normally, a 4-wire channel used with DS 201C is terminated with a CIU (DAS 828-type, DAS 829-type, or equivalent). This CIU provides level adjustment and amplitude equalization. The CIU may also provide alternate voice capability and switched network backup. In addition, the CIU provides an equal level loop-back capability to the central office that allows the central office to test the channel. When the channel is looped back, the data set is not available for use by the CPE.

TABLE C
DATA SET 201C OPTIONS

FEATURE	OPTION			PROVIDE
Transmit Line Signal Level	0 dBm	For Private Lines	ZA	One Per Set
	-1 dBm	For Switched Network	ZB	
	-2 dBm		ZC	
	-3 dBm		ZD	
	-4 dBm		ZE	
	-5 dBm		ZF	
	-6 dBm		ZG	
	-7 dBm		ZH	
	-8 dBm		ZI	
	-9 dBm		ZJ	
	-10 dBm		ZK	
	-11 dBm		ZL	
	-12 dBm		ZM	
	-13 dBm		ZN	
	-14 dBm		ZO	
-15 dBm	ZP			
Line Impedance	600 ohms		ZQ	One Per Set
	900 ohms		ZR	
Compromise Equalizer (See Note)	In		ZS	One Per Set
	Out		ZT	
Carrier On Sensitivity	-24 dBm for Private Line		ZU	One Per Set
	-44 dBm for Switched Network		ZV	
New Sync	Not Used		YA	One Per Set
	Under Customer Control		YB	

TABLE C (Cont)

DATA SET 201C OPTIONS

FEATURE	OPTION		PROVIDE	
Transmitter Timing	Internal	YC	One Per Set	
	External	YD		
Automatic Answer	Not Provided or Provided Under Control of Customer Interface Circuits RDY and DTR	YE	One Per Set	
	Provided Under Control of DTR Only	YF		
Ring Indication on Customer Interface	EIA Interface on Terminal 22	YG	One Per Set	
	Contact Interface Between Terminals 22 and 23	YH		
External Control of DSR	Yes	YI	One Per Set	
	No	YJ		
Grounding	Signal Ground Connected to Frame Ground	YK	One Per Set	
	Signal Ground Not Connected to Frame Ground	YL		
Type of Operation and Clear-to-Send Delay	4-Wire Private Line	Switched Carrier, 7-ms CS Delay	XA	One Per Set
		Continuous Carrier, 7-ms CS Delay	XB	
		Continuous Carrier, 0-ms CS Delay	XC	
	2-Wire Switched Network	Switched Carrier, 150-ms CS Delay	XD	
	2-Wire Private Line	Switched Carrier, 150-ms CS Delay	XE	

Note: Use option ZS for all installations.

(a) With option YI, the data set ready (DSR) lead (pin 6) to the CPE is controlled by the CIU (and the data set test switches) and turns **off** when the channel is looped back.

(b) With option YJ, the DSR lead (pin 6) is controlled only by the data set test switches. This option must be used if a CIU is not used or if the equivalent terminating device does not provide external control of the DSR lead.

generator and word comparator is contained in the following description of the tests.

3.10 Analog Loop-Back Self Test: This test allows the operation of a data set to be checked independently of connections to customer interface or telephone line interface (Fig. 5). The test can be performed regardless of data set options or connections to external equipment. The test is performed by depressing switches AL and ST. Switch AL disconnects the transmitter from the telephone line and loops back the transmitter output to the receiver input through an internal attenuator. Switch ST causes a repeated 15-bit test word to be encoded by the transmitter and sent to the receiver. The receiver demodulates this test signal

and checks its digital output with a 15-bit word comparator. The MC lamp blinks or lights continuously if the demodulated signal does not agree with the original test signal, indicating a faulty data set.

