

**J94027A, C, E, P/AR METER GENERATORS
AND J94027B P/AR METER RECEIVER
DESCRIPTION, OPERATION, AND MAINTENANCE**

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1. GENERAL INFORMATION

1.01 This section covers the description, operation, and maintenance of the J94027A, C, and E P/AR meter generators; the J94027B P/AR meter receiver; and the J94027B, List 2 calibration network. These sets are designed to provide a rating of some of the more important characteristics which affect the capability of a transmission facility to handle voiceband data signals. This rating is a measure of the amplitude and envelope delay distortion in the system under test.

1.02 This section is reissued to include the currently available P/AR meter generators and a calibration network. The added P/AR meter generators are coded J94027C (27C), a rack-mounted set, and J94027E (27E), an ac-operated portable set. The newer generators perform the same function as the J94027A (27A) P/AR meter generator with the following advantages:

- (a) They transmit pulses with a more precisely controlled repetition rate.
- (b) Adjacent pulses are bilateral (of opposite polarity) to eliminate the turnover effect possible with the unilateral pulse of the 27A set.
- (c) They have no internal or external adjustments.

The calibration network is coded J94027B, List 2 and is used when calibrating the 27B P/AR receiver with either a 27C or a 27E P/AR meter generator.

A. Purpose

1.03 It should be noted that the 27C and 27E P/AR transmitters are satisfactory for use

on local facilities and short-haul carrier systems. However, errors of up to six P/AR points may be encountered on long-haul systems that employ single sideband transmission. A new P/AR generator is being designed to overcome this problem and will supercede the 27C and 27E sets.

1.04 The P/AR (peak-to-average ratio) meter responds to the ratio of the peak and full-wave rectified average values of a low duty-cycle test pulse transmitted over a trunk or circuit. This ratio is indicated on a zero-suppressed percentage basis relative to the undistorted test signal. That is, if the pulse is received undistorted, the P/AR meter receiver indicates 100. Distortion normally causes the peak-to-average ratio to be reduced, producing a reading lower than 100. For example, if the pulse is distorted so that the peak-to-average ratio is decreased 22 percent, the P/AR meter reading will be depressed 44 units from 100 to a P/AR reading of 56 since the actual P/AR indication decreases twice as fast as the percentage decrease in the ratio. A low value for this P/AR reading indicates that the test pulse has been dispersed or spread out in time as a result of the line distortion. These same effects cause intersymbol interference in a data signal.

1.05 The equipment may be used to test customer-to-customer connections, single trunks or loops, portions of trunks or loops (such as a channel of a carrier facility), or the voice transmission path through a signaling unit or other equipment.

1.06 While the primary purpose of the P/AR meter is to check for data-handling capability, it can also be useful in indicating the general transmission quality of a voiceband channel whether it is to be used for speech or for data.

1.07 Measurements are made using a procedure similar to 1000-Hz loss measurements.

1.08 The P/AR meter is sensitive to a variety of transmission impairments. Primarily these are:

- (a) Envelope delay distortion (EDD)
- (b) Bandwidth reduction
- (c) High background noise.

Secondary impairments include:

- (d) Gain-slope distortion
- (e) Gain and phase ripples (echoes)
- (f) Resonances (tendency to sing)
- (g) Nonlinearities (compression, clipping, etc).

When several of these impairments are present, the P/AR meter provides a combined measure of all of the distortions.

1.09 The two main unavoidable impairments of a normal carrier channel are bandwidth restriction (due to the channel filters) and EDD introduced at the band edges. Therefore, any test over a carrier facility is not expected to provide a reading of 100 percent on the P/AR meter.

1.10 Two common kinds of nonlinear distortion are clipping and compression. Clipping usually occurs as a nonsymmetrical distortion. That is, either the positive or the negative peaks of the transmitted signal are clipped. This kind of distortion frequently occurs in companded carrier systems. When the 27A generator with its unilateral pulse is used as the generator, the clipping will cause different peak-to-average ratios depending on the polarity of the applied signal with respect to tip and ring. When the 27C or 27E generator is used, clipping will be identical, independent of tip and ring, since the bilateral pulse alternates the sequence of polarity applied, and the peak-to-average ratios will be the same.

