DIGITAL DATA SYSTEM
500A-TYPE DATA SERVICE UNIT
DESCRIPTION AND OPERATION

CONTENTS PAGE

1. GENERAL

1.01 This section contains information concerning the description and operation of the 500A-type data service unit, hereafter referred to as the DSU. Other than a description of interface signals and customer options, information pertaining to the associated customer-provided equipment (CPE) is not given.

1.02 This section is reissued to include information on multiple installations and additional options. Since this revision constitutes a general revision, arrows ordinarily used to denote changes have been omitted.

1.03 The DSU is primarily intended for full-duplex operation in 4-wire private line (PL) applications. It provides the CPE with access to the synchronous digital data system (DDS). The DSU accepts serial, unipolar data from the customer and transmits baseband, bipolar signals over the local channel to the serving central office (SCO).

1.04 The 500A-type DSU is apparatus-coded with respect to customer data rates as follows:

500A-L1/2—operates at 2.4 kb/s

500A-L1/3—operates at 4.8 kb/s

500A-L1/4—operates at 9.6 kb/s

500A-L1/5—operates at 56 kb/s.

All DSUs operating at speeds other than 56 kb/s will be referred to as subrate DSUs.

1.05 The customer interface provided by a subrate 500A-type DSU conforms to the electrical characteristics of EIA Standards RS-232-C and RS-334. The data and clock signals of a 500A-L1/5 DSU operating at 56 kb/s conform to the requirements of a balanced direct-coupled interface as specified in CCITT Recommendation V.35, while the control signals conform to EIA Standard RS-232-C.

2. PHYSICAL DESCRIPTION

2.01 The 500A-type DSU (Fig. 1) consists of a transmitter, receiver, control logic, and customer interface circuits mounted on two circuit packs (CPs) interconnected by a flexible cable harness. The CPs are contained in a housing with an aluminum cover and two black plastic faceplates.

2.02 The DSU is approximately 11-1/2 inches wide, 11 inches deep, 4 inches high, and weighs approximately 10-1/2 pounds.

2.03 The DSU will operate in an environment of +40 to +120°F with a relative humidity of less than 95 percent. Surface temperature of the

Fig. 1—500A-Type Data Service Unit

aluminum cover will be approximately 16°F higher than ambient.

2.04 The DSU has been designed to accommodate individual or multiple applications. For small installations, up to three DSUs may be stacked without exceeding maximum operating temperatures. Installations requiring more than three DSUs will make use of the 48A-type data mounting (590-102-139).

2.05 Power requirements for the self-contained 82A power unit are 105 to 129 volts ac at 57 to 63 Hz, not under control of a switch. Approximately 17 watts of power will be dissipated. A 3-conductor ac power cord is provided with the DSU.

2.06 A slide switch and light emitting diode (LED) assembly may be mounted on either the front or rear faceplate (see 3.30). It is factory-installed on the front faceplate. The assembly contains a 3-position switch and four LED indicators which are designated PWR, NS, LL, and RT on the faceplates.

2.07 The 500A-type DSU contains two CPs. HP1 CP performs the DSU logic functions and is common to all four DSUs. HN1, HN2, HN3, and HN4 CPs are analog boards and are speed-sensitive circuits; therefore, DSU transmission speeds are determined by these CPs. Each DSU will contain one logic board and one analog board as shown in Fig. 2. Table A lists DSU transmission speeds and CPs.

2.08 All customer interface leads of a subrate DSU are terminated in a 25-pin connector. Customer-provided equipment used with a subrate DSU must be terminated in a Cinch or Cannon DB-19604-432 plug and a DB-51226-1 hood, or equivalent. A DSU operating at 56 kb/s uses a 34-pin Winchester or Burndy connector. Customer-provided equipment used with a 56-kb/s DSU must be terminated in a Winchester MRA-34

