

**T1D DIGITAL LINE  
REPEATER DESCRIPTION  
DIGITAL TRANSMISSION SYSTEMS**

	CONTENTS	PAGE
1.	<b>GENERAL</b> . . . . .	1
2.	<b>LINE REPEATERS</b> . . . . .	1
3.	<b>OFFICE REPEATERS</b> . . . . .	2
4.	<b>REFERENCES</b> . . . . .	3

**1. GENERAL**

**1.01** This section describes the repeaters used in the T1D digital line. The T1D line repeaters regenerate the 3.152 megabit per second (Mb/s), 100-percent duty cycle, duobinary coded signals which are received from the preceding line section. The regenerated 3.152 Mb/s signal is then transmitted to the next location via the following line section. In the receive direction, the office repeaters regenerate the incoming duobinary signals and provide conversion to DS1C bipolar format. In the transmit direction, the office repeaters provide conversion from DS1C bipolar format to T1D duobinary format.

**1.02** This section is reissued to include the T1D repeater information used for retrofitting a T1 line. Tables A and B include the repeater information for initial and retrofitted lines. Revision arrows have been used to denote significant changes.

**2. LINE REPEATERS**

**2.01** ♦There are basically two applications of the T1D repeaters. One application, using 258- and 259-type repeaters, is for new installation or for growth to expand a T1C cable. The other, using 281- and 285-type or 288- and 289-type repeaters, is for retrofit T1D applications.♦

**2.02** All T1D line repeaters (Table A) consist of two complete regenerators in one housing. The two regenerators are referred to as side 1 and side 2 of the repeaters for convenience of identification. Both sides of the repeaters are powered from the same power supply. Through and looping line powering arrangements are selectable by field option switch at the repeater. ♦The line repeaters for a retrofitted line (Table A) must match the type apparatus case, cable, and line operations used. A block diagram of a regenerator is shown in Fig. 1 to illustrate the applicable features.

**2.03** Distorted and attenuated pulses from the previous line section are received at the input of the line regenerator. These pulses are coupled into an ♦active equalizer♦ through a high-pass network and an automatic line buildout (ALBO) network.

**2.04** ♦The active equalizer is designed to equalize pulses transmitted over pulp, PIC, or DEPIC cables having a maximum loss of 54 dB for pulp or 50.2 dB for PIC at 1.576 MHz. The ALBO network has negligible effect at maximum cable length. When the cable loss is less than 50.2 dB or 54 dB, the control circuit detects the increased signal and feeds a control signal to the ALBO network. The ALBO network inserts the proper amount of shaped loss at the input of the active equalizer to build out the cable loss to 50.2 or 54 dB for proper pulse equalization at high frequencies.

**2.05** The output of the active equalizer is fed to the summing network. Part of the signal from the line driver is fed back through a low frequency feedback network to the summing network. The summing network adds the output of the feedback network to the output of the active equalizer. The result is a well equalized pulse without low frequency distortion. This signal is

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then fed to the clock extraction circuit and the logic circuit. The clock extraction circuit uses the 3.152-MHz frequency component from the applied signal to control the time at which the output signals of the summing network are sampled. The extracted signal also controls the width of the regenerated pulses. The function of the logic circuit is to perform sampling and threshold operations and to regenerate the appropriate pulse. This regenerated pulse is then applied to the line driver which is used to drive the next section of cable. Also, the fault-locate output is extracted at the line driver circuit.♦

**2.06** The line current is simplexed over the cable pairs and applied to the line repeater power supply via the center taps of the input and output transformers. The dc power is extracted at each repeater by means of a series diode regulator which provides a nominal 11.2 volts. ♦This voltage powers both regenerators of the repeater.

**2.07** T1D repeaters are made in six sizes to fit various apparatus cases. The 281 and 285 codes are identical in size to the 201 and 205 codes (T1), respectively. The 258 and 259 codes are identical in size to the 218 and 219 repeaters (T1C), respectively. The 288 and 289 repeaters are identical in cross section to the 208 and 209 codes, respectively, but their length is greater in order to accommodate additional circuitry. These repeaters must be used in 475-type cases which have been modified by equipping them with extended length covers per the D-181050 Kit of Parts.

