KS-20159 EQUALIZER-AMPLIFIER

TESTS, ADJUSTMENTS, AND OPERATION

CONTENTS PAGE

1. GENERAL

1.01 This section outlines the tests and adjustments to be performed on the KS-20159 L1 ▶(Manufacture Discontinued) and KS-20159 L2◀ equalizer-amplifiers and the operating procedures when used for local programming.

1.02 This section is reissued for the following reasons:

- To show the KS-20159 L1 equalizer-amplifier Manufacture Discontinued and add the KS-20159 L2 equalizer-amplifier
- To add Part 7 covering the substitution of an amplifier.

This reissue does not affect the Equipment Test List.

1.03 The tests outlined in this section should be performed each time a circuit order or the service order specifies the use of a KS-20159 equalizer-amplifier. These tests may also be used to locate equipment troubles.

1.04 The intent of the tests outlined in this section is to determine whether the equalizer-amplifier is functioning correctly. If trouble is found in the plug-in circuit board, the defective board should be returned to a repair center. If replacing a circuit board does not clear the trouble, the entire equalizer-amplifier should be returned to the repair center.

2. RECOMMENDED TEST EQUIPMENT

2.01 The following items of test equipment are required for tests on the KS-20159 equalizer-amplifier:

(a) J94021A (21A) transmission measuring set (TMS)

(b) J94003A (3A) noise measuring set (NMS)

(c) 600-ohm resistor.

2.02 The amplifier covered in this section is a high-quality amplifier with broad frequency range. It is therefore necessary that good testing techniques be used in order to obtain a satisfactory result. Test equipment should be in good working condition and properly calibrated.

Caution: ▶The KS-20159 L1 AMPL IN jacks have 48-volt battery on them. A ground applied to the tips of these jacks will blow the office fuse. Turn the amplifier OFF before patching into AMPL IN jacks to avoid blowing the office fuse. The

KS-20159 L1 MONITOR jacks have 30 volts on them in normal operation. A ground applied to the upper MONITOR jack (J103) will blow the office fuse.

3. GAIN FREQUENCY

3.01 The gain-frequency response of the KS-20159 equalizer-amplifier should be measured in accordance with Chart 1.

CHART 1

GAIN-FREQUENCY TEST

APPARATUS:

1—J94021A (21A) Transmission Measuring Set

STEP	PROCEDURE
1	Connect the equipment as shown in Fig. 1 and remove the equalizer plug-in circuit board.
2	Turn on the 21A TMS and allow ample warm-up time.
3	The DB ATT dial on the amplifier should be set at 0 and the amplifier VERNIER GAIN control turned to its maximum clockwise position.
4	Turn on the amplifier.
5	Set the 21A DET INPUT to the +10 position.
6	Adjust the 21A OSC OUTPUT for −25 dBm at 1000 Hz.
7	The 21A DET should indicate +18.5 dBm ±1 dB. (This is the DET INPUT dial reading plus the meter indication.)
8	Sweep the 21A OSC frequency from 35 Hz to 15 kHz. ***Requirement:*** The gain should not change by more than ±0.5 dB from the 1000-Hz gain over the band of frequencies.
9	Turn the VERNIER GAIN control counterclockwise as far as it will go. ***Requirement:*** The 21A DET reading should drop approximately 2.5 dB.
10	Decrease the amplifier gain by rotating the DB ATT dial one step at a time counterclockwise.

CHART 1 (Cont)

STEP	PROCEDURE
	Requirement: The 21A DET indication should be lowered 2 $\pm$0.25 dB for each step except the last.
11	Turn the DB ATT dial to the OFF position.
	Requirement: The output should drop by at least 40 dB.

