

## "DATAPHONE®" DIGITAL SERVICE

### 1.544-MB/S DIGITAL SERVICE WITH 1.344-MB/S OPTION

#### OVERALL DESCRIPTION

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#### 1. GENERAL

**1.01** This section provides an overall description of the 1.544-Mb/s digital service including a 1.344-Mb/s digital service option. A general knowledge of the T1 digital line (Section 365-200-100) and the 1A-Radio Digital System (1A-RDS [Section 356-454-100]) is necessary for an understanding of this section.

**1.02** If this section is reissued, the reason for reissue will be given in this paragraph.

**1.03** The 1.544-Mb/s digital service provides for 2-point, full-duplex transmission of serial, bipolar, synchronous pulses at a data transfer rate of 1.544-Mb/s. A voice coordination channel is not included in the service offering. The digital service can be used for bulk-encoded voice signals, high-speed facsimile, and other digital applications.

#### 2. INTRODUCTION

**2.01** The 1.544-Mb/s digital service facility provides for the transmission of data at a rate of 1.544-Mb/s between digital serving areas (DSAs). The service channel for the 1.544-Mb/s digital service

is basically a 1.544-Mb/s digital line terminated at each end in a 551A channel service unit (CSU) on the customer premises. The CSU monitors and regenerates data from the local customer to ensure that it meets the digital line requirement. The 1.544-Mb/s digital service has constraints on signal format.

**2.02** The 1.344-Mb/s digital service option provides for the transmission of 1.344-Mb/s customer data. The 1.344-Mb/s digital service is basically the 1.544-Mb/s digital service facility terminated in a data service unit (DSU) on the customer premises. The DSU accepts the customer 1.344-Mb/s data and converts it into a 1.544-Mb/s bipolar pulse stream for transmission over the 1.544-Mb/s digital service facility. The 1.344-Mb/s digital service option has **no** constraints on signal format.

#### T1 Line Signal Format

**2.03** A standard T1 signal containing baseband, bipolar, 50 percent duty cycle, return-to-zero pulses is used for transmission over the digital line. The signal format is a sequence of digital 1s and 0s. The 0s of the sequence are at the zero-voltage level, and the 1s are alternately positive and negative with respect to the zero level. The fundamental advantage gained by this type of transmission is that the average dc energy in the bipolar pulse train is zero; thus, permitting the repeaters to be transformer-coupled to the T1 digital line. The repeaters only respond to the presence of a pulse in a particular time slot and, if a pulse is present, to generate a new pulse. Therefore, a completely new pulse train that is essentially free of noise and distortion is generated.

#### 3. SERVICE STRUCTURE

**3.01** The 1.544-Mb/s digital service uses T1 repeated facilities (called the service

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channel) for local distribution and for short-haul services. A station arrangement terminates the service channel on the customer premises and connects to the customer equipment. The following discussion, therefore, is divided into two parts: the service channel and the station arrangement.

## A. Service Channel

### Short-Haul

**3.02** Figure 1 shows a simplified block diagram of a service channel using short-haul carrier. In its simplest form, the circuit connects two stations by means of one central office. The short-haul facility can consist of a series of T1 spans, each span consisting of a repeatered line terminated at each end in repeaters. There are three general types of spans used in providing a service channel (Fig. 2): (a) loop span, (b) nonstandard interoffice span and (c) standard interoffice span.

- (a) A loop span connects the customer to the central office over T1 repeatered loop facilities. The span terminates in the station arrangement at the customer premises and in a line terminating unit (LTU), a span terminating assembly (STA), or an office repeater bay (ORB) at the central office.
- (b) A nonstandard interoffice span connects two central offices, at least one of which is not normally served by T1 carrier, and is terminated at both ends in LTUs or STAs.
- (c) A standard interoffice span connects by means of ORBs or STAs, two central offices

both of which are on an established T1 carrier route.

### Spare Local Facilities

**3.03** The LTU is a miniature version of the ORB. It normally contains circuitry to serve two T1 lines, a regular and a spare. When it is used in a nonstandard interoffice span, however, the protection spare feature is not normally used. A spare loop span is not provided for protection unless ordered by the customer. A standard interoffice span always contains maintenance spares.

### Long-Haul

**3.04** In long-haul transmission, the service channel consists of T1 spans connected to a long-haul facility (Fig. 3). Initially, the 1A-Radio Digital System (1A-RDS), using data under voice, will be used. However, other appropriate digital long-haul transmission facilities may be used.

