

WLR-1 AND WLR-2 WIDEBAND LOOP REPEATERS

(10 TO 51 KC)

DESCRIPTION

1. GENERAL

1.001 This addendum supplements Section 314-640-100, Issue 1. The attached pages must be inserted in the section in accordance with the filing instructions above.

1.002 This addendum is issued to:

- (a) add 3.14 (this changes succeeding paragraph numbers)
- (b) revise Fig. 8
- (c) update data auxiliary set nomenclature.

Attached:

Page 7 dated September 1968, revised

Page 8 dated September 1968, revised

Page 9 dated September 1968, revised

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1. GENERAL

1.01 This section describes the WLR-1 and WLR-2 wideband loop repeaters which are intended to extend the length over which 40.8-kilobit data can be sent on the local subscriber loops. They provide loss and delay equalization of the line, and amplification and regulation of the data set 301B signal in two directions of transmission.

1.02 The WLR-1 repeater is designed for office mounting on a 19-inch bay and is powered from a quiet -48 volt central office supply. The WLR-2 repeater can be mounted in an office on a 19-inch bay or, when housed in a watertight case, on a pole or in a manhole. The WLR-2 repeater normally receives its power from current sent over the simplex line facilities from a WLR-1 repeater.

2. EQUIPMENT DESCRIPTION

2.01 The WLR-1 repeater per J70159A is intended for use in a central office location where it will be mounted on a 19-inch relay rack with 10-inch guard rails. It may be mounted on a rack wider than 19 inches by using the appropriate adapters. The WLR-1 repeater can be used as a terminal or an intermediate repeater. It is powered from a quiet -48 volt supply and can provide power to WLR-2 repeaters at remote locations. A WLR-1 repeater is shown in Fig. 1.

2.02 The WLR-2 repeaters can be used as terminal or intermediate repeaters and are normally powered by current sent over simplex line facilities from WLR-1 repeaters. An option exists to power the WLR-2 repeaters from a J86463A 22-volt pole-mounted power plant. This option may be used where the resistance of the simplex loop from a WLR-1 at a central office is sufficiently great to reduce the powering current to less than the operating requirement. The WLR-2 repeaters are available for several applications. J70159B, Lists 1 and 2 includes a WLR-2 repeater in an airtight apparatus case suitable for pole and manhole mounting, respectively, (see Fig. 2). J70159D provides a repeater for standard 19-inch relay rack mounting and is shown in Fig. 3. J70159E provides a pole-mounted housing equipped to accommodate up to six WLR-2 repeaters per J70159D.

2.03 The repeaters consist of a basic aluminum framework 7 inches high by 17-1/4 inches wide by 8-1/4 inches deep. Jacks mounted on the rear of the unit extend another 1-1/4 inches making the overall depth of the repeater 9-1/2 inches. Brackets are provided to install the WLR-2 on a standard 19-inch relay rack or inside an apparatus case for pole or manhole mounting. This basic framework provides one centrally located compartment approximately 6-5/8 inches high by 9 inches wide for a control unit and four smaller compartments each ap-

