LOCAL CHANNEL EQUALIZATION OF 15-KHZ PROGRAM CIRCUITS

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1. GENERAL

1.01 This practice is revised, renumbered, and reissued to meet the 320 Division's new restructure specification.

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

1.03 It is assumed that the circuit to be equalized has met all the requirements for the pre-equalization tests. ***IF THE PRE-EQUALIZATION REQUIREMENTS HAVE NOT BEEN MET, DON'T PROCEED WITH THESE TESTS!***

1.04 This practice includes a suggested work form for recording the equalization data. The form, or one similar to it, should be prepared locally. Such a form is helpful in following the test and the behavior of the circuit for various equalizer adjustments.

1.05 When equalizing circuits 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. This can be accomplished by moving the Transmission Measuring Set (TMS, eg, HP3552A) to the end of the next section. 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.

1.06 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.

1.07 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.

1.08 In most instances, nonloaded cable pairs are used for 15-kHz 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 as to how to equalize these facilities.

1.09 In order to make these equalization 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.

2. EQUALIZATION TEST

2.01 The SD-55503-01 Equalizer is connected to the circuit as shown in Fig. 1. A decade resistor should be used in place of the resistors normally provided with the equalizer. This will speed up the testing procedure. Chart I outlines the procedure for equalizing a single section 15-kHz local program circuit.

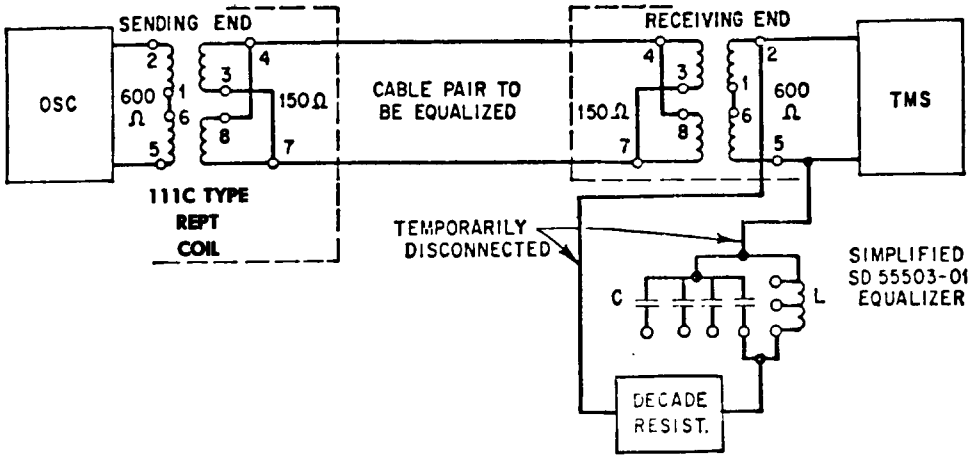

Fig. 1—Test Setup for Equalizing a Single Section with SD-55503-01 Equalizer

CHART 1

STEP	PROCEDURE
1	Connection test equipment to ac power. ***Requirement:*** Allow ample warmup time.
2	Adjust OSC for 0 dBm output to the repeating coil.
3	Measure the loss of the bare cable pair at 1, 5, 8, 10, 12, and 15 kHz. ***Requirement:*** The 1 kc loss should be 16.5 dB or less, with coils in the circuit (10 dB without coils). If not met, the section may be too long to equalize.
4	Connect the equalizer as shown in Fig. 1.
5	Strap the tuned circuit for a resonant frequency of about 18 kHz. ***Requirement:*** Strap inductance value for between 0.008 and 0.010 henries. Select value of capacity from Table A. See note below.*
6	Adjust the resistance decade box until 1 kc loss is about same as 15 kHz loss. ***Requirement:*** The two losses should be within ±0.5 dB.
7	If the above requirements are not met, select another value of inductance and capacitance from Table A and readjust the decade until this requirement is met. ***Note:*** Use of the attached worksheet will help the tester note the trend of the equalizing and help in selecting other values of L and C.
8	Measure the loss at the frequencies shown in suggested form attached. ***Requirement:*** ±1.0 dB of 1 kHz loss. Record these values.
9	Strap the resistance taps on the equalizer to agree as closely as possible to the final setting of the decade box obtained in Step 8. ***Requirement:*** Same as Step 8 above.

