DIGITAL TRANSMISSION SYSTEMS

T1C DIGITAL LINE

REPEATER DESCRIPTION

CONTENTS PAGE

1. GENERAL

1.01 This section describes the repeaters employed in the T1C digital line. The T1C repeaters regenerate the 3.152-Mb/s, 50-percent duty cycle, bipolar coded signals transmitted over the preceding line section. The regenerated 3.152-Mb/s signal is then transmitted to the next location via the following line section.

1.02 Whenever this section is reissued, the reason for reissue will be stated in this paragraph.

1.03 Two categories of repeaters are used in the T1C line: line repeaters (Table A) and office repeaters (Table B). As indicated in Table A, there are 12 codes of line repeaters for selection according to cable type, power option desired (through or looped), and type of apparatus case. As indicated in Table B, there are three codes of office repeaters. One type provides current regulation for the line; the second provides power looping for the line; and the third provides bridging functions. A typical office repeater and line repeater are shown in Fig. 1.

1.04 No field adjustments are required for the T1C repeaters except for selection of the powering options in the office repeaters prior to installation. All T1C repeaters incorporate automatic line build-out (ALBO) to compensate for changes in line loss. The T1C repeaters are designed to operate over a temperature range of 0°F to +140°F (office repeaters) and -30°F to +165°F (line repeaters).

2. LINE REPEATERS

2.01 Six codes of 218-type repeaters and six codes of 219-type repeaters are provided to cover the various types of installations, Table A. The A and C codes are used for pulp cable with losses between 5.7 and 38.7 dB, whereas the B and D codes are used for pulp cable with losses between 20 and 54 dB, as measured at 1.576 MHz. For pulp cable with losses between 20 and 38.7 dB, either code may be used. The E and F codes are used for PIC and DEPIC cable with losses between 5.7 and 54 dB.

2.02 All T1C line repeaters consist of two complete regenerators which provide pulse regeneration for one direction of transmission for two systems (unidirectional operation). The two regenerators are referred to as side 1 and side 2 for convenience of identification. Both sides of these repeaters are powered from the same power supply. Through and looping line powering arrangements are built into these repeaters per repeater code. The 219-type repeaters contain secondary surge protection, which is the only difference between them and the 218-type repeaters. A block diagram of these repeaters is shown in Fig. 2 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 equalizing amplifier through the input transformer and ALBO network. The ALBO

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network is used to automatically compensate for changes in cable loss.

2.04 The equalizing amplifier comprises two shaped feedback amplifiers (AMP 1, AMP 2, and EQL 1 through EQL 3) and is designed to properly equalize pulses transmitted over cables having the maximum loss of 54 dB at 1.576 MHz. The ALBO network has negligible effect at this cable length. When the cable loss is less than 54 dB, the peak detector circuit detects the increased signal and feeds a control signal to the variolosser diodes which in turn control the ALBO network. The ALBO network inserts the proper amount of shaped loss at the input to AMP 1 to build out the cable loss to 54 dB for proper pulse equalization.

2.05 The balanced output of AMP 2 is applied to the clock extraction circuit and also to the logic circuit. The signals applied to the clock extraction circuit are rectified and then applied to a crystal filter circuit. This resonant circuit extracts a 3.152-MHz frequency component from the applied signal. The extracted signal is first amplified and then used to control the time at which the output signals of AMP 2 are sampled. The extracted signal also controls the width of the regenerated pulse. 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 drivers which are used to drive the next section of cable.

2.06 A nominal line current of 120 mA is simplexed over the cable pairs and applied to the line repeater power supply via the center taps on the input and output transformers. The dc power is extracted at each repeater by means of a series diode regulator which provides dc voltage (nominal +5.5 and -4.0) to both sides of the repeater. Arrangements for through and looped powering of the line are provided by different repeater codes, Table A.

2.07 T1C line repeaters are intended for use in remote locations such as in manholes or on utility poles. The 218-type repeaters are intended to be used in the unprotected 479A apparatus case, whereas the 219-type repeaters are used in the protected 479B case.

2.08 The entire 218-type repeater structure is enclosed in an alumin can that is held in place with one screw. T iceplate bears the repeater code, vintage number, and manufacture date. These repeaters are about 6-1/2 inches long, 3 inches high, and 3/4 inch wide. The 219-type repeater is similar in appearance to the 218-type except that it is about 1-1/2 inches longer.