3.11 Digital Loop-Back Self Test: This test allows the operation of a data set and the connecting telephone facilities to be checked (Fig. 6). The test requires that the data set to be tested be connected by a 4-wire line to a location with a known good data set. The test is performed by depressing switch ST on the near-end data set and switch DL on the far-end data set. Switch ST causes the near-end data set to encode and transmit a repeated 15-bit test word to the far-end data set. Switch DL loops back the receiver output

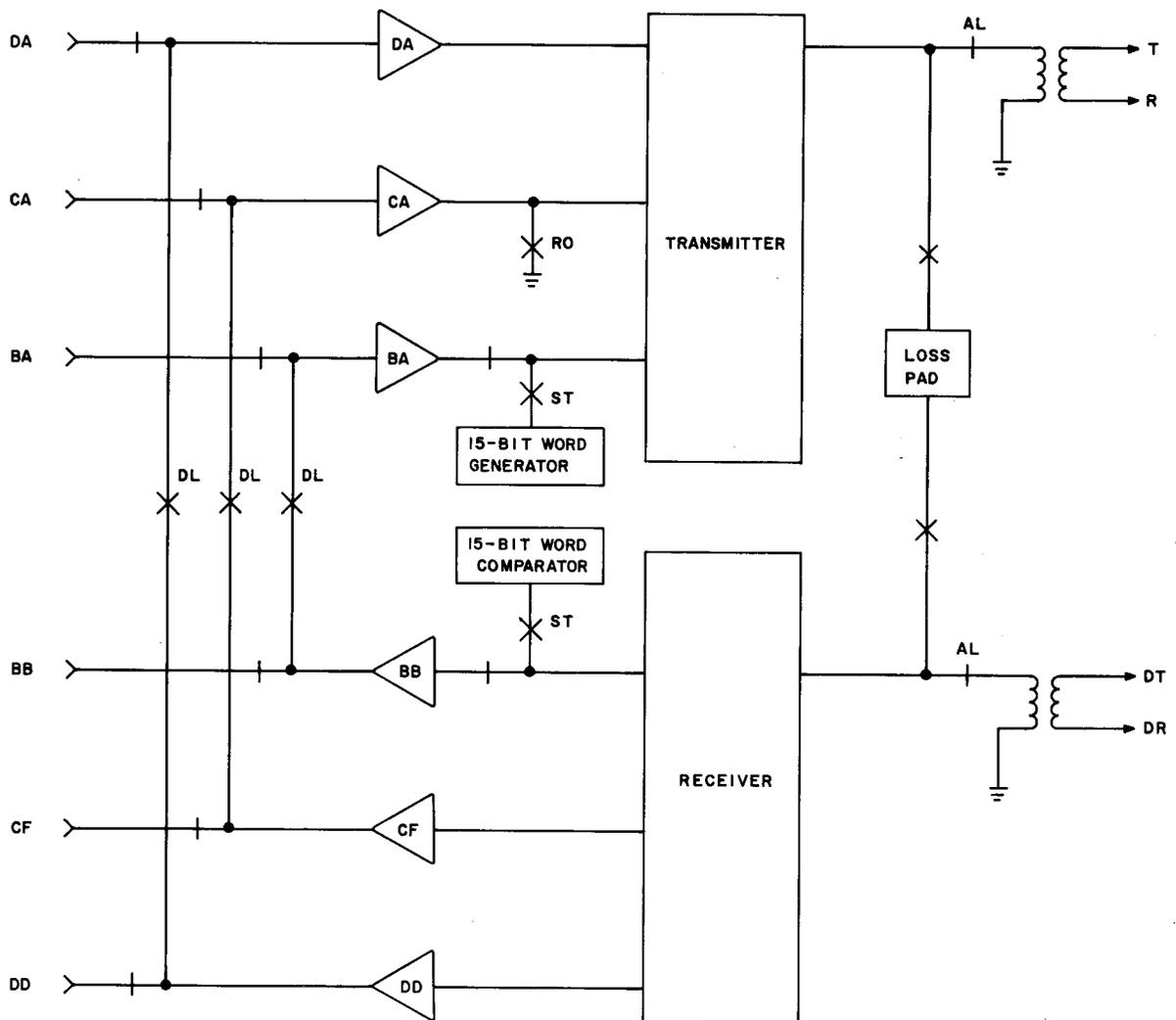


Fig. 4—Test Circuit—Simplified Functional Diagram

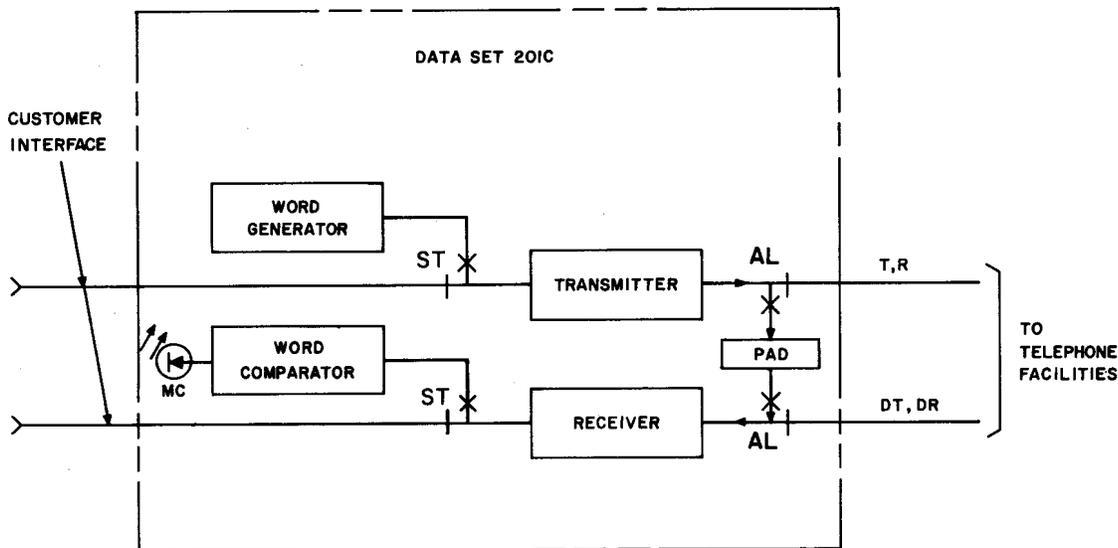


Fig. 5—Analog Loop-Back Self Test

to the transmitter input of the far-end data set and causes the encoded test word to be retransmitted. The near-end data set demodulates this test signal and checks its digital output with a 15-bit word comparator. The MC lamp blinks or lights continuously if the demodulated signal does not agree with the original test signal. If the MC lamp blinks more than two times per minute or lights continuously, a faulty data set or telephone line is indicated.

3.12 End-to-End Self Test: This test allows the operation of a data set and the connecting telephone facilities to be checked (Fig. 7). For 4-wire private line service, the test is performed by depressing switch ST on both data sets. Both data sets transmit the repeated 15-bit test word. The MC lamp on a data set blinks or lights continuously if an error is detected in the receiver output of that data set. For 2-wire private line service, switch RO on one