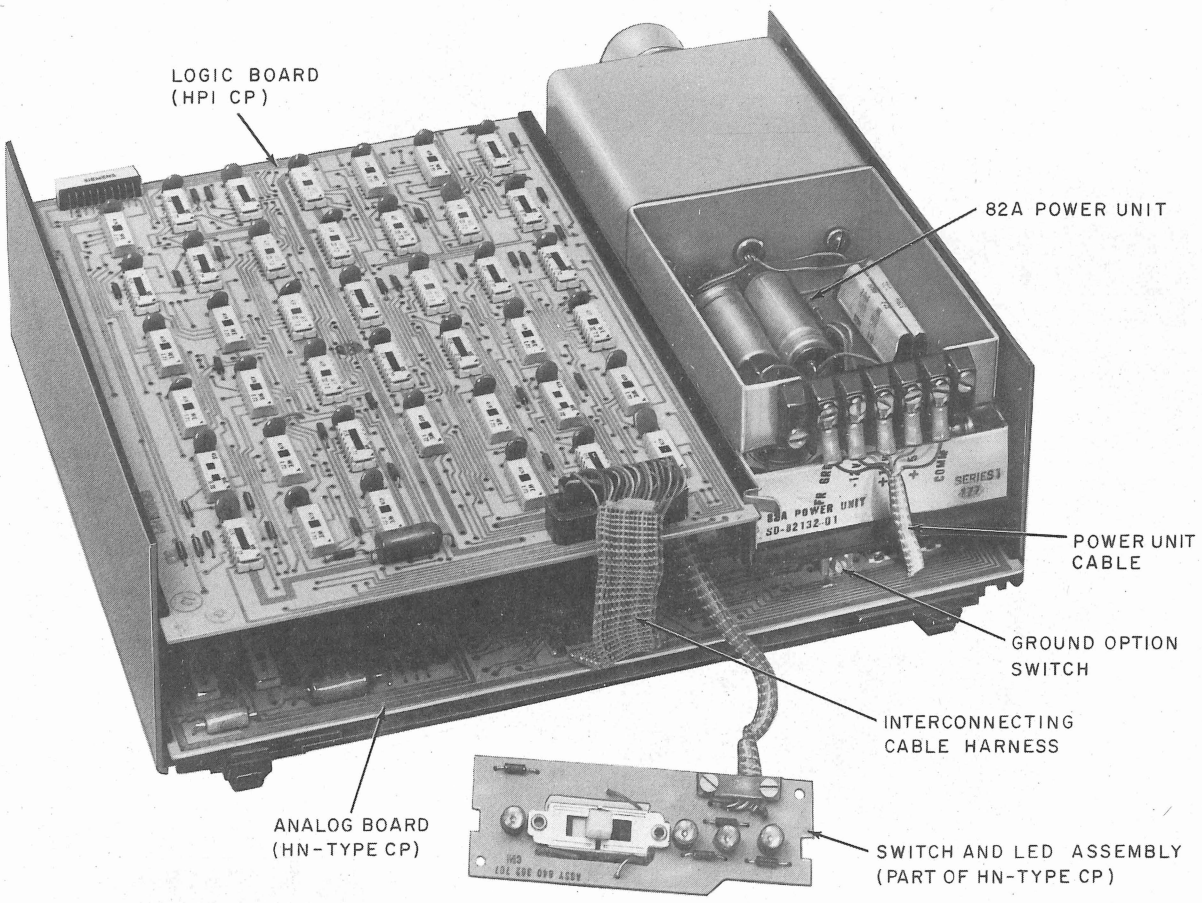

Fig. 2—500A-Type Data Service Unit—Front Internal View

TABLE A

DSU SERVICE BIT RATE AND CIRCUIT PACKS

DSU LIST	DSU SERVICE BIT RATE	ANALOG CP	LOGIC CP
500A-L1/2	2.4 kb/s	HN1	↑
500A-L1/3	4.8 kb/s	HN2	HP1
500A-L1/4	9.6 kb/s	HN3	
500A-L1/5	56 kb/s	HN4	↓

P-JTC6-H plug, or equivalent. Refer to Fig. 3 for customer interface location.

2.09 Roller switches S1 and S3 (Fig. 3 and 4) are used to select request to send, line build out network, system status, and circuit assurance options. The ground option is selected by switch S2 (Fig. 2) and the switch and LED assembly and LL spring clip options are set by hand.

3. FUNCTIONAL DESCRIPTION

3.01 This part contains a brief functional description of the transmitter, receiver, and customer interface circuits. The interface leads are described and a functional description of the DSU options is provided.