**2.08** When T1D is added to cable binder groups where no apparatus cases already exist, the 258 (unprotected) or 259 (protected) repeater should be used in a T1C/T1D case from the 818/819 family. These repeaters do not have separate codes for unidirectional and bidirectional operation. Bidirectional operation is achieved through proper assignment of the stub cable binder groups at their splice to the main cable. A 3-position switch is provided on the repeater to select the required power option for the unidirectional and bidirectional transmission arrangements. Refer to Table A for switch positions.

**2.09** Retrofitted lines require that the T1D repeaters used for retrofit must be compatible with the original line equipment as shown in Table A. The line repeaters are designated as unidirectional or bidirectional, protected or unprotected, and used on PIC, DEPIC, or pulp cables. The through or

loop powering options should be selected and made on each repeater as shown on the Span Line Record Card.♦

### 3. OFFICE REPEATERS

**3.01** The T1D office repeaters (Table B) provide line current regulation, line powering, and power looping options. Additional circuitry is required for signal conditioning (scrambling, descrambling), bipolar to duobinary format conversion, code violation detection and transferral, and maintenance. The bridging function required for patching and line restoration is done on the office side of the T1D repeater, and thus involves DS1C bipolar format signals. This will be provided by the 250C ♦or 286E♦ bridging repeater.

**3.02** Referring to the functional block diagram for the T1D office repeater in Fig. 2, the low-level incoming duobinary signal from the span line is regenerated by circuitry similar in function and implementation to the line regenerator. The ALBO in the regenerator can equalize end section cable losses, for pulp, DEPIC or PIC cables, which range between 4.3 and 37 dB at 1.576 MHz. After regeneration, the signal is converted from duobinary to unipolar, descrambled, and then converted to a bipolar format suitable for appearance at the DSX-1C. In the process of converting from duobinary to unipolar and descrambling, line errors are eliminated. In order that the line errors can be detected at the DSX-1C or terminal equipment, all duobinary code violations are detected and transferred to the unipolar-to-bipolar converter where they are inserted as bipolar violations. Equalizers located in the ORB provide for cable compensation between the office repeater and the DSX-1C cross connect bay. The equalizers used for T1D are the same as those used for low power T1C.

**3.03** On the transmit side of the office repeater, the DS1C signal from the DSX-1C is regenerated in a modified high-level T1C regenerator. After regeneration, the bipolar signal is converted to unipolar, scrambled, and then converted to a duobinary format suitable for transmission on the span line. Similarly, in order that errors in the DS1C signal can be detected at the far-end terminal equipment or DSX-1C cross connect bay, all bipolar code violations are detected and transferred to the unipolar-to-duobinary converter where they are inserted as duobinary violations.

**3.04** In order to permit very short end sections, a 12-dB artificial line (at 1.576 MHz) is provided at the transmit interface with the span line. For added flexibility when engineering end sections that are cable near-end crosstalk limited, a 0-dB artificial line will also be made available. Access to the span line for fault locating is provided at the DSX-1C cross connect bay. In order to preserve the format of the fault locating signal, the scrambler in the office repeater is automatically bypassed upon insertion of the fault locating signal on the transmit side at the DSX-1C bay. Also included in the office repeater is a line current regulator for powering the line repeaters and provision for power simplexing or looping.

**3.05** Since the T1D line signal appears as a DS1C signal on the office side of a T1D office repeater, the 250C low power bridging repeater (or 286E repeater for J98710 ORB) can be used with either T1D or T1C digital lines to allow (1) patching of a signal from a failed or intermittent system to a backbone or maintenance line, (2) the application of a quasi-random signal to a backbone or maintenance line, or (3) cross-connection of maintenance lines at an intermediate office.

**3.06** The 250C and 286E bridging repeaters are powered by the -48V office battery only and establish an 11.0-volt drop required for the output of 6-volt pulses. The overall nominal current drain of the repeater at 11.0 volts is 70 mA.