Note: See Fig. 11d and 12j for the difference in the two signals. The 27C and E generators produce successive pulses 180 degrees out of phase with each other, which are combined in a filter circuit to provide a bipolar waveform. The 27A generator produces a train of pulses which are identical.

1.11 Symmetrical nonlinear distortions which affect the positive and negative portions of the test signal equally will not cause a polarity turnover effect. However, if the peaks of the test signal are compressed by the nonlinearity, the peak-to-average ratio will be reduced.

1.12 High background noise reduces the P/AR rating because it increases the full-wave

average value of the received signal more than its peak value.

1.13 A comparison of the characteristics of the 27A, 27C, and 27E P/AR meter generators is shown in Table A.

B. 27A Generator Unit Description

1.14 The 27A generator unit of the P/AR equipment is shown in Fig. 1. A block diagram of the 27A generator is shown in Fig. 2.

1.15 There are two pushbutton controls on the generator. One is used in calibrating the

sensitivity of the P/AR meter receiver by changing the pulse repetition rate; the other is used with a lamp indicator to check the battery which powers the generator. Holding and blocking are provided and cannot be switched out.

1.16 When a 310-type plug is inserted into either the 600- or 900-ohm jack on the generator, the set is automatically turned on. Once turned on, the generator transmits pulses of a fixed amplitude, wave shape, and repetition rate.

1.17 The power supply shown in Fig. 2 supplies a regulated voltage to the P/AR meter generator circuits while the battery decays from

TABLE A

CHARACTERISTIC	GENERATORS			RECEIVER
	27A	27C	27E	27B
Impedance (Balanced)	600 Ohms or 900 Ohms	600 Ohms or 900 Ohms	600 Ohms or 900 Ohms	600 Ohms or 900 Ohms
Number of Outputs	One	Two	One	One (Input)
Pulse Repetition Freq	250 pps	253 pps	253 pps	
Pulse Polarity	Unilateral	Bilateral (Bipolar)	Bilateral (Bipolar)	
Peak Power Output	-7 dBm	-7 dBm	-7 dBm	
True RMS Power Output	-17.5 dBm	-18 dBm	-18 dBm	
Average Power Output	-22.2 dBm	-23.2 dBm	-23.2 dBm	
Adjustments, Number (Internal Circuit)	5	None	None	5
Input Attenuator Range				0 to 33 dB, coarse 0 to 3 dB, fine
Power Supply	24V Battery	(External) -48 ± 4 Vdc	(ac Line) 105 to 125 Vdc	24V Battery
Set Type	Portable	Relay-Rack Mounted (23 in.)	Portable	Portable
Operating Temperature	0° to 50°C	0° to 50°C	0° to 50°C	0° to 50°C
Overall Dimensions (Approximate, in inches)	6-1/2 Long 3-1/2 Wide 4-1/2 High	23 Wide 4 High 6 Deep	8-1/2 Long 7-1/4 Wide 5-3/4 High	11 Wide 7 High 7-1/4 Deep
Weight	4 Pounds	4.5 Pounds	6 Pounds	10 Pounds

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24 volts to 16 volts. The BAT CHK pushbutton and its associated lamp on the face of the generator are part of the battery check circuit of Fig. 2. When the battery decays to less than 16 volts, the lamp no longer lights.

1.18 The pulse generator circuit in Fig. 2 contains a solid-state relaxation oscillator with controls for adjusting the repetition rate and the width of the output pulses. The CAL CHK pushbutton on the generator changes the normal repetition rate of 250 pps to 375 pps.

1.19 The limiter puts square corners on the rounded pulses from the pulse generator. In addition, it provides the proper driving point impedance for the shaping filter.

1.20 The shaping filter performs the preliminary frequency weighting necessary for the final P/AR measurement. (Most of the frequency weighting is in the receiver.) It is also designed to give the generator output pulses bipolar (both a positive and negative going signal) characteristics.

1.21 The output circuit on the transmitter provides 600- and 900-ohm output impedance as well as dc holding and blocking.