3. OFFICE REPEATERS

3.01 Three codes of 220-type repeaters are provided for use in the office, Table B. A 220A repeater is shown in Fig. 1. The 220A and 220B repeaters consist of circuits carrying two separate directions of transmission (transmit and receive). The basic functions of these repeaters are to regenerate the incoming line signals and to provide passive through-connecting circuitry for outgoing line signals. The 220C bridging repeater is used to minimize transmission interruption during in-service line patching and restoral. This repeater is always used in conjunction with a 220A or 220B repeater; thus, it never interfaces with the line.

3.02 The 220A and 220B repeaters are identical except that the line current regulator circuitry is not provided in the 220B repeater, Fig. 3. The circuitry associated with the transmitting direction is passive and provides a 12-dB artificial line, secondary lightning protection, and a transformer for simplexing power to the line. The circuitry in the receiving direction is active. It provides pulse equalization, ALBO, timing recovery, and pulse regeneration, as well as secondary lightning protection.

3.03 Distorted and attenuated pulses from the line are received at the regenerator via the main distributing frame (MDF) or high-frequency distributing frame (HFDF). These pulses enter the regenerator through a 3-dB pad and secondary lightning protection; then they are coupled to the equalizing amplifier through the input transformer and ALBO network. The ALBO network is used to automatically build the cable section out to the correct loss at 1.576 MHz.

3.04 The equalizing amplifier in the office repeater is basically a short code pulp line repeater with slight modification of the ALBO circuit. It is also designed to operate with PIC and pulp insulated cables.

3.05 The clock and logic circuits are identical to those in the line repeaters.

3.06 The power supply is a zener regulated circuit consisting of two zener diodes and three rectifier diodes which develop the required positive and negative voltages used to operate the active circuits in the repeater. The choice of powering the office repeater either from -48 volt office battery or in series with the span line power loop is made on option block S101, Fig. 4.

3.07 Power for the line repeaters is derived from the line current regulator at one end or at both ends of the span through simplexed power loops, see 4.01. Each power loop requires a current of approximately 120 mA to develop the operating voltage of the line repeaters. The line current regulator circuit is powered from various combinations of office battery voltages (-48 volts and battery return; +130 volts and battery return; +130 volts and -48 volts; and +130 volts and -130 volts). Once the office battery assignments are made it is then necessary to select the proper options in the line current regulator circuit and also on option block S101, Fig. 4.

3.08 Four voltage test points are provided on the faceplate of the 220A repeater and two are provided on the 220B repeater in order to measure the current and voltage necessary to establish that a power loop is being powered properly and that the regulator is operating within its regulating range on the 220A. The -V test point is used with the other three test points as follows:

- -V with -I (220A and 220B) is used to measure the voltage across a 10-ohm resistor. This voltage indicates 1.2 volts when the line current is 120 mA.
- -V with +V (220A only) is used to measure the line voltage directly. The line voltage is the sum of the voltage drops across each line repeater and the cable resistance.
- -V with REG (220A only) is used to measure the voltage across the regulator in order to determine the operating point of the regulator.

3.09 The 220C bridging repeater (Fig. 5) is used to minimize transmission interruption during in-service line patching and restoral. This repeater is to be installed in even number repeater bay shelves, position 13. This repeater is always used in conjunction with a 220A or 220B repeater; thus, it never interfaces directly with the line. The major functions provided by the bridging repeater are as follows:

- Cross-connection of a signal from a working system to a maintenance line
- Cross-connection of a maintenance line at a through intermediate office
- Applying a signal to a maintenance line from a working system via the DSX-1C
- Applying a signal from a quasi-random signal source to a maintenance line.

3.10 As shown in Fig. 5, the bridging repeater is composed of three separate dual in-line packages (DIP), an automatic gain control circuit, a crystal filter, and a power supply. The amplifier DIP is a wideband differential amplifier with internal ac and dc feedback and a balanced output stage. In conjunction with several external components, it provides a controlled dc and signal output level with automatic gain equalization. The logic circuit contains threshold, decision, and regenerator circuitry used to determine the presence or absence of a pulse and to reconstruct the input signal. The functions of the clock extraction circuit and associated components are to extract timing information from the input signals from the amplifier and then to generate a 3.152-MHz clock signal. This clock signal is used to properly time the logic circuit.

3.11 Power for the bridging repeater is always provided by the -48 volt office battery through a 422-ohm series current-limiting resistor that is provided in the shop-wired repeater bay. The input battery power is connected to the repeater on the lead designated -RPT. Current flowing through the zener diodes establishes the negative power supply voltage. The positive power supply voltage is provided by current flow through a zener diode and the varistor. Normal power supply voltages are -4.7 and +6.2 volts.