4. NOISE

4.01 The noise of the KS-20159 L1 equalizer-amplifier should be measured in accordance with Chart 2.

CHART 2

NOISE TEST

APPARATUS:

1—J94003A (3A) Noise Measuring Set

1—600-Ohm Resistor

STEP	PROCEDURE
1	Connect the equipment as shown in Fig. 2.
2	Set the DB ATT dial on the amplifier to 0 and the VERNIER GAIN control to maximum clockwise position.
3	Turn on the 3A NMS and allow ample warm-up time.
4	Turn on the amplifier and note the indication on the 3A NMS.
	Requirement: The 3A NMS indication should not exceed 30 dBrn.
	Note: The above requirement is dependent upon using a power supply having a noise level not exceeding an indication of +59 dBrn when connected to the amplifier.

CHART 2 (Cont)

STEP	PROCEDURE
5	Reinsert the equalizer plug-in circuit board.

5. EQUALIZATION

Caution: If the pre-equalization tests outlined in Section 320-145-502 have not been met, do not proceed with the tests in Charts 3 and 4.

5.01 When equalizing circuits are more than one amplifier section in length, each amplifier section should be equalized separately. The section adjacent to the "sending end" should be equalized first. Each succeeding section should be equalized in tandem (series) with those previously equalized. When intermediate amplifiers are involved, the circuit should be equalized through the amplifier. This procedure should be followed through to the "receiving end" of the circuit.

5.02 The gain of the intermediate amplifiers should be adjusted to compensate for the equalized loss of the cable at 1000 Hz. The oscillator should remain at the sending end throughout the test in order to simplify the testing operations. Another reason for leaving the oscillator at the sending end is that slight corrections can be made in the equalization of each section, if necessary, in order to meet the overall loss-frequency requirements.

5.03 In some instances, it may be necessary to make slight readjustments of intermediate equalizers in order to obtain the desired frequency response. All adjustments should be coordinated with the control office.

5.04 In most instances, nonloaded cable pairs are used for program circuits. Where program loading is used, special equalizing procedures may be required. In these cases, the proper lines of organization should be consulted for instructions on equalizing these facilities.

5.05 In order to make these tests, it will be necessary to establish a talking circuit between the sending and receiving ends of the circuit. A message grade circuit will be satisfactory for this purpose.

CHART 3

5- OR 8-KHZ EQUALIZATION TEST

The procedure for equalizing a single of a 5- or 8-kHz local program circuit is given below. If more than one section is to be equalized, see 5.01.

Caution: Do not proceed if pre-equalization requirements have not been met.

APPARATUS:

1—J94021A (21A) Transmission Measuring Set

CHART 3 (Cont)

STEP	PROCEDURE
1	Connect the equalizer for the 5- or 8-kHz condition as outlined in Table A.
2	Connect the equipment as shown in Fig. 3.
3	Set the selector switch (S1) on the equalizer to 5 or 8 kHz.
4	Set R1 on the equalizer to 100 ohms.
5	Adjust the 21A OSC for 5 or 8 kHz at 0-dBm output. (The 21A OSC is a stable instrument whose output power does not vary with change in frequency.)
6	Adjust the amplifier gain using the DB ATT and VERNIER GAIN controls on the amplifier for a 0-dBm reading on the 21A DET.
7	Adjust the 21A OSC for 100 Hz.
8	Adjust R1 on the equalizer for a 0-dBm reading on the 21A DET.
9	Adjust the 21A OSC for 5 or 8 kHz.
10	Note the indication on the 21A DET.
11	Adjust the 21A OSC for 100 Hz.
12	Adjust R1 on the equalizer for the same indication as noted in Step 10.
13	Alternately check the indication at 5 or 8 kHz and adjust R1 at 100 Hz until the low and high losses are matched.
14	Check the required test frequencies as listed in Table B. ***Requirement:*** The loss at the intermediate frequencies should be equal to the 100-Hz loss ± 1 dB.
15	If the requirement in Step 14 is met, adjust the 21A OSC for 1000 Hz and adjust the amplifier gain for 0 dBm on the 21A DET.
16	If the requirement in Step 14 is not met, proceed with the compromise method that follows.

