

## NO. 5 CROSSBAR OFFICES

### THROUGH BALANCE DROP BUILD-OUT PROCEDURES AND VERIFICATION TESTS

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**1. GENERAL**

**1.01** This section provides the procedures for adjustment of the proper capacitance buildout for office cable in all 2-wire paths of all trunks switching intertoll (IT) traffic on a class 3 basis. It also provides the procedures for verification of the resultant balance.

**1.02** This section does not affect Equipment Test Lists.

**1.03** Initial balancing of an office requires that these procedures be performed with satisfactory verification test results to certify that the office is balanced. The verification portions of the procedures are also required as circuit order tests when new trunks are added in an office following initial balance certification or when rearrangement of equipment in a certified office may affect the through balance conditions in that office.

**1.04** The procedures of this section cannot be performed unless the network building-out (NBO) capacitor value for the office (see Section 660-472-500) is connected in the 4-wire terminating sets (4WTSs) of all IT trunks.

**1.05** Results of the procedures in this section should be recorded. Section 660-472-010 furnishes the information required to establish and maintain records of all results obtained.

**1.06** During initial balancing of an office, these procedures may be performed in the same sequence as they are presented in the text, Parts 2A through 2F, provided the toll switchboard associated with the switching machine is in the same building. When the switchboard is in another building, Parts 2C and 2D do not apply since that switchboard is balanced as a separate switching office.

**1.07** When performing circuit order work, use the applicable procedure indicated in Table A for the type of trunk being tested. The balance test results should be transcribed from Form E-2545A to the central office balance records discussed in paragraph 1.05.

**1.08** The recommended test equipment, balance test (BAL TST) circuits, test terminations, and techniques for use in these procedures are described in Section 660-472-504. Proper buildout of the BAL TST circuits and balance test terminations (BAL TST TERMS), described in Section 660-472-504, must be completed before these procedures can be performed. The procedures for trunk seizure, signaling, supervision, and maintenance of ground on E leads to hold connections for test purposes are available in the applicable Bell System Practices for the testboards and switchboards used, as is information on those portions of the master test frame (MTF) used in the procedures.

**SECTION 660-472-501**

**1.09** The requirements for through balance echo return loss (ERL) and singing point or singing return loss (SP/SRL) measurements are given in Section 660-472-300.

***Caution: Balance testing must be made on an out-of-service basis. The proper out-of-service procedures should be made on any working trunk prior to performing any balance tests.***

**TABLE A  
TEST SEQUENCE SUMMARY**

TYPE OF TRUNK	PROCEDURE	
	PART	FIGURE
2-way IT	2A, 2B, 2C	1, 2, 3
1-way IT (outgoing)	2A, 2C	1, 3
1-way IT (incoming)	2B, 2C	2, 3
Operator assistance	2E	5
Operator junctor	2F	6

**2. PROCEDURES AND VERIFICATION**

**A. Outgoing 2-Way or One-Way IT Trunks**

**2.01** All outgoing IT trunks must be built out to have the same path capacitance as the longest IT trunk path from the trunk link frame

plus the office growth factor. The BAL TST 2 circuit must be properly built out (see Section 660-472-504) before this procedure and verification is performed. In general, only Steps 1 through 3 and 11 through 14 are required when performing circuit order work since the build-out capacitance value is available in the office balance record.

13 Repeat Steps 1 through 12 on all remaining outgoing IT trunks in the office.

**Note:** Where the 4WTSs of the IT trunks are wired directly to the trunk relay equipment, Steps 7 and 8 will be similar for adjacent trunks and bays of trunk relay equipment. In these cases, one BO3 capacitance value can be used over a group of trunks, with the restriction that each trunk in the group must meet the ERL and SP/SRL requirements and all trunks in the group must have ERL and SP/SRL measurements within  $\pm 2$  dB of each other.