3.12 The entire 220-type 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 T1C 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. Two line fuses and four pin jacks are

also mounted on the faceplate of the 220A, whereas only two pin jacks are mounted on the faceplate of the 220B. The 220C is not equipped with pin jacks or fuses.

4. T1C SIMPLEX LINE POWERING

4.01 Figure 6 shows an example of the simplex powering arrangement that is used to power a T1C digital line using a 220A office repeater. For purposes of discussion, assume that the 220A office repeater employed will be powered separately from the line.

4.02 Shelf 1 is the first shelf of the power loop requiring power option block S101 to have B, E, H, and N options; whereas shelf 3 is the second shelf which requires that power options A, F, H, and N be selected, Fig. 4. Referring to Fig. 6, note that the -48, -130, and +130 volt office battery voltage and battery return (BR) are connected to the 220A office repeater. Once the cable length and number of line repeaters to be powered is established, the proper combination of office battery voltages can be determined; ie, -48, +130, +178, or +260 volts. After the required line voltages have been determined, switch positions for S201, S202, and S203 must be selected on the regulator circuit according to Table C.

4.03 The office repeater is powered separately from the line through a series-dropping resistor by setting the H and N option screws down on power option block S101, Fig. 4. The B and E options set up the proper power loop polarities for the first shelf of the power loop.

4.04 Shelf 3, the second shelf of the power loop, also defined as the power mate for shelf 1, is then conditioned to complete the loop. As in the case for shelf 1, assume that the 220A office repeaters located in shelf 3 are also powered separately from the line through a series-dropping resistor and by selecting options H and N on the power option block. The series dropping resistors are located external to the office repeaters in the office repeater bay. In order to complete the power loop with the correct battery polarities, the A and F options are selected in the shelf 3 repeater. Direction arrows in Fig. 4 depict the power loop path from the central office to the line and back.

4.05 Once the power loop is established, line voltage, regulator voltage, and line current are measured using the test jacks provided on the repeaters to ensure proper power loop operation, see 3.08. It is important, when measuring the line voltage drop, that test jack -V be used in conjunction with test jack +V from the first shelf of the power loop to the second shelf of the same power loop.

5. REFERENCES AND ASSOCIATED DRAWINGS

5.01 Detailed circuit information and schematics are contained in the following:

Drawing	Title
CD- & SD-3C205-01	T1C Digital Line—218 and 219-Type Repeaters
CD- & SD-3C253-01	Office Repeaters, 220 Type for T1C Digital Line
CD- & SD-3C252-01	T1C Office Repeater Bay Application Schematic

TABLE A

T1C LINE REPEATERS

REPEATER CODE	POWER OPTION	CABLE TYPE SEE NOTE 1	MAXIMUM LOSS RANGE (DB) SEE NOTE 2	APPARATUS CASE
218A	Through	Pulp (short code)	5.7 to 38.7	479A Unprotected
218B	Through	Pulp (long code)	20.0 to 54.0	
218C	Looped	Pulp (short code)	5.7 to 38.7	
218D	Looped	Pulp (long code)	20.0 to 54.0	
218E	Through	DEPIC & PIC	5.7 to 54.0	
218F	Looped	DEPIC & PIC	5.7 to 54.0	
219A	Through	Pulp (short code)	5.7 to 38.7	479B Unprotected
219B	Through	Pulp (long code)	20.0 to 54.0	
219C	Looped	Pulp (short code)	5.7 to 38.7	
219D	Looped	Pulp (long code)	20.0 to 54.0	
219E	Through	DEPIC & PIC	5.7 to 54.0	
219F	Looped	DEFIC & PIC	5.7 to 54.0	

Note 1: Refer to Section 855-351-110 for maximum and minimum cable lengths.

Note 2: The loss range indicates the range of cable loss over which the line repeaters will operate. This loss is the cable loss as measured at 1.567 MHz. For pulp cable, two repeater codes with the same power options are required to cover the entire loss range of 5.7 to 54.0 dB. For DEPIC and PIC cable, only one repeater code is required for each power option.