data set is also depressed, conditioning that data set to function as a receiver. If the MC lamp blinks more than two times per minute or lights continuously, a faulty data set or telephone line is indicated. For 2-wire switched network service, the test is performed by depressing switch ST on the far-end data set and switch RT on the near-end data set. The near-end data set is now conditioned to answer calls automatically and to transfer to the data mode. The near-end receiver now accepts 2-second blocks of the 15-bit test word. At the end of each block, the near-end transmitter will send a 2-second block of the 15-bit

test word (an ACK) or a 2-second block of its complement (a NACK) depending on the data received. If the received data is without errors, the ACK signal is transmitted. If errors are detected, the NACK signal is transmitted. If the MC and carrier on (CO) lamps go on and off simultaneously or all lamps are lighted continuously, an error condition is indicated. A test center can be used instead of the far-end data set in all the end-to-end tests.

C. Restrictions on Use of Self Tests

3.13 When DS 201C is used as an extension of a DS 209A-L1 multiplex system, refer to Section 592-032-100 for more information. Procedures used at the serving test center (STC) to maintain this system are contained in Section 666-511-504.

3.14 When DS 201C is used as a substrate off-net extension of the digital data system (DDS), refer to Section 314-919-100 for more information. Procedures used at the hub office STC to maintain the analog portion of this system are contained in Section 666-511-501.

