DATA SET 202T

TRANSMITTER-RECEIVER

SUPPLEMENTARY INFORMATION

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1. GENERAL

1.01 This section covers data set (DS) 202T 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 practices in this series as listed in Part 6 (REFERENCES). The information contained in this section supplements that in other practices and is not required for installation, maintenance, or testing under normal circumstances.

1.02 When this section is reissued, the reason for reissue will be listed in this paragraph.

1.03 DS 202T (Fig. 1) is designed for transmission of serial binary data asynchronously at speeds up to 1400 bits per second (bps) over basic 3002-type channels. Data transmission between 1400 and 1800 bps requires C2 conditioning. In its 2-wire configuration, DS 202T may be equipped with a reverse channel which provides signaling at rates up to 5 bps in a direction opposite to the primary channel. For detailed information on maximum bit rates in the various configurations, refer to Part 4.

2. EQUIPMENT CHARACTERISTICS

2.01 This part contains a description of the data set status indicators, test switches, and interface leads.

Fig. 1—Front View of Data Set 202T

STATUS INDICATORS

2.02 The data set status indicators monitor the power unit, certain interface leads, and the test modes. The status indicators are light emitting diodes (LEDs) which illuminate translucent designations located on the data set front cover.

2.03 The lamp designations and their normal functions are as follows:

- ***ON:*** Indicates that power is applied to the data set.
- ***MR (Modem Ready):*** Indicates the status of the data-set-ready signal. The lamp lights when the data set is in the data mode (data set ready lead is ***on***).
- ***RS (Request-to-Send):*** Indicates the status of the request-to-send lead from the customer interface. The lamp lights whenever the request-to-send lead is ***on,*** during local self test and remote test (2-wire), or when the continuous carrier option (ZN) is installed.
- ***CS (Clear-to-Send):*** Indicates the status of the clear-to-send lead from the data set. The lamp lights whenever the clear-to-send lead is ***on,*** during local self test and remote test (2-wire), or when the continuous carrier option (ZN) is installed.
- ***CO (Carrier On):*** Indicates the status of the received line signal detector lead from the data set. The lamp lights whenever the received line signal detector lead is in the ***on*** condition or during local self test and remote test (2-wire).
- ***TM (Test Mode):*** Indicates that the data set is in the test mode. The lamp lights whenever one of the test switches is depressed. If an error is detected during local self test, the TM lamp goes off.

TEST SWITCHES

2.04 The data set is equipped with three pushbutton switches which are accessible at the front panel. The functions of the switches are as follows:

- ***AL (Analog Loop-Back):*** This switch is a push-to-operate, push-to-release type. When the button is operated, the TM lamp lights and the output of the data set transmitter is looped back to the receiver input for test purposes.
- ***LT (Local Self Test):*** This switch is a push-to-operate type and must be held in during the test. When the switch is depressed, all status indicator lamps light to provide a lamp test. The output of the transmitter is looped to the input of the receiver and a random 63-bit word is transmitted at 1547 bps.
- ***RT (Remote Test):*** This button is a push-to-operate, push-to-release type. If the data set is operating 4-wire, the RT switch connects received data to send data. This conditions the data set to operate as a repeater for remote testing purposes. If the data set is operating 2-wire, the RT switch conditions the data set to be remote tested from a test center.

2.05 Detailed information on the various test modes is given in Part 3 (FUNCTIONAL DESCRIPTION).

INTERFACE LEADS

A. Customer Interface

2.06 The customer interface is the point of connection between DS 202T and the customer-provided equipment (CPE). The customer must supply the plug and the necessary cable to connect the CPE to the data set.

2.07 The signals on all the DS 202T customer interface leads meet the requirements of EIA Standard RS-232C.

2.08 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. Table A gives a summary of the pin assignment of EIA data and control leads, signal states, EIA designations, and mnemonic designations.

2.09 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.

2.10 The operation of DS 202T terminator circuits is dependent only on the signal voltage on the interface lead and conforms to EIA Standard RS-232C 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 circuits, the rise and fall time through the transition region does not exceed 15 μs.

2.11 The open circuit driver voltage on any DS 202T interface circuit 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.

2.12 ***Protective Ground (AA):*** This lead is electrically bonded to the data set housing and chassis. It is connected to local power ground through the power transformer. Later model data sets do not provide frame ground at the interface.

2.13 ***Transmitted Data (BA):*** Signals on this lead are generated by the transmitting data terminal and are transferred to the modulator of the data set for transmission to the distant end. A positive signal is a binary "0" or space, and a negative signal is a binary "1" or mark. The CPE must not transmit data unless an ***on*** condition is present on the clear-to-send (CB) and data set ready (CC) interface circuits (except for analog loop-back test, described later). The transmitting CPE should hold BA in the marking condition when no data is to be transmitted. With 0 volts on the BA circuit and the clear-to-send and data set ready circuits ***on,*** the BA circuit is in an indeterminate state and either a marking or spacing data signal will be transmitted.

2.14 ***Received Data (BB):*** Signals on this lead are generated by the receiving data set in response to data signals received from the distant data set. With the local copy option installed in half-duplex operation, the BB signal follows the transmitted data signal delayed by less than 2 ms, and may be used to monitor the transmitted data.