14 When all trunks have been tested, remove terminations, release trunks, and disconnect test equipment.

STEP	PROCEDURE
1	At the MTF, set up an incoming class call for through-switch completion on the toll originating test line. Key pulse (dial) the ABC code of the outgoing IT trunk selected for test, and transfer the connection to the TRK TST jack appearance.
2	Patch the test trunk jack to the jack appearance of the 4WTS assigned to the BAL TST 2 circuit.
3	Terminate the transmit and receive ports of the BAL TST 2 4WTS with 600-ohm terminations. See Fig. 1.
4	Set up test equipment to perform capacitance measurements as described in Part 2B of Section 660-472-504 and connect the test equipment to the transmit and receive ports of the 4WTS associated with the IT trunk selected for test.
5	Connect a 7A capacitor box (or equivalent) across the BO3 capacitor in the selected trunk.
6	Verify that no straps are connected on the BO3 capacitor.
7	Adjust the capacitor box to a value giving the greatest return loss. Note the value of capacitance and the return loss. (If a capacitor box is not used, adjust the BO3 by screw settings or straps.)
8	Remove the capacitor box and strap the IT trunk BO3 capacitor with the value obtained in Step 7.
9	Verify that the return loss is the same as that obtained in Step 7. (Due to manufacturing tolerances, the indicated values of BO3 capacitors may vary, and small corrections to the value strapped may be necessary.) Readjust the strapped value for small corrections if necessary. When large changes are required to obtain the same return loss as in Step 7, investigate for trouble.
10	Record the value strapped on the BO3 capacitor on Form E-6003 or E-6004.
11	Set up test equipment to measure ERL or SP/SRL as described in Part 2B of Section 660-472-504.
12	Measure the ERL and SP/SRL and record the results on Form E-6003 or E-6004. (When performing circuit order work, enter the results on Form E-2545A also.)

**Note:** The ERL and SP/SRL should meet the median requirements given in Section 660-472-300.

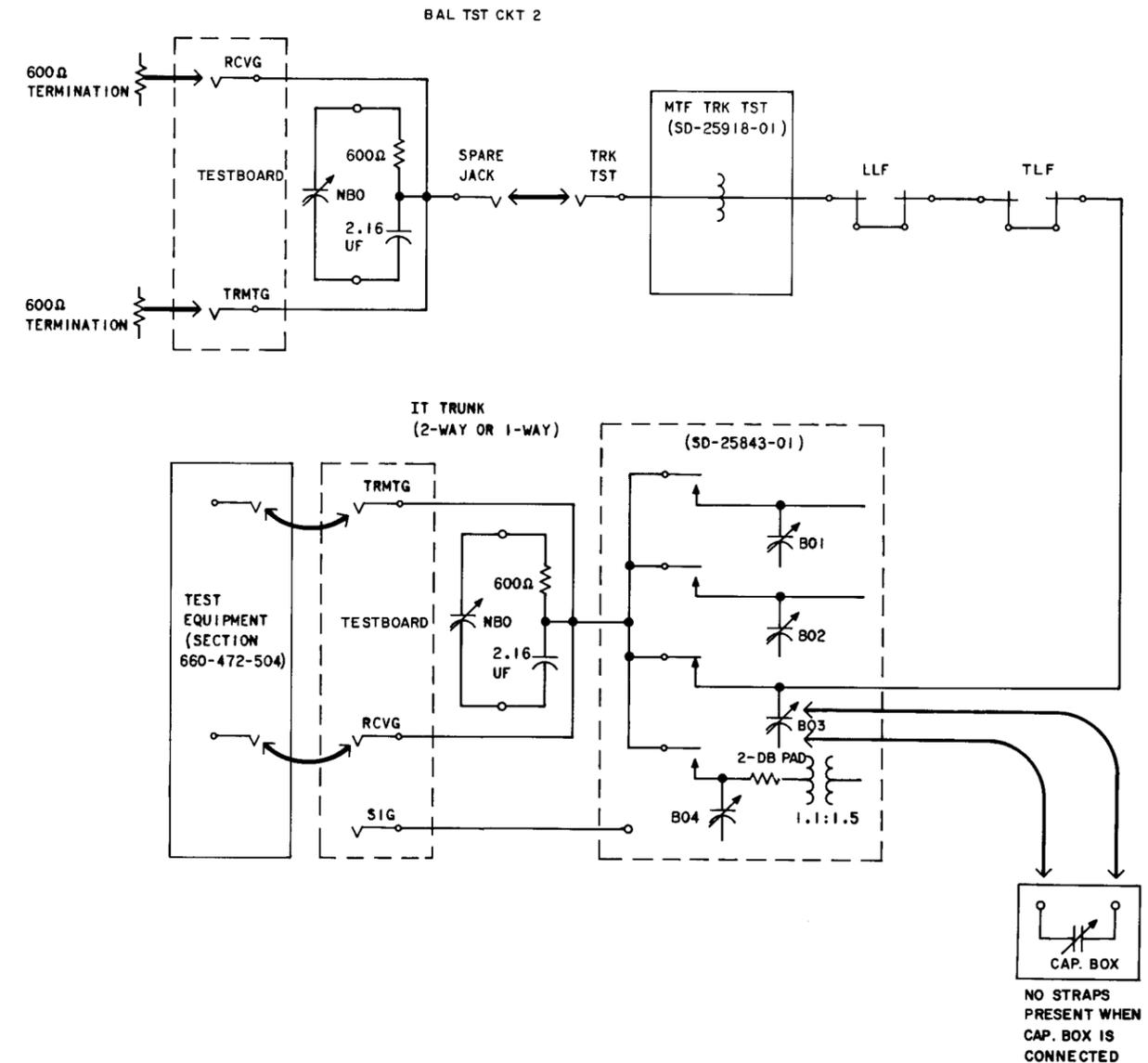


Fig. 1—Outgoing 2-Way or One-Way IT Trunks

**B. Incoming 2-Way or One-Way IT Trunks**

**2.02** Each incoming IT trunk must be built out with capacitance to equal the path capacitance of the longest IT trunk path to the line link frame plus any office growth factor.