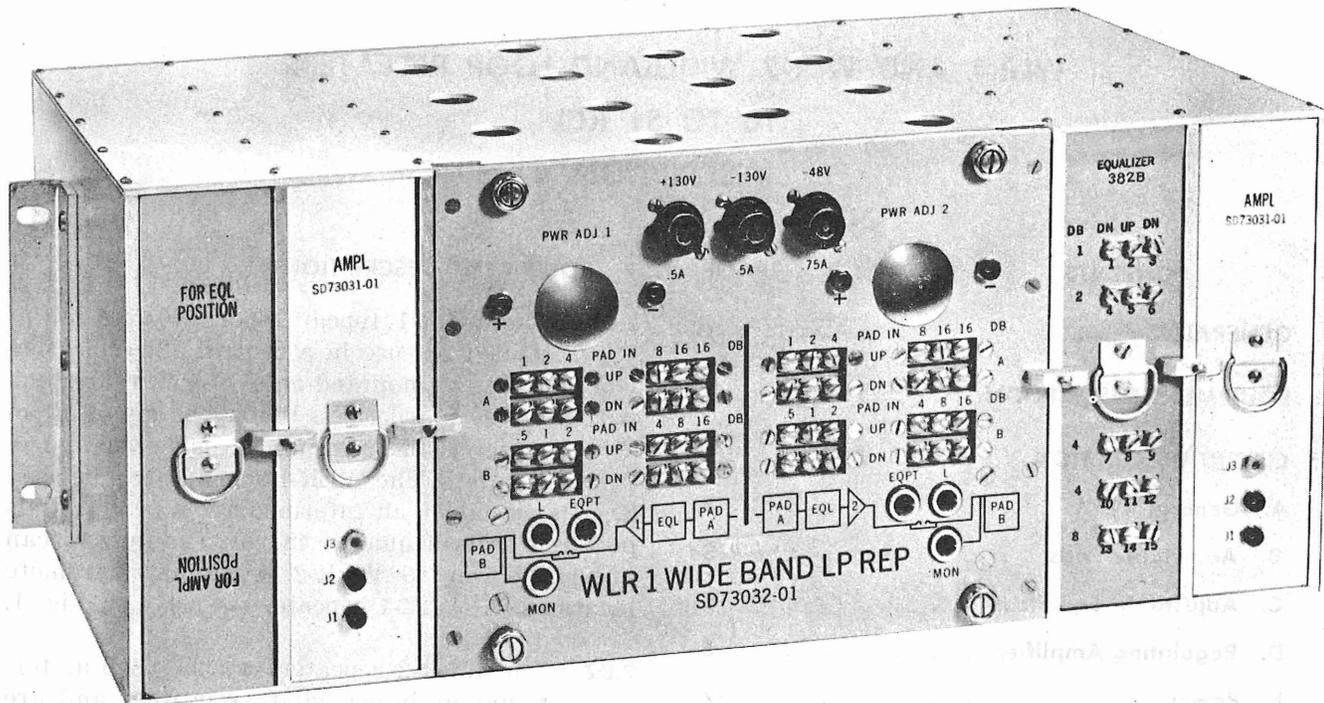


Fig. 1 - WLR-1 Wideband Loop Repeater

approximately 6-5/8 inches high by 1-3/4 inches wide.

2.04 The smaller compartments accommodate two plug-in J70159C amplifiers plus two plug-in 382B equalizers. When an amplifier or equalizer is not required, a shorting plug (ED-73185), physically simulating these plug-in units, is used. Retainers are included on the main framework to lock the plug-in units in place.

2.05 The J70159C amplifier is a fixed output regulating amplifier and includes an arrangement for fixed gain operation. It is a transistorized plug-in unit consisting of a printed circuit board mounted to a molded plastic front panel and enclosed in an aluminum can approximately 6-5/8 inches high by 1-3/4 inches wide. Pin jacks located on the front panel permit checking the dc supply voltage and the transistor emitter voltage of the output stage of the amplifier. Adjusting screws to set up the ampli-

fier for fixed gain or regulated gain operation are provided on the printed board and are accessible through holes in the can. A pull ring is provided on the front panel for removal of the unit.

2.06 The 382B equalizer is used to equalize the 10- to 51-kc loss slope of the line. It is a plug-in unit consisting of five fixed equalizers on a printed circuit board which is joined to a molded plastic front panel and enclosed in an aluminum can approximately 6-5/8 inches high by 1-3/4 inches wide. Screws located on the front panel permit the use of any combination of the five fixed equalizers to provide 0 to 19 db of slope in 1-db steps. A pull ring is also provided on the front panel of this unit.

2.07 The control unit comprises two printed circuit boards which contain the common transmission and power control equipment. There are two variations of this control unit associated with the WLR-1 and WLR-2 repeaters.

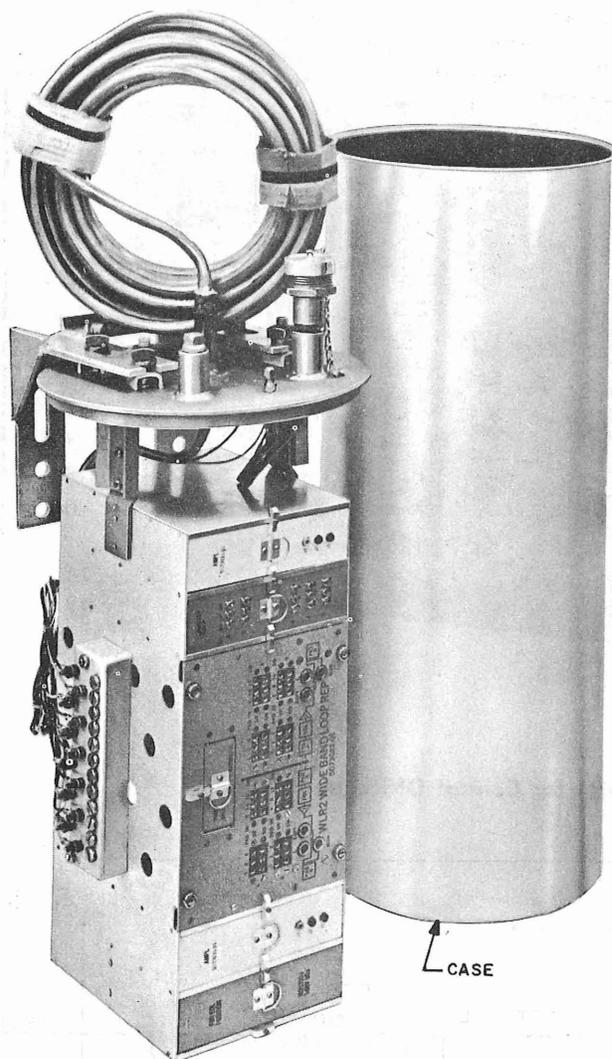


Fig. 2 – WLR-2 Wideband Loop Repeater for Pole or Manhole Mounting

2.08 The front panel of the WLR-1 control unit contains the following:

- (a) Fuses for the +130, -130, and -48 volt power supplies.
- (b) PWR ADJ rheostats for control of current to power remote repeaters.
- (c) Test jacks (+) and (-) for measuring the current to remote repeaters.
- (d) Screw terminals for adjustment of the input and output pads.
- (e) Line (L), equipment (EQPT), and monitoring (MON) jacks for each direction of transmission.