2.15 ***Request-to-Send (CA):*** Signals on this lead are generated by the CPE to condition the local data set to transmit data. With the data set ready lead ***on,*** the carrier is transmitted in less than 1 ms after the CA lead turns ***on.*** The ***on*** condition must be maintained whenever the CPE has information ready for transmission. The data set transmits all signals on the transmitted data lead while the ***on*** condition is maintained on the request-to-send and clear-to-send leads. In half-duplex operation, the ***off*** condition of request-to-send holds the data set in the receive mode, and the ***on*** condition holds the data set in the transmit mode. CPE designed for either transmit-only or duplex operation may continuously hold CA in the ***on*** condition. If the data set is equipped with the JY2 reverse channel circuit pack, a signal may be received on the reverse channel regardless of the state of the local CA lead. This type of operation is called independent reverse channel operation. If the data set is equipped with the JY1 reverse channel circuit pack, the local CA circuit must be ***on*** in order for the reverse channel to be able to receive. This is called dependent reverse channel operation.

2.16 ***Clear-to-Send (CB):*** The ***on*** condition of the CB lead is a response to an ***on*** condition on the request-to-send circuit delayed by

TABLE A

SUMMARY OF INTERFACE LEADS

LEAD NO.	FUNCTION	EIA DESIGNATION (RS-232-C)
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	Positive 14 Volts	— †
10	Negative 14 Volts	— †
11 & 19	Secondary Request-to-Send	SCA
12	Secondary Received Line Signal Detector	SCF
25	Carrier Detector Reset	Unassigned

* Not provided on later models.
† Reserved for data set testing.

180, 60, 30, or 8 ms, depending on the clear-to-send interval option selected. The ***on*** state of CB indicates to the CPE that signals presented on the transmitted data lead will be transmitted to the communication channel. The ***off*** condition is an indication to the CPE that it should not transfer data on the transmitted data lead. When request-to-send is turned ***off*** by the CPE, CB goes ***off*** in less than 1 ms.

2.17 ***Data Set Ready (CC):*** Signals on the CC lead indicate the mode of the data set. The ***on*** condition indicates that the data set is in the data mode and is capable of transmitting and receiving data signals. The ***on*** condition is required in conjunction with an ***on*** condition on the request-to-send and clear-to-send circuits when transmitting data. The ***off*** condition indicates that the data set is in some mode other than the data mode. The ***on*** condition of this circuit should not be interpreted to mean that a communication channel has been established to a remote data station or to determine the status of any remote terminal equipment.

2.18 ***Signal Ground (AB):*** This circuit establishes the common ground reference potential for all interface circuits except protective ground. This circuit is normally connected to protective ground 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 telco installer.

2.19 ***Received Line Signal Detector (CF):*** An ***on*** condition on the CF lead indicates that the data carrier is being received and has been received for at least 7 ms (option Q) or 23 ms (option N). This circuit normally does not turn ***on*** in the presence of noise, out-of-band signals or other non-FSK signals even when the fast mode carrier detection option (Q) is selected. When the data carrier is lost due to an end of transmission or to a telephone line interruption, the ***off*** condition follows after a 10-ms time delay. The ***off*** condition on CF causes the received data circuit to be clamped to the mark condition if the clamp option (F) is installed. The CF circuit responds to carrier signals from either the local or distant transmitting data set when optioned for local copy of the primary channel (option ZA). The CF circuit is ***off*** during the squelch interval when the squelch option is used.

2.20 ***Circuits 9 and 10:*** These circuits originate in the data set for use by the telco personnel in data set testing. Pin 9 provides an access to the +14 volt dc supply; pin 10 provides an access to the -14 volt dc supply. The CPE must not be connected to these leads.

2.21 ***Secondary Request-to-Send (SCA):*** This circuit is available on data sets equipped with reverse channel, and is used to provide communication from the receiving data set to the transmitting data set simultaneously with the primary data channel. This circuit is operational only when the request-to-send (CA) lead is ***off.***

2.22 ***Secondary Received Line Signal Detector (SCF):*** This lead is provided only on data sets equipped with reverse channel. It is used to signal the data set transmitting on the primary channel regarding conditions at the receiving data set simultaneously with the transmission on the primary data channel. With the local copy option for the reverse channel (option ZE), the SCF circuit responds to reverse channel carrier from either the local or distant data set. If the data set is equipped with the JY1 reverse channel circuit pack, the request-to-send (CA) lead must be ***on*** in order to receive the reverse channel signal from the distant data set. If the data set is equipped with the JY2 reverse channel circuit pack, the reverse channel can receive independently of the state of the request-to-send (CA) lead.

2.23 ***Carrier Detector Reset (CR):*** This circuit is used to reset the carrier detector on systems requiring fast turnaround. A positive pulse of greater than 0.2 μs duration resets the carrier detector so that the receiver is ready for new data. The carrier detector reset terminator is ***off*** for a negative applied voltage or if the terminal is left unconnected. An option is provided to disable the carrier detector reset terminator.

B. Telephone Line Interface

2.24 The telephone line interface is the point of connection between DS 202T and the 2-wire or 4-wire private line.

(a) ***DT1, DR1—First Tip and Ring Pair:*** In 2-wire operation, data signals are transmitted and received through these terminals. In 4-wire operation, data signals are transmitted through these terminals.

(b) ***DT, DR—Second Tip and Ring Pair:*** In 2-wire operation, these terminals are not used. In 4-wire operation, data signals are received through these terminals.