**2.03** This procedure is dependent on proper buildout of the code 100 BAL TST TERM (see Section 660-472-504). In general, only Steps 1 and 9 through 12 are required when performing circuit order work since the build-out capacitance value is available in the office balance record.

STEP	PROCEDURE
1	At the testboard jack appearance of the IT trunk to be tested, seize and key pulse (dial) 100 to establish a switched connection to a code 100 BAL TST TERM.
2	Connect a 7A capacitor box (or equivalent) across the BO1 capacitor in the IT trunk circuit under test. (See Fig. 2.)
3	Verify that no straps are connected on the BO1 capacitor.
4	Set up test equipment to perform capacitance measurements as described in Part 2B of Section 660-472-504 and connect test equipment to the transmit and receive ports of the incoming IT trunk 4WTS.
5	Adjust the capacitor box to a value giving the greatest return loss. Note the value of capacitance and the return loss. (If a capacitor box is not used, adjust the BO1 by screw settings or straps).
6	Remove the capacitor box and strap the value determined in Step 5 on the BO1 capacitor.
7	Verify that the return loss is the same as that measured in Step 5. (Due to manufacturing tolerances, the indicated values of BO1 capacitors may vary, and overall corrections to the value strapped may be necessary.) Readjust the strapped value for small corrections if necessary. When large changes are required to obtain the same return loss as in Step 5, investigate for trouble.
8	Record the value strapped on the BO1 capacitor on Form E-6003 or E-6004.
9	Set up test equipment to measure ERL or SP/SRL as described in Part 2B of Section 660-472-504.

10 Measure the ERL and SP/SRL and record on Form E-6003 or E-6004. (When performing circuit order work, enter the results on Form E-2545A also.)

**Note:** The ERL and SP/SRL measurements must meet the requirements given in Section 660-472-300.

11 Repeat Steps 1 through 10 on all remaining incoming IT trunks.

**Note:** Where the 4WTSs of the IT trunks are wired directly to the trunk relay equipment, Steps 5 and 6 will be similar for adjacent trunks and bays of trunk relay equipment. In these cases, Steps 5 and 6 can be performed once to obtain the BO capacitance value for a group of adjacent trunks, with the restriction that each trunk in the group must meet the ERL and SP/SRL requirements and all trunks included in the group must have ERL and SP/SRL measurements within  $\pm 2$  dB of each other.