**3.07** Four pin jacks are provided on the faceplate of the current regulator repeaters 260A and C (-V, -I, +V, and REG) and 286A and C (-V, -I, +, and REG). Two pin jacks are provided on the faceplate of the current looping repeaters 260B and D (-V and -I) and 286B and D (-I and +). The pin jacks are used to verify that proper power loop voltage and current is present and to verify that the regulator is operating within its regulating range. The -V (260-type) or + (286-type) pin jack is used as a common reference point for measurements as follows:

- -V with -I or -I with + is used to measure the voltage across a 10-ohm resistor to verify line current. The voltage should be 1.2 volts.
- -V with +V or -V with + is used to measure line voltage directly. The line

voltage is the sum of the voltage drops across each line repeater and the cable resistance.

- -V with REG or + with REG is used to measure the voltage across the regulator in order to determine the operating point of the regulator.

**3.08** The 260-type office repeater, which is about 10-1/2 inches long, 6 inches high, and 1-1/2 inches wide, plugs into a slot provided in the J98725( ) office repeater bay shelf. A quick-release spring catch on the lower front of these repeaters is used to hold the repeater in place but permits easy removal. In addition to the pin jacks described previously, there are two fuses mounted on the faceplate of the regulating type repeater. The 250C bridging repeater is not equipped with pin jack test points or fuses.

**3.09** The 286-type retrofit office and bridging repeaters which are 10 inches long, 8 5/8 inches high, and 1 9/16 inches wide, plug into a slot provided in the J98710 ( ) bay. These repeaters have the same features and functions as the new installation T1D repeaters. The 286A and B repeaters also have jack access to the line on the faceplate. Refer to Table B for the proper replacement repeater codes.

#### 4. REFERENCES

**4.01** For additional information relating to the T1D repeaters, refer to the following documents:

SECTION	TITLE
365-280-100	T1D Digital Line, General Description, Digital Transmission Systems
855-351-115	T1D Digital Line, Carrier Engineering, System Application, Transmission and Outside Plant Design Procedures
DRAWING	TITLE
CD/SD-3C378-01	Office Repeaters--Type 250

TABLE A

## T1D LINE REPEATERS

CODE	CABLE	LINE POWERING	LINE CURRENT	APPARATUS CASE	PROTECTED	OPERATION
258A	Pulp	Thru/ Loop - Uni Loop - Bi	120 mA	479A, 818A1C, 818A2C, C1C	No	Uni-Bi
258B	PIC DEPIC	Thru/ Loop - Uni Loop - Bi	120 mA	479A, 818A1C, 818A2C, C1C	No	Uni-Bi
259A	Pulp	Thru/ Loop - Uni Loop - Bi	120 mA	479B, 819A1C, A2C 819B1C, B2C, C1C	Yes	Uni-Bi
259B	PIC DEPIC	Thru/ Loop - Uni Loop - Bi	120 mA	479B, 819A1C, A2C 819B1C, B2C, C1C	Yes	Uni-Bi
281A	Pulp	Thru/Loop	120 mA	466	No	Uni
281B	Pulp	Thru/Loop	120 mA	466	No	Bi
281C	PIC DEPIC	Thru/Loop	120 mA	466	No	Uni
281D	PIC DEPIC	Thru/Loop	120 mA	466	No	Bi
285A	Pulp	Thru/Loop	120 mA	468	Yes	Uni
285B	Pulp	Thru/Loop	120 mA	468	Yes	Bi
285C	PIC DEPIC	Thru/Loop	120 mA	468	Yes	Uni
285D	PIC DEPIC	Thru/Loop	120 mA	468	Yes	Bi
288A	Pulp	Thru/Loop	120 mA	475A, 475F	No	Uni

TABLE A (Contd)

## T1D LINE REPEATERS

CODE	CABLE	LINE POWERING	LINE CURRENT	APPARATUS CASE	PROTECTED	OPERATION
288B	Pulp	Thru/Loop	120 mA	475A, F	No	Bi
288C	PIC DEPIC	Thru/Loop	120 mA	475A, F	No	Uni
288D	PIC DEPIC	Thru/Loop	120 mA	475A, F	No	Bi
289A	Pulp	Thru/Loop	120 mA	475B, G	Yes	Uni
289B	Pulp	Thru/Loop	120 mA	475B, G	Yes	Bi
289C	PIC DEPIC	Thru/Loop	120 mA	475B, G	Yes	Uni
289D	PIC DEPIC	Thru/Loop	120 mA	475B, G	Yes	Bi