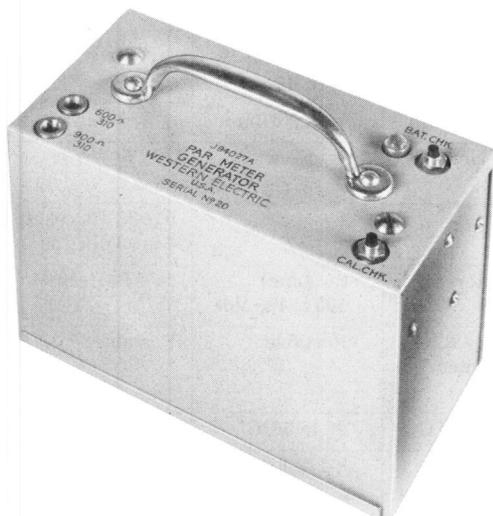


Fig. 1—J94027A P/AR Meter Generator

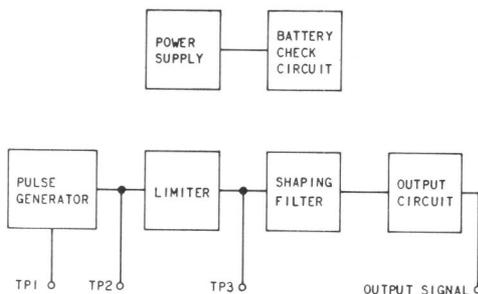


Fig. 2—27A P/AR Meter Generator—Block Diagram

C. 27C Generator Unit Description

1.22 The 27C generator unit of the P/AR equipment is shown in Fig. 3. A block diagram of the 27C generator is shown in Fig. 4.

1.23 There are no front panel controls; all connections to the generator are made internally to terminals mounted on the circuit board. The circuit board is made accessible by removal of the cover which is secured by four lock screws. The generator has two balanced outputs with each output having either a 600- or a 900-ohm impedance. These outputs are independent of each other and can be used simultaneously. Impedance selection is made on installation by setting the internal switches S1 and S2 in the appropriate position.

Note: The output jacks will be designated with the appropriate impedance.

1.24 The set is powered from an external -48 ± 4 volt dc supply capable of delivering 250 mA of current. A 1/2-ampere fuse (F1), which fuses the line voltage, is provided to protect the set against damage caused by component failure or accidental shorts. The second fuse holder furnished contains a spare fuse.

1.25 The crystal oscillator, a highly accurate frequency source, provides two 126.5-Hz square-wave outputs 180 degrees out of phase with each other. The two square-wave outputs from the crystal oscillator are differentiated and summed in the summing differentiator circuit. Thus, the input to the pulse generator is a train of negative spikes at a 253-pps rate.