12 When all trunks have been tested, remove terminations, release the trunk, and disconnect test equipment.

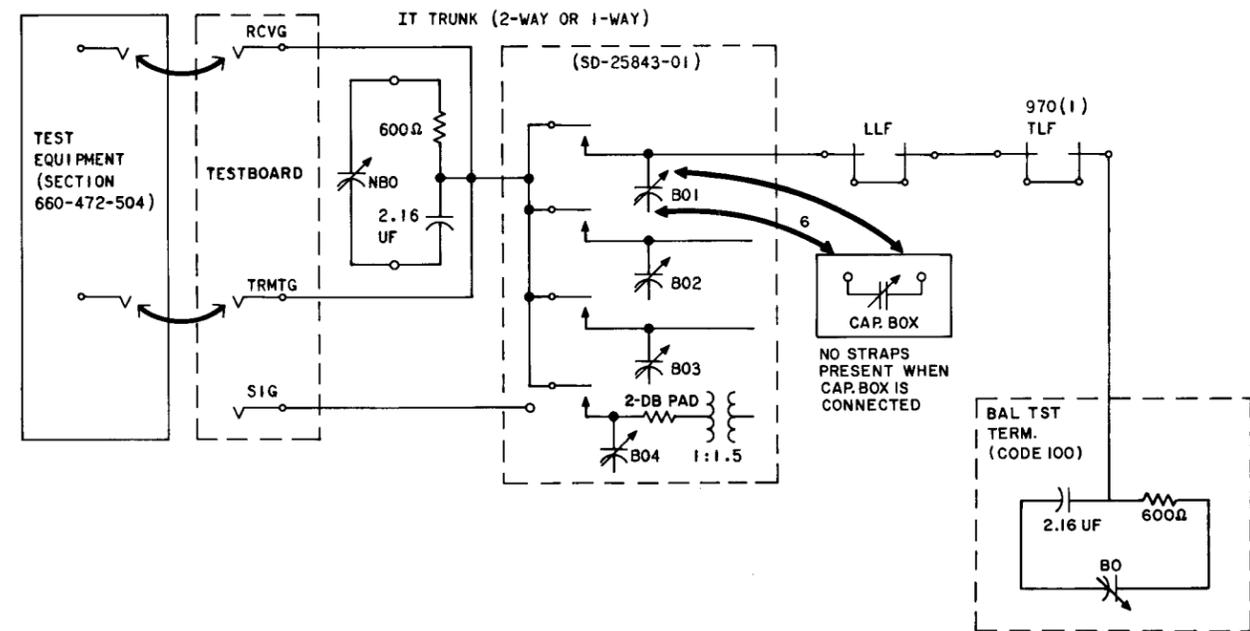


Fig. 2—Incoming 2-Way or One-Way IT Trunks

**C. Switchboard Path of IT Trunks**

**2.04** This procedure is required in offices where operator access to IT trunks can be made via the direct switchboard appearances of the IT trunks.

**2.05** The buildout of both the operator assistance (OA) trunks (121) per Section 660-472-500

and the BAL TST 2 circuit per Section 660-472-504 must be completed before this procedure and verification is performed. In general, only Steps 1 through 4 and 13 through 16 are required when performing circuit order work since the build-out capacitance value is available in the office balance record.

13 Set up test equipment to measure ERL or SP/SRL as described in Part 2B of Section 660-472-504.

14 Measure the ERL and SP/SRL and record with other information required to complete an entry on Form E-6003 or E-6004. (When performing circuit order work enter the results on Form E-2545A also.)

**Note:** The ERL and SP/SRL must meet the median requirements given in Section 660-472-300.

15 Repeat Steps 4 through 14 on all remaining direct access paths to IT trunks appearing on the switchboard.

**Note:** When the 4WTSs of the IT trunks are wired directly to the trunk relay equipment, Steps 9 and 10 will be similar. In these cases, one BO2 capacitance value can be used over a group of trunks, with the restriction that each trunk in the group must meet ERL and SP/SRL requirements and all trunks in the group must have ERL and SP/SRL measurements within  $\pm 2$  dB of each other.

16 When all trunks have been tested, remove terminations, release trunks, and disconnect test equipment.

STEP	PROCEDURE
1	At the MTF, set up an incoming class call for through-switch completion on the toll originating test line to signal the toll testboard over an OA trunk (121), and transfer the connection to the TRK TST jack appearance.
2	Patch the TRK TST jack to the jack appearance of the 4WTS assigned to BAL TST 2 circuit.
3	At the toll switchboard, answer the incoming 121 trunk signal with a cord circuit.
4	Connect the calling cord of the cord circuit to the switchboard jack appearance of the IT trunk selected for test.
5	At the testboard, terminate with 600-ohm terminations the transmit and receive ports of the 4WTS associated with the IT trunk selected for test. See Fig. 3.
6	Set up test equipment to perform capacitance measurements as described in Part 2B of Section 660-472-504 and connect the test equipment to the transmit and receive ports of the 4WTS of BAL TST 2 circuit.
7	Verify that no straps are connected on the BO2 capacitor.
8	Connect a 7A capacitor box (or equivalent) across the BO2 capacitor in the IT trunk.
9	Adjust the capacitor box to a value giving the greatest return loss. Note the value of capacitance and the return loss. (If a capacitor box is not used, adjust the BO2 capacitor by screw settings or straps.)
10	Remove the capacitor box and strap the IT trunk BO2 capacitor with the value obtained in Step 9.
11	Verify that the return loss is the same as that obtained in Step 9. (Due to manufacturing tolerances, the indicated values of BO2 capacitors may vary, and small corrections to the value strapped may be necessary.) Readjust the strapped value for small corrections if necessary. When large changes are required to obtain the same return loss as in Step 9, investigate for trouble.
12	Record the value strapped on the BO2 capacitor and the return loss on Form E-6003 or E-6004.