TABLE B

## T1D OFFICE REPEATERS

CODE	TYPE	MOUNTING	LINE POWERING	LINE CURRENT REGULATOR	LINE CURRENT	CABLE	NOTES
260A	Current Regulating	T1C/T1 ORB J98725 ( )	48/±130V	120 mA	120 mA	PIC/PULP DEPIC	1, 8
260B	Current Looping	T1C/T1 ORB J98725 ( )	Loop	None	120 mA	PIC/PULP DEPIC	8
260C	Current Regulating	T1C/T1 ORB J98725 ( )	48/±130V	120 mA	120 mA	PIC/PULP DEPIC	9, 1
260D	Current Looping	T1C/T1 ORB J98725 ( )	Loop	None	120 mA	PIC/PULP DEPIC	9
250C	Bridging	T1C/T1 ORB J98725 ( )	None	None	None	ABAM 600-Type	
286A	Current Regulating	206 ORB/ J98710 ( )	48/±130V	120 mA	120 mA	PIC/PULP DEPIC	1, 2, 4, 5
286B	Current Looping	206 ORB/ J98710 ( )	Loop	None	120 mA	PIC/PULP DEPIC	2, 4, 5
286C	Current Regulating	206 ORB/ J98710 ( )	48/±130V	120 mA	120 mA	PIC/PULP DEPIC	1, 2, 3, 6, 7
286D	Current Looping	206 ORB/ J98710 ( )	Loop	None	120 mA	PIC/PULP DEPIC	2, 3, 6, 7
286E	Bridging	206 ORB/ J98710 ( )	None	None	None	ABAM 600-Type	

**Note 1:** Has options for powering -48, -130, +130 volts and GRD.

**Note 2:** Has an option switch to select 0 or 12 dB XMT LBO which is similar to 7.5, 4.5, or 0.5 dB 221/231 type repeaters.