3.15 When DS 201C is used as a remote extension of a DS 209A-L1 multiplex system or as a

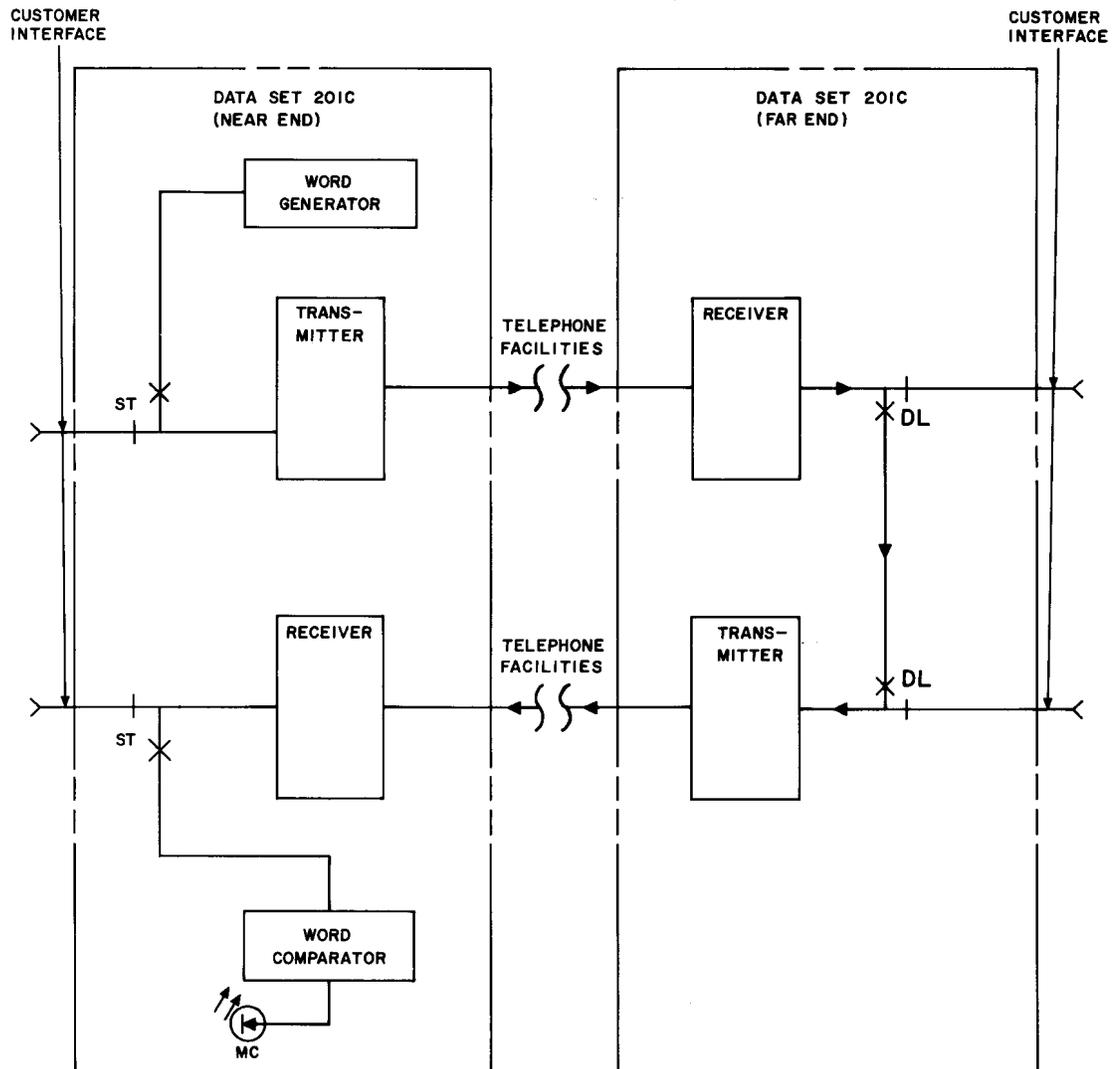


Fig. 6—Digital Loop-Back Self Test

subrate off-net extension of the DDS, the following restrictions apply to the use of the self tests:

- (a) The analog loop-back self test cannot be performed at a remote extension with options as installed. If the internal timing option is temporarily installed or the M23B cord is temporarily removed at the remote extension, this test can be performed.
- (b) The digital loop-back self test cannot be performed from a remote extension (with

options as installed) in toward DS 201C collocated with DS 209A-L1. If the internal timing option is temporarily installed or the M23B cord is temporarily removed at the remote extension, this test can be performed.