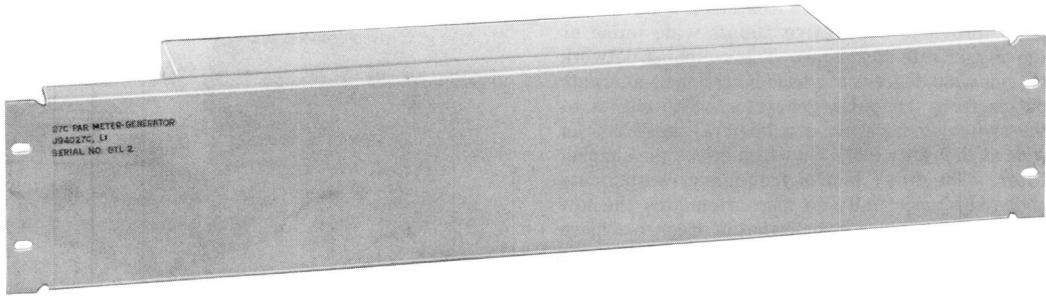


Fig. 3—J94027C P/AR Meter Generator

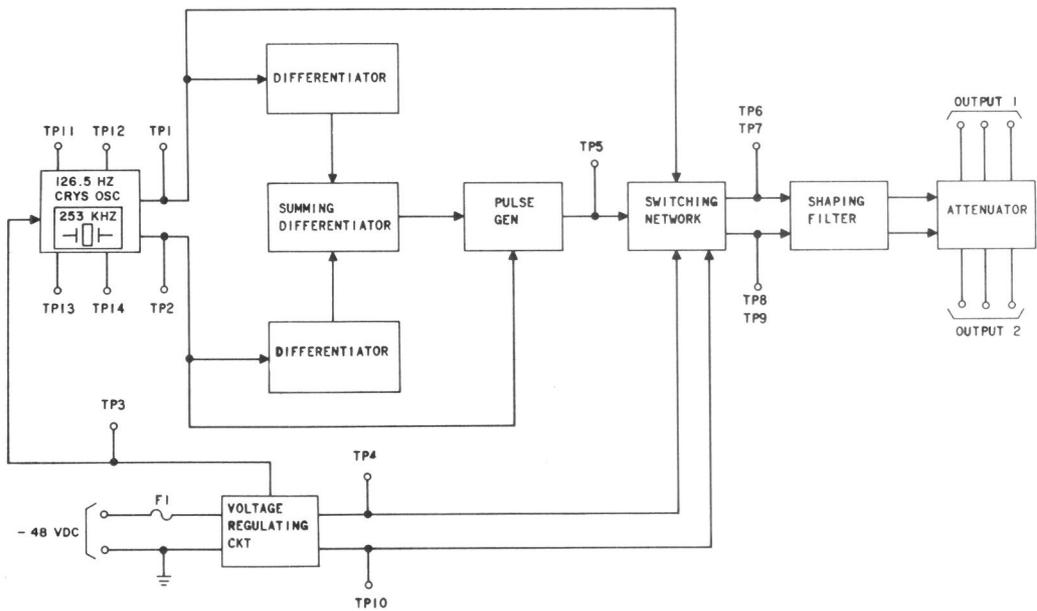


Fig. 4—27C P/AR Meter Generator—Block Diagram

1.26 The pulse generator, a monostable multivibrator, provides a negative 200- μ s wide pulse at the trigger rate of 253 pps. The switching network provides 180 degrees of phase inversion to alternate pulses from the pulse generator. The output of the switching network is a bilateral pulse 200 μ s wide at the rate of 253 pps which drives the shaping filter. The filter blocks frequency components above the voiceband and also attenuates the low frequency components somewhat in order to achieve the desired output pulse shape. The fixed attenuator ensures the correct output level at either the 600- or 900-ohm outputs. The voltage regulating circuits provide regulation and filtering of the external -48 volt dc supply used to power the set.



Fig. 5—J94027E P/AR Meter Generator

D. 27E Generator Unit Description

1.27 The 27E generator unit is shown in Fig. 5. A block diagram of the 27E generator is shown in Fig. 6.

1.28 The generator operates from a 105- to 125-volt, 50- to 60-Hz ac source. The total

power consumption is approximately 5.5 watts. A pushbutton switch turns the set ON and OFF; a pilot lamp which is part of the switch indicates when the set is ON. A 1/2-ampere fuse (F1) fuses the line voltage.

