SPECIAL SERVICE LINK LINEUP
CENTRAL OFFICE TO STATION 2-WIRE
LINK USING E6 REPEATERS

CONTENTS PAGE

1. GENERAL

1.01 The E6 repeatered line is used in several types of service circuits. Each of these special circuits may consist of one or more of the following links: private branch exchange (PBX) to central office (CO), CO to CO, and CO to station. This section provides lineup procedures for the CO to station 2-wire link.

1.02 This section is reissued to:

(a) Add information on the interconnection of the test sets

(b) Make the figures agree with the text

(c) Correct switch designations.

1.03 The CO to station link may include E6 repeaters, repeater disablers, dial long line (DLL) units, and line building-out (LBO) networks on loaded or nonloaded lines. The equipment used in individual links varies widely; therefore, the procedures in this section rely on the circuit layout record (CLR) to provide the necessary details for specific links.

1.04 The CLR provides the following information:

(a) Equipment used at the CO and station.

(b) Initial adjustments or prescription settings of all E6 repeaters, LBO networks, and gain units. Temperature corrections, if required, are included.

(c) Simplex or loop strapping options for E6 repeater disablers.

(d) Diagram of special service circuit showing 1-kHz net loss and echo return loss requirement for each link.

(e) Overall expected measured loss (EML) for the special service circuit.

1.05 Lineup of CO to station links begins with initial adjustments of the E6 repeater, LBO networks, and gain units according to the information on the CLR. Gain is checked with the J99254A (54A) transmission measuring set (TMS) and, if required, final LBO adjustments are made using the J99254C (54C) return loss measuring set (RLMS). Where available, the KS-20501 RLMS (see Section 103-106-115) may be used as an alternative to the 54C set. It is powered from commercial 60-Hz supply only and needs no auxiliary supply. Where this section specifies using the 500- to 2500-Hz sweep of the 54C set, the echo range of the KS-20501 set may be used. Where this section specifies using the 2000- to 3000-Hz sweep, the high range of the KS-20501 set may be used. Although the readings of the 54C and the KS-20501

sets usually differ a little from each other, the same numerical requirements should be used for the readings of the KS-20501 set and the 54C set.

2. APPARATUS

2.01 The following listed test apparatus or the equivalent is required for performing the CO to station lineup:

1—Line Extension Cord, ED-97023-30

1—J99254A (54A), L1 Transmission Measuring Set (TMS) with Cords

1—J99254B (54B) Test Stand

1—J99254C (54C) or KS-20501 Return Loss Measuring Set (RLMS) with Cords (Required only if LBO networks are adjusted)

1—Circuit Layout Record (CLR)

1—832A Network

1—4097B Network

1—4066H Network (Termination at station).

3. LINK WITH AN 830E NETWORK AT CO AND NONLOADED CABLE

3.01 With this circuit layout, LBO network adjustments and gain settings are made initially in accordance with the CLR. Gain is checked with the 54A TMS, and final adjustment of the 830E network is accomplished by checking return loss with the 54C RLMS.

STEP	PROCEDURE
1	Consult the CLR to determine gain settings of the 831-type network in the E6 repeater.
2	Set the adjustment screws of the 831-type network in accordance with the CLR. (If the gain is specified in dB, refer to Part 8.)
3	Check the gain of the E6 repeater by using the procedure in Part 8 of this section.
4	Adjust the 830E network at the CO by using the 54C RLMS and the procedure in Part 9.

4. LINK WITH AN 830A, 830B, OR 830G NETWORK AT CO AND LOADED CABLE

4.01 With this circuit layout, network adjustments are made in accordance with the CLR. No gain adjustment for this link is required.

5. LINK WITH AN 832A NETWORK AT CO AND NONLOADED CABLE

5.01 When the 832A network is installed, no LBO network adjustments or repeater gain adjustments for this link are required.

6. LINK WITH AN 832A NETWORK AT CO AND LOADED CABLE

6.01 When the 832A network is installed, no LBO network adjustments or repeater gain adjustments for this link are required.

7. LINK WITH 830E AND 830F NETWORKS AT CO AND NONLOADED CABLE

7.01 With this circuit layout, the nonadjustable 830F network has been provided to add delay

distortion. Part 9 of this section contains the procedure for adjustment of the 830E network.

