

**2-WIRE AND 4-WIRE TRANSMISSION ONLY
CHANNEL UNIT DESCRIPTION
D4 CHANNEL BANK
DIGITAL TRANSMISSION SYSTEMS**

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1. GENERAL

1.01 This section provides a detailed description of the 2-wire and 4-wire transmission only and the 4-wire equalized transmission only channel units used in the D4 channel bank.

1.02 This section is reissued to add channel unit input and output levels and to expand on the functional descriptive information. Since this reissue is a general revision, no revision arrows have been used to denote significant changes.

1.03 This section provides a functional description of the channel unit(s) at a block diagram level. The transmission paths and signaling circuits that characterize the unit(s) are described herein. Circuit elements that are common to all units (active filters, pulse amplitude modulators and demodulators, gates, and channel unit logic functions) are mentioned in this section and described in detail in the general channel unit descriptive Section 365-170-101. Voice frequency (VF) levels, circuit and signaling options, and attenuator settings are given on the circuit layout record card (CLRC). The procedures for

making the settings and adjustments are covered in Section 365-170-000 (TOP).

2. CHANNEL UNIT DESCRIPTION

A. Application

2-Wire Transmission Only (2TO)

2.01 The 2TO unit (Fig. 1) is provided for use on 2-wire metallic extensions which require no signaling or use end-to-end inband signaling (eg, a short private line for data transmission). The unit provides a hybrid on the drop side for 2-wire to 4-wire conversion, with a compromise balance network of 900 ohms. It contains a dc loop-sealing current option which is used to break down a high resistance film that may build up on extensions with unsoldered hand twisted splices.

4-Wire Transmission Only (4TO)

2.02 The 4TO unit is provided for use on moderate length 4-wire metallic extensions requiring no signaling or using end-to-end inband signaling. It can also be used in back-to-back carrier applications. The unit contains the dc loop-sealing current option for extensions with hand-wrapped splices.

4-Wire Equalized Transmission Only (4ETO)

2.03 The 4ETO (Fig. 2) unit is provided to interface the D4 bank with relatively long 4-wire metallic extensions where no signaling is required or where inband end-to-end signaling (eg, a private line for data transmission) is used. The unit contains all gain and active equalization circuits required on all loaded or nonloaded 4-wire extensions with 1-kHz losses up to 15 dB. It also contains the dc loop-sealing current option for extensions with hand-wrapped splices.

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B. Transmission Paths**2T0**

2.04 The 2-wire, 900-ohm balanced line is converted to a 4-wire 600-ohm unbalanced circuit by means of a hybrid transformer T1 in the 2T0 channel unit (Fig. 3). The hybrid is balanced with a compromise network and adjustable network buildout capacitors (NBOC). Optional sealing current is supplied to the T and R leads of the 2-wire facility to insure positive connection of hand wrapped splices in the cable. The nominal sealing current is 30 mA but may be momentarily increased to 60 mA by depressing the ZAP switch.

2.05 The transmit path contains an amplifier and an attenuator. The attenuator provides 16.5 dB of adjustment range in steps of 0.1 dB to adjust VF level at the test jack to the required -8.5 dB TLP.

2.06 The active transmit filter passes a band of VF from 300 through 3000 Hz. The frequencies above 4 kHz are suppressed to prevent foldover noise below 4 kHz.

2.07 The output of the filter is connected to the transmit gate which samples the VF and converts to pulse amplitude modulation (PAM) at a rate determined by the channel unit logic circuit which is under control of the D4 common circuits. The output of the transmit gate is connected to the D4 common circuits for transmission.

2.08 The received PAM pulses from the D4 common circuits are converted to VF in the receive gate and passed to the active receive filter. The receive filter output level at the test jack is $+4.0$ dB TLP.

2.09 The receive attenuator provides 16.5 dB of adjustable range to adjust the VF level at the 2-wire facility to the requirement shown on the CLRC.

4T0

2.10 The 4T0 channel unit (Fig. 4) is coupled to the 4-wire facility via transformers T1 and T2. A DC sealing current option is used to maintain good conduction when hand wrapped splices are used in the T-R or T1-R1 cable pairs. The nominal sealing current is 30 mA but may be momentarily increased to 60 mA by depressing the ZAP switch.