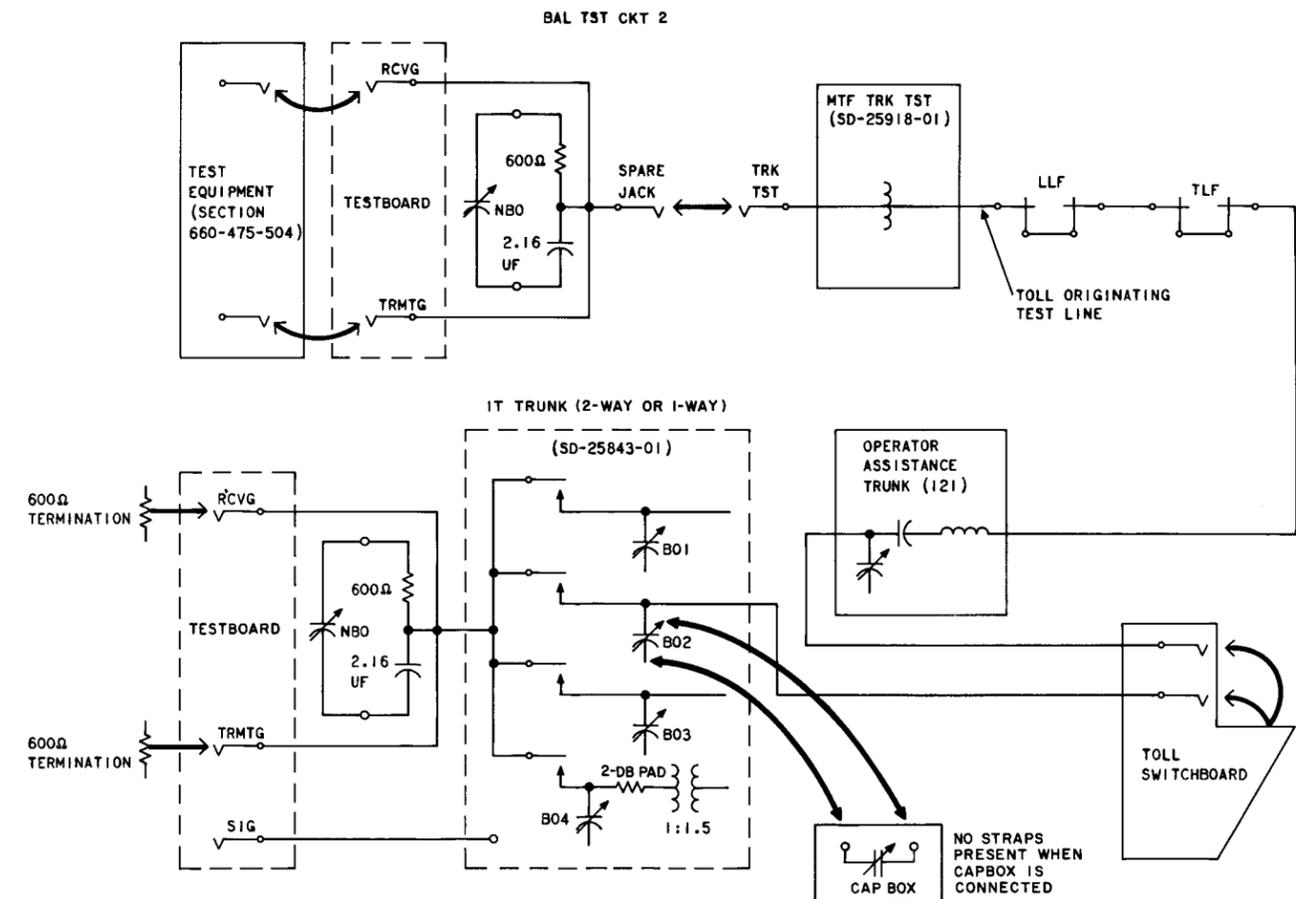


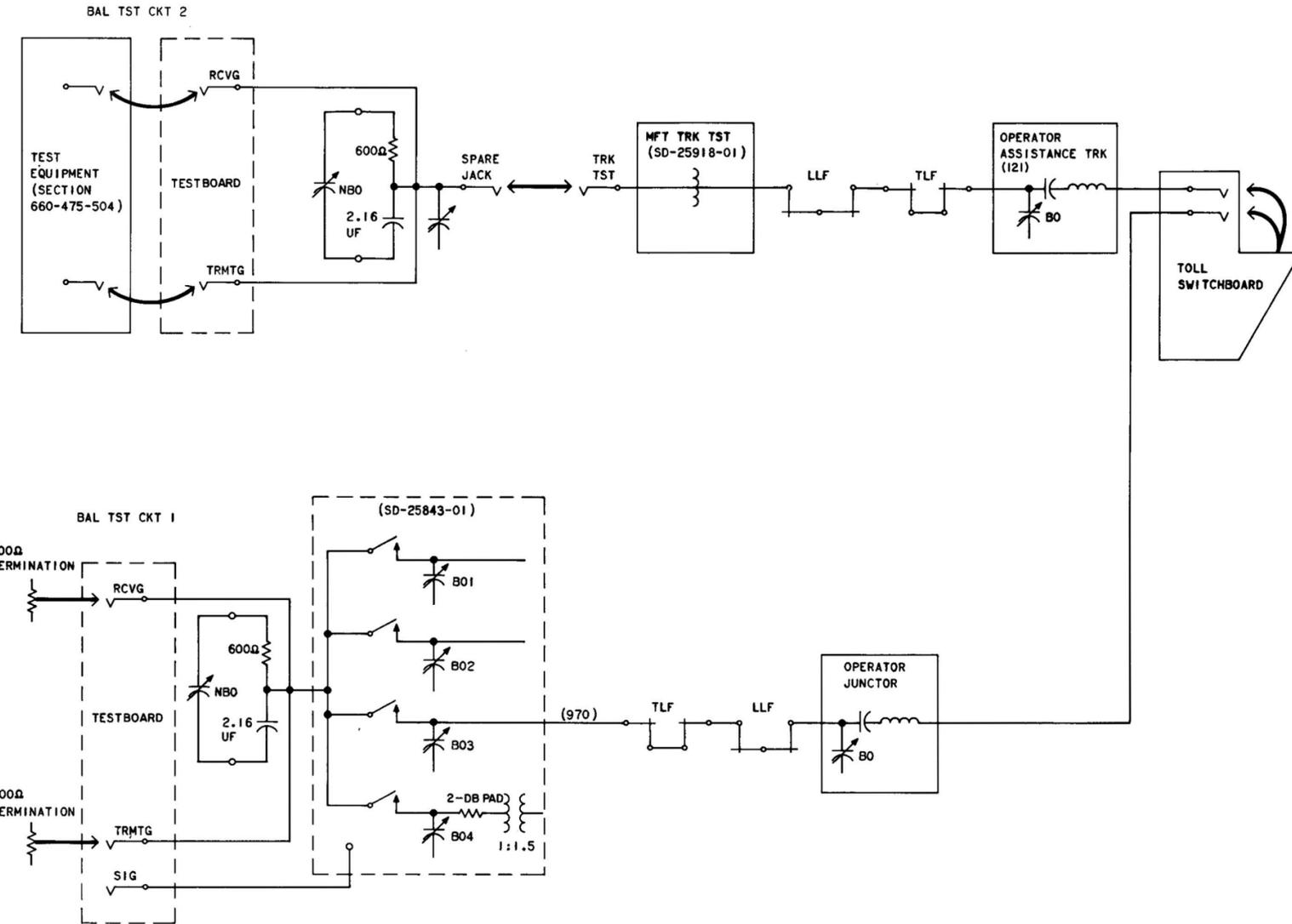
Fig. 3—Switchboard Path of IT Trunks

**D. Performance Measurement of Operator Assistance and Operator Junctor Trunks**

**2.06** This verification procedure is required in offices where IT-to-IT connections are made through the toll switchboard. The procedure verifies the initial balance work buildout of the operator

assistance (OA) and operator junctor (OJ) trunks performed in the procedures in Section 660-472-500 when determining an office NBO. The office NBO value must be strapped in the 4WTSs and final buildout of the BAL TST circuits (Section 660-472-504, Part 3D) must be complete before this procedure is performed.

STEP	PROCEDURE
1	At the MTF, set up an incoming class call for terminating completion on the toll originating test line to any 121 OA trunk. Transfer the connection to the TRK TST jack.
2	Patch the TRK TST jack to the jack appearance of the 4WTS assigned to the BAL TST 2 circuit. See Fig. 4.
3	At the switchboard, use a cord circuit to seize and key pulse (dial) 970 into an OJ trunk. Connect the answer cord of the cord circuit to the jack appearance of the 121 trunk selected in Step 1. Close the cord circuit TALK-MON key.
4	Terminate the BAL TST 1 transmit and receive ports with 600 ohms.
5	Set up test equipment to measure ERL or SP/SRL as described in Part 2B of Section 660-472-504 and connect the test equipment to the transmit and receive ports of the BAL TST 2 circuit.
6	Measure the ERL and SP/SRL and record with other information required to complete an entry on Form E-6003 or E-6004.  <i>Note:</i> The ERL and SP/SRL measurements must meet the requirements specified in Section 600-472-300.
7	Repeat Steps 1 through 6, using the same 121 trunk, on all OJ trunks.
8	Repeat Steps 1 through 7 on all 121 trunks using any one OJ trunk.