1.29 The generator has a single output with either a 600- or a 900-ohm input impedance. The

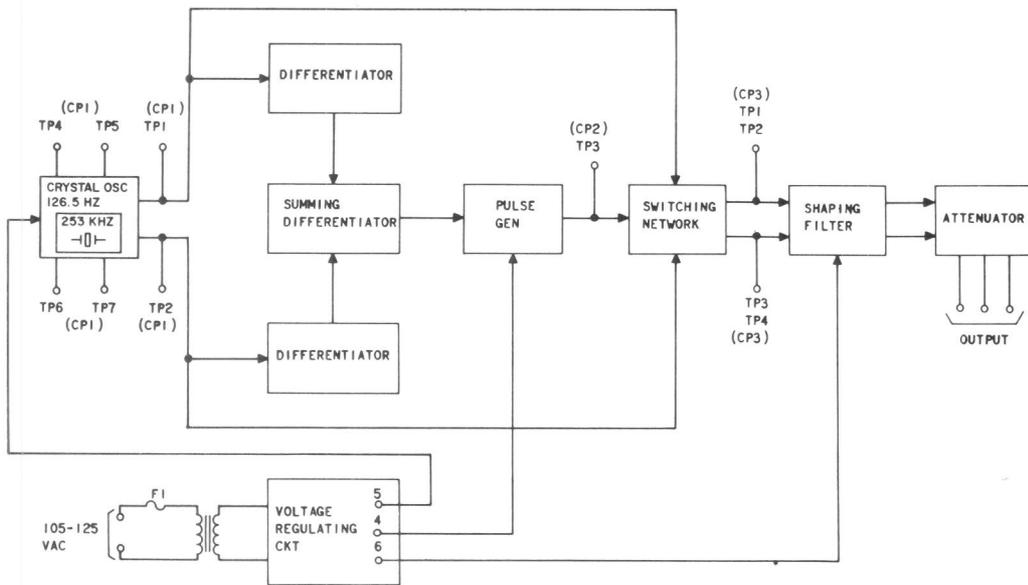


Fig. 6—27E P/AR Meter Generator—Block Diagram

selection of the appropriate impedance is made with front panel switch S2. The output is taken from either the 310-type jack or binding posts labeled T (tip), R (ring), and S (sleeve). A chassis ground is available at the binding post labeled GND.

1.30 The crystal oscillator, a highly accurate frequency source, provides two 126.5-Hz square-wave outputs 180 degrees out of phase with each other. The two square-wave outputs from the crystal oscillator are differentiated and summed in the summing differentiator circuit. Thus, the input to the pulse generator is a train of negative spikes at a 253-pps rate.

1.31 The pulse generator, a monostable multivibrator, provides a negative 200- μ s wide pulse at the trigger rate of 253 pps. The switching network provides 180 degrees of phase inversion to alternate pulses from the pulse generator. The output of the switching network is a bilateral pulse 200 μ s wide at the rate of 253 pps which drives the shaping filter. The filter blocks frequency components above the voiceband and also attenuates the low-frequency components somewhat in order to achieve the desired output pulse shape. The fixed attenuator ensures the correct output level for either the 600- or the 900-ohm output, selection of which is made by a front panel switch. The voltage regulating circuit rectifies the ac power input to a -48 volt regulated direct current, which is used to power the set.

E. 27B Receiver Unit Description

1.32 The 27B receiver unit of the P/AR equipment is shown in Fig. 7. A block diagram of the 27B receiver is shown in Fig. 8.



Fig. 7—J94027B P/AR Meter Receiver

1.33 The receiver has four controls in addition to an ON-OFF switch. Adjustment of the detector input signal to a reference level is provided by coarse and fine controls. A toggle switch is used to set the input impedance to either 600 or 900 ohms. A pushbutton is provided for checking the battery.

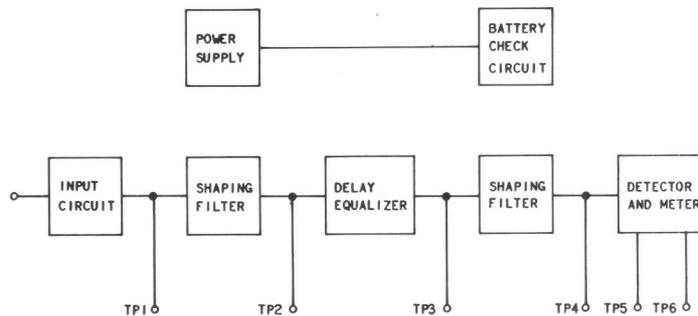


Fig. 8—27B P/AR Meter Receiver—Block Diagram

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1.34 There are two meters on the front panel of the 27B P/AR meter receiver. The smaller of these is used alternately for the battery check and for measuring the average value of the input signal. The large meter gives the value of P/AR for the facility, circuit, or equipment under test.

1.35 There are two sets of 5-way binding posts on the set. One is used for the input and the other is used as an output to an oscilloscope. An oscilloscope is not necessary, but it sometimes may be of value in diagnosing the transmission impairment causing a low P/AR reading.

1.36 One of the functions of the receiver is to apply frequency weighting and delay equalization to the pulse from the generator. Following this, the receiver detects the peak and full-wave average values of the pulse and displays a measure of their ratio on the meter.