## B. Station Arrangements

### CSU for 1.544-Mb/s Digital Service

**3.05** The 551A CSU (Fig. 4) is located on the customer premises and provides the customer with a transmit and a receive pair using the standard T1 bipolar signal format. The customer's data signal must satisfy the pulse-density and zero-sequence restrictions of the T1 line which are listed in Table A. Circuitry is provided to monitor the customer's data input and, if necessary, to add pulses to meet the requirements of the digital line. Added pulses will result in errors in the customer's data.

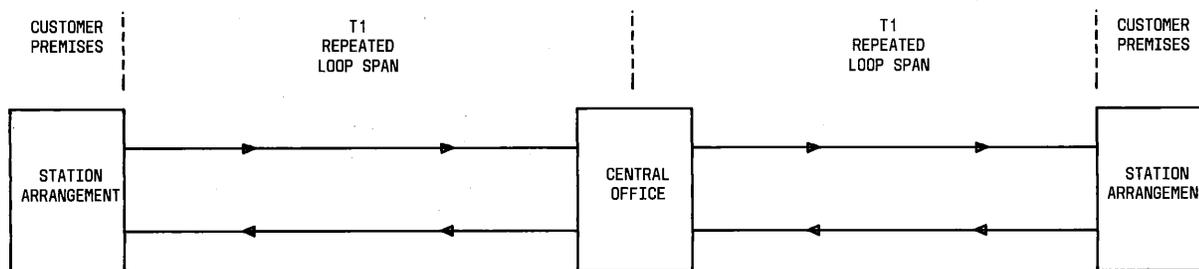
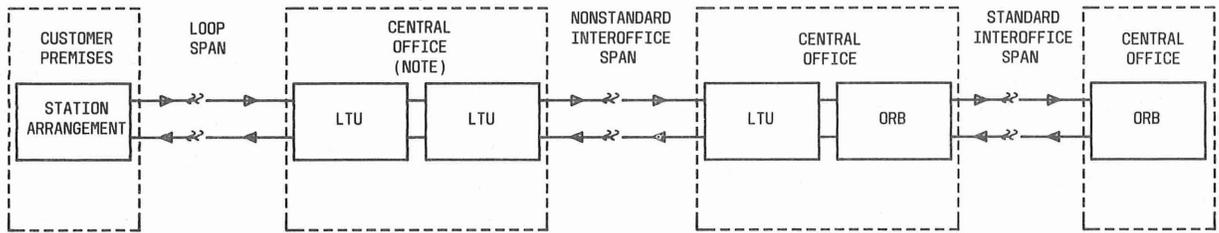


