

**AUTOMATIC INTERCEPT SYSTEM (AIS)—EXTENDED RANGE
NET BUILD-OUT (NBO) AND DROP BUILD-OUT (DBO) CAPACITOR
SELECTION AND APPLICATION—AIS TEST CIRCUIT**

CONTENTS	PAGE	CONTENTS	PAGE
1. GENERAL	1	5. Test Results NBOC Selection	21
2. AIS OPERATIONAL PROCEDURES	2	6. NBOC Selection Incoming Trunk	22
3. TEST APPARATUS AND TEST CIRCUITS	2	7. NBOC Selection Outgoing Trunk	23
A. Test Apparatus	2	8. Buildout of Code 101 Test Circuit	24
B. Test Circuits	2	9. DBOC Selection	25
4. OFFICE CABLING CAPACITANCE MEASUREMENTS	3		
5. NBOC SELECTION AND APPLICATION	6	1. GENERAL	
6. CODE 101 TEST CIRCUIT—BUILDOUT PROCEDURES	8	1.01 This section provides the procedures for the selection of NBOC and DBOC for the AIS-Extended Range. Build out of the AIS test circuits is also described.	
7. DBOC SELECTION AND APPLICATION	9	1.02 Whenever this section is reissued, the reasons for reissue will be presented in this paragraph.	
8. REFERENCES	10	1.03 Satisfactory balance is required to certify that an AIS is initially balanced. The procedures in this section provide echo return loss (ERL) and singing return loss (SRL) values which will meet the requirements specified in Section 660-479-301. Forms used to record the balance measurements are described in Section 660-479-101. General information about balancing is provided in Section 660-479-100.	
Figures		1.04 The general procedure used in balancing any office is provided in the following steps:	
1A. Method of Connecting RLMS to Trunk 4WTS or to TEST HYBRID	11/12	(a) Measurement of office cabling capacitance on sample trunks	
1B. Typical Jack Access on AIS Trunks	13/14	(b) Determination of NBOC value (Section 852-405-101)	
2A. Capacitance Measurements 4W Trunk	15/16		
2B. Capacitance Measurements 2W Trunk	17/18		
3. Optimization of NBOC Value in AIS Connection	19		
4. Sample Worksheet	20		

NOTICE

Not for use or disclosure outside the
Bell System except under written agreement

- (c) Strapping of NBOC value in 4WTS of trunks
- (d) Build out of test circuits
- (e) Balance verification tests (Section 660-479-301)
- (f) Application of DBOCs as required.

1.05 While performing the procedures presented in this section, the tester must be made aware that the ERL and SRL measurements should be made at the same time. Adjustments required to achieve one value of return loss could affect the other two values. This is the reason for requiring all three measurements to be made whenever a procedure is performed.

1.06 All trunks must meet transmission requirements for noise and 1000-Hz loss before any balance procedure is performed. If these requirements are met, the possibility of open or shorted circuits, wrong pads plugged into 4WTS, and the reading of excessive noise should be eliminated.

2. AIS OPERATIONAL PROCEDURES

3.01 In order to access the trunks incoming and outgoing to the AIS, certain commands are used at the maintenance center teletype (TTY). The following commands are from Section 250-402-501.

2.02 Removal of Trunks From Service: To remove a trunk from service, use

M TK RMV ngtu c!

where n = connector and scanner network number (0 or 7)

g = group number (0-7)

tu = decimal number of the equipment location in group (00-63)

c = connector and scanner used to set up connection (0 or 1).

This command removes the trunk from service and makes it busy.

2.03 Connecting Trunks: To connect two trunks, use

M TK TTT ngtu c—ngtu 3!

2.04 Disconnecting Trunks: To disconnect two trunks, use

M TK TTT ngtu c—7!

This disconnects the trunks but does not restore them to service.

2.05 Restoring Trunk to Service: To restore a trunk to service, use

M TK RST ngtu 0!

3. TEST APPARATUS AND TEST CIRCUITS

A. Test Apparatus

3.01 Test apparatus required to perform the procedures given in this section are as follows:

Return Loss Measuring Set (RLMS)—Wiltron Model 9041 (or 9031), KS-20501, or equivalent. Use of the KS-20501 may require special settings different from the Wiltron set. Where applicable, lettered steps are used in the procedures.

Decade Capacitance—7A or equivalent. Required range zero μF to 0.028 μF in 0.001 μF steps with accuracy of $\pm 1\%$. The Wiltron set has both NBO and DBO decade capacitors in the lid of the set.

3.02 The required initial dial settings on the test apparatus are presented in Fig. 1A for 4-wire trunks and Fig. 2B for 2-wire trunks.

B. Test Circuit

3.03 There are three test circuits in the AIS. The only test circuit that has the capability of being built out is the code 101. As capacitive reactance cannot be switched in the AIS, codes 100 and 102 test circuit cannot be balanced. The test circuits provide the following functions:

Code 100: Balance termination (900-ohms, 2.16 μF) for noise measurements.

Code 101: Jack ended test circuit (TM jack) for talking and making transmission measurements. Also used with 4 WTS for balance measurements.

Code 102: Milliwatt supply for 1000-Hz transmission measurement.

Procedures for build out of the code 101 test circuit are presented in this section.