1.37 The power supply shown in Fig. 8 contains two 24-volt batteries. The BAT CHK pushbutton and the small meter on the face of the P/AR meter receiver are a part of the battery check circuit. When the small meter indicates less than BAT MIN with the BAT CHK button depressed, the batteries must be replaced.

1.38 The input circuit of Fig. 8 provides a balanced 600- or 900-ohm input impedance with dc holding and blocking for the receiver. The COARSE and FINE RECEIVED LEVEL ADJ controls are also included in the input circuit.

1.39 Figure 8 shows two shaping filters. These filters, and those in the transmitter, provide the frequency weighting necessary for a meaningful P/AR measurement.

1.40 The delay equalization circuit compensates for the delay distortion of the shaping filters. The equalization has been adjusted so that the delay-versus-frequency characteristic between the pulse generator and the detector is almost flat when the P/AR meter generator is connected directly to the P/AR meter receiver.

1.41 Finally, the detector circuit shown in Fig. 8 contains two full-wave average detectors and one peak detector. One of the average detectors is connected to the small meter on the face of the P/AR meter receiver. This meter and the level

controls mentioned in 1.38 are used to adjust the average value of the measured pulse to a constant. The second average detector and the peak detector are used in deriving the P/AR reading which appears on the large meter.

1.42 The P/AR receiver will operate satisfactorily over a range of approximately 7-dB gain to 25-dB loss from a nominal (-17.5 dBm true rms) transmitted signal.

F. 27B, List 2 Calibration Network Description

1.43 The front view of the 27B, List 2 calibration network is shown in Fig. 9; the rear view is shown in Fig. 10.

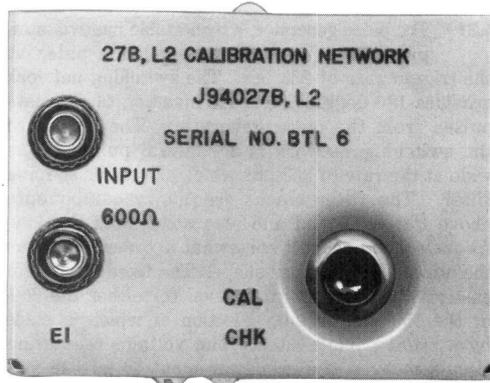


Fig. 9—J94027B, L2 Calibration Network—Front View

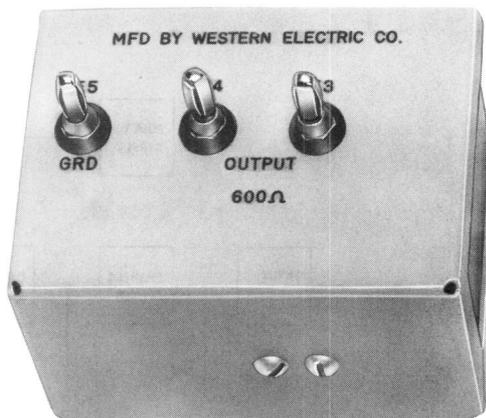


Fig. 10—J94027B, L2 Calibration Network—Back View

1.44 The calibration network is used when calibrating the 27B P/AR receiver with either a 27C or a 27E P/AR meter generator. The network consists of resistors and capacitors and requires no power. The input and output impedance of the network is 600 ohms. The network input is equipped with a pair of binding posts; the output is equipped with banana plugs which allow the network to fit directly into the 27B P/AR receiver input. The calibration check is made with the generator and receiver impedance switch in the 600-ohm position. A pushbutton CAL CHK switch

mounted on the calibration network is depressed to make the calibration check.

2. OPERATING INSTRUCTIONS

A. 27A Generator With a 27B Receiver—Calibration Check

2.01 To ensure measurement accuracy, the 27A set should be calibrated weekly or when the batteries are changed. Calibration of the set compensates for battery decay and other aging effects. The procedure is as follows.