***Note:** This value of inductance will equalize a cable pair with a 1 kHz loss of about 10 dB. This corresponds to the loss of a bare cable in Step 3 above. See paragraph 2.03 also.

TABLE A

VALUES OF INDUCTANCE AND CAPACITANCE TO TUNE EQUALIZER TO 18 KHz

251A INDUCTOR (HENRIES) (L)	187A CAPACITOR (MF) (C)	251A INDUCTOR (HENRIES) (L)	187A CAPACITOR (MF) (C)
0.018 (1-8)*	0.004 (1+2)**	0.004 (4-7)*	0.020 (6)**
0.015 (1-7)	0.005 (3)	0.003 (1-3)	0.026 (2+3+6)
0.012 (1-6)	0.007 (4)	0.0025 (4-6)	0.031 (3+4+6)
0.010 (2-8)	0.008 (1+2+3)	0.002 (1-2)	0.039 (4+5+6)
0.009 (1-5)	0.009 (1+4)	0.0014 (2-4)	0.056 (1+6+7)
0.008 (3-8)	0.010 (3+4)	0.001 (6-8)	0.079 (2 thru 7)
0.006 (1-4)	0.013 (2+3+4)		

* Terminal numbers.
** Connect units in parallel when two or more are shown.

2.02 The selection of the proper L/C ratio from Table A may require trying more than one strapping of the equalizer before the correct ratio is found. A quick rule of thumb in selecting the ratio is to remember that the larger L (inductance) is, the lower the loss will be in the range between 1 kHz and 15 kHz. This is particularly true at frequencies between 8 kHz and 10 kHz. So, if after a series of measurements the loss is found to be too high, increase the value of L and remeasure the overall losses. The decade resistor may require some readjustment, also.

2.03 In some situations the equalized losses over the band of frequencies will be found to be consistently higher or lower than the 1 kc equalized loss. These losses can be shifted slightly by making small changes in the resistance of the equalizer. The loss at some frequencies will then be more than the 1 kHz loss while other frequencies will be less.

2.04 The KS-16816, L1 Equalizer may be used to equalize a nonloaded cable pair to 15 kHz. It has the advantage that four fixed L/C ratios and resonant frequencies are available by means of a selector switch. Table B shows the resonating frequency for each of the switch positions.

TABLE B

RESONATING FREQUENCIES

Switch Position	Resonant Frequency (kc)
15 KHZ-1	17.6
15 KHZ-2	18.2
15 KHZ-3	21.3
15 KHZ-4	23.7

2.05 One of the big advantages of the KS-16816, L1 Equalizer is that it has an adjustable resistance element which eliminates the need for soldering which is necessary with the SD-55503-01 Equalizer. This speeds up the equalization considerably. Chart II gives the procedure for making this test with the KS-16816, L1 Equalizer. The test setup is shown in Fig. 2.

2.06 When a Telephone Company amplifier is located at the receiving end of the section, the procedure for equalizing is the same as in Chart I or II with the following exception. The amplifier gain at 1 kHz should be adjusted to give 0 dBm output. This assumes a 0 dBm test tone is applied at the sending end. The TMS should be connected to the output terminals of the amplifier.

2.07 In those situations where the circuit is more than one amplifier section in length, each 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. At intermediate amplifiers the circuit should be equalized at the output terminals of each amplifier. This procedure should be followed to the "receiving end" of the circuit.

3. NOISE AND CROSSTALK TESTS

3.01 For 15 kc circuits, the test setup for the final noise measurements is shown in Fig. 3. The 3C type NMS should be equipped with the 15-kHz flat weighting network. The sets should be connected to the circuit in accordance with the standard practices for the instruments.

3.02 The noise measurements should be corrected to the +8 VU volume level (amplifier output) by adding the equalized loss of the circuit. For instance, if the equalized loss, with intermediate amplifiers adjusted to proper levels, is 20 dB and the NMS reads 13 dB of noise at the −20 dB point, the corrected noise is 33 dBrn (20 + 13). This assumes there is no Telephone Company-owned amplifier at the measuring end.