COMPROMISE METHOD

If a hump or dip which does not exceed 2 dB in magnitude occurs in the response, proceed with Step 17. If it is greater than 2 dB, see Part 6.

CHART 3 (Cont)

STEP	PROCEDURE
17	Using R1, reset the 100-Hz loss to equal the 5- or 8-kHz loss plus or minus one-half the magnitude of the dip or hump (increase loss for dip and decrease loss for hump). ***Note:*** This adjustment will yield a response characteristic which will have some portions of the response as much as 1 dB greater or less than the 100-Hz value.
18	If the compromise method fails to yield satisfactory results, see Part 6.

CHART 4

15-KHZ EQUALIZATION TEST

The procedure for equalizing a single section of a 15-kHz local program circuit is given below. If more than one section is to be equalized, see 5.01.

Caution: Do not proceed if pre-equalization requirements have not been met.

APPARATUS:

1—J94021A (21A) Transmission Measuring Set

STEP	PROCEDURE
1	Connect the equalizer for the 15-kHz condition as outlined in Table A.
2	Connect the equipment as shown in Fig. 3.
3	Set the selector switch (S1) on the equalizer to 15 kHz-1.
4	Set R1 on the equalizer to 100 ohms.
5	Adjust the 21A OSC for 15 kHz at 0-dBm output. (The 21A OSC is a stable instrument whose output power does not vary with change in frequency.)
6	Adjust the amplifier gain using the DB ATT and VERNIER GAIN control on the amplifier for a 0-dBm reading on the 21A DET.
7	Adjust the 21A OSC for 100 Hz.

CHART 4 (Cont)

STEP	PROCEDURE
8	Adjust R1 on the equalizer for a 0-dBm reading on the 21A DET.
9	Adjust the 21A OSC for 15 kHz.
10	Note the reading on the 21A DET.
11	Adjust the 21A OSC for 100 Hz.
12	Adjust R1 on the equalizer to equal the value noted in Step 10.
13	Alternately check the indication at 15 kHz and adjust R1 at 100 Hz until the high and low losses are matched.
14	Check the losses at 1 and 8 kHz.
	Note: At this point one of the three conditions typically exists. The conditions and their remedies are as follows.
	Condition (a): The losses at 1 and 8 kHz are within $\pm$1 dB of the 100-Hz loss.
	Remedy (a): Check the response at the required test frequencies listed in Table B.
	Requirement: The loss at the test frequencies should be equal to the 100-Hz loss $\pm$1 dB.
15	If the requirement in remedy (***a***) is met, adjust the 21A OSC for 1 kHz and adjust the amplifier gain for a 0-dBm reading on the 21A DET.
16	If the requirement in remedy (***a***) is not met, see condition (***b***) or (***c***), whichever is more applicable.
	Condition (b): A hump occurs in the response curve which exceeds 1 dB.
	Remedy (b): Sweep through the frequency band of 100 Hz to 15 kHz and note the peak magnitude of the hump. Rotate S1 on the equalizer to the next higher position and repeat the procedure starting with Step 5.
	Condition (c): A dip occurs in the response curve which exceeds 1 dB.
	Remedy (c): Sweep through the frequency band of 100 Hz to 15 kHz and note the peak magnitude of the dip. If the magnitude of the dip is greater than the magnitude of the hump in the preceding switch position, return to the preceding position and try the compromise method that follows. If the magnitude of the dip is less than the magnitude of the hump in the preceding switch position, proceed to the compromise method.

CHART 4 (Cont)

STEP	PROCEDURE
	COMPROMISE METHOD
	If a hump or dip which does not exceed 2 dB in magnitude occurs in the response, proceed with Step 17. If it is greater than 2 dB, see Part 6.
17	Rotate S1 to the 15-kHz position that gives the smaller response deviation.
18	Using R1, reset the 100-Hz loss to equal the 15-kHz loss plus or minus one-half the magnitude of the dip or hump (increase loss for dip and decrease loss for hump). *Note:* This adjustment will yield a response characteristic which will have some portions of the response as much as 1 dB greater or less than the 100-Hz value.
19	If the compromise method fails to yield satisfactory results or if the magnitude of the hump or dip exceeds 2 dB, see Part 6.