- (c) The digital loop-back self test cannot be performed from a remote extension (with options as installed) in toward a hub office of the DDS. If the internal timing option is temporarily installed or the M23B cord is

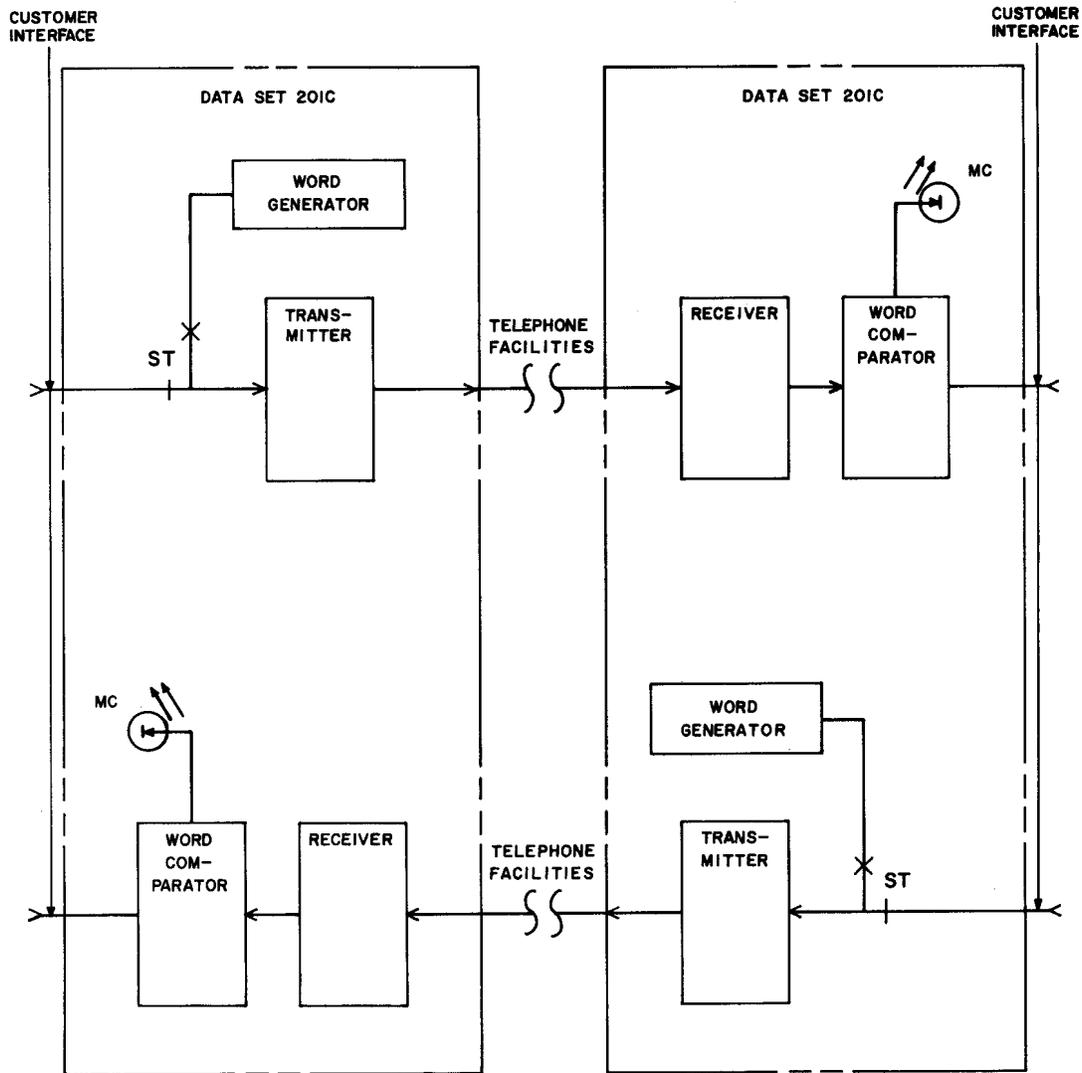


Fig. 7—End-to-End Self Test

temporarily removed at the remote extension, this test can be performed.

4. APPLICATIONS

4.01 This part describes some common applications for DS 201C. Typical options for each application are identified. The applications described are as follows:

- Switched Network
- Point-to-Point
- Multipoint
- Extended Service

- Digital Data System Off-Net.