TABLE B

T1C OFFICE REPEATERS FOR PULP AND PIC CABLES

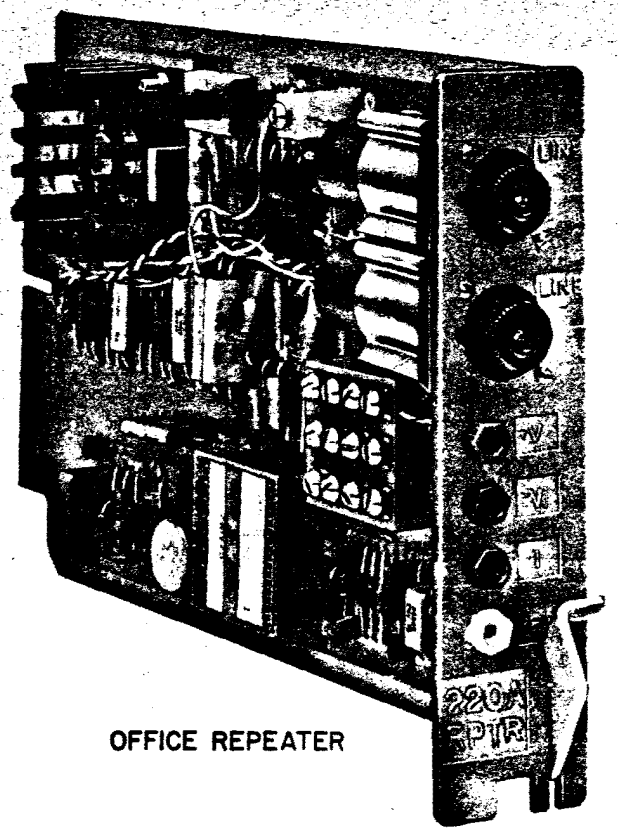
CODE	FUNCTION
220A	Provides 48V, 130V, 178V, and 260V current regulation for line
220B	Provides power looping for line (no line current regulation)
220C	Bridging regenerator for restoration and patching

TABLE C

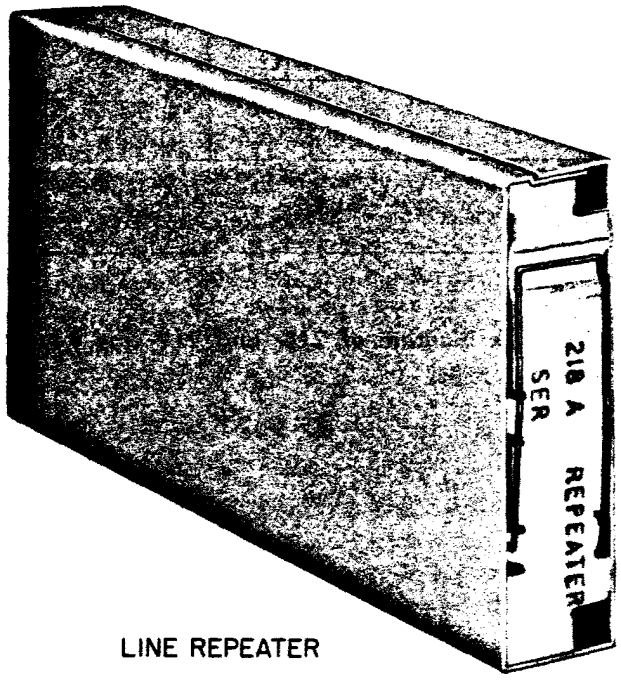
LINE CURRENT REGULATOR POWERING OPTIONS

OFFICE BATTERY	OPTIONS REQUIRED			
	SWITCH		SELECTOR BLOCK S203	S203 SCREW POSITION
	S201	S202		
—48 volts & battery return*	W	Z	V	Down
+130 volts & battery return*	X	Y or Z	Open	Up
+130 & —130 volts (260 volts)	W	Y	Open	Up
+130 & —48 volts (178 volts)	W	Z	Open	Up

* When —48 volt office battery and battery return is used it is necessary to replace the LINE + fuse with a dummy fuse. Conversely, when +130 volt battery and battery return is used, replace LINE — fuse with a dummy fuse.