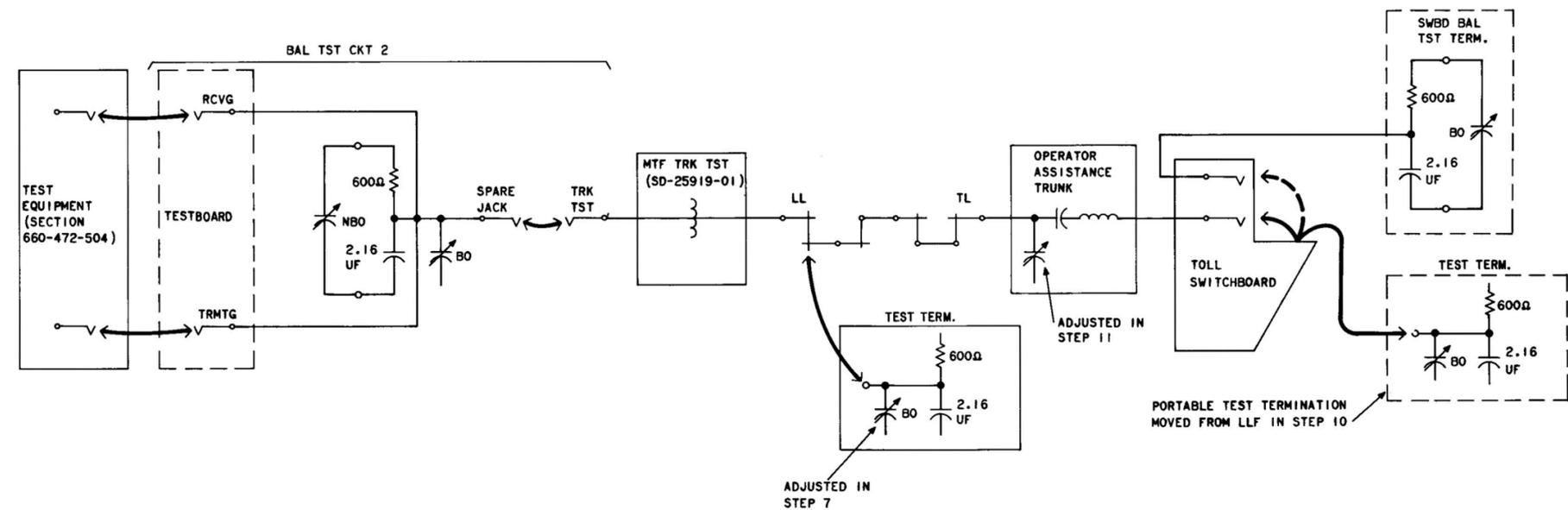
**Fig. 4—Performance Measurement of Operator Assistance and Operator Junctor Trunks**

**E. Operator Assistance Trunks Added in an Office Certified for Balance**

**2.07** This procedure is required for all operator assistance (121) trunk additions. The BO capacitor adjustment compensates for the inductive reactance of the loading coils in the trunk circuit, making the trunk effectively transparent impedancewise.

STEP	PROCEDURE
1	At the MTF, set up an incoming class call for terminating completion on the toll originating test line to 121. Transfer the connection to the TRK TST jack.
2	Patch the TRK TST jack to the jack appearance of the 4WTS assigned to the BAL TST 2 circuit.
3	At the toll switchboard, answer the incoming signal using a cord circuit.
4	Set up the test equipment to perform capacitance measurements as described in Part 2B of Section 660-472-504 and connect test equipment to the 4WTS transmit and receive ports of the BAL TST 2 circuit.
5	On the line link vertical assigned to the MTF toll originating test line, place a 351E plug to bridge the connection and hold supervision (see Fig. 5). Then manually release the vertical hold magnet on the trunk link frame appearance of the OA trunk under test. (Magnet may be allowed to reoperate if no other select magnet is operated.)
6	At the line link frame, connect a portable 600Ω + 2.16 μF test termination equipped with a BO capacitor across the tip and ring punchings of the 351E plug.
7	Strap the BO capacitor on the portable test termination to a value giving the greatest return loss. (This value will be less than the office NBO.)
8	Remove the 351E plug.
9	At the MTF, remove the patch to prevent test equipment interference, release the connection, and reestablish the connection to the <i>same</i> OA (121) trunk per Step 1.
10	At the MTF, transfer the connection to the TRK TST jack, replace the patch, and, using a cord circuit at the switchboard, connect the portable test termination (with the BO capacitor strapped with the value determined in Step 7) to the switchboard jack appearance of the OA (121) trunk under test. (The TALK-MON key must be closed during transmission testing.)

- 11 Permanently strap the BO capacitor in the OA (121) trunk to a value giving the greatest return loss. (This adjustment compensates for inductive reactance of the trunk circuit loading coils.)
- 12 Record the BO capacitance value strapped and other information required to complete an entry on Form E-6003 or E-6004.
- 13 Remove the portable test termination and connect the 121 trunk with a cord circuit to the switchboard BAL TST TERM.
- 14 Set up test equipment to measure ERL or SP/SRL as described in Part 2B of Section 660-472-504.
- 15 Measure the ERL and SP/SRL and record the results on Form E-6003 or E-6004 and on the circuit order Form E-2545A.  
**Note:** The ERL and SP/SRL of all trunks tested must meet the *median* requirements given in Section 660-472-300.
- 16 Release the connection and disconnect the test equipment.
- 17 Repeat Steps 1 through 16 on each added trunk.