3.02 The 500A-type DSU provides for transmission and reception of digital data over local transmission facilities. Bipolar pulses, which are defined as positive and negative voltage levels with successive pulses alternating in polarity, are transmitted over 4-wire cable pairs to and from an office channel unit (OCU) located in the SCO. This bipolar voltage level is representative of a binary 1 and a binary 0 where a binary 1 is transmitted as a nominal ± 1.4 volt pulse and binary

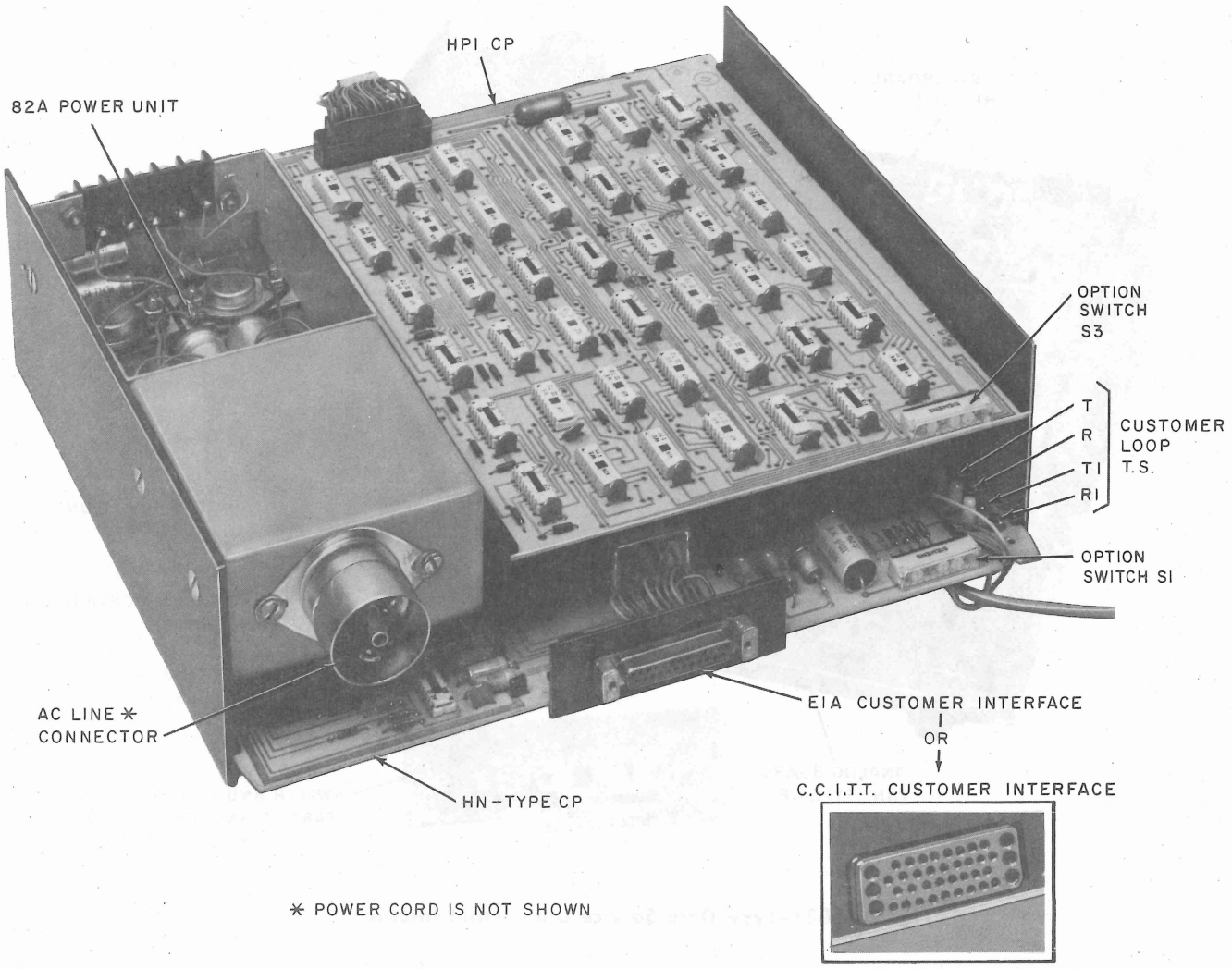

Fig. 3—500A-Type Data Service Unit—Rear Internal View

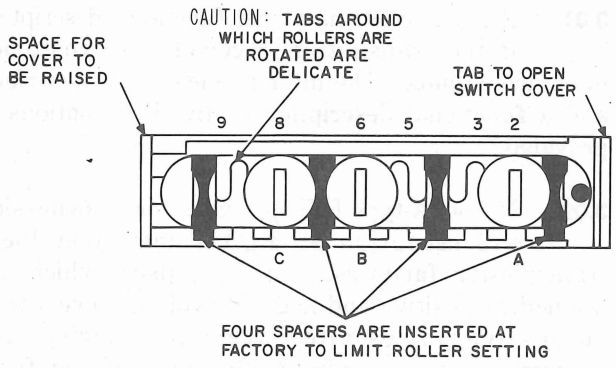

Fig. 4—Detail of Switch for Installing Options

0 is transmitted as zero voltage. The sum of all transmitted voltages must equal zero to prevent dc buildup on the line.