Fig. 1—Example of a Short-Haul Service Channel



NOTE: A CENTRAL OFFICE NOT NORMALLY SERVED BY T1 CARRIER

Fig. 2—Types of Spans Used in a Service Channel

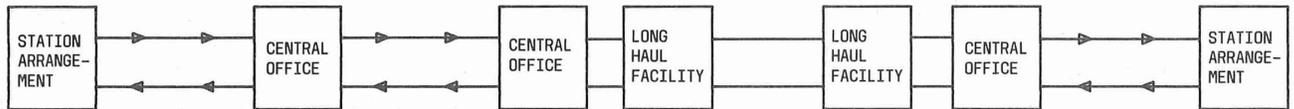


Fig. 3—Example of a Service Channel Using a Long-Haul Facility

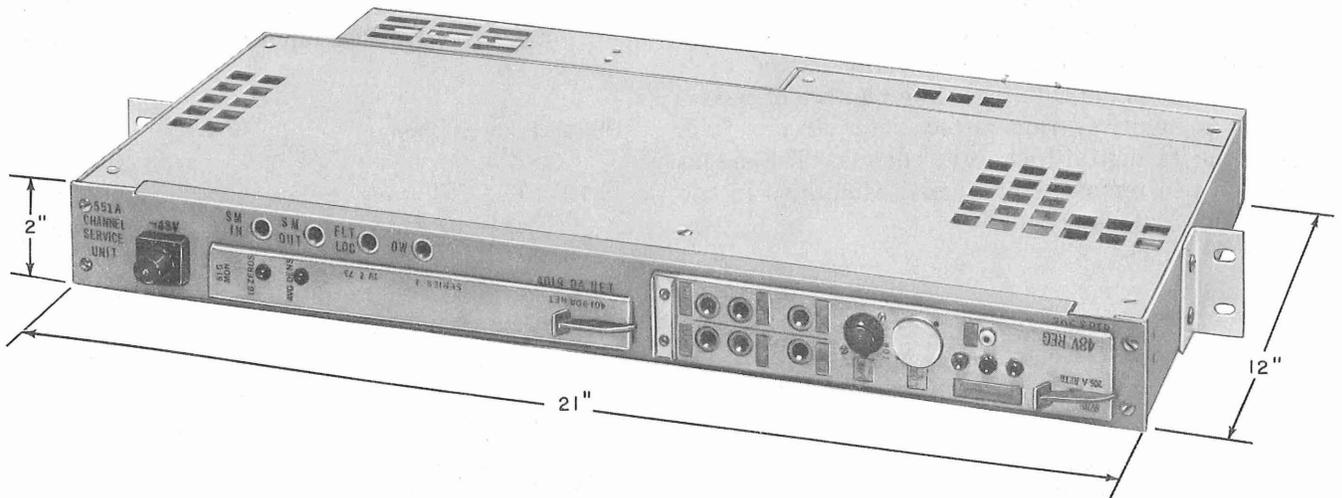


Fig. 4—551A Channel Service Unit

**Functions**

3.06 The CSU performs the following functions:

- (a) serves as a bipolar interface between the customer's equipment and the digital line
- (b) monitors the data transmitted by the customer and, when necessary, adds pulses and eliminates bipolar violations
- (c) regenerates the received data and terminates the digital line

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- (d) contains a fault-locating jack for testing repeaters on the digital line
- (e) contains an order-wire jack for communication with the serving central office
- (f) contains jacks for manually looping the CSU and aiding in maintenance testing
- (g) includes remote loop-around through the signal monitor.

**Note:** With encrypted signal transmission from some customers, the 16-zero lamp will light frequently without the average pulse density falling below a satisfactory level and causing bit stream alteration. The 16-zero lamp lighting with the transmission of encrypted signals should not be used as a basis for notifying the customer of unacceptable or otherwise unsatisfactory transmission.

**Functional Description**

**3.07** The 551A CSU (Fig. 5) consists of a 4019DA series 2 signal monitor, a 206-type repeater, a 598-type fault locating filter (optional) and a remote test relay. It also contains jacks for testing the signal monitor or repeater. In addition to the transmit and receive pairs, three other pairs (shown in Fig. 5) may be provided from the T1 cable to the CSU.

**3.08** The signal monitor provides the interface to the customer's equipment and monitors the pulse density of the customer's transmitted data stream. Lights indicate when the number of pulses in the customer's transmitted data stream falls below the T1 digital line requirements. The signal monitor also removes any bipolar violations in the customer's data stream.

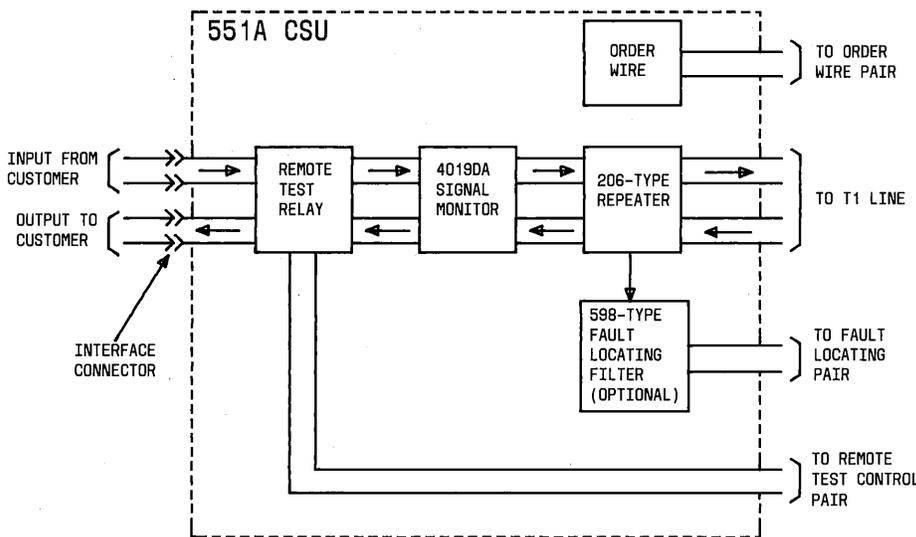
**3.09** The 206-type repeater serves as the interface to the T1 line and regenerates the customers received data. The 598-type fault locating filter may be provided if the repeater is to be tested remotely from the serving central office.