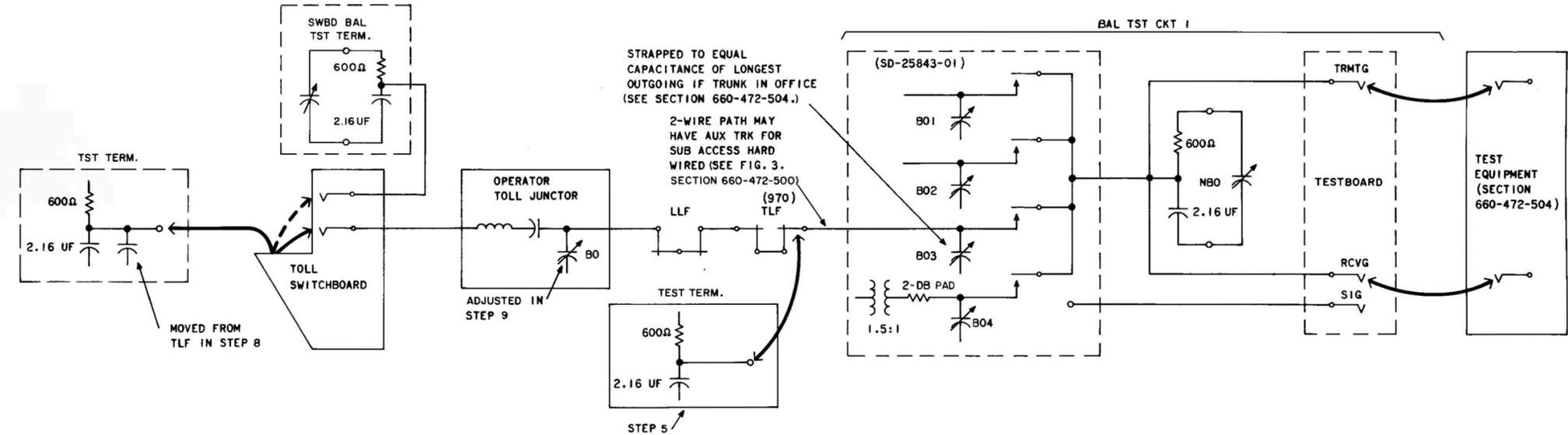
**Fig. 5—Operator Assistance Trunks Added in an Office Certified for Balance**

**F. Operator Junctor Trunks Added in an Office Certified for Balance**

**2.08** This procedure is required for all operator junctor (OJ) trunk additions. The BO capacitor adjustment compensates for the inductive reactance of the loading coils in the trunk circuit, making the trunk effectively transparent impedancewise.

- 10 Record the BO capacitance value strapped and other information required to complete an entry on Form E-6003 or E-6004.
- 11 Remove the portable test termination and connect the OJ trunk with the cord circuit to the switchboard BAL TST TERM.
- 12 Change test equipment setup to measure ERL or SP/SRL as described in Part 2B of Section 660-472-504.
- 13 Measure the ERL and SP/SPL and record the results on Form E-6003 or E-6004 and on circuit order Form E-2545A.
- Note:** The ERL and SP/SRL of all trunks tested must meet the *median* requirements given in Section 660-472-300.
- 14 Release the connection at the switchboard and disconnect test equipment.
- 15 Repeat Steps 7 through 14 on each added trunk.

STEP	PROCEDURE
1	At the toll switchboard, use a cord circuit to seize the OJ trunk to be tested and key pulse (dial) 970 to connect to the TLF (trunk link frame) appearance of the BAL TST 1 circuit.
2	Set up test equipment to perform capacitance measurements as described in Part 2B of Section 660-472-504 and connect the test equipment to the transmit and receive ports of the BAL TST 1 4WTS.
3	Place ground on the sleeve at the TLF appearance of the BAL TST 1 circuit to provide off-hook supervision (see Fig. 6). Manually release the vertical hold magnet. (The magnet may be allowed to reoperate if no other select magnet is operated on the switch.)
4	At the TLF, connect a portable 600Ω + 2.16 μF test termination equipped with a BO capacitor across the tip and ring of the FA or FB terminal punchings.
5	Adjust the BO capacitor on the portable test termination to a value giving the greatest return loss. (This value will be less than the NBO value.)
6	Remove the portable test termination and ground placed in Step 3. At the TLF, release the cord circuit connected at the switchboard.
7	Repeat Step 1.
8	Use the cord circuit to connect the portable test termination to the OJ switchboard jack appearance. (The TALK-MON key must be closed for transmission testing.)
9	Adjust the BO capacitor in the OJ trunk to a value giving the greatest return loss. (This adjustment compensates for the inductive reactance of the trunk circuit loading coils.)



**Fig. 6—Operator Junctor Trunks Added in an Office Certified for Balance**