2.09 The front panel of the WLR-2 control unit contains the following:

- (a) Screw terminals for adjustment of the input and output pads.
- (b) Power selector plug-in unit which includes screws to set up the current paths for various powering conditions. These screws are accessible when the plug-in unit is removed.
- (c) Line (L), equipment (EQPT), and monitoring (MON) jacks for each direction of transmission.

3. CIRCUIT DESCRIPTION

A. General

3.01 The circuitry for the data signal is the same for each direction of transmission in both the WLR-1 and WLR-2 repeaters and is shown in block diagram form in Fig. 4. The incoming signal from a balanced line first passes through a one-to-one turns ratio transformer to the unbalanced circuit of the repeater. The transformer is associated with parallel resistor and capacitor networks across its input and output to improve the impedance match between 135-ohm terminations in the band of interest.

3.02 After the signal passes through the transformer and build-out network, it passes through the input pad which essentially is adjusted to reduce the level of the signal to -40 dbm at the input of the amplifier. An adjustable equalizer which compensates for the loss slope of the cable is located between the input pad and the amplifier. The signal level is then increased by the amplifier to a level of +11.7 dbm ± 0.5 db at its output. The signal then passes through the EQPT and L jacks and an output pad where its level can be adjusted as required and through the output transformer and its associated build-out networks to the 135-ohm balanced line. The output and input transformers together with their build-out networks are identical.

B. Adjustable Pads

3.03 The input and output pads consist of a cascade of T pads any combination of which may be placed in the circuit by adjusting two screw-down connectors. The input pad con-