A. Switched Network

4.02 In switched network service, one DS 201C has access to any other DS 201C. Typical options for DS 201C in switched network service are shown in Table D.

B. Point-to-Point

4.03 In point-to-point service, one DS 201C has access to only one other DS 201C. This service can be provided over either 4-wire (duplex operation) or 2-wire (half-duplex operation) private lines. Typical options for DS 201C in point-to-point service are shown in Table E.

TABLE D

TYPICAL OPTIONS FOR DS 201C IN SWITCHED NETWORK SERVICE

FEATURE	SELECT OPTION
Transmit line signal level	Determined at time of installation
Line impedance	900 ohms (ZR)
Compromise equalizer	In (ZS)
Carrier on sensitivity	-44 dBm (ZV)
New sync	Not used (YA)
Transmitter timing	As required by CPE
Automatic answer	As required by CPE
Ring indication	As required by CPE
External control of DSR	No (YJ)
Grounding	Signal ground connected to frame ground (YK)
Type of operation	Switched carrier, 150-ms CS delay (XD)

TABLE E

TYPICAL OPTIONS FOR DS 201C IN POINT-TO-POINT SERVICE

FEATURE	SELECT OPTION
Transmit line signal level	0 dBm (ZA)
Line impedance	600 ohms (ZQ)
Compromise equalizer	In (ZS)
Carrier on sensitivity	-24 dBm (ZU)
New sync	Not used (YA)
Transmitter timing	As required by CPE
Automatic answer	Not applicable
Ring indication	Not applicable
External control of DSR	As required by installation
Grounding	Signal ground connected to frame ground (YK)
Type of operation	See note

Note: For 4-wire service, select either continuous carrier, 7-ms CS delay (XB) or continuous carrier, 0-ms CS delay (XC) as required by CPE. For 2-wire service, select switched carrier, 150-ms CS delay (XE).

C. Multipoint

4.04 Polling systems use multipoint private lines which allow a centrally located data terminal (master or hub) to access or be accessed by any number of remote data terminals. The master terminal can transmit data to or receive data from the remote terminals by accessing each terminal individually, setting up synchronization (handshaking), and either transmitting or receiving.

4.05 Several remote terminals may wish to transmit simultaneously to the master terminal. However, only one remote terminal can transmit and the others must wait their turn. There are two common methods that the master terminal may use to select which remote terminal will transmit next: hub polling and roll call polling.

4.06 With hub polling, the master terminal works down a list of remote terminals and addresses each in turn. Some remote terminals may be polled more than others, or priority sequencing may be used. With roll call polling, the master terminal addresses only the remote terminal at the end of the line and the other remote terminals pass the polling message down the line until all the remote terminals have been interrogated.

4.07 In a polling system, the data set at the master terminal requires different options than the data sets at the remote terminals. The data set at the master terminal transmits continuously to all remote data sets, but receives from one remote data set at a time. Therefore, the data set at the master terminal must be equipped with continuous carrier and new sync (to quench the receiver clock between messages). The remote data sets receive continuously but transmit only when polled. Therefore, the remote data sets must be equipped with switched carrier. New sync is not required because the remote data sets are receiving continuously. Typical options for DS 201C at master and remote terminals are shown in Table F.

D. Extended Service

4.08 DS 201C can be used as a 2400-bps extension of a DS 209A-L1 multiplex system. In a typical system, data from the CPE is fed into an extension DS 201C which transmits the data to another DS 201C collocated with a DS 209A-L1. The DS 209A-L1 multiplexes the data with data

coming in on other ports (such as three 2400-bps channels, or a 2400-bps channel and a 4800-bps channel). The data is transmitted at 9600 bps to a distant DS 209A-L1 that demultiplexes the data. A DS 201C collocated with the distant DS 209A-L1 transmits the data to another extension DS 201C. There are many possible combinations of data sets and channels in a multiplex system. For more information, refer to Section 592-032-100. Typical options for a collocated or an extension DS 201C are shown in Table G.