(c) ***TEK5 and TEK6:*** These leads are used in conjunction with a line-terminating device such as the DAS 828A or 829-type. A relay contact provided by the line terminating device may be connected to these terminals to remotely control the data set ready (CC) and clear-to-send (CB) customer interface drivers.

3. FUNCTIONAL DESCRIPTION

3.01 This part contains information pertaining to the data set oscillator, transmitter, receiver, power rectifier, reverse channel, test modes, and options. Refer to Fig. 2 for a functional block diagram of DS 202T.

A. Oscillator

3.02 A crystal-controlled oscillator supplies an 844.8-kHz square wave, which performs the following functions:

(a) Modulation of transmitted carrier

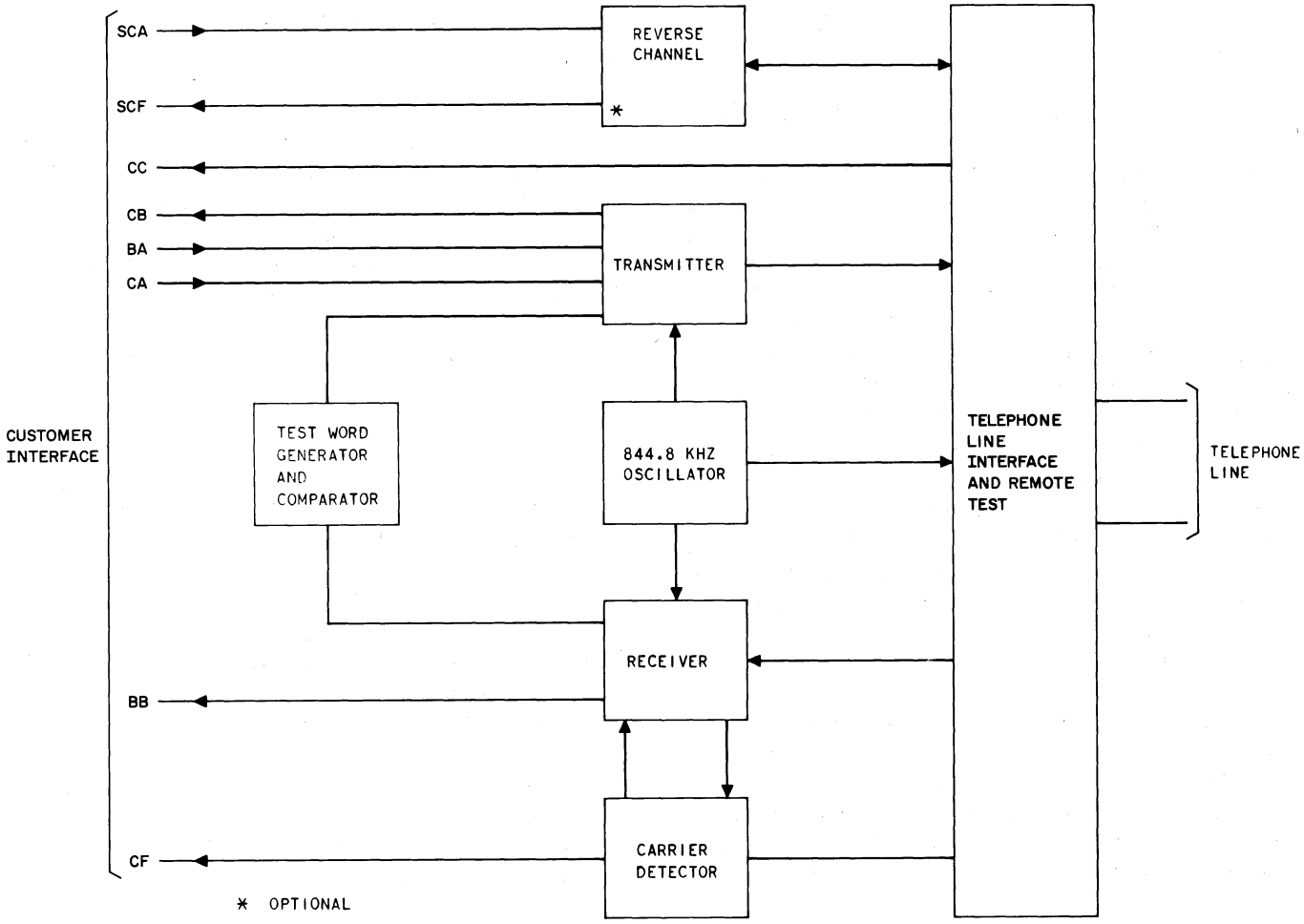

Fig. 2—Data Set 202T, Functional Block Diagram

(b) Clear-to-send timing

(c) Soft turnoff and squelch timing

(d) Reverse channel carrier generation.

B. Transmitter

3.03 In the transmitter, positive and negative voltages from the CPE are converted to mark and space tones which can be transmitted over voice-grade private lines. A negative voltage at the transmitted data (BA) interface lead is interpreted as a mark and is transmitted as a 1200-Hz tone. A positive voltage at the interface is interpreted as a space and is transmitted as a 2200-Hz tone. The transmitter output level is approximately 0 dBm.