**Note 3:** Replaces EXCP repeaters. (Requires ED-3C655-30 equalizers.)

**Note 4:** Has 3-volt output.

**Note 5:** Has jacks on front faceplate.

**Note 6:** Has 6-volt output.

**Note 7:** Does not have jacks on front faceplate.

**Note 8:** Has a 12 dB XMT-LBO similar to 7.5 dB 221/231 codes.

**Note 9:** Has 0 dB XMT-LBO similar to 4.5 or 0.5 dB 221/231 codes.

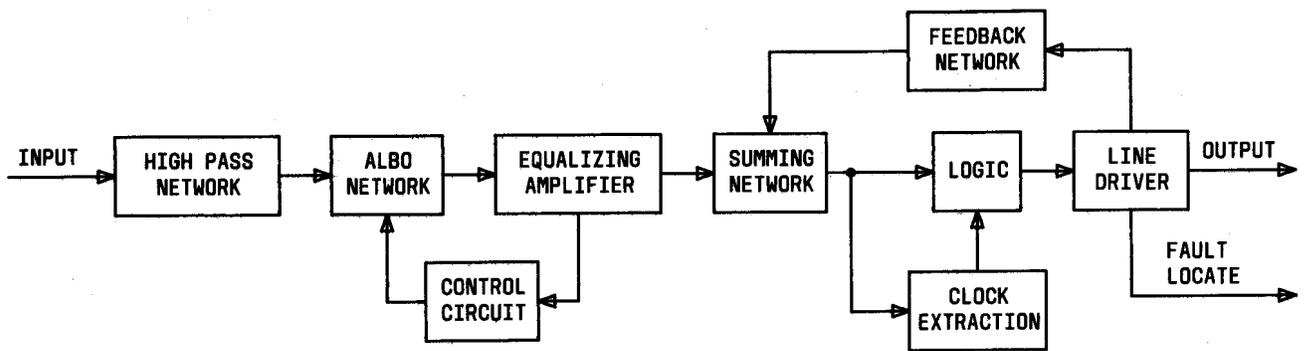


Fig. 1—T1D Line Repeater Block Diagram

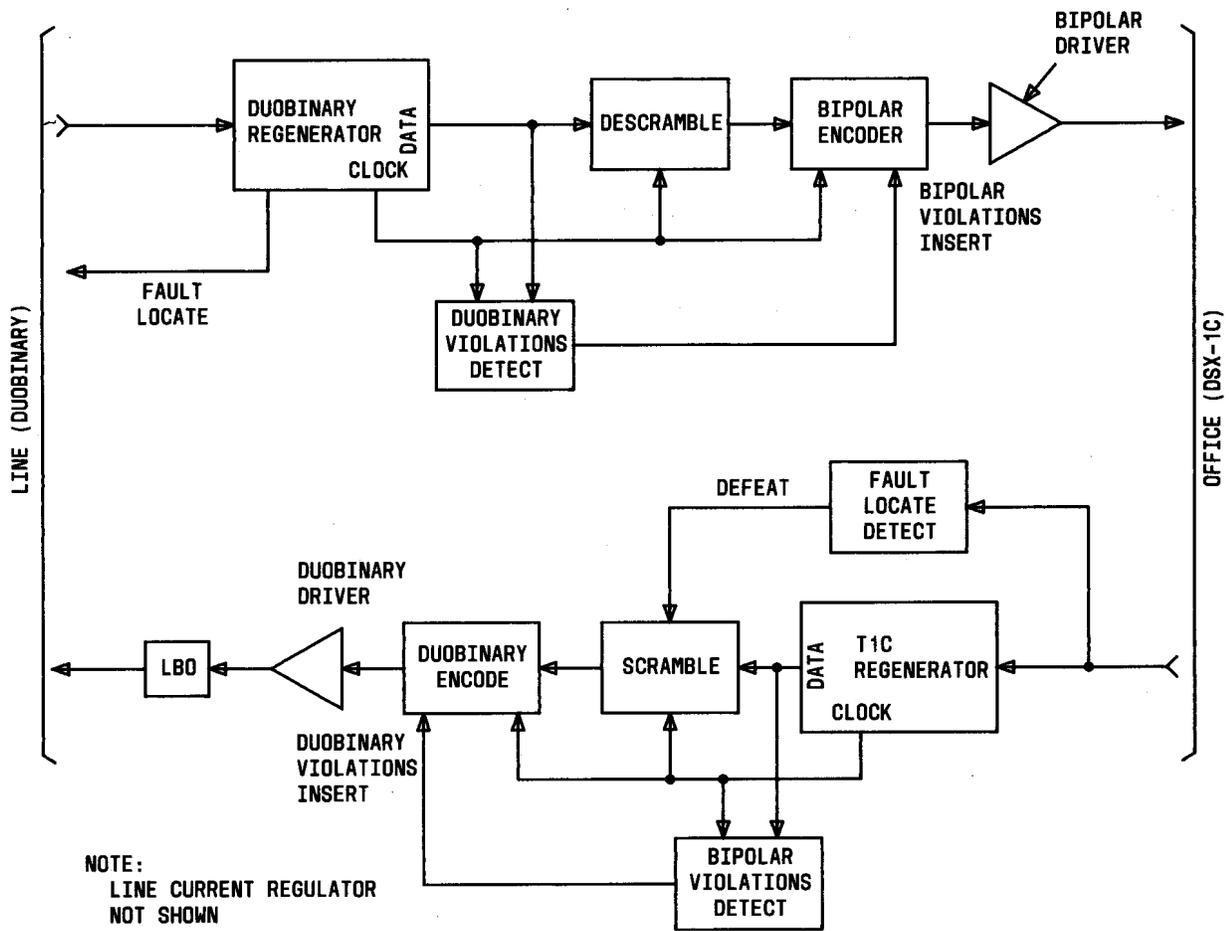


Fig. 2—T1D Office Repeater Block Diagram