8. ADJUSTMENT OF REPEATER GAIN

8.01 The repeater gains should be set according to the CLR. At the CO, check the gain of the E6 repeater by using the procedure in the following steps:

STEP	PROCEDURE
1	Consult the CLR to determine gain settings of the 831-type network in the E6 repeater. ***Note:*** Under certain circumstances, the gain of a single repeater will be used to supply gain for two adjacent links. The gain on the CLR for those cases will be higher than that ordinarily required. The single repeater will also contain the proper LBO for the adjacent link. If a repeater disabler is used on this link, the enabler relay must be blocked in its operated position.
2	Place the printed wiring-board side of the 831-type network face up. Loosen screws A through K and 1 through 9. All adjustments on the gain network are now made by tightening some of these screws. Contact with the printed wiring-board conductors is made under the screwheads. Therefore, the screwheads should be either fully down on or fully clear of the printed wiring board, as required.
3	Set the 54B test stand and 54A TMS near the −48 volt power distribution outlet, which is provided on bays equipped with E6 repeaters.
4	Connect −48 volt power ▶from the repeater bay◀ to the 54B test stand ▶and patch the TMS TST PWR jack of the 54B to the TEST PWR jack of the 54A TMS, using the P5F cords. Patch the TMS A and B jacks of the 54B to the A and B jacks of the 54A, using the 3P7B cords with 310-type plugs (Fig. 1).◀ ***Note:*** The 54A TMS has neither a switch to apply power nor a pilot light. No warm-up period is necessary. No connection to the cable pairs is required for the gain adjustment of the 831-type network.
5	Carefully insert the repeater into the 54B test stand. Lower (do not drop or force) the repeater into the stand so that the repeater terminals at the back of the repeater fit into the connector of the test stand. Rotate the ▶turret◀ of the 54B test stand so that the 831-type gain unit side of the repeater is easily accessible.
6	All screws on the gain unit side should have been loosened as in Step 2. Consult the CLR for the specified gain adjustment. Refer to Table A to determine the necessary screw settings for this specified gain value. ***Example:*** In the row corresponding to 12-dB gain, screws A, B, C, E, H, and 1, 2, 4, 5, 7, 9, are listed to be turned down. Tighten these firmly, but not excessively, and leave all other screws raised. ***Caution: Excessive tightening may strip threads.***