E. Digital Data System Off-Net

4.09 DS 201C can be used as a 2400-bps subrate off-net extension of the DDS. In this system, data from the CPE is fed into an extension DS 201C which transmits the data to another DS 201C located in a DDS hub office. At this office, the data is demodulated to a serial train of EIA voltages that are fed into the DDS and transmitted to the distant end. For more information, refer to Section 314-919-100. Typical options for a hub office or an extension DS 201C are shown in Table G.

5. MAINTENANCE

5.01 It is recommended that the service using DS 201C be maintained on a set change-out basis when trouble is isolated to the data set. The defective (or suspected defective) data set must be tagged with the symptoms and/or reasons for change-out, to aid in trouble analysis and repair. In order to isolate trouble to the data set, the maintenance procedures contained in Section 592-029-300 should be followed.

5.02 A field support team has been established at Bell Telephone Laboratories (BTL) to assist in solving technical and application-related problems encountered in providing DS 201C service. If a problem requiring technical assistance is encountered, normal escalation steps (locally established routine) should be followed. The 295 DATEC control center will provide contact with a BTL field support team member. Following resolution, if the problem appears to be of a recurring nature or of common interest, the 295 DATEC control center will issue advisories to all areas. This procedure will assist in providing minimum down-time and maximum trouble-free service to the customer.

TABLE F

TYPICAL OPTIONS FOR DS 201C IN MULTIPOINT SERVICE

FEATURE	SELECT OPTION
Transmit line signal level	0 dBm (ZA)
Line impedance	600 ohms (ZQ)
Compromise equalizer	In (ZS)
Carrier on sensitivity	-24 dBm (ZU)
New sync	Note 1
Transmitter timing	As required by CPE
Automatic answer	Not applicable
Ring indication	Not applicable
External control of DSR	As required by installation
Grounding	Signal ground connected to frame ground (YK)
Type of operation	Note 2

Note 1: For master terminal, select under customer control (YB). For remote terminals, select not used (YA).

Note 2: For master terminal, select either continuous carrier, 7-ms CS delay (XB) or continuous carrier, 0-ms CS delay (XC) as required by CPE. For remote terminals, select switched carrier, 7-ms CS delay (XA).

TABLE G

TYPICAL OPTIONS FOR DS 201C IN EXTENDED SERVICE OR AS A SUBRATE OFF-NET EXTENSION OF DDS

FEATURE	SELECT OPTION
Transmit line signal level	0 dBm (ZA)
Line impedance	600 ohms (ZQ)
Compromise equalizer	In (ZS)
Carrier on sensitivity	-24 dBm (ZU)
New sync	Not used (YA)
Transmitter timing	External (YD)
Automatic answer	Not applicable
Ring indication	Not applicable
External control of DSR	As required by installation
Grounding	Signal ground connected to frame ground (YK)
Type of operation	See note

Note: For DS 201C collocated with DS 209A-L1 in extended service or used at a hub office of DDS, select switched carrier, 7-ms CS delay (XA). For all other locations in extended service or DDS, select either continuous carrier, 7-ms CS delay (XB) or continuous carrier, 0-ms CS delay (XC) as required by CPE.

SECTION 592-029-150

6. REFERENCES

6.01 Additional information concerning DS 201C is contained in the following publications:

SECTION	TITLE	SECTION	TITLE
314-919-100	Digital Data System—Substrate Off-Net Extension Arrangements—Description	592-032-100	Data Set 209A-L1—Transmitter-Receiver—Description and Operation
590-002-100	Data Services—2000 and 2400 BPS Provided by Data Set 201-Type—Reference Guide	592-862-100	Data Station 201C— Description and Operation
592-029-100	Data Set 201C—Transmitter-Receiver—Description and Operation	592-862-200	Data Station 201C— Installation and Connections
592-029-200	Data Set 201C—Transmitter-Receiver—Installation and Connections	666-511-501	Test of Data Services Provided by Data Set 201C From a Private Line Test Room
592-029-300	Data Set 201C—Transmitter-Receiver—Maintenance	666-511-504	Test of Data Services Provided by Data Set 209A-L1 From a Private Line Test Room
592-029-500	Data Set 201C—Transmitter-Receiver—Test Procedures Using 914-Type Data Test Set	999-100-138	Data Set 201C—How to Operate Manual
		6.02	Detailed information concerning DS 201C is contained in CD- and SD-1D239-01.