3.03 System control codes are identified by deviations of the preceding bipolar format. These deviations are defined as bipolar violations, where successive bipolar pulses do not alternate in polarity.

A. Transmitter

3.04 Refer to Fig. 5 for a functional block diagram of the 500A-type DSU. The transmitter consists of transmit logic and line driver circuitry, which accepts digital data in the form of positive

and negative voltages from the CPE and transmits balanced, bipolar signals over the local channel. Customer data is encoded by the transmit logic into a format suitable for transmission. Since a long sequence of 0s does not provide transitions to maintain timing recovery, sequences of six or seven consecutive zeros in the data stream, depending on service rate (subrate or 56 kb/s) are replaced with zero suppression codes to maintain synchronization.

3.05 In response to a request-to-send (CA) OFF condition, idle code sequences are formed and applied to the line driver. These idle codes indicate to the remote DSU that no customer data is being transmitted. A delay in the turn-on of clear-to-send (CB), after CA has turned ON, is provided to allow the remote DSU to exit the idle condition and enter the data mode in preparation for data transmission.

3.06 The line driver converts the binary outputs of the transmit logic into a balanced, bipolar signal. This signal is then transformer-coupled to the cable pair.

B. Receiver

3.07 The receiver consists of receive logic, clock recovery, and a line receiver. The line receiver may be subdivided into an analog-to-digital (A/D) converter, and automatic gain control associated with automatic line build-out circuitry. The receiver functions will be discussed in reverse order to simulate signal flow.

3.08 Since local cable pairs may vary in length and gauge, an automatic line build-out network is provided to compensate for these variations. The automatic line build-out network automatically inserts attenuation, which varies with frequency, in order to make the net transmission loss simulate a maximum length of local cable pairs. Because the range of adjustment provided by the network is limited, a fixed line build-out network, which is switch selectable, is needed to insert additional loss in the case of extremely short local cable pairs.

3.09 The automatic gain control (AGC) provides gain and frequency compensation to equalize the cable characteristics of a maximum length cable