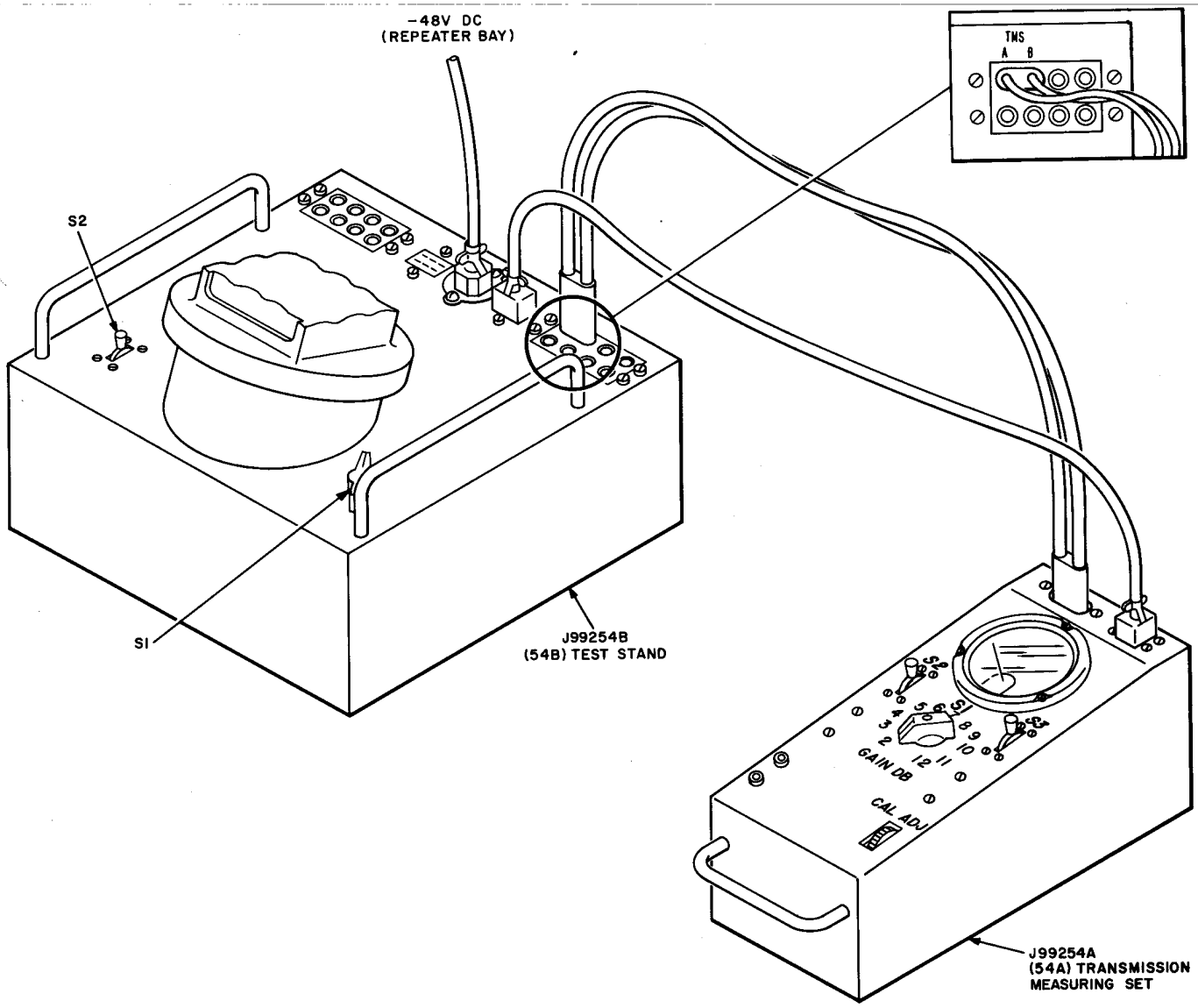

Fig. 1—Converter Gain—Test Equipment Connections

STEP	PROCEDURE
	Converter Unit Gains
7	On the 54B test stand, set switch S2 to a neutral position and switch S1 to GAIN position.
8	Throw S2 on the 54A TMS to CAL and adjust the knurled knob CAL ADJ to give a 0-dB reading on the meter. Then set S2 to MEAS position. The position of other keys and knobs on the 54A set does not affect this reading.