2.11 The gain of the transmit amplifier is adjustable to compensate for variable input levels.

For a TLP of $+7$ dB to -9 dB at the metallic line interface, option -7 dB TRMT is applied by inserting a jumper plug into Jack J3 with the white area covered. For a TLP of $+0.5$ dB to -16.0 dB at the metallic line interface, the option -7 dB is not used and a jumper plug is inserted into jack J3 with the white area showing. The output of the transmit amplifier connects to the transmit attenuator which has a range of 0 to 16.5 dB in steps of 0.1 dB. With the proper setting of the transmit amplifier gain, the level at the TEST JACK is adjusted by the transmit attenuator to the required -8.5 dB TLP.

2.12 The transmit filter passes a band of frequencies from 300 through 3000 Hz and is used primarily to reject frequencies above 4 kHz which would produce foldover noise below 4 kHz. The output of the filter connects to the transmit gate which samples the VF and converts to PAM at a rate determined by the channel unit logic circuit under control of the D4 common circuits. The output of the transmit gate is connected to the D4 common circuits for transmission.

2.13 The received PAM pulses from the D4 common circuits are converted to VF in the receive gate and passed to the active receive filter. The filter output level at the test jack is $+4.0$ dB TLP.

2.14 The VF is amplified by the receive amplifier and is passed to the receive attenuator which has a range of 0 to 16.5 dB adjustable in 0.1 dB steps.

2.15 The VF level at the metallic facility is adjustable by a combination setting of the receive amplifier and attenuator. For a metallic interface TLP of $+7$ dB to $+9.5$ dB, the receive amplifier gain is 5 dB (jumper plug in black side of J2). For a metallic interface TLP of 0 to -16 dB, the receive amplifier gain is reduced by applying the -7 dB RCV option (jumper plug in white side of J2).

4ETO

2.16 The 4ETO channel unit (Fig. 5) is coupled to the 4-wire facility via transformers T1 and T2. The transformers provide impedance matching to loaded and nonloaded cable. Impedance values can be selected by switch S1 on T1 and S5 on T2. The 1200-ohm position is used when the channel unit connects to loaded cable. The 600-ohm position is used for average to short lengths of nonloaded cable and the 150-ohm position is used when connected to long lengths of nonloaded cable.

2.17 Sealing current is enabled by inserting jumper plugs into jack J2 with the white area showing. Sealing current of 30 mA is applied on an optional basis to the T-R and T1-R1 cable pairs to insure good connection of the hand wrapped cable pair splices. A ZAP switch when operated increases the sealing current to 60 mA on a momentary basis when required to clean excessively corroded splices.

2.18 The secondary of transformer T1 is arranged to provide a 600-ohm selected 6-dB or 13-dB pad which adjusts the VF input level to the equalizer.

2.19 The active equalizer provides equalization for all gauges of nonloaded and H-88 loaded cables with up to 15 dB of 1-kHz insertion loss. Four switch combinations provide equalization for low frequency rolloff (SL), the 3250-Hz bump height (HT), bump band width (BW), and a low frequency adjustment of 401 Hz for loaded cable (L) or 1800 Hz for nonloaded cable (N). The output of the equalizer passes through a high pass filter and inputs to the transmit amplifier.

2.20 The output of the transmit amplifier is adjusted to the -8.5 dB TLP at the test jack by the transmit attenuator which has a range of attenuation from 0 to 16.5 dB in steps of 0.1 dB. When the input at the metallic interface is above 0 dB TLP, the -7 dB option is applied by inserting jumper plugs into the blank sides of J3 to obtain the proper -8.5 dB TLP at the test jack.

2.21 The -8.5 dB output of the transmit attenuator connects to the transmit filter. The filter is used mainly as a low pass filter suppressing frequencies above 4 kHz to prevent foldover noise below 4 kHz. The output of the filter is sampled by and converted to PAM by the transmit gate which is under control of the channel logic circuit and the D4 common circuits.

2.22 The receive PAM signals from the D4 common circuits are sampled by the receive gate controlled by the channel logic circuit and pass to the active receive filter. The output of the receive filter is reconstructed VF signals at a +4.0 dB TLP at the test jack.

2.23 The receive amplifier operates at a fixed gain and the receive attenuator has an attenuation range of 0 to 16.5 dB in 0.1 dB steps. The VF signals are adjusted by the receive attenuator to the required

TLP value at the line side over a range of +7.0 to -3.0 dB TLP.