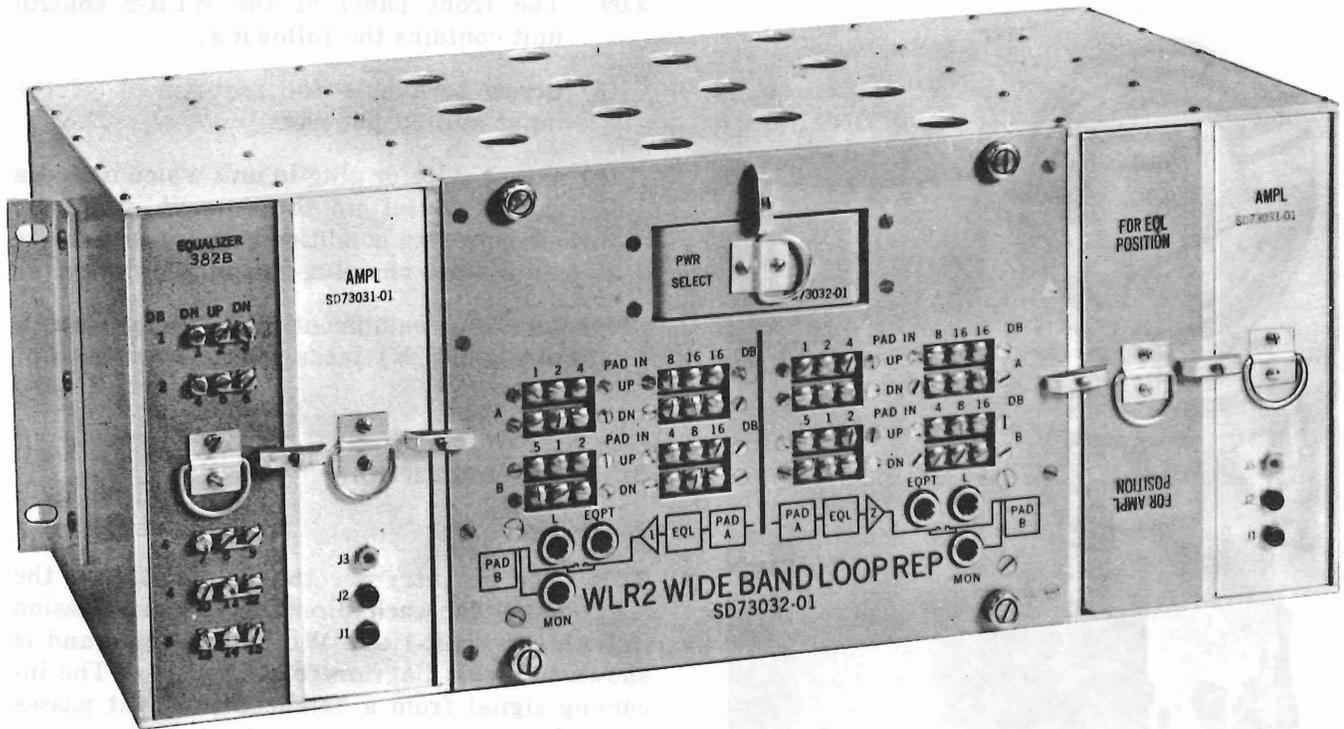


Fig. 3 – WLR-2 Wideband Loop Repeater for Central Office Mounting

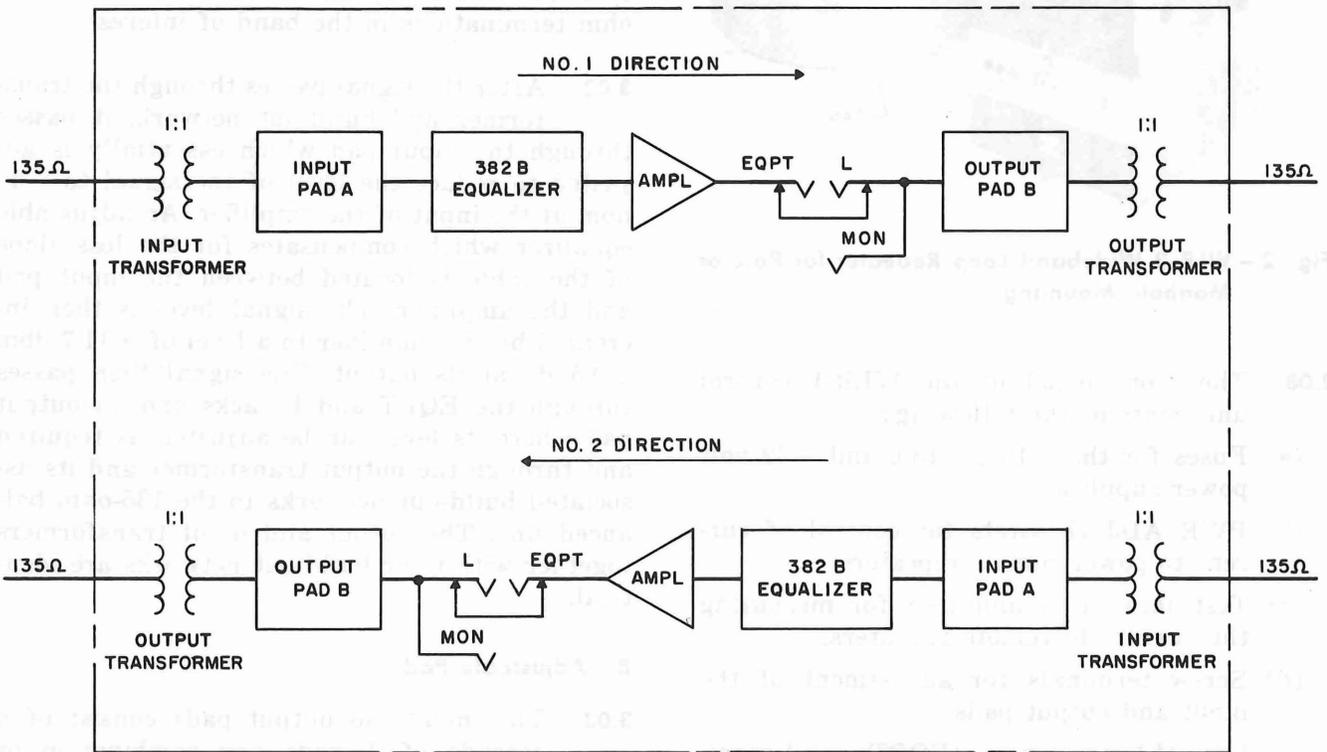


Fig. 4 – Block Diagram of Wideband Loop Repeater

sists of six T pads with losses of 1, 2, 4, 8, 16, and 16 db to provide 0 to 47 db of attenuation in 1-db steps. The output pad contains six T pads with losses of 0.5, 1, 2, 4, 8, and 16 db to provide 0 to 31.5 db of attenuation in 0.5-db steps. To insert a pad in the circuit, the screw corresponding to the desired pad marked PAD IN-DN should be tightened until the terminals are shorted, while the screw corresponding to the desired pad marked PAD IN-UP should be loosened until the terminals are no longer shorted. For removal of a pad from the circuit, the above procedure should be reversed. Since a pad is either "in" the circuit or "out" of the circuit, one of its screws must be "up" and the other must be "down" at all times.

C. Adjustable Equalizers

3.04 There are provisions for two plug-in 382B equalizers in each repeater, one for each direction of transmission. In cases where an equalizer is not required, a shorting plug is inserted in the space accepting the equalizer.

3.05 Each equalizer contains five separate sections which have loss slopes of 1, 2, 4, 4, and 8 db across the 10.2- to 51-kc frequency band. Each section is designed to equalize a cable loss characteristic which is a compromise between the insertion loss characteristics of 19-, 22-, 24-, and 26-gauge cable. Any combination of the individual sections can be inserted in the circuit by means of three screw terminals per section located on the front of the unit. To insert a section in the circuit, the screws corresponding to the desired loss slope marked DB-DN should be tightened until the terminals are shorted, while the screw corresponding to the desired section marked DB-UP should be loosened until the terminals are no longer shorted. For removal of a section from the circuit, the above procedure should be reversed. A length of cable with a loss slope of up to 19 db can be equalized to within ± 0.5 db by this method. Delay equalization is accomplished as a result of the loss equalization.