C. Receiver

3.04 The function of the receiver is to convert mark and space tones to negative and positive voltages. The carrier detector in the receiver responds to valid incoming line signals by turning ***on*** the received line signal detector (CF) circuit. In order for the carrier detector to respond, the incoming signal must be in the data band for a certain length of time (limits are determined by the carrier detector option) and must have a level of at least -32 dBm. For signals in the data band, the receiver provides a negative voltage (mark) on the received data (BB) interface lead for signals between 1100 and 1500 Hz and provides a positive voltage (space) for signals between 1800 and 2300 Hz.

3.05 The receiver also performs compromise equalization to compensate for the average

slope distortion and envelope delay distortion encountered in the transmission facility.

D. Power Rectifier

3.06 The KS-21239-L1 or -L4 transformer (or the ac supply of the 39A1 or 40B1 data mounting) provides a 24-volt ac source to the power rectifier of the data set. The output of the rectifier and voltage regulator (with reference to circuit ground) is as follows:

- +5 (±0.25) volts
- +11 (±3.0) volts
- +14 (±2.5) volts
- -11 (±3.0) volts
- -12 (±1.2) volts
- -14 (±2.5) volts.

E. Reverse Channel

3.07 The reverse channel provides a 387-Hz on/off amplitude modulated signal at a maximum of 5 bps. For the JY1 reverse channel circuit pack, the request-to-send (CA) circuit must be ***on*** for the reverse channel to be in the receive mode. For the JY2 reverse channel circuit pack, the reverse channel receive operation is independent of the condition of the request-to-send (CA) circuit. However, for both JY1 and JY2 circuit packs, the reverse channel transmitter is inhibited when the request-to-send (CA) circuit is ***on*** to prevent simultaneous transmission of data on both channels in the same direction. The receive level sensitivity of the JY2 circuit pack is -45 ±1.5 dBm, which is 3 dB more sensitive than the JY1 circuit pack. This increase provides more margin for transmission loss at the 387-Hz carrier frequency.

F. Test Modes

3.08 The data set test modes are as follows:

- Analog loop-back
- Local self test
- Remote test (2-wire)
- Remote test (4-wire).

Three test switches on the front of the data set are labeled AL, LT, and RT.

3.09 ***Analog Loop-Back Test:*** In the analog loop-back mode, data signals applied on the BA (transmitted data) interface lead with CA (request-to-send) positive are processed through the transmitter and looped back through the receiver to the BB (received data) interface lead. The customer interface leads may be monitored for proper operation. Depressing the AL switch until it locks conditions the data set as follows:

(a) Disconnects the data set from the line and terminates the line in 600 ohms.

(b) Modifies the feedback path from transmitter to receiver to decrease the signal level of the transmitter.

(c) Lights the TM (test mode) lamp.

3.10 ***Local Self Test:*** When the nonlocking LT button is depressed, the data set is conditioned for self-test as follows.

(a) All interface leads are made inoperative and the data line is terminated in 600 ohms.

(b) All status indicator lamps light to check for lamp failures.

(c) A repeating 63-bit pseudo-random word (identical to the test word in the 914- and 903-type test sets) is generated at 1547 bps.

(d) The test word is processed by the transmitter and receiver circuitry and the resulting word is compared to the original word.

(e) If an error is detected, the TM lamp goes off.

3.11 A properly operating data set will sometimes fail in a self-test interval of more than 15 seconds because an error in only one bit will cause the TM lamp to go off. However, more than one failure in five successive tests of 15 seconds duration should not occur.

3.12 ***Remote Test (2-Wire):*** The remote test mode for 2-wire operation allows the

attendant at the serving test center (STC) to test data set circuitry, with the exception of the customer interface. When the locking RT button is depressed, the data set is conditioned for remote test as follows:

(a) All customer interface leads are made inoperative and all status indicator lamps light.

(b) A repeating 63-bit pseudo-random word is generated at 1547 bps.

(c) The test word is processed by the transmitter and receiver circuitry and the resulting word is compared to the original word. In addition, the test word is transmitted to the STC.

(d) If an error is detected, constant spacing (2200 Hz) is transmitted to the STC instead of the random word.

3.13 At the STC, the 63-bit pseudo-random word can be checked for errors to establish an error rate (caused by the channel). The attendant at the STC can apply a tone to the line to cause errors in the internal loop-back signal of the data set under test. This causes the data set to transmit constant spacing. If the data set under test is equipped with reverse channel, it transmits steady marking (1200 Hz) whenever 387 Hz is transmitted by the test center and detected by the reverse channel receiver.

3.14 ***Remote Test (4-Wire):*** The remote test for a 4-wire data set is a digital loop-back test. In the digital loop-back mode, the attendant at the STC can test data set circuitry, with the exception of the customer interface circuits. Depressing the locking RT switch conditions the data set as follows.

(a) All customer interface leads are made inoperative and the ON and TM lamps light.

(b) The output of the demodulator is coupled to the input of the modulator so that the attendant at the test center can perform a digital loop-back test.

OPTIONS

3.15 DS 202T is provided with optional features which must be selected prior to placing the data set in service. Table B provides a summary of these options. Several of the options available with DS 202T depend on a different option in the distant data set(s); when selecting options, care must be taken to choose options which are compatible with the distant data set. For more information on option selection, refer to the APPLICATIONS subpart in Part 4.

3.16 ***2-Wire Operation:*** This option is used when 2-wire facilities are selected and half-duplex service is satisfactory. The 2-wire option can be selected with reverse channel (ZC) or without reverse channel (ZD). If option ZC is selected, the data set must be equipped with a JY1 or JY2 circuit pack and option ZE (local copy on reverse channel IN) or ZF (local copy on reverse channel OUT) must also be selected.