3. CIRCUIT OPTIONS

3.01 When sealing current option is required, the plug and jack settings are given in Table B.

3.02 In the 4TO channel unit, the option of a 7 dB gain is given in Table B.

3.03 In the 4ETO channel unit, the option to reduce the transmit gain by 7 dB is given in Table B.

3.04 The options to be included in the circuit design will be shown on the CLRC.

3.05 The ranges of equalization; slope, height, and bandwidth are shown in Table C.

3.06 The transmit and receive path impedance selections are shown in Table C.

3.07 The transmit path insertion gain or loss, attenuator ranges, and metallic interface input levels are shown in Table D.

3.08 The receive path insertion gain or loss, attenuator ranges, and metallic interface input levels are shown in Table D.

3.09 The actual insertion gain or loss values, attenuator settings, and input levels to be applied to the circuit will be given on the CLRC.

4. REFERENCES

4.01 The following is a list of sections associated with the 2TO, 4TO, and 4ETO channel units.

SECTION	TITLE
365-170-000	D4 Channel Bank (TOP)
365-170-100	D4 Channel Bank Description
365-170-101	D4 Channel Bank - Channel Unit Description
855-351-103	System Application - Digital Channel Banks Applications - Engineering Considerations for D1, D2, D3, and D4
855-351-105	D4 Channel Bank - Channel Units Application Engineering Carrier Engineering

TABLE A
CHANNEL UNITS

J98726()	SD/CD	CHANNEL UNIT TYPE	FACEPLATE MARKING
SJ	7C031-0_	2-Wire Transmission Only	2TO
SH	7C030-0_	4-Wire Transmission Only	4TO
SQ	7C037-0_	4-Wire Equalized Transmission Only	4ETO

TABLE B
CHANNEL UNIT OPTIONS

CHANNEL UNIT MARKING	OPTION	FUNCTION
4TO (Gray) J89726SH SD7C030-0__	J4 (2 Sect.)	Insertion of plugs into black sides (white showing) of J4 delivers approximately 30 mA of sealing current to cable pairs T-R and T1-R1.
	ZAP	While depressed, this switch supplies an additional 30 mA of sealing current to the loop to clean splices.
	(J3)—7dB TRMT	Insertion of plug into J3 determines gain of transmit amplifier. With plug in white side, gain is 1.7 dB. With plug in black side, gain is 8.8 dB.
	(J2)—7dB RCV	Insertion of plug into J2 determines gain of receive amplifier. With plug in white side, gain is -2.0 dB. With plug in black side, gain is +5.0 dB.
2TO (Gray) J98726SJ SD7C031-0__	J2 (2 Sect.)	Insertion of plugs into black sides (white showing) of J2 delivers approximately 30 mA of sealing current to cable pairs T-R.
	ZAP	While depressed, this switch supplies an additional 30 mA of sealing current to the loop to clean splices.
	NBOC 2, 4, 8 16, 32, 64	Six slide switches are used for inserting and removing NBOC capacitors according to circuit requirements.
4ETO (Gray) J98726SQ SD7C037-0__	J2 (2 Sect.)	Insertion of plugs into black sides (white showing) of J2 delivers approximately 30 mA of sealing current to cable pairs T-R and T1-R1.
	ZAP	While depressed, this switch supplies an additional 30 mA of sealing current to the loop to clean splices.
	J3 -7 dB (2 Sect.)	Insertion of plugs into black sides (white showing) of J3 provides an additional 7.0 dB of attenuation in the transmit path.

TABLE C

EQUALIZATION AND BALANCE CONTROLS FOR 4ETO CHANNEL UNITS

CONTROL		POSITIONS	FUNCTION
NAME	CIRCUIT BOARD STAMPING		
Slope	SL	0 to 15	Switch in position 0 (no numbers showing) provides no equalization and unit frequency response is essentially flat; ie, for 0 dB at 1 kHz. 500 Hz = -0.4 dB and 3000 Hz = +0.1 dB. As switch position number increases, gain at 1 kHz increases to +6.6 dB (N) or +11.4 dB (L) for position 15 (numbers 1, 2, 4, and 8 showing). With N selected gain at 500 Hz decreases to -4 dB relative to 1 kHz and gain at 3000 Hz increases to +4.4 dB relative to 1 kHz. SL is the primary unit low-frequency equalization control.
Height	HT	0 to 15	Switch in position 0 (no numbers showing) provides no equalization. As switch position number increases, gain at 3250 Hz increases to +11 dB for position 15 (numbers 1,2,4, and 8 showing) relative to 1 kHz. Used in conjunction with bandwidth (BW) as primary unit high-frequency equalization controls.
Bandwidth	BW	0 to 15	Switch in position 0 (no numbers showing) or HT control in position 0 provides no equalization. As switch position number increases, width of gain "bump" at 3250 Hz increases; height of "bump" is still determined by HT control.
Facility	N/L	N or L	Switch set to N (N showing) for nonloaded cable applications and generally set to L (L showing) for loaded cable applications. With switch set to N, SL control provides greater equalization at higher frequencies than it does with the switch set to L.
Transmit Path (S1) Input Impedance	OPEN/150	Open, 1200, 600, or 150	Selects input impedance seen by line; 1200 ohms for loaded cable; 600 ohms or 150 ohms for non-loaded cable.
Receive Path (S5) Output Impedance	OPEN/150	Open, 1200 600, or 150	Selects output impedance seen by line; positions same as S1.