D. Regulating Amplifier

3.06 Amplification of the data set 301B signal is provided by the J70159C amplifier. It is a plug-in unit which can be set for fixed gain or regulating gain with three screw terminals

located inside the unit and accessible through a slot in the cover of the amplifier (see Fig. 5). A schematic diagram is shown in Fig. 6.

3.07 The regulating action of the J70159C amplifier is designed specifically for the data set 301B signal, which has only slight variations in its average power. Application of these repeaters to other types of TELPAK A data signals should be investigated for compatibility. The J70159C amplifier can be used with its fixed gain or nonregulating option, when required for transmission of facsimile over local customer loops.

3.08 In the fixed gain condition, the unit functions as a 3-stage direct-coupled transistor feedback amplifier. The amplifier employs shunt feedback at the output and hybrid feedback at the input. The amplifier is designed for essentially flat amplitude and linear phase response in the 10.2- to 51-kc frequency range. Gain is determined by the values of the resistors in the feedback path.

3.09 In the regulating condition, the series resistor of a pi pad in the feedback path is replaced by a thermistor as shown in Fig. 6. The thermistor resistance, which determines the gain of the amplifier, is controlled by direct current from a difference amplifier which compares a dc voltage proportional to the output signal with a reference voltage.

3.10 The operation of the regulator in response to a change in the level of the input signal may be summarized as follows. Assume the input level increases by several db, thus causing the output level to rise accordingly. The output signal is monitored and converted to a proportional dc voltage by a half-wave voltage doubler rectifier. The increased dc voltage is applied to one input of a difference amplifier whose other input is connected to a reference voltage developed by a reverse-biased diode. The difference amplifier responds to the increased difference of its inputs by increasing the current through the thermistor. The resistance of the thermistor begins to decrease and increases the feedback voltage to the input of the amplifier. However, because of thermal inertia of the thermistor, the full change of level cannot be made immediately. As the gain of the amplifier decreases, the input voltage to the difference amplifier is also de-