3.03 The circuit noise at the "receiving end" of the circuit should not exceed 33 dBrn when referred to the +8 VU level point. The DB dial of the NMS should be set to bring the meter indications above the "0" mark. Occasional extreme meter excursions may be ignored. The noise should be measured during the heavy traffic period.

3.04 The crosstalk should be observed using the setup of Fig. 3 and using the monitoring receiver provided with the NMS. No intelligible words or syllables should be heard with the DB dial of the set adjusted to the same dial setting for measuring noise. The circuit should be monitored for at least 10 minutes during the heavy traffic load period.

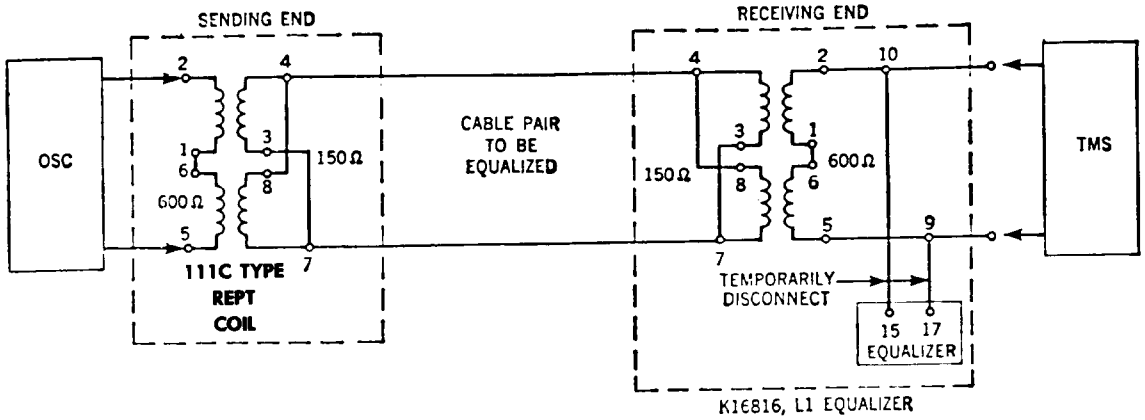

Fig. 2—Test Setup for Equalizing a Single Section Using KS-16816, L1 Equalizer

CHART II

STEP	PROCEDURE
1	Connect test set to ac power.
	Requirement: Allow ample warmup time.
2	Adjust OSC for 0 dBm output to the repeating coil.
3	Measure 1 kHz loss as shown in Fig. 2 with equalizer removed.
	Requirement: The 1 kHz loss should be 16.5 dB or less with coils in the circuit (10 dB without coils). If not met, the circuit may be too long to equalize.
4	Connect equalizer to the circuit as shown in Fig. 2.
5	Set the selector switch to 15 kHz-1.
6	Measure the loss at 1 and 15 kHz.
7	Adjust the resistance.
	Requirement: Make 1 kHz loss same as 15 kHz loss.
8	If requirement of Step 6 cannot be met, set selector switch on 15 kHz-2, then 15 kHz-3, then 15 kHz-4, if necessary.
	Note: Readjust resistance for each position.
	Requirement: Same as Step 7.
9	Make frequency run using attached form.
	Requirement: ±1.0 dB of 1 kHz loss. Record these values.
10	Clamp resistance by means of thumbscrew.