3.17 ***4-Wire Operation:*** This option is used when 4-wire point-to-point or multipoint facilities are selected. The 4-wire option used with 4-wire facilities provides duplex capability.

3.18 ***Local Copy on Primary Channel in 2-Wire:*** With this option installed, the receiver continuously monitors the transmitted line signal while in the data mode and provides a local copy on the received data circuit.

3.19 ***Soft Turnoff and Squelch Intervals:***

(a) When a data terminal turns request-to-send ***off*** at the end of a message, transients occur which may cause spurious signals to be received at a distant station. With the soft carrier turnoff option, the data set transmits out-of-band carrier (900 Hz) for a period of either 24 or 8 ms after request-to-send is turned ***off.*** This option should be used in conjunction with the received data clamp option and results in a steady mark on the received data circuit of the distant data set. The 8-ms option should be used when the distant data set has the fast received line signal detector option. The 24-ms option should be used when the distant data set is a 202D, 202R, or 202T with the normal received line signal detector option. Neither the 8- nor 24-ms option should be used at the remote stations of a multipoint system when intermessage intervals are less than 10 ms. For this case, the 0-ms (quick turnoff) option should be used (at the remote stations) in conjunction with the received data clamp and the carrier detector

TABLE B

SUMMARY OF OPTIONS

FEATURE	OPTIONS	DESCRIPTION		SWITCH SETTING										PROVIDE
				S3 Switch Contact Setting On Transmitter-Receiver										
				1	2	3	4	5	6	7	8	9	0	One Per Data Set
4-Wire Operation	ZK*			0	0	X	X	0	0	0	X	X	X	
2-Wire Operation w/o Reverse Channel	ZD			X	0	X	0	0	X	X	0	0	0	
2-Wire Operation With Reverse Channel	ZC†			X	X	0	0	X	0	X	0	0	0	
					S2 Switch Contact Setting On Transmitter-Receiver									
				1	2	3	4	5	6	7	8	9	0	One Per Data Set
4-Wire Operation	ZK*			X	—	—	—	—	—	—	—	—	—	
Local Copy on Primary Channel in 2-Wire	ZA	IN		X	—	—	—	—	—	—	—	—	—	
	ZB†	OUT		0	—	—	—	—	—	—	—	—	—	
Soft Turnoff and Squelch Intervals		Soft Turnoff	Squelch											
	Z	0	0	—	—	0	X	—	—	—	—	0	X	One Per Data Set
	Y*	8 ms	0	—	—	0	X	—	—	—	—	0	0	
	X	24 ms	0	—	—	0	X	—	—	—	—	X	0	
	W	0	9 ms	—	—	0	0	—	—	—	—	0	X	
	V	0	156 ms	—	—	X	0	—	—	—	—	0	X	
	T	8 ms	9 ms	—	—	0	0	—	—	—	—	0	0	
	S	8 ms	156 ms	—	—	X	0	—	—	—	—	0	0	
	R	24 ms	156 ms	—	—	X	0	—	—	—	—	X	0	
Fast Carrier Detection	Q*	IN		—	—	—	—	0	—	—	—	—	—	One Per Data Set
	N	OUT		—	—	—	—	X	—	—	—	—	—	
Clear-to-Send Interval	M*	8 ms		—	—	—	—	—	0	0	—	—	—	One Per Data Set
	K	30 ms		—	—	—	—	—	0	X	—	—	—	
	J	60 ms		—	—	—	—	—	X	0	—	—	—	
	G	180 ms		—	—	—	—	—	X	X	—	—	—	
Control by DAS 828- or 829-Type	B*	IN		—	—	—	—	—	—	—	0	—	—	One Per Data Set
	A	OUT		—	—	—	—	—	—	—	X	—	—	
Clamp	F*	IN		—	0	—	—	—	—	—	—	—	—	One Per Data Set
	E	OUT		—	X	—	—	—	—	—	—	—	—	
Carrier Detector Reset				Strapping on Transmitter-Receiver CP										One Per Data Set
	ZL	IN		Install E21-E23										
	ZM*	OUT		Install E22-E23										
Continuous Carrier	ZN	IN		Install E24-E25										One Per Data Set
	ZO*	OUT		Install E25-E26										
Compromise Equalization	ZU	Maximum		Install E27										One Per Data Set
	ZV	Minimum		Install E28										
Local Copy on Reverse Channel				Strapping on Reverse Channel CP										One Per Data Set
	ZE	IN		Install E21-E22										
	ZF*	OUT		Install E21-E23										
Grounding Option				Screw Switch S1 Setting on Interface Circuit										One Per Data Set
	ZG*	Signal Ground Connected to Frame Ground		S1 Closed										
	ZH	Signal Ground Not Connected to Frame Ground		S1 Open										

X Rocker down on side adjacent to numbers.
0 Rocker up on side adjacent to numbers.
— Rocker may be in either position.
* Factory furnished.
† Factory furnished instead to 4-wire option when reverse channel CP is installed.

reset options (at the master station). With the 0-ms (quick turnoff) option, carrier is turned off in less than 1 ms after the request-to-send circuit is turned ***off.*** The 24-ms soft turnoff option should not be used if the time interval between consecutive turnoffs of the request-to-send circuit is less than 165 ms. This condition is required because the soft turnoff timer requires up to 165 ms to cycle through its timing sequence when the 24-ms interval is selected. The 8-ms or 0-ms option should be used if this fast switching mode of the request-to-send circuit is encountered.