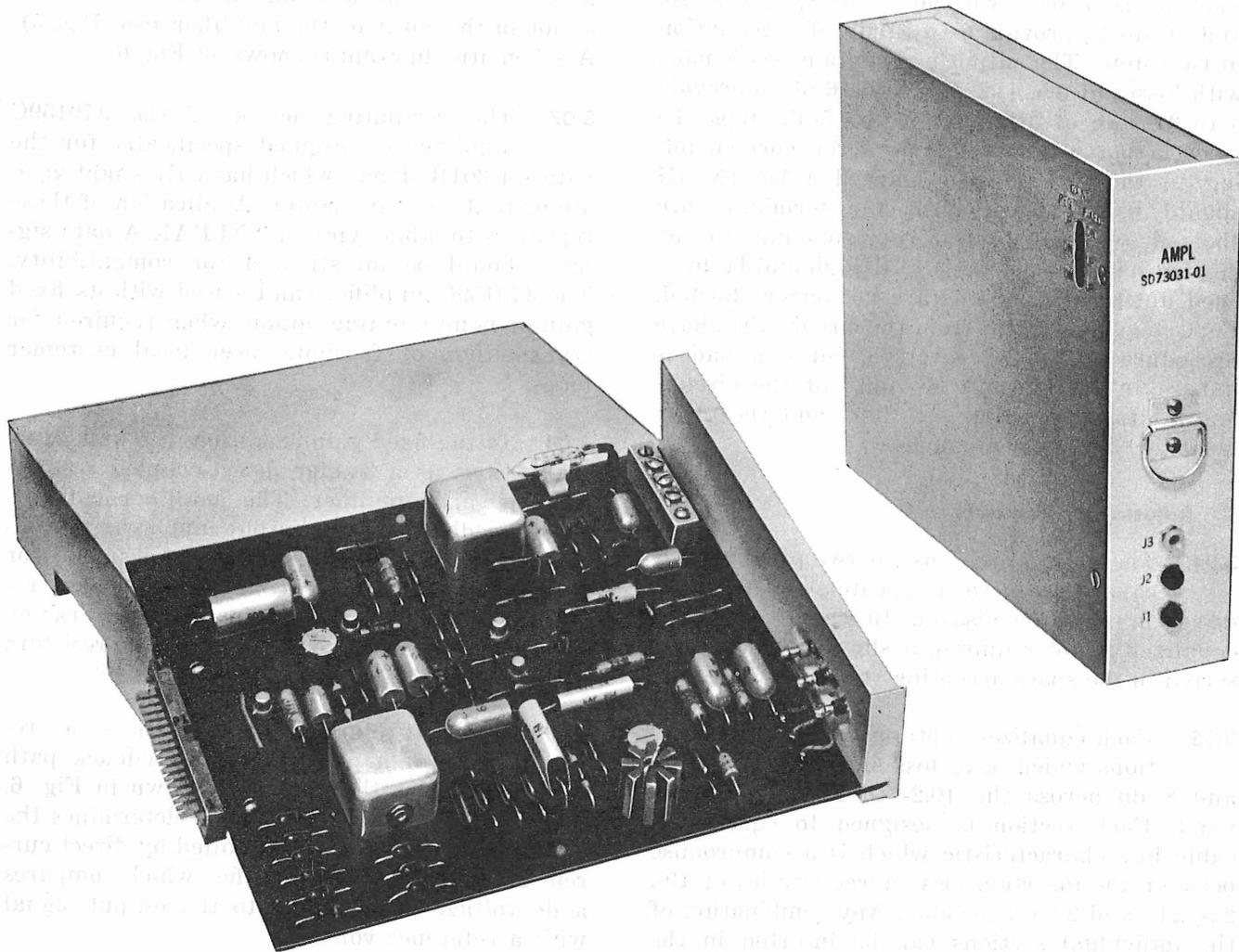


Fig. 5 – Regulating Amplifier J70159C

creased toward its former value. Thus, the thermistor current is reduced to a value which represents the change in gain of the amplifier needed to return the output signal to its normal value. When equilibrium is reached, a small servo-type error signal remains in the output of the amplifier. This same error signal at the input of the difference amplifier causes the required change in amplifier gain that compensates for the original increase in signal level.

3.11 The intended operating range of the regulator is ± 4 db from the normal input level with the output changing by less than ± 0.5 db from normal. The regulating characteristic is shown in Fig. 7. The thermistor is shunted by a

fixed resistor to prevent the gain of the amplifier from becoming excessive in the absence of an input signal. This limits the change in gain to +7 db.

3.12 The response time of the regulator to a change in the input level depends on whether the signal is increased or decreased. Approximately 2 seconds are required to correct an instantaneous 1-db increase in signal level. On the other hand, a sudden 1-db decrease in signal level requires approximately 10 seconds to stabilize. This is due to the thermal time constant of the thermistor. Large changes, such as initially applying the signal, require approximately 20 seconds for the output to stabilize.