OFFICE REPEATER



LINE REPEATER

Fig. 1—Typical T1C Repeaters

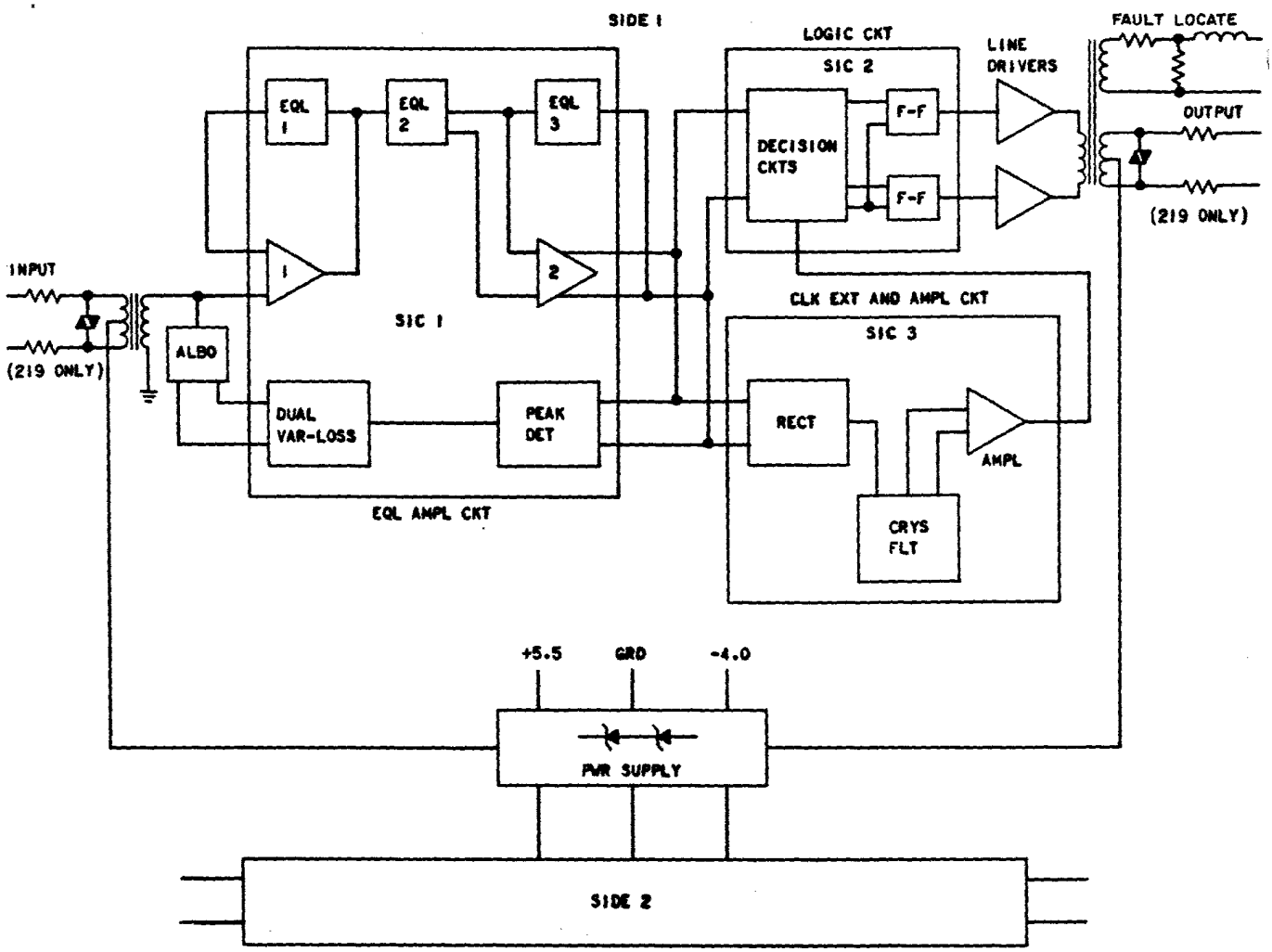