Note: In 2-wire applications for terminals which immediately turn ***on*** request-to-send as soon as the received line signal detector goes ***off,*** the 8-ms soft turnoff option is incompatible with the 8-ms clear-to-send delay option and the 24-ms soft turnoff option is incompatible with the 8-ms and 30-ms clear-to-send delay options.

(b) In half-duplex operation on 2-wire facilities, when a station that has been transmitting has its request-to-send circuit turned ***off,*** the telephone line may reflect signals (echoes) back to that station for a period up to the round trip delay of the circuits (about 1 ms per 100 miles each way). The squelch option when used with the received data clamp option prevents the demodulator of the station that has been transmitting from delivering these reflections as data to the received data circuit. DS 202T provides for either 9-, 156-, or 0-ms (no squelch) options. The 156-ms option is recommended for use on 2-wire private line facilities and on 4-wire private lines with talk-back. The 9-ms option may be used on 2-wire private line facilities of less than 50 miles. On facilities longer than 50 miles, the 9-ms option may be used only if the customer terminal is able to ignore echoes. The no squelch (0-ms) option should be used on 4-wire data sets and may be used on 2-wire data sets if the data terminal is able to ignore echoes.

3.20 ***Fast Carrier Detection:*** DS 202T is provided with an option for either normal or fast response of the carrier detector to an incoming data signal. With the normal option, the received line signal detector turns ***on*** in approximately 23 ms if data signals are received and turns ***off*** in approximately 10 ms if data signals are not received. This option is compatible with the clear-to-send delay options in DS 202C, 202D, 202E, and 202R and is recommended when the distant data set has either the 180-, 60-, or 30-ms clear-to-send delays. With the fast option, the received line signal detector circuit turns ***on*** in approximately 6 ms if marking carrier is received. The circuit turns ***off*** in approximately 5 ms for carrier frequencies between 860 Hz and 940 Hz (soft carrier turnoff). If the carrier frequencies are outside of these limits but are within the limits for the normal mode, the normal mode response times will occur. This option must be used when the remote data set uses the 8-ms clear-to-send timing option.

3.21 ***Clear-to-Send Timing:*** The ***on*** condition of the clear-to-send circuit from the data set is a response to an ***on*** condition on the request-to-send circuit delayed by a time interval which permits the data set to establish operations with the distant receiver. DS 202T provides four clear-to-send timing options: 180, 60, 30, and 8 ms.

(a) ***180 ms:*** This option is recommended for use on 2-wire private line facilities greater than 400 miles round trip and is required when the distant data set has the 156-ms squelch option.

(b) ***60 and 30 ms:*** The 60- and 20-ms options should be used in 4-wire point-to-point and multipoint facilities to be compatible with the turn-on time of the received line signal detector of DS 202C, 202D, and 202R.

(c) ***8 ms:*** This option is recommended for use on duplex multipoint systems requiring fast start-up of the data set and is compatible only with a DS 202T at the distant end. With this option, the data terminal must keep the transmitted data circuits in the mark state when request-to-send is ***on*** until the clear-to-send indication is given. The distant data set must be optioned for fast carrier detection.

3.22 ***Control By Data Auxiliary Set (DAS) 828-Type or 829-Type:***

(a) When this option is installed, the data set ready (CC) lead is externally controlled by the DAS 828A, 829-type or equivalent line terminating unit. This indicates to the CPE when the private line channel is in a maintenance mode or other test condition.

(b) When this option is not installed, the data set ready lead is always ***on*** except when the data set is in one of the three test modes.

3.23 ***Clamp:*** With the received data clamp installed, the clamp circuit will squelch the received data circuit when the received line signal detector is ***off.*** If desired by the customer, the clamp circuitry associated with the received line signal detector may be disabled. With this option, noise may cause spurious signals on the received data circuit even if the received line signal detector is ***off.*** It is recommended that the clamp IN option always be installed.

3.24 ***Carrier Detector Reset:*** DS 202T provides a carrier detector reset interface circuit on pin 25 of the customer interface. This interface circuit is provided for turning ***off*** the received line signal detector circuit in less than 0.2 ms for those cases where the 0-ms soft turn-off interval of the remote data set is used to minimize the time between received messages at the master station of a split bridge multipoint system. If this circuit is not used by the CPE, this option should not be installed in the data set, because noise may trigger the circuit if it is not held ***off*** by the CPE.

3.25 ***Continuous Carrier:*** With the continuous carrier option installed, carrier is transmitted as long as the data set is in the data mode. The clear-to-send circuit remains ***on*** and options M, K, J, and G are inoperative. This option may be used on duplex facilities and in transmit-only service over 2-wire facilities. With the carrier under control of request-to-send, carrier is transmitted in less than 1 ms after the request-to-send circuit is turned ***on.*** This option is required to control the direction of data transmission in half-duplex operation over 2-wire facilities. It may also be used in duplex services to provide a means of signaling the remote terminal (for example, carrier-off could be used as an out-of-service indication).

3.26 ***Local Copy on Reverse Channel:*** With this option installed, the receiver monitors the reverse channel transmitter and provides a local copy on the secondary received line signal detector (SCF) circuit. The local copy signal is delayed less than 50 ms.