**3.10** The remote test relay is used to loop the transmit and receive leads at the interface connector so that loop-around testing can be performed from a remote location. This loop-around includes the signal monitor which will remove any bipolar violations in the signal from the serving central office to the CSU.

**3.11** The CSU is normally line-powered from the central office in order to prevent the lack of signals on the T1 line should the customer's power fail.

**Physical Description**

**3.12** The CSU weighs approximately 7-1/2 pounds and measures externally approximately 2



**Fig. 5 — 1.544-Mb/s Station Arrangement—55A1 CSU—Block Diagram**

inches high, 21 inches wide and 12 inches deep. It is designed to mount in a 23-inch relay rack or a cabinet. The customer connections are provided by a 15-pin connector at the rear of the unit.

### Interface Specifications

**3.13** Table A lists the electrical characteristics at the interface connector (Fig. 5) for 1.544-Mb/s digital service. Whenever these specifications are violated, the system performance may be degraded.

### DSU for 1.344-Mb/s Option

**3.14** The DSU for 1.344-Mb/s digital service provides for the transmission of 1.344-Mb/s customer data over a 1.544-Mb/s digital service facility. As shown in Fig. 6, the DSU and CSU, located on the customer premises, provide for full-duplex high-speed synchronous data transmission. The DSU, which is actually a 306A-L1/2 data set (DS), accepts serial digital data signals from the customer at a 1.344-Mb/s data rate and processes these signals into the T1 line signal format for transmission at the T1 line rate of 1.544-Mb/s.

TABLE A

551A CSU INTERFACE SPECIFICATIONS

FEATURE		SPECIFICATION
CABLE TYPE		SHIELDED TWISTED PAIR
IMPEDANCE		100 OHMS NOMINAL (BALANCED TO GROUND WITH NO DC COMPONENT)
LENGTH		500 FEET MAXIMUM
SIGNAL FORMAT (INPUT AND OUTPUT)		BIPOLAR RETURN-TO-ZERO
PULSE AMPLITUDE	INPUT	$3 \pm 1.5$ VOLTS PEAK
	OUTPUT	$2.75 \pm 0.25$ VOLTS PEAK INTO 100-OHM TERMINATION
INPUT AND OUTPUT PULSE WIDTH (HALF-AMPLITUDE)		$325 \pm 50$ ns
DATA RATE	ABSOLUTE ACCURACY	1.544 Mb/s $\pm 75$ b/s
	LONG-TERM STABILITY	$\pm 25$ b/s
INPUT or OUTPUT		
INPUT PULSE CONSTRAINTS	PULSE DENSITY	3 PULSES IN ANY 24 TIME SLOTS
	ZERO SEQUENCES	MAXIMUM OF 15 CONSECUTIVE 0s
	DOTTING PATTERN	MAXIMUM OF 250 BIT INTERVALS OF DOTTING

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The CSU monitors the output of the DSU to ensure that it meets the T1 line requirements. The 1.544-Mb/s T1 line signal received by the DSU from the CSU is processed and delivered to the customer as a serial digital signal at a 1.344-Mb/s rate.

**Functional Description**

**3.15** As shown in Fig. 6, the DSU accepts the customer's 1.344-Mb/s data and converts it to a 1.544-Mb/s bipolar pulse stream. The 200-kilobit per second difference between the customer and line bit rates is due to the data being organized in frames such that every 193rd bit is a framing bit. Within the frame, every 8th bit is a stuffing or added bit. The stuffing bits are necessary to supply timing information to T1 repeaters.

**3.16** On the receiving end, the framing and stuffing bits are removed by the DSU, and

the 1.344-Mb/s data is regenerated and transmitted to the customer.