TABLE D

CHANNEL UNIT ATTENUATION, GAIN, AND LOSS PARAMETERS

CHANNEL UNIT	TRANSMIT PATH (T, R TO TST JACK) —8.5 dB TLP POINT)				RECEIVE PATH (TST JACK + 4.0 dB TLP POINT TO T1, R1, OR T, R (2W))			
	G_T INSERTION GAIN (+) OR LOSS (—) dB	ATTENUATOR RANGE (dB)	INPUT LEVEL (dB) AT T AND R (NOTE)		G_R INSERTION GAIN (+) OR LOSS (—) dB	ATTENUATOR RANGE (dB)	OUTPUT LEVEL (dB) AT T AND R (NOTE)	
			MIN	MAX			MIN	MAX
2TO	+0.5	0 - 16.5	— 9.0	+5.0	—4.0	0 - 16.5	—10.5	0
4TO	+7.5 (HI) +0.5 (LO)	0 - 16.5 —	—16.0 — 9.0	+0.5 +7.0	+3.0 (HI) —4.0 (LO)	0 - 16.5 —	— 9.5 —16.0	+7.0 0
*4ETO	+6.5 (HI) —0.5 (LO)	0 - 16.5 —	—15.0 —	+7.0 —	+3.0 —	0 - 16.5 —	— 3.0 —	+7.0 —

Note: Special service channel unit input and output levels are recommended values. In some cases, attenuator ranges cover a wider distribution of levels. It is recommended that circuit levels be constrained within the input and output levels specified in the table.

* Units with active post equalization.