3.27 ***Compromise Equalization:*** Compromise equalizer options are available on DS 202T-L1, series 6 and higher. Option ZV (minimum compromise equalization) provides reduced envelope delay distortion compensation to eliminate an over-equalization condition on channels with low envelope delay distortion. Option ZU (maximum compromise equalization) provides the same equalizer characteristics provided on data sets without the equalizer options (series 5 and lower). For data bit rates above 1200 bps, it is necessary to perform a data distortion test to determine the proper equalizer option setting. The procedure for this data distortion test is contained in Section 592-031-500.

3.28 ***Grounding Option:*** The protective and signal grounds are normally tied together by means of a screw switch on the interface circuit located on the backplane at the inside rear of the housing. This arrangement is intended to provide additional margin against longitudinal power line noise. The screw switch may be opened at the request of the customer. Due consideration must be given to possible noise conditions, ground potential differences, safety conditions, local electrical codes, and the data terminal manufacturer's recommendations.

4. EQUIPMENT CAPABILITIES

4.01 This part contains information concerning the performance of DS 202T on 3002 private lines. In addition, the various applications for DS 202T are described, and recommended options for each application are given.

PERFORMANCE

4.02 The recommended channel for DS 202T is the 3002 private line. The recommended bit rate and channel conditioning is given as follows:

(a) 4-wire private line and 2-wire private line without reverse channel:

- Basic conditioning up to 1400 bps
- C2 conditioning between 1400 and 1800 bps.

(b) 2-wire private line with reverse channel:

- Basic conditioning up to 1200 bps.

4.03 DS 202T is capable of a long term average of less than 1 bit error per 100,000 bits transmitted if the data set is used on circuits with conditioning recommended in 4.02. The peak data

distortion limit is specified in terms of peak start-stop distortion as defined in EIA Standard RS-404. The requirement is that the maximum start-stop distortion of a 10-bit ASCII character shall not exceed the following limit more than once per 10,000 characters over a long term average.

(a) For 1200 bps service with or without reverse channel, the limit is 35 percent.

(b) For service above 1200 bps without reverse channel, the limit is 40 percent.

(c) For service above 1200 bps with reverse channel, the limit is not specified.

APPLICATIONS

A. 2-Wire Point-to-Point

4.04 In this application, DS 202T operates as either a transmitter or a receiver in a half-duplex mode (alternately in each direction) or in a simplex mode (receive only or transmit only). The half-duplex or simplex modes are selected as options or as a function of the state of the interface signals from the CPE. Reverse channel may be used with either of the above modes.

4.05 Refer to Table C for the recommended options for a DS 202T in a point-to-point application with another DS 202T or a 202D or 202R. The options to be installed in the distant data set are shown on Table D. The recommended options shown on Table C are engineered to maximize protection against interference. Other option combinations are possible which may optimize a particular system, taking into account the propagation delay of the private line network and the insensitivity of the data terminal to various kinds of interference. These combinations may include the removal of the clamp and squelch options and the use of shorter clear-to-send intervals than recommended. The successful operation and interface trouble analysis of such systems during the transient start-up periods are the responsibility of the customer. The telco is responsible for the steady state performance of these systems.

B. 4-Wire Point-to-Point

4.06 On 4-wire circuits, simultaneous transmission in both directions is possible. Refer to Table C or E for selecting options to ensure compatibility with the remote data set.

4.07 With the continuous carrier option OUT, the carrier signal is transmitted whenever the request-to-send circuit is turned ***on.*** With the continuous carrier option IN, the carrier signal is transmitted continuously and the option for

TABLE C

RECOMMENDED OPTIONS FOR 2-WIRE OR 4-WIRE WITH TALK-BACK

OPTION	RECOMMENDATION
Line Interface	2-Wire or 4-Wire
Local Copy on Primary Channel	Optional for 2-Wire
Soft Turn-Off and Squelch	24-ms and 156-ms
Fast Carrier Detection	OUT
Clear-to-Send Interval	180-ms
Clamp	IN
Carrier Detector Reset	OUT
Continuous Carrier	OUT
Local Copy on Reverse Channel	Optional
Grounding	Frame Grd to Signal Grd

TABLE D

RECOMMENDED OPTIONS FOR DISTANT DATA SET FOR 2-WIRE OR 4-WIRE WITH TALK-BACK

OPTION	202D	202R	202T
Squelch	IN	IN	156-ms
Clear-to-Send	200-ms	200-ms	180-ms
Receive Line Signal Detector Timing (Fast Carrier Detection)	40-ms	40-ms	OUT (23-ms)
Soft Carrier Turn-Off	IN	IN	24-ms
Received Data Clamp	IN	IN	IN
Reverse Channel	Optional (2W)	Not Available	Optional (2W)
Carrier Detector Reset	Not Available	Not Available	OUT
Local Copy — Primary Channel	IN (2W)	IN (2W)	Optional (2W)
Local Copy — Reverse Channel	IN (2W)	Not Available	Optional
Continuous Carrier	Not Available	OUT	OUT

clear-to-send interval and soft turn-off interval are unimportant because these intervals never occur.