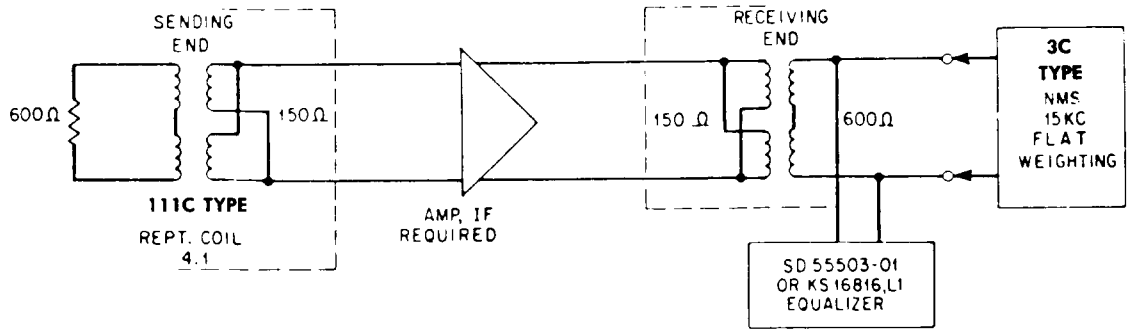

Fig. 3—Final Noise Test for 15 kHz Circuit

4. LEVEL MEASUREMENTS

4.01 When intermediate amplifiers are required, the gain of the amplifier should be adjusted to offset the equalized 1-kHz loss to that point. This means that the amplifier gain may require resetting each time the equalizer is adjusted.

4.02 The overall 1-kHz transmission should be measured from the "sending end" to the "receiving end" of the equalized circuit. This value should be recorded for future reference by the control office.

5. WORK FORM FOR RECORDING DATA

5.01 The work form (see Fig. 4), or one similar to it, should be prepared locally. Data obtained in the tests should be recorded on this form so that the deviations in equalization can be analyzed. This worksheet may also be filed at the control office for future reference if the Telephone Company desires to do so.

6. TROUBLE-HUNTING HINTS

6.01 The trouble-hunting hints outlined below give some idea as to where to look for specific troubles. It is not intended to include all sources of troubles in the list. Hence, other possibilities should not be overlooked.

6.02 *Circuit Is Noisy on Initial Noise Test*

Sources of Noise

(1) Protector carbons dirty

(2) Induction from central office battery

(3) Load coil on cable pair

(4) High resistance splices in cable

(5) Grounded tip or ring conductor

(6) Repeating coil missing

(7) Repeating coil shield may require grounding

(8) Excessive power line induction.

Remedial Measures

(1) Select another cable pair.

(2) Clean or replace carbons.

(3) If noise is due to excessive power line induction or central office battery, consult your supervisor.

6.03 *Circuit Losses Cannot Be Equalized Properly*

Sources of Troubles

(1) Bridged taps on loop

(2) Repeating coils improperly strapped or missing

(3) Equalizer located on wrong side of repeating coil

(4) Equalizer strapped incorrectly

(5) Cable partially loaded	(1) Consult cable assignment bureau for makeup of cable. If bridged taps are present, select another cable pair.
(6) Amplifier input and output impedances not correct.	(2) Check repeating coils and equalizer.

Remedial Measures

SHEET____ OF ____ SHEETS

PROGRAM EQUALIZATION WORKSHEET 15 KHZ CIRCUITS

Circuit No. _____ From _____ To _____ Order No. _____

Date Tested _____ Tested by _____ Date Serv. Due _____

Sending End _____ Receiving End

Location _____ *Location _____

Equip. _____ Equip. _____

INSERT SYMBOL (▷) AND OFFICE WHERE INTERMEDIATE AMPLIFIER IS LOCATED

PRELIMINARY NOISE _____ METALLIC VARLEY _____

LOOP RES. _____ INSULATION RESISTANCE _____

FREQ. HERTZ	DB LOSS	DEV.□	DB LOSS	DEV.□	DB LOSS	DEV.□	DB LOSS	DEV.□	DB LOSS	DEV.□	DB LOSS	DEV.□
1000												
35												
70												
100												
250												
400												
500												
1000												
2000												
3000												
4000												
5000												
6000												
7000												
8000												
9000												
10000												
11000												
12000												
13000												
14000												
15000												
1000												
EQL SETTING												
IND.												
CAP.												
RES.												

CKT Level at*_____ dbm Amp. Gain Step at* _____

Amp. No. at* _____ Amp. Loc. at* _____ Floor ____ RR ____ Bay ____

Final Ckt Noise at*_____ dbRN

*Receiving end

□ Deviation from 1000~ loss

Fig. 4—Program Equalization Worksheet 15 KHz Circuits