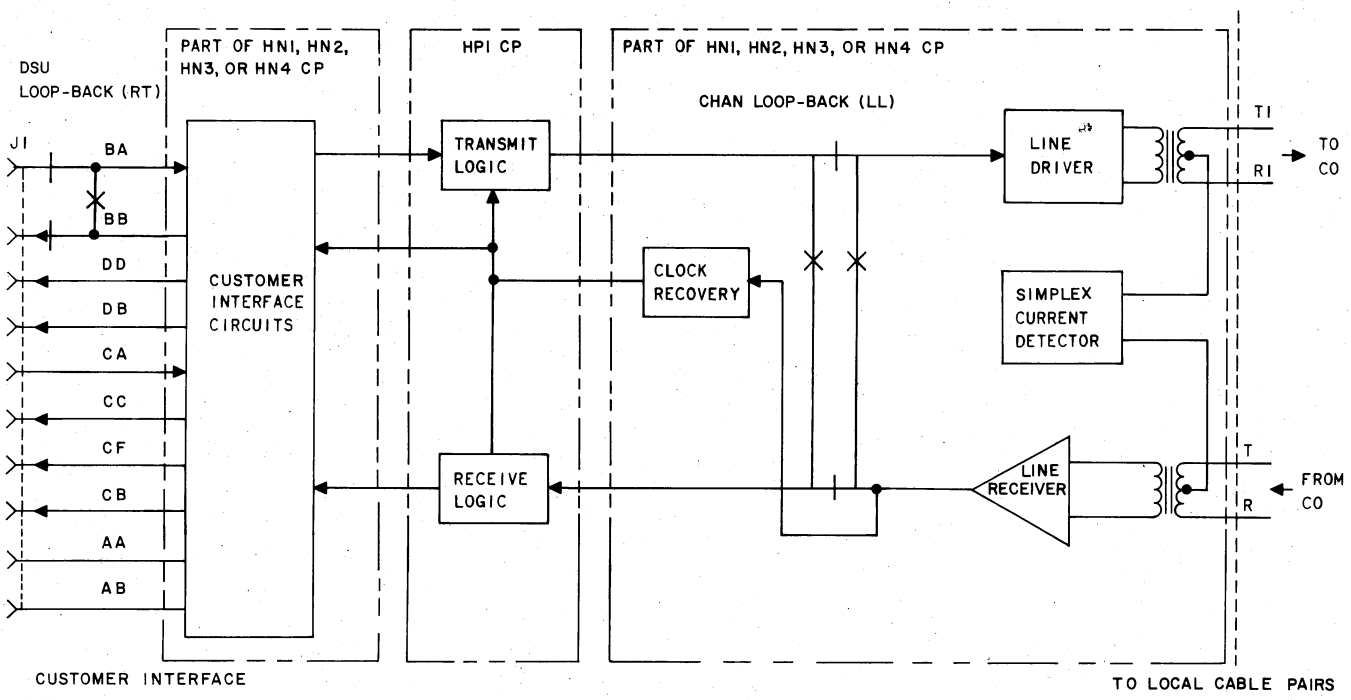

Fig. 5—Functional Block Diagram of 500A-Type Data Service Unit

pair. As a result of the different characteristics relative to cable gauge, the AGC network averages signal attenuation for the range of standard local cable gauges (19 through 26).

3.10 The A/D converter slices the signal to produce a binary representation of the received bipolar signal.

3.11 The clock recovery circuitry consists of a voltage-controlled oscillator connected in a phase-locked loop. A phase comparator synchronizes the oscillator to the received signal timing signal. Thus, a sampling clock is derived from the received bipolar signal and is used to sample the data pulses.

3.12 In the receive logic circuitry, the data stream is sampled, inverted, and the data bits reconstructed to fully occupy each respective time slot. The data stream then passes through a violation detector to recognize bipolar violation sequences (idle code, zero suppression code, DSU loop-back code, and out-of-service code).

3.13 When a bipolar violation sequence occurs, the data stream is examined for the presence of a valid control code by the receive logic. After the detection of three consecutive control codes, the appropriate control state is entered.

3.14 The receiver output logic combines the outputs of the control state circuitry and the installer options to control the customer interface and indicator LEDs as well as other circuits located within the transmit and receive logic.

C. Customer Interface Circuits

3.15 The 500A-type DSU is provided with ten (subrate services) or fourteen (56-kb/s service) interface leads for connection to the CPE. These leads and their corresponding pin numbers are given in Tables B and C. A description of the interface leads is given below with the EIA nomenclature for each lead appearing in parentheses following the lead designation.

3.16 ***Transmitted Data (BA):*** The direction of signal flow on this lead is from the CPE to the DSU. The serial, binary data bits on this lead are generated by the CPE for transmission to the remote CPE. Data bits are transmitted only if the following interface lead conditions are met: CC is ON, CA is ON, and CB is ON. For subrate services, BA meets the requirements of an EIA-type interface, while 56-kb/s service is a balanced direct-coupled signal sent over the BA(A) and BA(B) leads.

3.17 ***Request to Send (CA):*** The direction of signal flow on this lead is from the CPE to the DSU. Signals on this lead are generated by the CPE to turn the local data transmitter ON. An OFF condition on this lead causes the DSU to transmit the idle code sequence, provided CC is ON. A constant ON condition must be maintained whenever the CPE has data ready for transmission.

3.18 ***Serial Clock Receive (DD):*** The direction of signal flow on this lead is from the DSU to the CPE. Signals on this lead provide the CPE with receive signal element timing. For subrate services, DD meets the requirements of an EIA-type interface while 56-kb/s service utilizes a balanced direct-coupled signal sent over the DD(A) and DD(B) leads.

3.19 ***Serial Clock Transmit (DB):*** The direction of signal flow on this lead is from the DSU to the CPE. Signals on this lead provide the CPE with transmit signal element timing. For subrate services, DB meets the requirements of an EIA-type interface while 56-kb/s service utilizes a balanced direct-coupled signal sent over the DB(A) and DB(B) leads. DB is identical to DD.