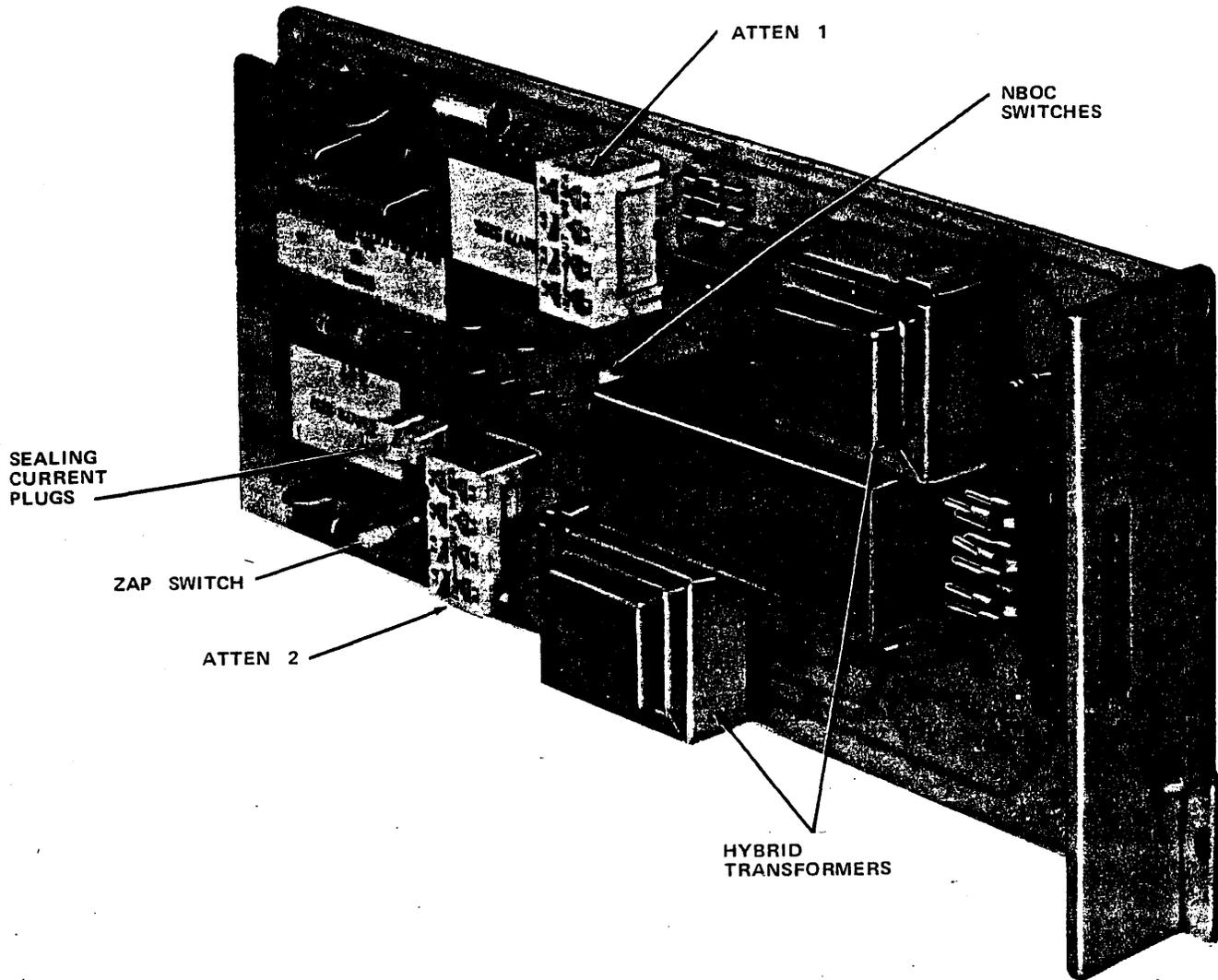


Fig. 1—2-Wire Transmission Only (2TO)