TABLE A

831-TYPE NETWORK
E6 GAIN-UNIT SETTINGS

TOTAL 1-KHZ GAIN (DB) MEASURED*	SERIES OR SHUNT GAIN† (DB)	SERIES SCREWS DOWN	SHUNT SCREWS DOWN	TOTAL 1-KHZ GAIN (DB) MEASURED*	SERIES OR SHUNT GAIN† (DB)	SERIES SCREWS DOWN	SHUNT SCREWS DOWN	TOTAL 1-KHZ GAIN (DB) MEASURED*	SERIES OR SHUNT GAIN † (DB)	SERIES SCREWS DOWN	SHUNT SCREWS DOWN	TOTAL 1-KHZ GAIN (DB) MEASURED *	SERIES OR SHUNT GAIN† (DB)	SERIES SCREWS DOWN	SHUNT SCREWS DOWN
0.0	0.0	BCDGHJK	123	3.4	1.8+	ADEFGJK	13467	6.8	4.0	CDEJK	1578	10.1	6.3+	DGHK	469
0.1	0.0	ABDGHJK	14	3.5	1.9	BCEFGJK	567	6.9	4.0+	BDEJK	3578	10.2	6.4	BCGHK	12469
0.2	0.1	ADGHJK	134	3.6	2.0	CEFGJK	12567	7.0	4.1	ABCEJK	123578	10.3	6.5	ABGHK	13469
0.3	0.1+	BCGHJK	5	3.7	2.0+	AEFGJK	23567	7.1	4.2	CEJK	24578	10.4	6.5+	AGHK	123469
0.4	0.2	ABGHJK	35	3.8	2.1	ABCDFGJK	24567	7.2	4.3	AEJK	134578	10.5	6.6	BCDEFHK	2569
0.5	0.2+	GHJK	235	3.9	2.1+	CDFGJK	134567	7.3	4.4	ABCDJK	1234578	10.6	6.7	ABDEFHK	3569
0.6	0.3	BCDEFHJK	145	4.0	2.2	ADFGJK	8	7.4	4.5	CDJK	2678	10.7	6.8	DEFHK	4569
0.7	0.3+	CDEFHJK	345	4.1	2.3	ABCFGJK	128	7.5	4.5+	ADJK	13678	10.8	6.9	BCEFHK	124569
0.8	0.4	BDEFHJK	2345	4.2	2.3+	CFGJK	238	7.6	4.6	ABCJK	123678	10.9	7.0	CEFHK	234569
0.9	0.4+	DEFHJK	16	4.3	2.4	AFGJK	148	7.7	4.7	CJK	24678	11.0	7.1	AEFHK	179
1.0	0.5	BCEFHJK	36	4.4	2.5	BCDEGJK	348	7.8	4.7+	AJK	134678	11.1	7.2	BCDFHK	1279
1.1	0.6	ABEFHJK	1236	4.5	2.5+	ABDEGJK	12348	7.9	4.8	ABCDEFGHK	1234678	11.2	7.2+	CDFHK	2379
1.2	0.6+	AEFHJK	246	4.6	2.6	DEGJK	258	8.0	4.8+	CDEFGHK	25678	11.3	7.3	ADFHK	1479
1.3	0.7	BCDFHJK	1346	4.7	2.6+	ACEGJK	1358	8.1	4.9	ADEFGHK	135678	11.4	7.4	ABCFHK	12479
1.4	0.7	ABDFHJK	56	4.8	2.7	BEGJK	458	8.2	5.0	ABCEFGHK	1235678	11.5	7.5	CFHK	23479
1.5	0.7+	ADFHJK	1256	4.9	2.8	ABCDGJK	12458	8.3	5.1	CEFGHK	245678	11.6	7.5+	BFHK	579
1.6	0.8	BCFHJK	2356	5.0	2.8+	CDGJK	23458	8.4	5.1+	AEFGHK	345678	11.7	7.6	ABCDEHK	2579
1.7	0.9	CFHJK	1456	5.1	2.9	ADGJK	168	8.5	5.2	BCDFGHK	12345678	11.8	7.7	CDEHK	13579
1.8	0.9+	AFHJK	3456	5.2	2.9+	BCGJK	368	8.6	5.3	CDFGHK	9	11.9	7.8	BDEHK	4579
1.9	1.0	ABCDEHJK	123456	5.3	3.0	CGJK	12368	8.7	5.4	ADFGHK	129	12.0	7.9	ABCEHK	124579
2.0	1.0	CDEHJK	27	5.4	3.1	AGJK	2468	8.8	5.5	ABCFGHK	239	12.1	8.0	ACEHK	134579
2.1	1.1	BDEHJK	137	5.5	3.2	ABCDEFJK	13468	8.9	5.5+	CFGHK	149	12.2	8.0+	BEHK	1234579
2.2	1.2	ABCEHJK	47	5.6	3.2+	CDEFJK	568	9.0	5.6	AFGHK	349	12.3	8.1	EHK	2679
2.3	1.2	ACEHJK	1247	5.7	3.3	ADEFJK	12568	9.1	5.6+	ABCDEGHK	12349	12.4	8.1+	BCDHK	3679
2.4	1.3	BEHJK	2347	5.8	3.4	ABCEFJK	23568	9.2	5.7	ACDEGHK	159	12.5	8.2	CDHK	23679
2.5	1.3	ABCDHJK	157	5.9	3.5	CEFJK	14568	9.3	5.8	ABDEGHK	1259	12.6	8.2+	BDHK	14679
2.6	1.4	ACDHJK	357	6.0	3.5	AEFJK	34568	9.4	5.9	DEGHK	2359	12.7	8.3	DHK	124679
2.7	1.4+	BDHJK	12357	6.1	3.6	ABCDFJK	234568	9.5	6.0	BCEGHK	1459	12.8	8.4	BCHK	134679
2.8	1.5	DHJK	2457	6.2	3.6+	CDFJK	178	9.6	6.1	CEGHK	12459	12.9	8.5	CHK	5679
2.9	1.5+	ACHJK	13457	6.3	3.7	ADFJK	378	9.7	6.1+	BEGHK	23459	13.0	8.6	BHK	125679
3.0	1.6	BHJK	167	6.4	3.8	ABCFJK	12378	9.8	6.2	ABCDGHK	169	13.1	8.7	HK	135679
3.1	1.7	HJK	367	6.5	3.8+	CFJK	2478	9.9	6.2+	ACDGHK	1269	13.2	8.8	BCDEFGK	1235679
3.2	1.7+	BCDEFGJK	12367	6.6	3.9	BFJK	3478	10.0	6.3	ABDGHK	1369	13.3	8.9	CDEFGK	145679
3.3	1.8	ABDEFGJK	2467	6.7	3.9+	ABCDEJK	123478								

Notes: * Measured total gain is the gain measured with a 54A TMS. Possible variation in measured gain due to component allowances is ± 0.3 dB for gains above 13 dB and in proportion for lower gains.

† Measured series or shunt gain with the K screw UP.