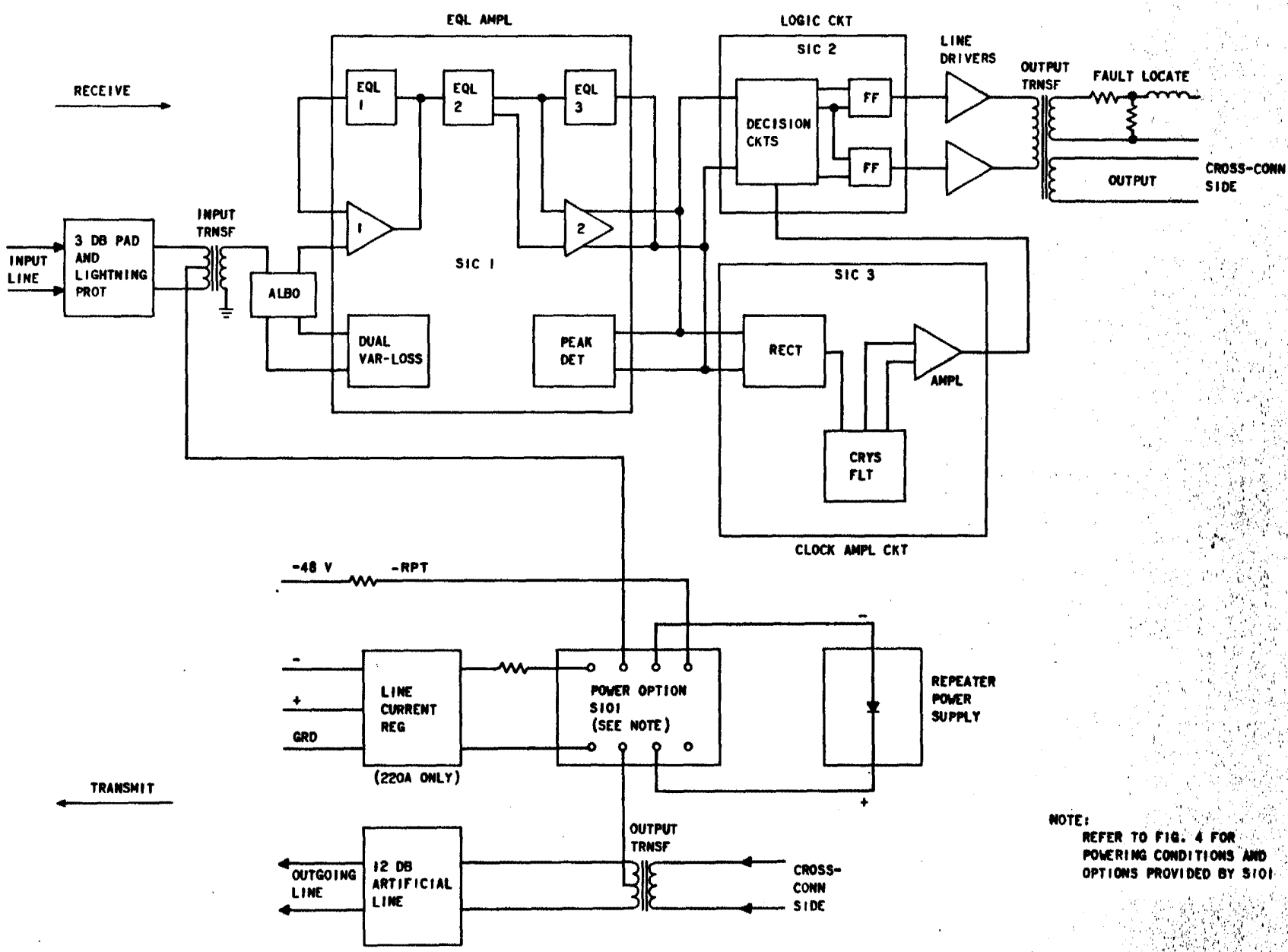
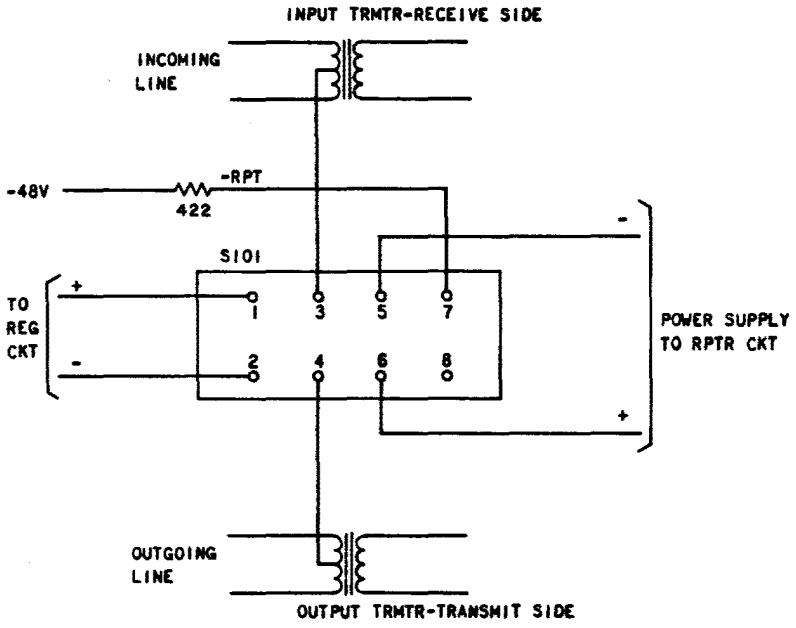