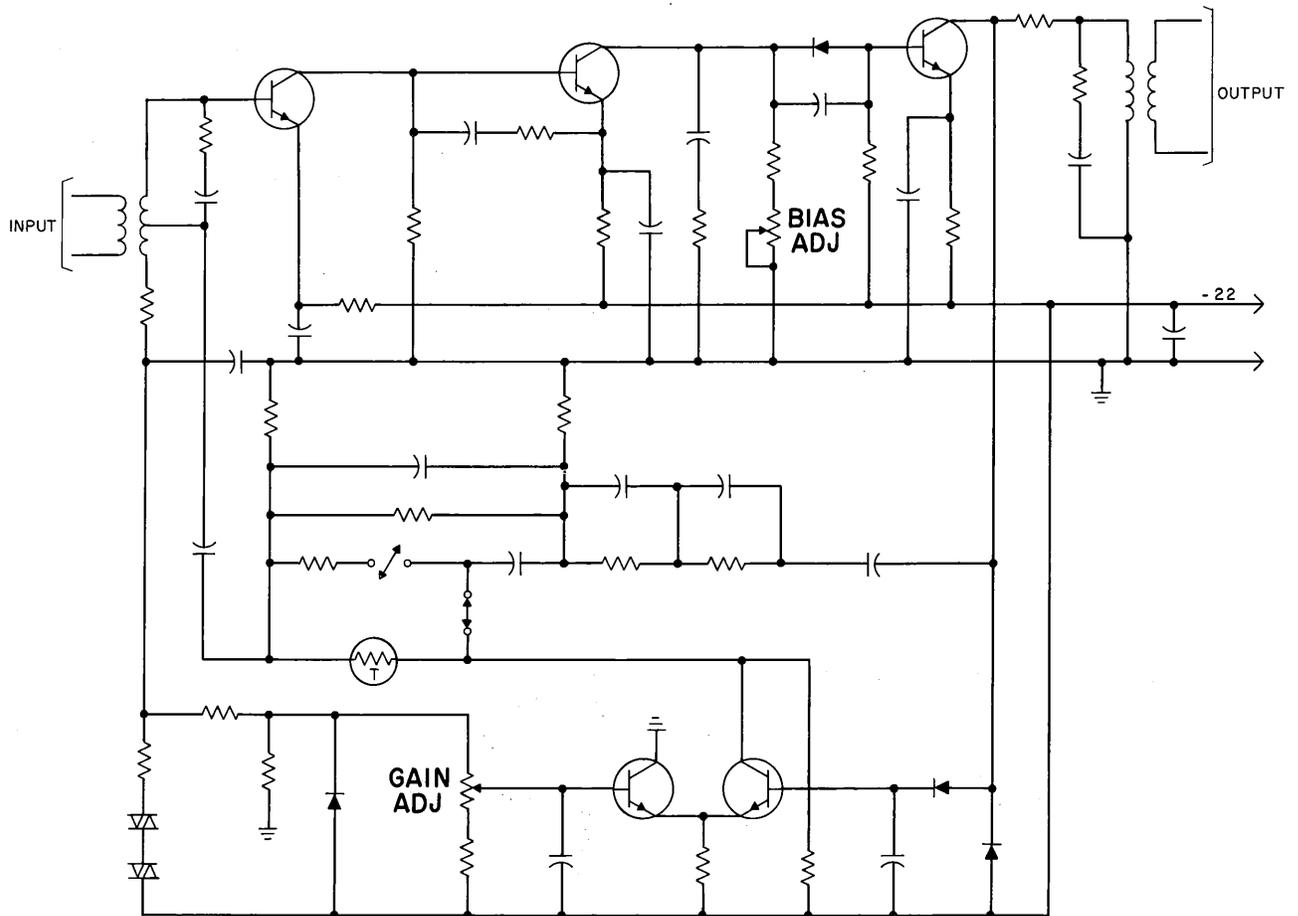


Fig. 6 — Amplifier Circuit

3.13 The amplifier performs normally over a temperature range of -40 to $+140^{\circ}\text{F}$. A change of output voltage from the voltage doubler, caused by temperature changes in the associated two diodes, is compensated by an equivalent voltage change from the reverse-biased reference diode which is subject to the same temperature changes. The difference amplifier itself is inherently stable with temperature changes. Once the gain has been set by adjusting the reference voltage with the potentiometer, the output will not vary by more than ± 0.3 dB over the temperature range of -40 to $+140^{\circ}\text{F}$. The reference diode also provides the bias voltage for the first stage. Since the 3-stage amplifier is direct coupled, the reference-bias voltage determines the operating-bias voltages of the remaining two stages. Temperature compensation is provided by two forward-biased diodes in the voltage divider across the reference diode.

3.14 The WLR-1 and WLR-2 repeaters are capable of regulating over a temperature range of -40 to 140°F if the line-up to adjust the signal levels is made when the cable temperature is in the range of 50 to 70°F . If the initial line-up is made when the cable temperature is outside this range, the system may have to be readjusted at some later time in order to center the regulation characteristic.

E. Power

3.15 The WLR-1 repeater is powered by the -48 volt local battery supply. It provides means for sending sealing current through the line or powering remote WLR-2 repeaters. The simplex current is derived from combinations of $+130$, -130 , and -48 volt batteries and is controlled by the PWR ADJ potentiometers located on the front of the WLR-1 repeater. There is

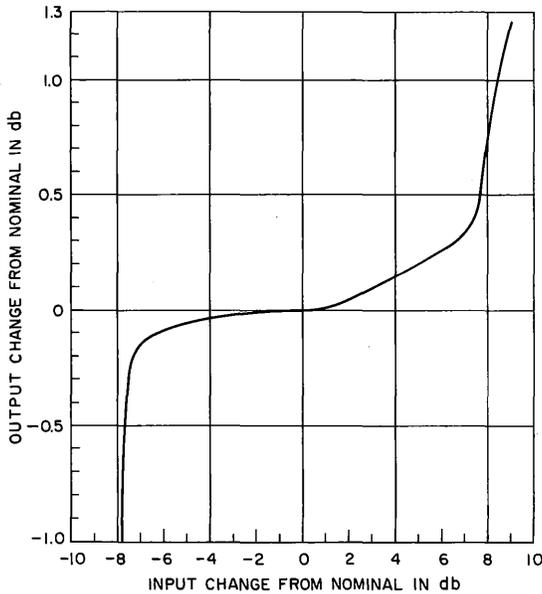


Fig. 7 — Regulation Characteristic of Amplifier

one control for each simplex loop, and the current can be monitored by reading a voltage across the + and - test jacks associated with

each control. Fuses are provided on the front of the repeater for the +130, -130, and -48 volt supply leads.

3.16 The WLR-2 repeater is normally remotely powered from a WLR-1 repeater. A plug-in power selector is located on the front panel of the repeater. This power selector includes adjusting screws accessible only when the plug-in unit is removed for setting up the current paths for various powering conditions. In cases where the resistance of the local loop is such that some pole-mounted repeaters cannot be powered by simplex current, an option exists to power these repeaters with J86463A 22-volt pole-mounted power plant.

4. LINE LEVELS

4.01 Wideband signal levels for typical customer loops are shown in Fig. 8. These values refer to the 30.6-kc component of the 301B idle signal or to a 30.6-kc sinusoidal test tone. However, the rms power in the 301B data signal remains fairly constant for both idle and random data signals.