6. EFFECTS OF EXTERNAL COMPONENTS

6.01 Normally the procedures in Charts 3 and 4 will yield very satisfactory equalization of unloaded line. In some cases, however, equalization may become difficult to achieve and may become especially difficult on long lengths of line made up of mixed gauges or when several equalizers are being used in tandem. For these more difficult cases, it may be necessary to use external resistors or capacitors to achieve satisfactory equalization. These components may be connected directly to the terminals provided on TB-2 as shown in Fig. 4. The values of these components are dependent upon the particular line being equalized and can only be determined experimentally. The explanations in the following paragraphs should prove useful in determining component values.

SERIES RESISTANCE

6.02 Adding resistance in series with inductor L1 may prove effective in providing additional flattening between 5 and 15 kHz. For example, if position 15 kHz-2 is found to produce a hump in the equalized response within this frequency range, while position 15 kHz-3 produces a dip, and if the 15-kHz compromise method in Chart 4 fails to yield a satisfactory response, then series resistance should be added. To determine the necessary value, place the selector switch in the position which produced the dip (position 15 kHz-3 in example cited), and note the magnitude of the dip with R1 set at 100 Hz to match the loss at 15 kHz. Increase the loss at 100 Hz by the amount of the dip by decreasing R1. This setting of R1 is the approximate value of series resistance which should be connected as shown in Fig. 4A. R1 should then be rotated to zero. This method will improve the response by about 1 dB and will also increase the equalized loss by approximately the same amount.

SHUNT RESISTANCE

6.03 Connecting a resistance in shunt with the drop side of T1 may be expected to yield essentially the same results as the series resistance described in 6.02. However, its value is less easily determined. To obtain a suitable value, proceed as in 6.02 through the point of reducing the low-frequency loss by the amount of the dip. At this point, connect a resistance of between 1500 and 5000 ohms as shown in Fig. 4B. Resistor R1 may now have to be readjusted slightly to match the high- and low-frequency loss. If the added resistance is too small, a hump will occur in the

equalized response, whereas too large a resistance will only partially remove the dip.

SERIES OR SHUNT CAPACITANCE

6.04 Connecting a capacitor either in shunt or series with the selected internal capacitor may in some cases provide additional flattening between 5 and 15 kHz. The need for shunt capacity is typically characterized by a hump in the equalized response within this frequency range which cannot be removed, even in position 15 kHz-4. Adding the shunt capacity will reduce the resonant frequency of the circuit and the equalized loss. However, lowering the frequency too much will tend to produce either a hump or a horizontal S shape in the response which, in either case, will give a relatively sharp roll-off very near 15 kHz. Typically, it should not be required to lower the resonant frequency by more than 5 kHz. For the 15 kHz-4 position, this requires a shunt capacitor of about 0.015 μf which should be connected as shown in Fig. 4C.

6.05 The equalized response which requires series capacitance for additional flattening is difficult to characterize because of its similarity to the type of response requiring series or shunt resistance. The effect of this capacitance is to raise the resonant frequency of the circuit and to increase the equalized loss. Since the resonant frequencies of all four 15-kHz positions are relatively high, very little additional flattening may be expected by raising them further. In any case they should not be raised by more than 5 kHz. This will require a series capacitance between 0.009 and 0.25 μf, depending upon which switch position is used. The series capacitance should be connected as shown in Fig. 4D.

7. SUBSTITUTION OF AMPLIFIER

7.01 It is possible to substitute the amplifier portion of a spare unit for testing purposes. The procedure is as follows.

(1) Set the attenuator of the spare to the same loss as on the regular amplifier.

(2) Turn the power switches of both amplifiers OFF.

(3) Patch the amplifiers as follows:

- EQ OUT of regular to AMP IN of spare
- AMP OUT of spare to LINE OUT of regular.