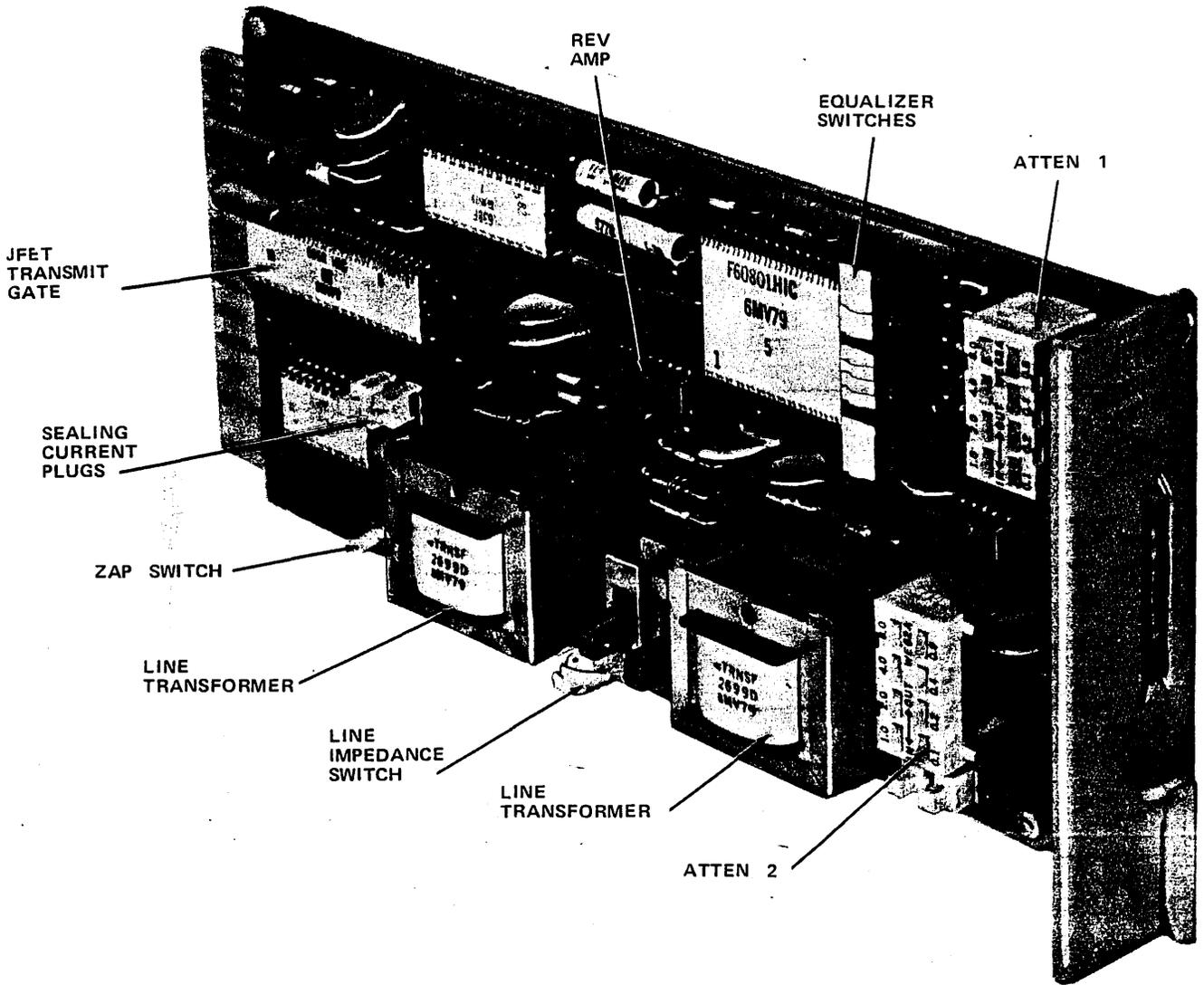


Fig. 2—4-Wire Equalized Transmission Only (4ET0)