STEP	PROCEDURE
9	Rotate GAIN DB knob S1 to the specified gain. Make certain that screw K on the 831-type network is loosened. Operate S3 to SERIES and rotate gain knob S1 counterclockwise until the meter reads between 0 and +1 dB. The series converter gain equals the sum of the gain knob setting plus the meter reading. Note this value.
10	Throw switch S3 from SERIES to SHUNT. Measure and note this gain.
11	Compare the two measured gain values with the value given for the 831-type network adjustment shown in Table A. ***Example:*** For 12-dB total gain, the separate converters should measure 7.9-dB gain as shown in Table A. If both series and shunt gain measurements fall within ±0.2 dB of this value and the difference between the two gain readings is less than 0.2 dB, proceed to measure the combined gain as described in Step ▶14.◀ . If not, adjust the gain of either the series or shunt converter or both as in the following steps.
12	Verify that the proper screws are turned down and that all others are clear of the printed wiring board. If no error can be found and the series converter gain measurement deviates by more than ±0.2 dB from the listed value, throw S3 to SERIES. Recalibrate as in Step ▶8◀ and then restore S2 to MEAS. Adjust screws A through J on the 831-type network to give the tabulated gain for a single converter to within ±0.1 dB. ***Note:*** Screw A gives the finest gain change; screws B, C, etc, give larger changes in approximately 2:1 steps. Tightening a screw on the series converter lowers the gain; loosening a screw raises the gain.
13	If the shunt converter gain measurement deviates by more than ±0.2 dB from the listed value, throw S3 to SHUNT and adjust the measured gain to within ±0.1 dB of the listed value, using screws 1 through 9 on the 831-type network. ***Note:*** Screws 1, 2, etc, are the fine gain adjustment. Loosening a screw on this converter lowers the gain; tightening a screw raises the gain.
14	The gains of the individual converters must agree with each other within 0.2 dB before combined gain can be measured.
15	Tighten screw K on the 831-type network and leave it in this position. (This screw connects series and shunt converter units together in the operating position.)
16	Recalibrate the 54A TMS.
17	Throw S3 to SH and SER and measure combined gain. This should check specified gain to within ±0.3 dB. Record the measured gain in pencil in the rectangular recess on the front face of the repeater after the word GAIN.
18	With S3 on SH and SER, operate ▶S2◀ to LOAD MEAS; the meter reading will decrease slightly. If this decrease is less than 0.4 dB, record both gain measurements on the repeater face. This data will be valuable for future maintenance checks on the repeater.

STEP	PROCEDURE
19	Repeaters that fall off in gain more than 0.4 dB between MEAS and LOAD MEAS are considered defective. Their converters should be returned to the Western Electric Company for repair.

9. ADJUSTMENT OF LINE BUILDING-OUT NETWORKS

9.01 The following procedures apply to the 830E and 830G LBO networks. These are the only networks that should require final adjustment by return loss measurement in the CO to station link. If an 830A or B network needs some touching up, use the procedure given in Section 311-100-551.

STEP	PROCEDURE
	A. 830E Network
1	Mount the 832A network on the NETWORK A side of the repeater and secure it by all four screws.
2	Slide the 830E network into the NETWORK B side of the repeater and secure it with all four screws on the connector block. *Note:* All four screws are needed since they also make the required electrical connections between the gain unit and the networks.
3	At the station end of the line, request that the line be terminated by placing either a "live" telephone, a 4066H network adjusted per Table B, or a 600-ohm 2-μF termination on the trunk. See Section 311-100-500 for further detail.
4	▶Insert the repeater into the turret of the 54B test stand. Rotate the turret so that the adjusting screws on the 830E network are accessible at the front of the test stand. Set switch S1 to NORM and switch S2 to neutral.◀
5	Connect the ▶LINE EXT A and B jacks on the◀ 54B test stand to the ▶vacant position on the repeater shelf by using the cord, per ED-97023-30, Group 2. Patch from the TST PWR jack of the 54C RLMS to the RLMS TST PWR jack of the 54B, using a P5F cord. Use a 3P7B cord to connect the RL jack of the 54B to the MEAS RL jack of the 54C. Connect the 4097B network to the pin jacks of the 830E network as shown in Fig. 2.◀ The 4097B (Section 103-104-101) network provides an easily adjusted inductance for determining the proper setting of inductance in the 830E network. Operate the key on the 4097B to 830E; dial readings will correspond to the inductance settings on the network (ie, if the dial reads 0.4 as optimum setting, the 0.4 screw on the network should be loosened; all others should be tightened).

TABLE B

ADJUSTMENTS OF 4066H NETWORK

RANGE OF DIRECT CURRENT SUPPLIED TO 500-TYPE TELEPHONE SET WITH HANDSET OFF THE CRADLE (MILLIAMPERES)	SCREW SWITCH TO BE CLOSED (TURNED IN); ALL OTHERS TO BE OPEN (TURNED OUT)
36 or less	A
37—50	B
51—61	C
62 or more	D

Note: Only one adjusting screw should be in the turned-in position for any of the dc ranges of current supplied to the 500-type set being balanced by the network. All others should be turned out two complete turns.

STEP	PROCEDURE
	Note: If a 4097B network is not available, a cut-and-try method utilizing the inductance screws on the 830E network must be used to obtain the proper inductance setting. This may be done as follows: (a) Tighten down the L screw on the 830E network. This enables the internal inductance of the network. (b) Set the inductance initially to 0.0 mH by tightening down all screws. Tightening down a screw removes the particular value of inductance from the network circuit. (c) Network inductance may be increased by loosening, or turning out, screws marked 0.05, 0.1, 0.2, 0.4, 0.8.
6	Loosen the screw labeled L on the 830E network. This removes the internal inductance of the 830E network from the circuit and replaces it with the inductance of the 4097B network. Set the 4097B network to 0.0 mH.
7	On the 830E network, set the dials of adjustable resistors R1 to the 1/4 range (90° clockwise) and R2 to zero (fully counterclockwise).
8	Set the 830E network building-out resistance (BOR) screws, L screws, and C screws per Table C.