STEP	PROCEDURE
1	Turn the receiver ON and connect it to the generator. (Inserting the 310-type plug into the output jack turns the generator on.)
2	Check the battery in the generator by depressing the switch marked BAT CHK and observing the indicator lamp. If there is any illumination from the lamp, the battery is acceptable.
3	Check the battery in the receiver by depressing the switch marked BAT CHK. The RECEIVED LEVEL meter should read above the BAT MIN mark on the meter for proper operation.
4	Turn the INPUT IMPEDANCE switch on the receiver to correspond to the chosen generator output impedance.
5	Adjust the COARSE and FINE RECEIVED LEVEL ADJ controls on the receiver to make the RECEIVED LEVEL meter read at REF LEVEL.
6	The P/AR meter should now read 100. If it does not, adjust the mechanical zero adjuster on the meter to make it read 100. <i>Note:</i> Step 6 should be made with the meter panel face up and then repeated with the meter panel in a vertical position.
7	Reverse the leads between the generator and receiver. If the meter does not read 100, refer to Part 3.
8	Depress the CAL CHK switch on the generator and follow the instructions of Step 5; the P/AR meter should read 33 ± 2 . If this condition is not met, refer to Part 3.

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B. 27C or 27E Generator With a 27B Receiver—Calibration Check

2.02 To ensure measurement accuracy, the 27B set should be calibrated monthly or when the battery is changed in the 27B. A J94027B, List 2 calibration network is required to make a calibration check. The procedure is as follows.

STEP	PROCEDURE
1	Turn the generator and receiver ON.
2	Plug the output of the J94027B, List 2 calibration network into the receiver INPUT and connect the generator OUTPUT to the network INPUT.
3	Check the battery in the receiver by depressing the BAT CHK switch. The RECEIVED LEVEL meter should read above the BAT MIN mark on the meter for proper operation.
4	Set the IMPEDANCE switch on the 27E generator and the 27B receiver to the 600-ohm position. If a 27C generator is used, connect from the 600-ohm output jack to the 27B receiver if possible. If only a 900-ohm output is provided, see note to Step 7.
5	Adjust the COARSE and FINE RECEIVED LEVEL ADJ controls on the receiver to make the RECEIVED LEVEL meter read at REF LEVEL.
6	The P/AR meter should now read 100. If it does not, adjust the mechanical zero adjuster on the meter to make it read 100. <i>Note:</i> Step 6 should be made with the meter panel face up and then repeated with the meter panel in a vertical position.
7	Depress the switch on the calibration network and repeat Step 5. The P/AR meter should read 59 ± 2 . If this condition is not met, refer to Part 3. Remove the calibration network. <i>Note:</i> If the 900-ohm output is used with the 27C generator, the reading should be 56 ± 2 with the 27B receiver on 900 ohms.

C. Measurement Procedure (Compandored Trunks)

2.03 The measurement procedure for compandored trunks or facilities is as follows.

STEP	PROCEDURE
1	Connect the generator to the trunk to be tested; use the 600- or 900-ohm output, as necessary. The generator should be connected to the trunk at a zero or higher transmission level point. If the trunk is tested with TP2, it will be necessary to transmit the P/AR signal through an auxiliary attenuator, eg, a 5A attenuator.

STEP	PROCEDURE
2	Connect the 27B receiver to the other end of the trunk to be tested. Operate the IMPEDANCE switch to the required impedance.
3	Adjust COARSE and FINE RECEIVED LEVEL ADJ controls on the receiver to make the RECEIVED LEVEL meter read at the REF LEVEL line.
4	Read the P/AR rating of the trunks. <i>Note:</i> The above procedure may be followed when making measurements on noncompandored trunks.

2.04 When using a 27A generator, the P/AR reading should be obtained for both polarities of transmitted test signal on compandored trunks. (When using the 27C or 27E generators, only one polarity is necessary.) The connections between the 27A generator and the trunk must be transposed. (See also 1.10.) The two readings are averaged to obtain the rating.

Note: This transposition is made only at the transmitting end of the trunk.

D. Measurement Procedure (Other Type Facilities)

2.05 Procedures and requirements for other type facilities and tests (ie, loops, end-to-end, DATA-PHONE[®]) are covered in appropriate sections.

NOTES