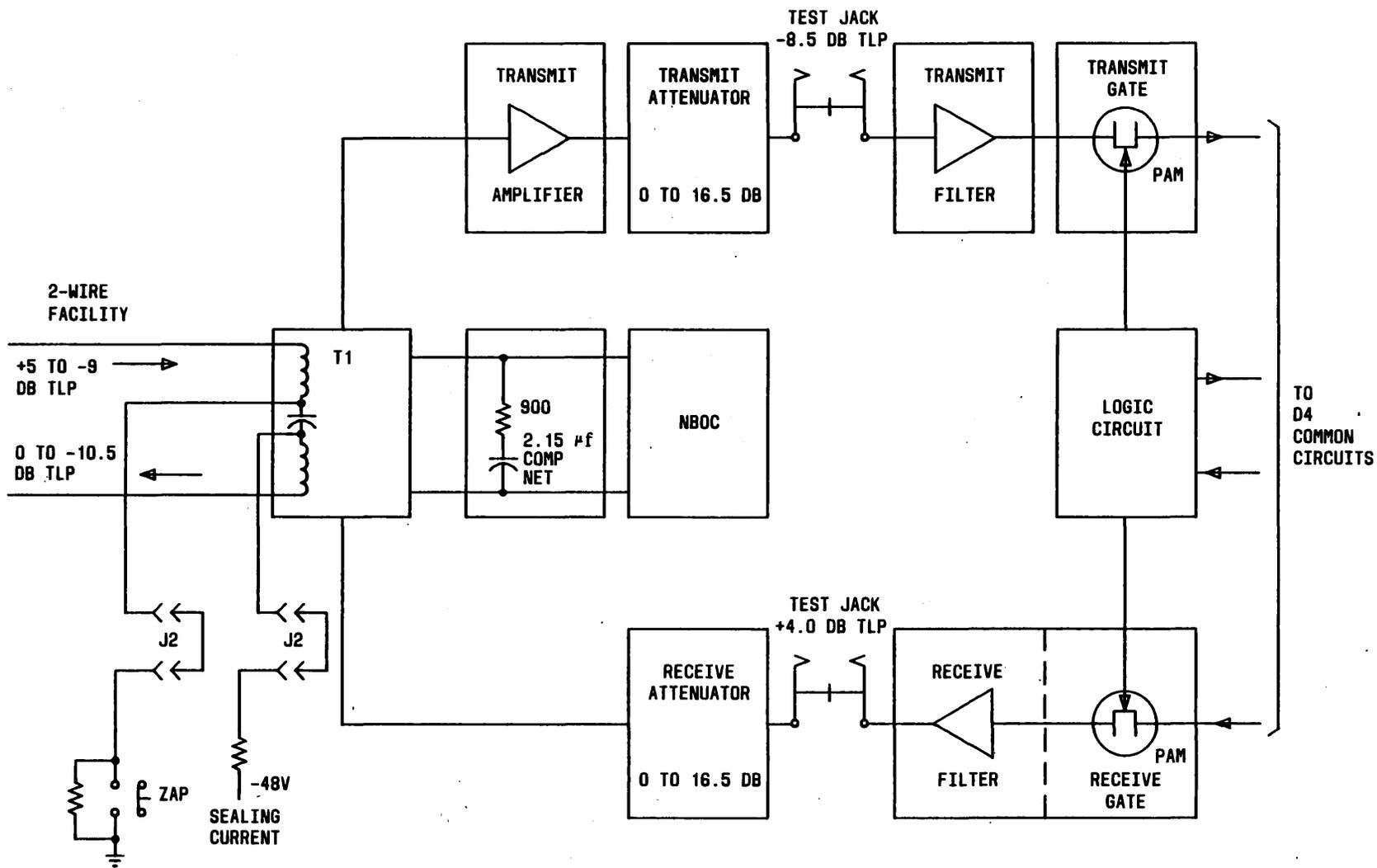


Fig. 3—2-Wire Transmission Only (2TO) Transmission Paths

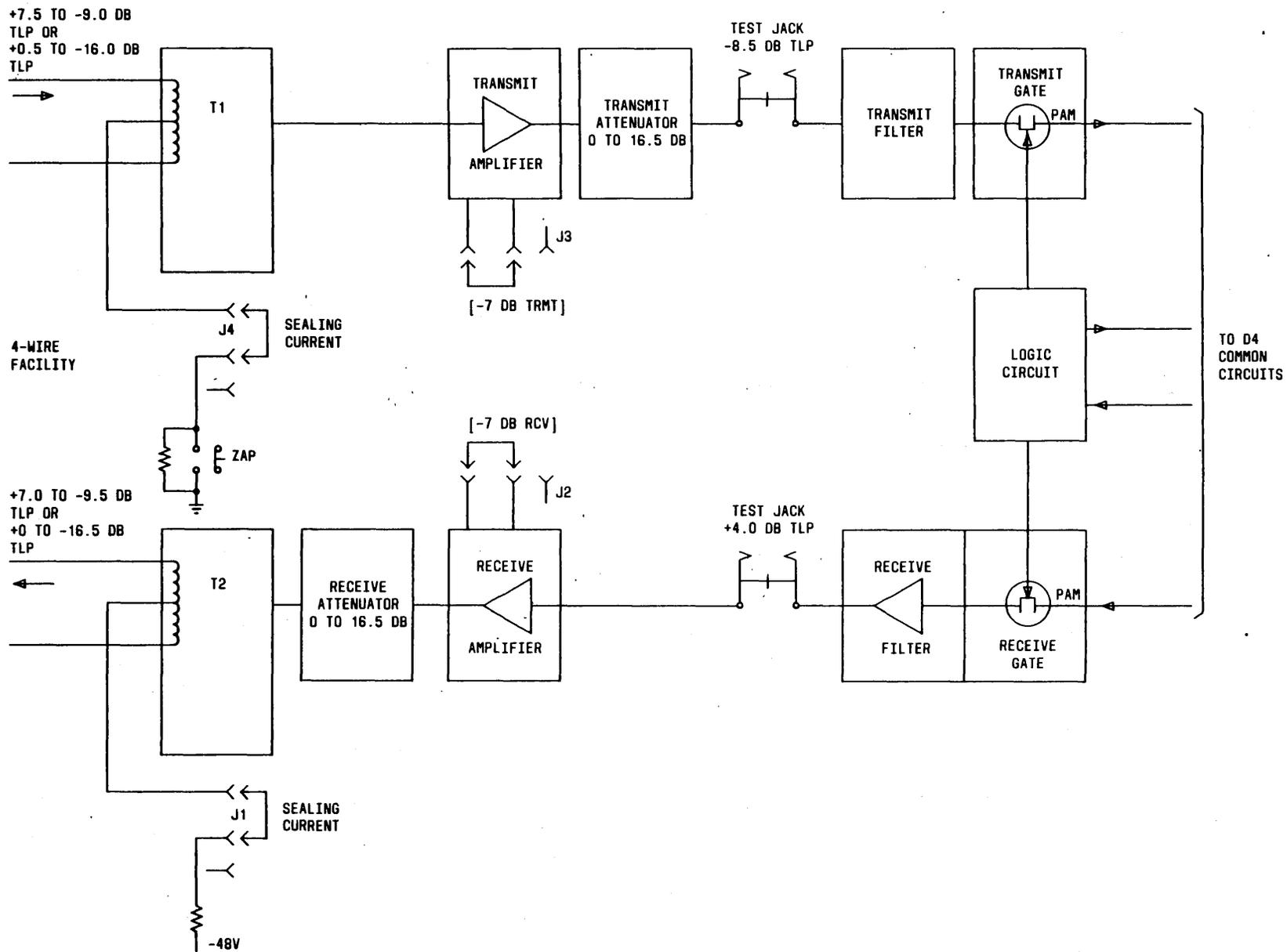