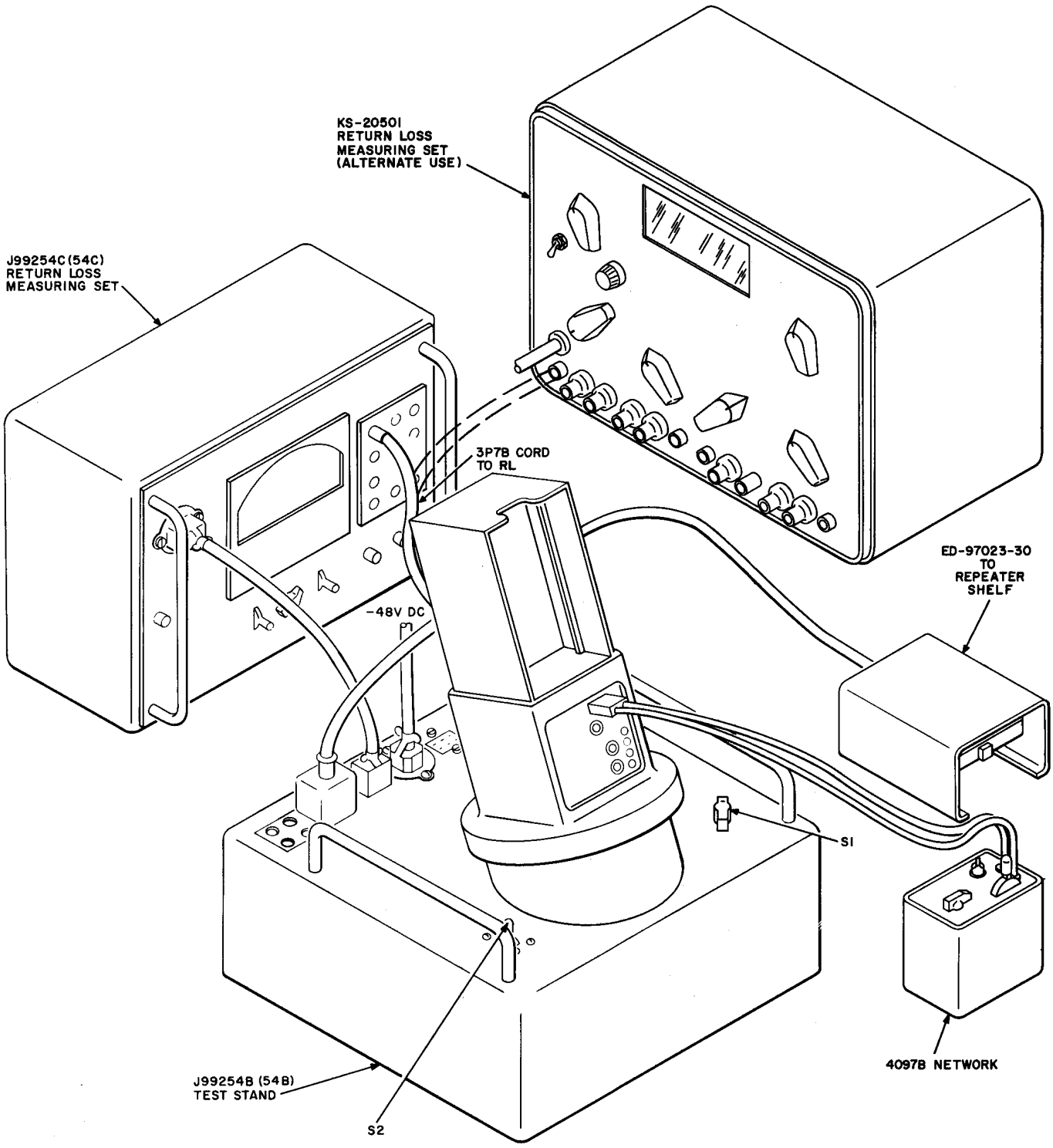

Fig. 2—Return Loss Adjustment of E6 Repeater—Test Equipment Connections

TABLE C

830E NETWORK
INITIAL SETTINGS

BOR REQUIRED FOR VARIOUS LOOP RESISTANCES		
LOOP RESISTANCE* OF CABLE PAIR	SCREWS	POSITION
≤ 400 ohms	BOR	UP
	R	DOWN
> 400 ohms	BOR	DOWN
	R	UP
L SCREWS		
Start† with either all L-value screws (including the L screw) down, or when using the external 4097B network (with L screw up on 830E), start with knob set to 0.		
POTENTIOMETERS		
Start† with potentiometers R1 set to 1/4 range (90° clockwise) and R2 set to 0 (fully counterclockwise).		
C SCREW		
Total BT < 3 kft.		UP‡
Total BT between 3 and 6 kft and most located closer than 2 kft from repeater.		UP‡
Total BT between 3 and 6 kft and most beyond 2 kft from repeater.		DOWN‡

Notes:

* Average temperature.