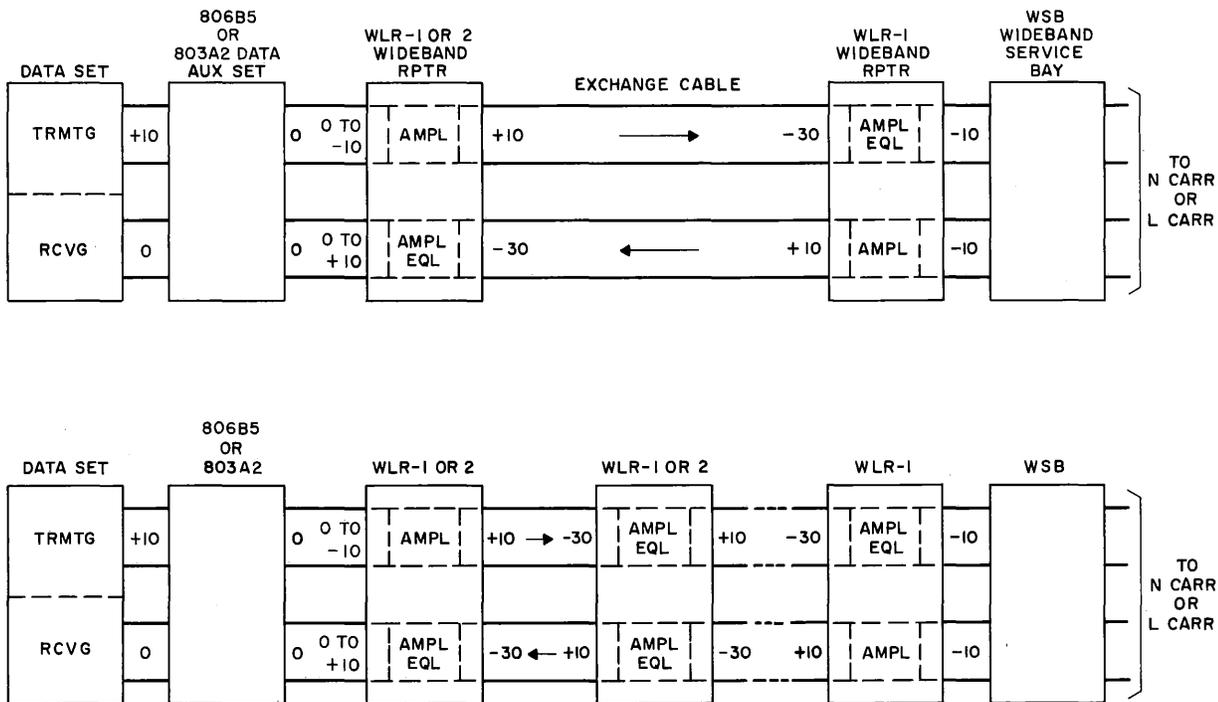


Fig. 8 — Typical TELPAK A Customer Loops

4.02 Each repeater can provide 40 dB of gain with an input level as low as -30 dBm and an output level as high as $+10$ dBm with 135-ohm terminations. In a typical installation shown in Fig. 8, the intermediate repeaters will produce $+10$ dBm at the output with an input level ranging from -30 to $+10$ dBm by means of adjustable pads at the input of the repeater. The central office terminal repeater produces -10 dBm at the input to the wideband service bay (WSB) with its input ranging from -30 to $+10$ dBm. The other direction of transmission accepts -10 dBm from the WSB and has a maximum output of $+10$ dBm. The transmitting and receiving levels at the line side of the data auxiliary set 803A2 or 806B5 are established at 0 dBm. This permits loop around tests from the WSB using normal line levels. The $+10$ dBm output level of the line amplifier limits the length of the end section to 10 dB. Sections in excess of this loss require a repeater at the customer location. In the particular case where an N carrier low group signal is in the same sheath as the 40.8-kilobit data signal, the transmit power of the repeaters should be reduced to prevent near-end crosstalk interference. This is accomplished by the adjustable pad in the output of each repeater.

5. TESTING ARRANGEMENTS AND FACILITIES

5.01 Both types of repeaters have two sets of three jacks marked L, EQPT, and MON located electrically at the output of each amplifier. The L jack breaks the signal path and per-

mits access to the line by way of the output pads and output transformer. The EQPT jack opens the circuit and permits access to the output of the amplifier. The MON jack permits monitoring of the data signal without breaking the signal path.

5.02 The repeaters can be looped for testing purposes by connecting a patch cord equipped with 310 plugs from the EQPT jack of one direction to the L jack of the other direction.

5.03 The front panel of each amplifier includes pin jacks to monitor the supply and emitter voltages. Since the amplifiers are plug-in units, a defective unit can be detected simply by replacing it with a good amplifier or merely by interchanging the amplifiers in the two directions of transmission. The input signal to the amplifier may be checked when necessary by replacing the amplifier with the shorting plug. The same shorting plug when turned upside down and inserted in the equalizer slot can be used in repeaters which do not require equalizers.

6. DRAWINGS (Not Attached)

SD-73031-01 — WLR-1 and WLR-2 Wideband Loop Repeaters Amplifier Schematic.

SD-73032-01 — WLR-1 and WLR-2 Wideband Loop Repeaters Application Schematic.