Fig. 4-4-Wire Transmission Only (4TO) Transmission Paths

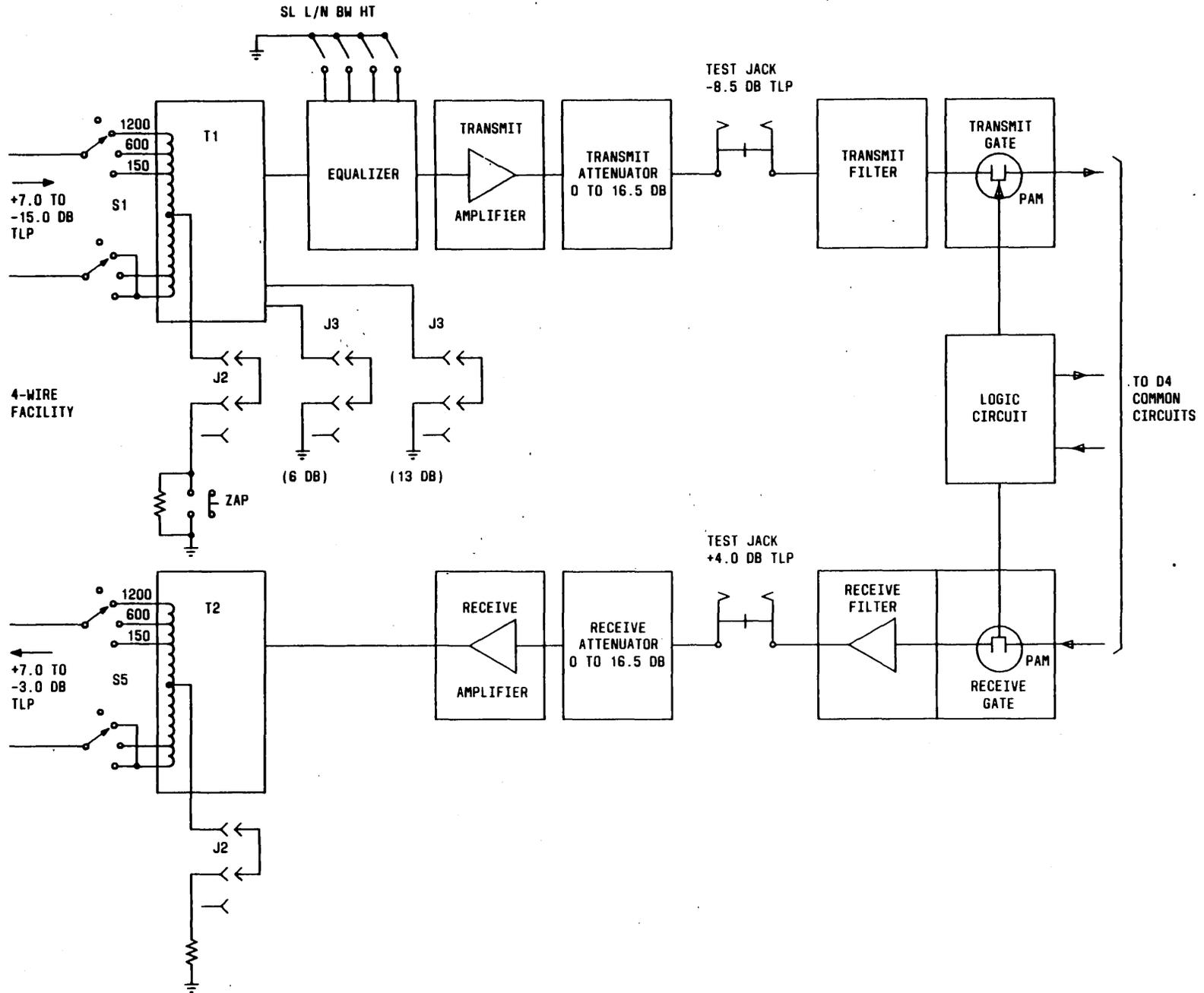


Fig. 5-4-Wire Equalized Transmission Only (4ETO) Transmission Paths