† Initial settings are for starting only. Final settings must be obtained by optimizing with a 54C RLMS or a KS-20501 RLMS.

‡ If >20 dB ERL and >16 dB for the 2 to 3 kHz RL (with 4066H network termination) are not met, try other condition of C screw. If results are about the same, use C in UP condition.

STEP	PROCEDURE
	 ***The BOR screws must be set the same (both tightened or both loosened) to prevent circuit unbalance.***
9	Set ▸switch S1 to◂ the 500 to 2500 frequency range of the 54C set and adjust the SEND LEVEL ADJ control to obtain a 10-dB reading on the black scale. This will prevent overloading the E6 repeater.
	 ***On subsequent readings, subtract 10 dB from the sum of the AT1 dial and meter reading to obtain the true return loss.***
	Maximum Return Loss
	Note: The objective in the next part of the lineup procedure is to obtain the maximum return loss for the specific facilities assigned to the trunk. A high return loss assures adequate margin against echo and singing. Perform the following steps.
10	Set switches on the 54C measuring set as follows: S1 to 500—2500 ~ S2 to MEAS S3 to 900Ω 2 MF.
11	Increase the value of inductance (L) by operating the switch and key on the 4097B network until maximum return loss is obtained.
12	Adjust R1 ▸on the 830E network◂ for maximum return loss indication on the 54C measuring set.
13	Set switch S1 to 2000—3000 ~ and adjust R2 ▸on the 830E network◂ for maximum RL.
14	Set switch S1 to 500—2500 ~ and repeat Steps 11 and 12.
15	Repeat Step 13. ***If a significant increase in return loss is indicated (ie, 0.5 dB), repeat Steps 11 and 12 at least twice or until additional return loss cannot be obtained. If an increase or decrease of 0.05 in L improves the RL in the SP (2000—3000 Hz) band, use that value.***
16	Repeats Steps 14 and 15 until optimum adjustments are obtained.
17	The foregoing steps should lead to a maximum return loss (500 to 2500~) in excess of 20 dB (30-dB meter reading since the set was calibrated at 10 dB). If the ERL (500–2500~) is less than 20 dB or the SP (2000—3000~) is less than 12 dB, change the position of the C screw and repeat lineup procedure. Use the C screw position that gives the better

STEP	PROCEDURE
	values for ERL and SP. If the results are almost equal for both conditions, use C in the UP position for better high-frequency response.
18	If the minimum return loss cannot be obtained, make sure the termination is on circuit and the B side of the repeater is connected to the cable pair. If requirements still cannot be met, replace the 830E network with a new network and repeat the entire lineup procedure. ***Note:*** Removing the termination should always reduce the return loss. It is possible to misalign the repeater without a termination at the PBX and obtain return losses in the order of 11 dB, but the circuit would be unstable.
19	If acceptable values of return loss are obtained, tighten the L screw on the 830E network and set in the amount of inductance (L) that was obtained with the 4097B network.
20	Disconnect the 4097B network from the 830E network and, if there has been more than a 1-dB reduction from the previous indication, readjust R1 and R2 for maximum return loss. This completes the lineup of the 830E network. ***Note:*** Record the measured return loss (meter reading −10 dB) on the CLR for future reference.
21	Request that the termination at the station be removed.
	B. 830G Network (For Touch-Up Only)
1	Patch from the TST PWR jack of the 54C RLMS to RLMS TST PWR jacks of the 54B test stand. Patch from the RL jack of the 54B test stand to MEAS RL jack of the 54C RLMS by using a 3P7B cord. These connections are shown in Fig. 2.
2	Have the circuit to be measured turned down at both ends.
3	Patch from the vacant position on the repeater shelf where the E6 repeater will be installed to the 54B test stand LINE EXT A and B jacks by using the ED-97023-30, Group 2 cord as shown in Fig. 2. Insert the plug gently in order not to damage the shelf-connector spring contacts. Rotate the turret of the 54B test stand to bring the 830G network forward for easy accessibility. The network connected to line A is uppermost.
	Building-Out Capacitor (BOC) and LATTICE Adjustments
4	Set the switch on the 54B test stand to RL LINE B. Set S1 switch on the 54C RLMS to 2000—3000~. If the 54A TMS is also plugged into the 54B test stand, operate switch S3 to SH and SER. This is required only on early models of the 54B test stand.
5	Plug in the power cord of the 54C RLMS to a 120-volt 60-Hz ac outlet and turn the PWR switch on. A 10-minute warm-up period is required. On the 54C RLMS, set S2 to SEND LEVEL CAL, S3 to 900Ω 2 μF and gain knob AT1 to 0 on the RETURN LOSS scale. Calibrate the 2000—3000~range of the 54C RLMS to 0 dB by adjusting the SEND LEVEL ADJ knob for 2000—3000~. Release S2 to MEAS.