(4) Turn the power switches ON.

Note: To substitute an entire equalizer-amplifier for another, the option straps on the spare (options Y or Z, X or W, and U or V) must be made the same as on the working unit. The attenuator and equalizer settings must be set the same. Then the spare unit can be substituted by patching at the LINE IN/AMP IN and AMP OUT/LINE OUT jacks.

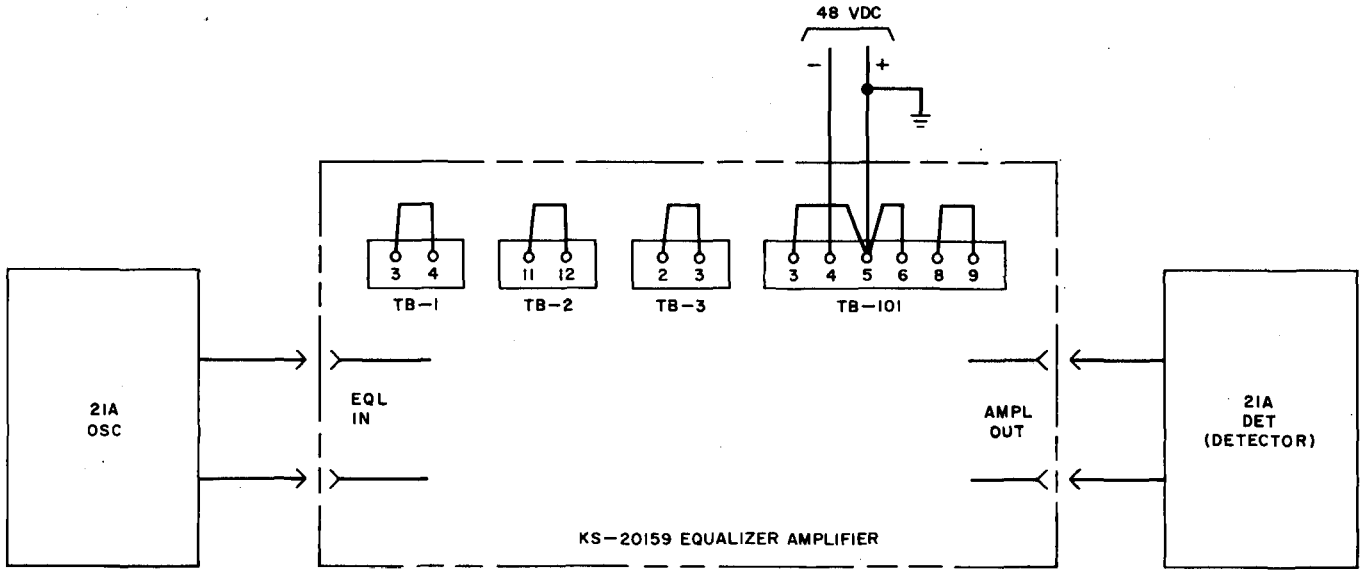


Fig. 1—Setup for Gain-Frequency Test for KS-20159 Equalizer-Amplifier

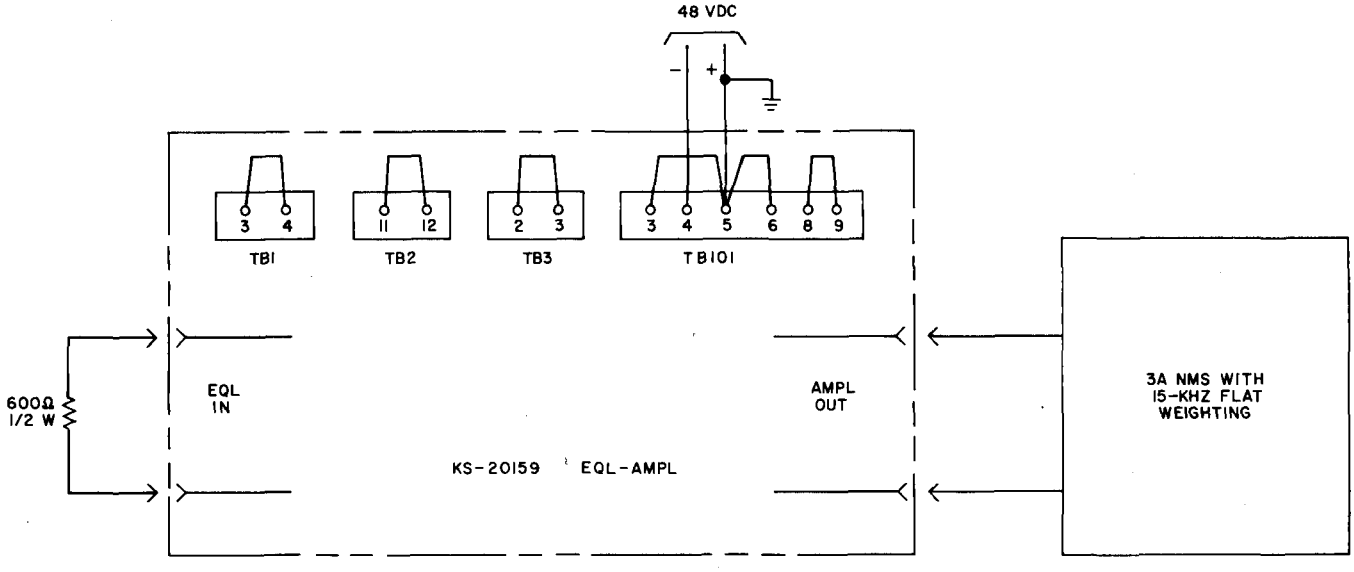


Fig. 2—Setup for Noise Test for KS-20159 Equalizer-Amplifier

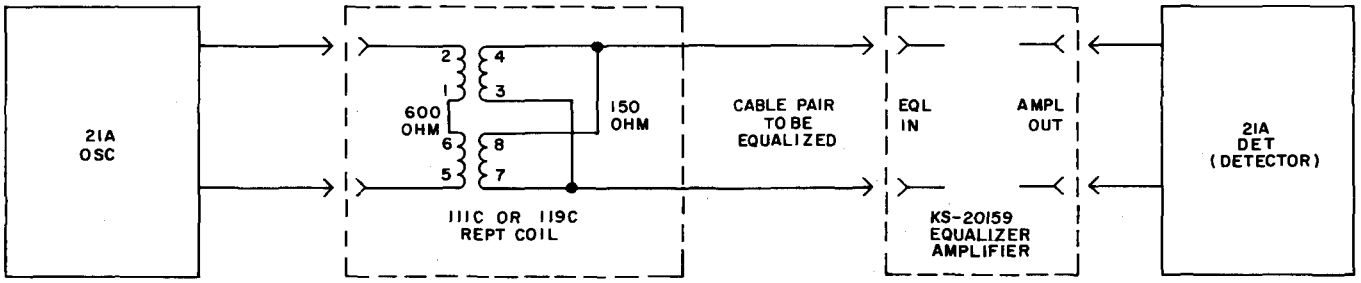
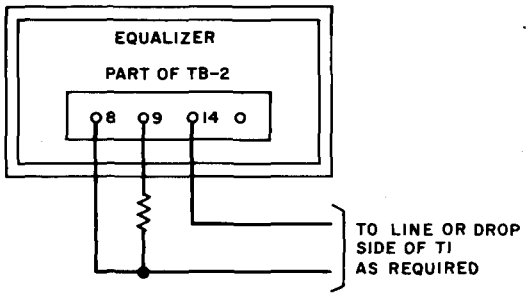
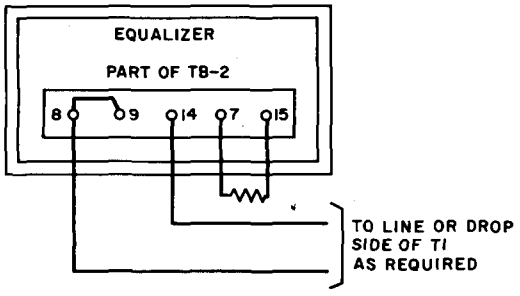