3.20 ***Received Data (BB):*** The direction of signal flow on this lead is from the DSU to the CPE. Signals on this lead are generated by the receiving DSU in response to the data stream received from the remote DSU. For subrate services, BB meets the requirements of an EIA-type interface, while 56-kb/s service is a balanced direct-coupled signal given serially on the BB(A) and BB(B) leads.

3.21 ***Data Set Ready (CC):*** The direction of signal flow on this lead is from the DSU to the CPE. Signals on this lead are generated by the local DSU to indicate readiness to operate. Once ac power is applied to the DSU, the CC lead is normally in the ON condition. The CC lead will turn OFF under the following conditons:

- The DSU enters the test mode remote terminal (RT) or local line (LL)

TABLE B

SUBRATE 500A-TYPE DSU INTERFACE

INTERFACE PIN NO.	500A-TYPE DSU LEAD		EIA RS-232-C NOMENCLATURE	
	FUNCTION	DESIG	FUNCTION	DESIG
1	Frame Ground	FG	Protective Ground	AA
2	Send Data	SD	Transmitted Data	BA
3	Receive Data	RD	Received Data	BB
4	Request to Send	RS	Request to Send	CA
5	Clear to Send	CS	Clear to Send	CB
6	Data Set Ready	DSR	Data Set Ready	CC
7	Signal Ground	SG	Signal Ground	AB
8	Received Line Signal Detector	RLSD	Received Line Signal Detector	CF
9-14	Not used			
15	Serial Clock Transmit	SCT	Transmitter Signal Element Timing	DB
16	Not used			
17	Serial Clock Receive	SCR	Receiver Signal Element Timing	DD
18-25	Not used			

- The DSU is equipped with the system status option (option XK) and an out-of-service is received.

3.22 ***Received Line Signal Detector (CF):*** The direction of signal flow on this lead is from the DSU to the CPE. Signals on this lead are generated by the local DSU and indicate that data is being received and has been received for an appropriate interval. The CF lead is turned OFF when any of the following conditions exist: out-of-service indication (reception of out-of-service code or loss of signal), CA interface lead of the remote DSU is OFF, or when the DSU is in the RT loop-back mode. When CF lead is OFF, BA interface lead is held in the mark-hold (binary 1) condition.

3.23 ***Clear to Send (CB):*** The direction of signal flow on this lead is from the DSU to the CPE. Signals on this lead are generated by the local DSU to indicate to the CPE readiness to transmit data. CB OFF condition is an indication to the CPE that no data can be transmitted. CB turns ON in response to an ON condition of CA by the CPE after a delay to allow the remote DSU to exit the idle state. With the circuit assurance option (option YQ) installed, the clear-to-send indication is a result of an ON condition on both CA and CF interface leads and the transmitting DSU must have exited the idle state before CB turns ON.

D. Simplex Current Detector

3.24 Reversal of the local channel simplex current by the OCU will operate a polarity-sensitive relay circuit wired between the center taps of the transmit and receive transformers. Operation of this relay will cause a loop-back of the local channel between the line driver and line receiver and will also connect the transmit logic to the receive logic. Functionally, this is the remote CHAN loop-back which is controlled by the serving test center (STC). The customer may achieve the same result by positioning the slide switch to LL, which in this case is called local line loop-back.

E. Switch and LED Assembly

3.25 A slide switch provides control of the loop-back test functions while the LEDs monitor modes. When the switch is positioned to LL (local line loop-back), the transmit and receive

TABLE C

500A-L1/5 (56-KB/S) DSU INTERFACE

INTERFACE CONN. TERM*	500A-L1/5 DSU LEAD		EQUIVALENT NOMENCLATURE		
	FUNCTION	DESIG	FUNCTION	EIA RS-232-C DESIG	CCITT DESIG
A	Frame Ground	FG	Protective Ground	AA	101
B	Signal Ground	SG	Signal Ground	AB	102
C	Request-to-Send	RS	Request-to-Send	CA	105
D	Clear-to-Send	CS	Clear-to-Send	CB	106
E	Data Set Ready	DSR	Data Set Ready	CC	107
F	Received Line Signal Detector	RLSD	Received Line Signal Detector	CF	109
P	Send Data	SD(A)	Transmitted Data	BA(A)	103
S	Send Data	SD(B)	Transmitted Data	BA(B)	103
R	Receive Data	RD(A)	Received Data	BB(A)	104
T	Receive Data	RD(B)	Received Data	BB(B)	104
V	Serial Clock Receive	SCR(A)	Receiver Signal Element Timing	DD(A)	115
X	Serial Clock Receive	SCR(B)	Receiver Signal Element Timing	DD(B)	115
Y	Serial Clock Transmit	SCT(A)	Transmitter Signal Element Timing	DB(A)	114
AA	Serial Clock Transmit	SCT(B)	Transmitter signal Element Timing	DB(B)	114