Fig. 2—Block Diagram of 218- and 219-Type Repeaters



NOTE:
REFER TO FIG. 4 FOR POWERING CONDITIONS AND OPTIONS PROVIDED BY SIOI

Fig. 3—Block Diagram of 220A and 220B Repeaters



POWERING CONDITION				
OFFICE REPEATER POWERED IN SERIES WITH LINE REPEATERS	AT POWERING OFFICE	1	TWO CABLE SYSTEM-1ST SHELF OF POWER LOOP-OFFICE REPEATER IN POWER LOOP WITH TRANSMIT LINE REPEATERS	B,D,G
		2	TWO CABLE SYSTEM-2ND SHELF OF POWER LOOP-OFFICE REPEATER IN POWER LOOP WITH RECEIVE LINE REPEATERS	A,G,M
	AT POWER LOOPING OFFICE	1	TWO CABLE SYSTEM-1ST SHELF OF POWER LOOP-OFFICE REPEATER IN POWER LOOP WITH TRANSMIT LINE REPEATERS	B,D,G
		2	TWO CABLE SYSTEM-2ND SHELF OF POWER LOOP-OFFICE REPEATER IN POWER LOOP WITH RECEIVE LINE REPEATERS	A,G,M
OFFICE REPEATER POWERED SEPARATELY FROM LINE REPEATERS	AT POWERING OFFICE	3	TWO CABLE SYSTEM-1ST SHELF OF POWER LOOP	B,E,H,N
		4	TWO CABLE SYSTEM-2ND SHELF OF POWER LOOP	A,F,H,N
	AT POWER LOOPING OFFICE	3	TWO CABLE SYSTEM-1ST SHELF OF POWER LOOP	B,E,H,N
		4	TWO CABLE SYSTEM-2ND SHELF OF POWER LOOP	A,F,H,N