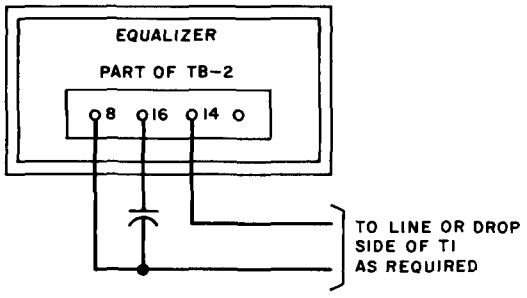
Fig. 3—Test Setup for Equalizing a Single Section Using the KS-20159 Equalizer-Amplifier



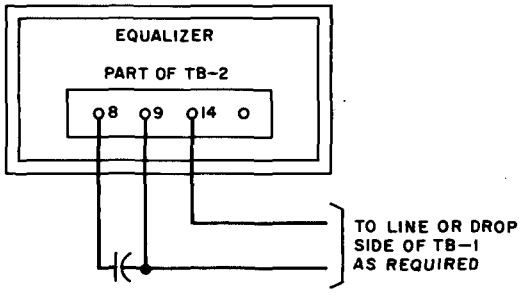
A SERIES RESISTANCE



B SHUNT RESISTANCE



C SHUNT CAPACITANCE



D SERIES CAPACITANCE

Fig. 4—External Component Connections

TABLE A

EQUALIZER STRAPPING

EQUALIZER CONDITION	TERMINATING IMPEDANCE (NOTE 1)	TERMINAL STRAPPING		EQUALIZER INPUT TERMINALS	EQUALIZER OUTPUT TERMINALS TO AMPLIFIER (NOTE 2)	AMPLIFIER OUTPUT TERMINALS	LINE OUTPUT TERMINALS
		TB-3	TB-2				
5 and 8 kHz	600	2 to 3	8 to 9; 9 to 10 10 to 11 12 to 13 13 to 14	1 and 2 of TB-1	5 and 6 of TB-2	19 and 20 of TB-2	17 and 18 of TB-2
	150 (Note 3)	1 to 2	8 to 9; 9 to 10 10 to 11 12 to 13 13 to 14	1 and 2 of TB-1	5 and 6 of TB-2	19 and 20 of TB-2	17 and 18 of TB-2
15 kHz	600	2 to 3	7 to 8; 8 to 9 10 to 11 12 to 13 14 to 15	1 and 2 of TB-1	5 and 6 of TB-2	19 and 20 of TB-2	17 and 18 of TB-2
	150 (Note 3)	1 to 2	7 to 8; 8 to 9 10 to 11 12 to 13 14 to 15	1 and 2 of TB-1	5 and 6 of TB-2	19 and 20 of TB-2	17 and 18 of TB-2

Note 1: Terminating impedance is the impedance into which the equalizer must operate.

Note 2: If the equalizer is used without an amplifier, then on TB-2, terminals 5 and 6 should be connected to terminals 19 and 20.

Note 3: The strapping for 150-ohm terminating impedance is required only when the equalizer is to be used in conjunction with an amplifier which has a 150-ohm input impedance.

TABLE B

TEST FREQUENCIES (IN Hz)

5-KHZ CIRCUITS	8-KHZ CIRCUITS	15-KHZ CIRCUITS
100	50	50
250	70	70
500	100	100
1000	250	250
2000	500	400
3000	1000	500
4000	2000	1000
4500	3000	2000
5000	4000	3000
	5000	4000
	6000	5000
	7000	6000
	8000	7000
		8000
		9000
		10,000
		11,000
		12,000
		13,000
		14,000
		15,000