* All terminals not listed are not used.

paths are looped toward both the SCO and the customer interface. Loop-back tests may then be performed by the STC or from the CPE location. When the switch is positioned to RT (remote terminal loop-back), interface leads BA and BB are connected and disconnected from the CPE. Remote terminal loop-back may also be activated remotely from the STC by transmitting a control code sequence containing bipolar violations. Remote terminal loop-back is called DSU loop-back when originated by the STC. The switch is placed in the center position for normal operation (data mode). A spring clip, provided with the DSU, is placed over the switch when the DSU is used on multipoint lines to prevent the switch from being placed in the LL position. This is a telco option at all stations except the master station.

3.26 The LED assembly indications are as follows:

PWR—Illuminates when ac power is supplied to the DSU and +5 volts dc is available.

NS—Illuminates when no signal is present at the DSU.

LL—Illuminates when the DSU is switched to the LL mode or when the CHAN loop-back code is detected by the simplex current detector.

RT—Illuminates when the DSU is switched to the RT loop-back mode or when the DSU loop-back code is detected by the control code detection circuitry.

F. Customer Options

3.27 DSU 500A-type is provided with three options which may be requested by the customer. The features available as options are described in the following paragraphs.

3.28 ***Signal Ground to Frame Ground (Option YK—Connected, Option YL—Disconnected):*** Installation of this option internally connects signal ground to frame ground.

3.29 ***Request to Send (Option YS—Continuous, Option YT—Switched):*** The YS option is used with CPE which is not capable of turning ON the CA interface lead. With this option installed, the DSU operates as if the CA interface lead is constantly ON. The YT option is used with CPE which is capable of switching on the CA interface lead.

3.30 ***Switch and LED Assembly (Option XN—Installed on Front Panel, Option XM—Installed on Rear Panel):*** This option is used to provide ease of viewing the switch and LED assembly, depending on required mounting position of the DSU.

G. Telco Option

3.31 The DSU is provided with two options which must be selected by the telco engineer for initial installation of the DSU.

3.32 ***LL Spring Clip (Option XO—Installed, Option XP—Not Installed):*** When DSU is used on multipoint lines, the spring clip is placed over the slide switch to prevent its being placed in the LL position.

3.33 ***Line Build-Out Network (Option WV—Installed, Option WW—Removed):*** For DSU installations where the local cable pairs may be too short for proper operation of the line receiver, a line build-out network must be installed to provide additional attenuation. Refer to Section 880-601-115 for information as to when this option should be installed.

4. OPERATION

4.01 This part contains information concerning the manual operation of 500A-type DSU. The DSU has only two modes of operation: the data mode and the loop-back mode.

4.02 Proceed as follows for conducting a manual loop-back test:

(a) For local line loop-back, position the slide switch to LL and observe illumination of respective LED. (Refer to 3.25.)

(b) For remote loop-back, position the slide switch to RT and observe illumination of respective LED.

(c) At completion of loop-back tests, restore the slide switch to the center position.

5. REFERENCES

5.01 Detailed information concerning the 500A-type DSU is contained in CD- and SD-1D235-01.

5.02 The following Bell System Practices (BSPs) are listed for reference.

SECTION	TITLE
314-410-310	Digital Data System—Private Line Local Channel Trouble Analysis
314-410-510	Digital Data System—Private Line Local Channel Test and Requirements
314-901-300	Digital Data System—Serving Test Center—Private Line Circuit—Maintenance Procedures
590-102-139	48A1 Data Mounting—Identification
595-200-180	Digital Data System—500A-Type Data Service Unit (DSU)—Summarizing Specification

SECTION	TITLE
595-200-200	Digital Data System—500A-Type Data Service Unit—Installation and Connections
595-200-300	Digital Data System—500A-Type Data Service Unit—Maintenance
595-200-500	Digital Data System—500A-Type Data Service Unit—Test Procedures
880-601-115	Digital Data System—Engineering Considerations—Customer Loops—Engineering and Maintenance