C. 4-Wire Multipoint

4.08 In multipoint operation, two bridging techniques are commonly used. One bridging technique, called split bridge operation, is used where all transmission is between a master station and associated remote stations (remote stations cannot intercommunicate directly). This system permits the master station to operate with the continuous carrier option IN (request-to-send is permanently ***on***). This eliminates the start-up delay each time a new transmission is initiated. However, for the remote stations, the turnaround time is controlled by the time required to turn ***on*** the carrier detector at the master station if the clamp option (at the master station) is IN. Refer to Table E for rules for setting each option to ensure compatibility with the other data sets in the system and to obtain the minimum turnaround time.

4.09 With the 8-ms clear-to-send interval at the remote station and the fast carrier detection option in the master data set, the master station receiver will be unclamped before the remote station receives a clear-to-send indication. The remote station may send data as soon as the clear-to-send indication is received. This whole procedure repeats for the next remote station at the end of the message from the previous remote station.

4.10 Another bridging technique, conference multipoint, permits any station in the system to transmit and receive from any other station nonsimultaneously. Where the customer desires to obtain local copy through the receive leg, a "talk-back" feature may be added to the bridge. When the talk-back feature is provided, the squelch option should be IN along with the other options of Table C to prevent line reflections from being interpreted as valid data after the request-to-send circuit is turned ***off.*** If the talk-back feature is not used, options must be selected using Table E.

4.11 The carrier detector reset option available with DS 202T is a new feature not available on earlier DS 202-type. It is provided to minimize the time interval between received messages at each station of a conference multipoint system or at the master station of a split-bridge multipoint

TABLE E

RECOMMENDED OPTIONS FOR 4-WIRE POINT-TO-POINT AND MULTIPOINT WITHOUT TALK-BACK USING DATA SET 202T

OPTION	RECOMMENDATION
Clear-to-Send Delay	8 ms if remote data set is a 202T with fast mode carrier detection. 30 ms if remote data set is a 202T with normal mode carrier detection or a 202R, 202D5, or D6 with 40-ms carrier detector timing. 60 ms if remote data set is 202C, 202D3, 202D4 or is a 202R, 202D5 or 202D6 with the 40-ms carrier detector timing
Fast Carrier Detection	IN (fast mode) if remote data set is a 202T with 8-ms clear-to-send delay. OUT (normal mode) if remote data set is optioned for 30, 60, 180, or 200 ms clear-to-send delay.
Soft Carrier Turnoff (Note)	24 ms if remote data set is a 202C, 202D3, D4, D5, D6, 202R, or 202T with normal mode fast carrier detection. 8 ms if remote data set is a 202T with fast carrier detection option. Quick turnoff if remote data set uses carrier detector reset option.
Received Data Clamp	IN
Carrier Detector Reset	IN — at master station of broadcast polling or bridge multipoint system when remote data sets use the quick carrier turnoff and master station is able to implement this circuit. OUT — all other times.
Continuous Carrier	IN — for point-to-point applications and for data set as master station of split bridge multipoint systems. OUT — may be used for above applications and should be used for data set at the remote station of split bridge multipoint system.
Alternate Voice	Optional (with DAS 828A or 829-type).
Switched Network Backup	Optional (with DAS 828A or 829-type).

Note: DS 202T must be optioned for the 8-ms or quick turnoff when the interval between consecutive turnoffs of the request-to-send circuit is less than 165 ms.

system. The carrier detector reset option may be used effectively only if the CPE detects the end of a received message with an end of message code or by knowledge of the length of the received word. After detecting the end of the message, the CPE may apply a short positive going pulse of at least 0.2 ms to the carrier detector reset circuit. This pulse turns ***off*** the carrier detector of the received line signal detector circuit which in turn clamps the received data circuit to a negative level if the clamp option is used as recommended. The remote data set that sent the message should be optioned for the 0-ms soft turn-off interval so that the carrier turns off

immediately at the end of the message. Another remote data set may start sending steady marking to the master station immediately. The receiver at the master station will be clamped during this transfer process so that spurious signals will not be detected.

5. MAINTENANCE AND TESTS

5.01 It is recommended that DS 202T service be maintained on a set change-out basis when trouble is isolated to the data set. It is imperative that the defective (or suspected defective) data set be tagged with the symptoms and/or reason for change-out to aid in troubleshooting analysis and repair.

5.02 A regional field support team has been established at Bell Telephone Laboratories to assist in solving technical and application-related problems encountered in providing DS 202T service. In the event that a problem is encountered which requires further technical assistance, normal DATEC escalation steps (or locally established routine) should be followed. The 195 DATEC Control Center will provide immediate on-line contact with the assigned Bell Telephone Laboratories field support team member. After the problem has been resolved, if it appears to be of a recurring nature or of common interest, the 195 DATEC Control Center may issue advisories to all areas. This procedure will assist in providing minimum downtime and maximum trouble-free service to the customer.

6. REFERENCES

6.01 The following BSPs provide additional information concerning DS 202T.

SECTION	TITLE
592-031-100	Data Set 202T Transmitter-Receiver—Description and Operation
592-031-180	Data Set 202T—Summarizing Specification
592-031-200	Data Set 202T Transmitter-Receiver—Installation and Connections
592-031-300	Data Set 202T Transmitter-Receiver—Maintenance
592-031-500	Data Set 202T Transmitter-Receiver—Test Procedures
592-861-100	Data Station Using Data Set 202T—Description and Operation
592-861-200	Data Station Using Data Set 202T—Installation and Connections
666-511-502	Test of Data Services Provided by Data Set 202T from a Serving Test Center

6.02 Additional information concerning DS 202T is contained in CD- and SD-1D243-01.