STEP	PROCEDURE
6	Adjust gain knob AT1 on the 54C RLMS until the meter reads on scale.
7	If no screw settings are given, start with A, E, F, and Y, Y. This initial setting corresponds to that of a 26-gauge cable with a 3000-foot end section. Only the LATTICE; X, X; or Y, Y screws should be turned down in an 830G network. ***Never*** should both X, X and both Y, Y screws be turned down concurrently.
8	Bring the meter on scale by rotating ◗AT1◖ on the 54C RLMS.
9	Request a termination at the distant end and observe the meter of the 54C RLMS for a change indicating that the termination has actually been connected to the line being used. This termination is to be 900 ohms in series with 2.14 μF for a 900-ohm impedance station.
10	Optimize the return loss by adjusting BOC screws A through F to obtain the highest return loss. Do this by increasing the BOC in 0.004-μF steps; if this causes the return loss to rise, increase the capacitance still further until a maximum is reached. If no maximum is found by increasing the BOC, decrease the capacitance in 0.004-μF steps and follow up until a maximum return loss is obtained. If critical, repeat with 0.002-μF steps. ***Note 1:*** In some cases the adjustment may not be critical. In such cases, use the average of the two settings where a decrease in return loss is just noticeable. ***Note 2:*** If there are two BOC settings that give the same average meter reading, choose the setting for which the meter needle wavers less. ***Note 3:*** Negative values of return loss sometimes occur. ***Note 4:*** Remove screwdriver from screwheads when observing 54C RLMS readings. ***Note 5:*** The 830G network BOC should not exceed 0.039 μF when both Y, Y screws are down. Should the optimization procedure indicate that more BOC is necessary, use screws X, X; turn down screws 1, 2, 3 and 1, 2, 3; and add BOC in the above described manner.
11	The values of the BOC screws are as follows: **CAPACITANCE OF BOC SCREWS OF NETWORK ±2%** A 0.001 μF D 0.007 μF F 0.025 μF B 0.002 μF E 0.013 μF G 0.049 μF C 0.004 μF ***Example:*** Tightening a screw adds capacitance. Thus, when the A, E, and F screws are down, they equal 0.001 plus 0.013 plus 0.025, or 0.039 μF. In this case, 0.004 μF could be added by tightening screw C. To remove 0.004 μF, the screws would be A, B, D, and F down.
12	Set S1 on the 54C RLMS to 500—2500~. Set S2 to SEND LEVEL CAL. Calibrate the 500—2500~range of the 54C RLMS to 0 dB by adjusting the SEND LEVEL knob for

STEP	PROCEDURE
	500—2500~. Release S2 to MEAS. Bring the reading of the meter on scale by rotating gain knob AT1. Turn out LBO screw(s) for the gauge originally selected. Turn LBO screw(s) in for one of the other gauges. ***Note 1:*** The screw setting that gives the greater return loss value is the better setting, but screw(s) for one gauge only should be left down. ***Note 2:*** If the setting for two different gauges gives the same results, use the one for coarser wire, ie, set for 19 gauge when the same results within 0.5 dB are obtained on 19 and 22 gauges. **Building-Out Resistor (BOR) Adjustment**
13	Set S1 on the 54C RLMS to 500—2500~sweep. Reduce the initial BOR value on LBO to the next lower value to verify that the return loss is increased. If not, increase the BOR value. ***Note 1:*** The condition that gives the greater return loss value is the better setting. If the same results are obtained for two different values of BOR, set for the lower value of resistance. Be sure that the same value of resistance is used in the tip and ring side of line, ie, 1 + 1, 2 + 2, 3 + 3 screws must be in a corresponding position. When different values are used, the circuit becomes unbalanced and is susceptible to noise. ***Note 2:*** The resistance values that can be obtained are as follows: All screws down — 0 ohms 1, 2 and 1, 2 — 33 ohms 1, 3 and 1, 3 down — 66 ohms 1 and 1 down — 99 ohms 2, 3 and 2, 3 down — 132 ohms 2 and 2 down — 165 ohms 3 and 3 down — 198 ohms No screws down — 231 ohms