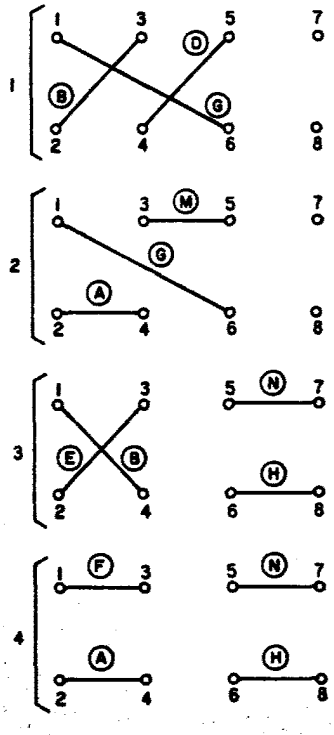


Fig. 4—Powering Conditions and Options Provided by S101

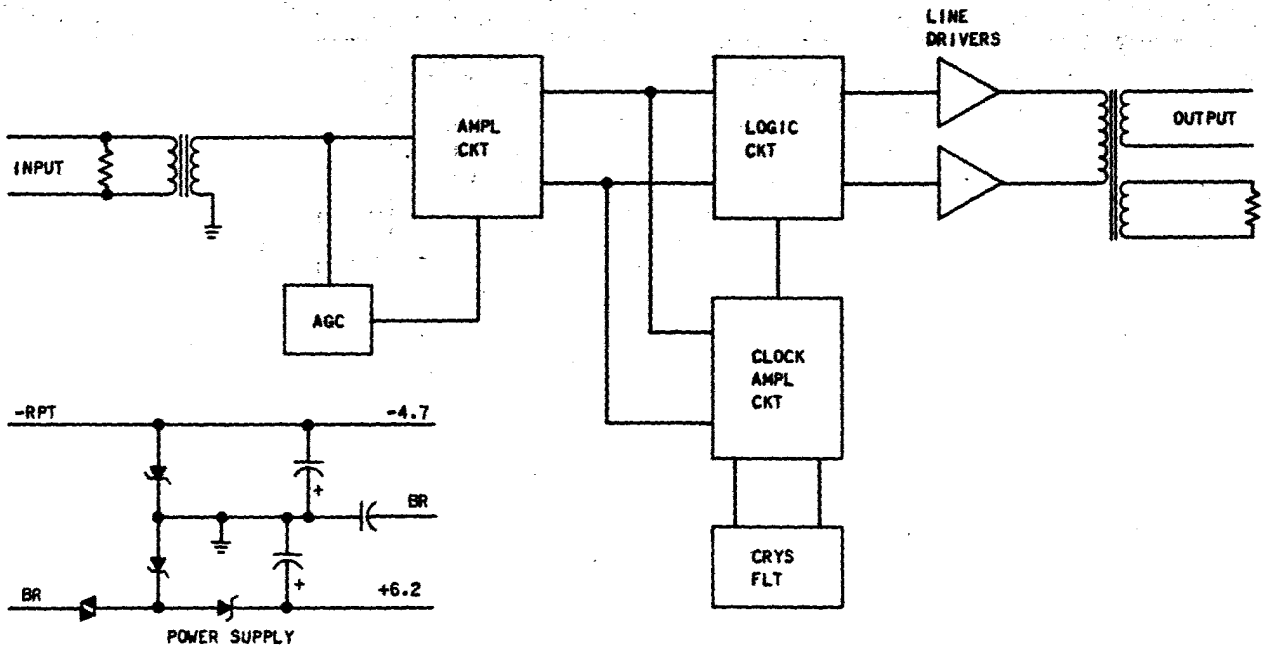


Fig. 5—Block Diagram of 220C Briding Repeater

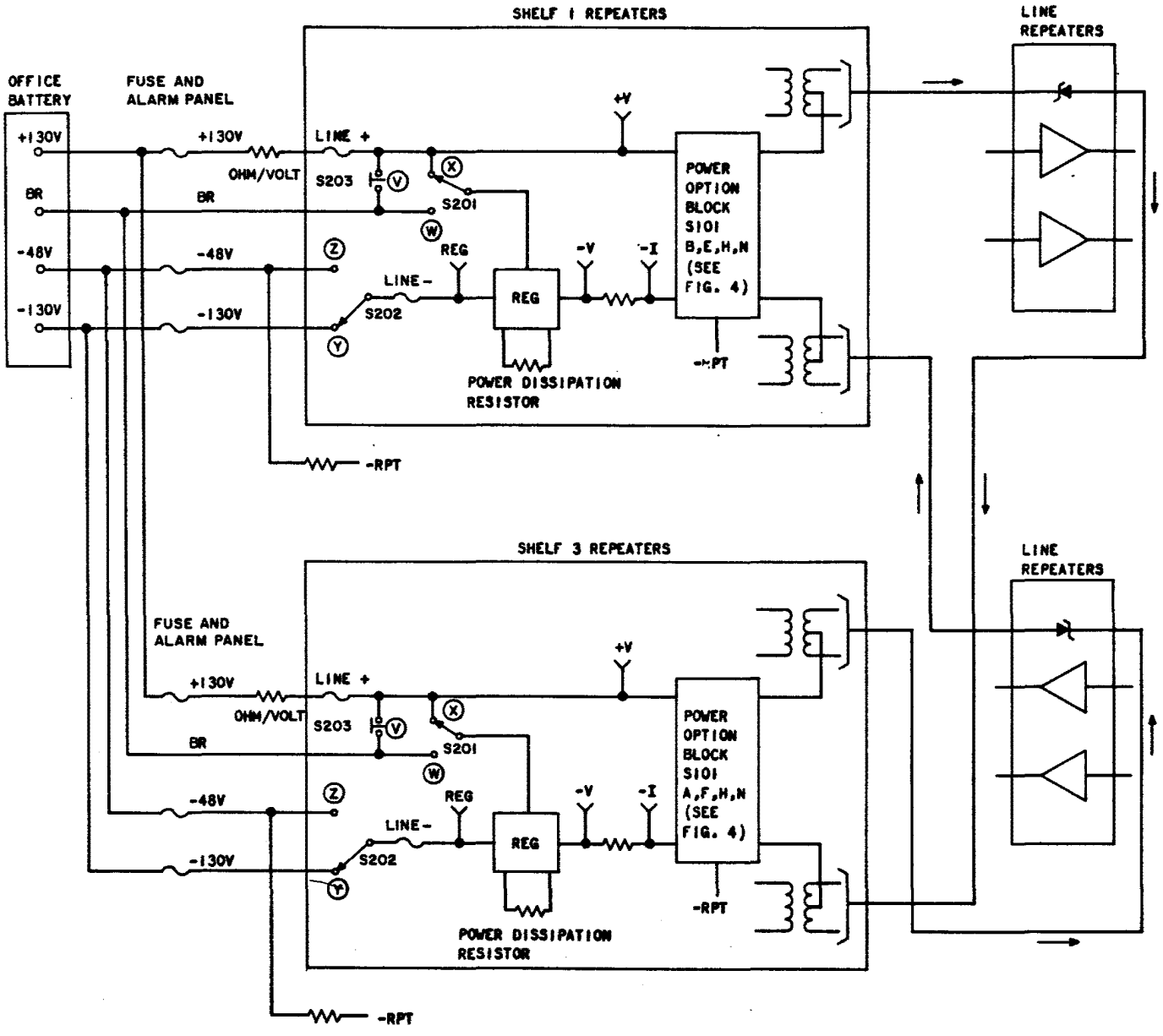


Fig. 6—Simplex Powering Arrangement