**3.17** Although the CSU is line-powered from the serving central office, the DSU is locally powered by the customer.

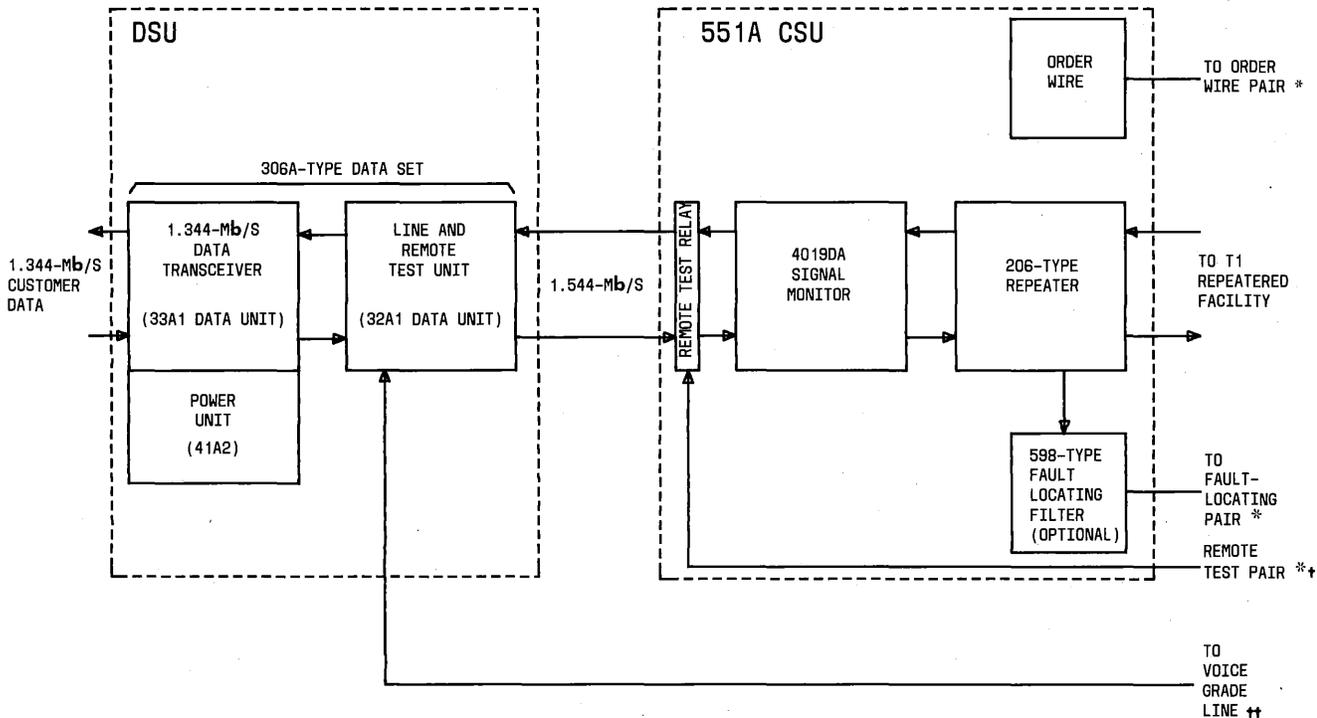
**Interface Specification**

**3.18** The interface specifications for the DSU are contained in Section 593-801-100.

**Physical Description**

**3.19** The DSU weighs approximately 30 pounds and has external dimensions of 23-1/4 inches wide, 6 inches high and 10 inches deep.

**3.20** The DSU is normally mounted with the CSU in a cabinet or a 23-inch frame. A 3-conductor cord is used to feed 117-volt power to the DSU.



\* AS REQUIRED FOR MAINTENANCE OF T1 LINE.  
 † FOR TESTING T1 LINE BY LOOPING BACK SIGNAL AT DROP SIDE OF 551A CSU.  
 †† USED BY THE WIDEBAND DATA TEST AREA FOR TRANSMISSION OF A 2800-HZ REMOTE TEST TONE TO ACTIVATE RT1 AND RT2 LOOPBACKS WHEN SECTIONALIZING WIDEBAND DATA CIRCUIT TROUBLES.

**Fig. 6—1.344-Mb/s Station Arrangement—DSU and CSU—Block Diagram**

**4. REFERENCES**

**4.01** The following sections provide more detailed information.

<b>SECTION</b>	<b>TITLE</b>	<b>SECTION</b>	<b>TITLE</b>
		365-200-103	Digital Transmission Systems—T1 Carrier—J98713F Line Terminating Unit—Description
314-645-300	DATAPHONE® Digital Service—1.544-Mb/s Digital Service With 1.344-Mb/s Option—Maintenance and Trouble Isolation	365-320-100	Digital Transmission Systems—T1 Digital Line—Order-Wire Description
314-645-500	DATAPHONE® Digital Service—1.544-Mb/s Digital Service With 1.344-Mb/s Option—Test	593-015-100	Data Set 306—Identification
356-454-100	Digital Transmission Terminals for Analog Facilities—1A-Radio Digital System—Overall Description	593-801-100	Wideband Data Station Using Data Set 306—Point-to-Point, Limited Distance—Description and Operation
365-200-100	Digital Transmission Systems—T1 Digital Line—General Description	595-105-100	551A-Type Channel Service Unit—Description