4. OFFICE CABLING CAPACITANCE MEASUREMENTS

4.01 To determine the NBOC value for an AIS office, it is necessary to find the longest incoming and longest outgoing trunk within the office. This is the 2-wire path between the incoming or outgoing point of good impedance (4WTS, impedance compensator or 2-dB pad) and the trunk circuit. By measuring the capacitance, the length of the 2-wire path is determined—the higher the capacitance, the longer the cable. If the measurements exceed the following values, the cable length is excessive and requirements will not be met:

CABLE GAUGE *	LENGTH FEET	RESISTANCE OHMS **	CAPACITANCE μF
22	1020	32.6	.024
24	600	31.2	.013
26	396	32.8	.008

* For mixed gauges, the resistance must be measured.

** The resistance requirement of 33 ohms for the AIS must not be exceeded.

4.02 Capacitance measurements are made using a RLMS and a decade capacitor. When measuring 2-wire facilities, the internal hybrid of the RLMS is used with the decade capacitor connected to the NBO jack (EXT NET jack of the KS-20501 RLMS). Maximum return loss is measured and the adjusted value in the decade capacitor is equal to the cable capacitance. In the measurement of 4-wire facilities, the decade capacitor is connected to the NBOC of the 4WTS. Only the facility between the 4WTS or the RLMS (on 2-wire facilities) and the input to the trunk circuit can be measured. A characteristic of the AIS switch blocks capacitance reactance so that any capacitance connected to the opposite side of the switch will not influence the RLMS reading.

4.03 To determine if DBOCs are required, it is necessary to measure the shortest trunks in the samples. This is done in the same manner as measuring the longest trunks.

4.04 The following procedure is used to measure office cabling capacitance.

STEP	PROCEDURE
1	<p>Capacitance measurements are made on a random sampling basis. Select at least four samples in each of the following trunk groups—two of the estimated longest and two of the estimated shortest trunks:</p> <ul style="list-style-type: none"> Incoming from RAIC Incoming from No. 1 Trunk Connector Incoming from Class 5 (local) Incoming Inquiry from CIB Outgoing to CIB

STEP	PROCEDURE
	Outgoing to ONI
	Outgoing to Supervisory Position
	Outgoing from RAIC to HAIC.
	Note: If the AIS is a two network system, use outgoing trunks assigned to network 0 for the longest estimated trunk and network 1 for the shortest estimated trunk if they are crossconnected at an MDF not colocated with the AIS. If an AIC IDF is provided, ignore this note. Cable runs vary in routing due to cable rack loading and should not be used for estimating length.
2	Remove the estimated longest incoming trunk from service. Use TTY commands in Part 2. Caution: Capacitance measurements must be made on an "out-of-service" basis. The proper out-of-service procedure should be made on any working trunk prior to performing these measurements.
3	Remove either an outgoing trunk or the code 101 test circuit from service.
4	Connect the two trunks (or test circuit).
5	Connect the RLMS, decade capacitor and terminations as shown in Fig. 1 and 2. Be sure that the outgoing trunk or code 101 test circuit is properly terminated. Figure 1A shows the connection to the test equipment. Figure 1B shows typical jack connections. Fig. 2A is used for 4-wire trunks and Fig. 2B for 2-wire trunks.
6	Make the following checks on the trunk being measured. (a) All strapping is removed from NBOCs and DBOCs. (If screws, all screws in "up" position.) (b) S-1 screw is down. (c) COMP NET screw is down. (d) All SX IND screws are up.
7	Set all dials on the RLMS as shown on Fig 1A for 4-wire trunks and Fig. 2B for 2-wire trunks.
8a	When measuring capacitance on 4-wire trunks using the Wiltron RLMS, compensate for transhybrid loss in the 4WTS of the circuit under test by doing the following steps: — Place a short on the 2-wire port of the 4WTS (or connect the DBO cord from the lid and press the AC SHORT switch and hold it operated). — Adjust the THL dB switch until the meter reads zero.

STEP	PROCEDURE
	— Remove the short (or release the AC SHORT switch).
8b	When measuring capacitance on 4-wire trunks using the KS-20501 RLMS, compensate for transhybrid loss in the 4WTS of the circuit under test by doing the following steps: <ul data-bbox="505 516 1588 758" style="list-style-type: none"><li data-bbox="505 516 1138 541">— Place a short on the 2-wire port of the 4WTS.<li data-bbox="505 579 1409 604">— Adjust the THL OR ADD switch until the RLMS meter reads zero.<li data-bbox="505 642 1588 705">— If a zero reading cannot be obtained, set the ADD dB switch to the -10 position and readjust the THL OR ADD switch to obtain a zero reading.<li data-bbox="505 737 773 762">— Remove the short.
9	Adjust the dials on the decade capacitor and the ADD dB switch on the RLMS until the maximum on-scale reading on the RLMS meter is obtained.
10	Read and record the value in μF in the dial settings of the decade capacitor. This is the capacitance of the incoming trunk. <p data-bbox="418 989 1555 1073">Note: If the value measured is greater than the values for capacitance given in paragraph 4.01 for the type of cable, balance requirements given in Section 660-479-301 cannot be met. Refer the problem to a transmission engineer.</p>
11	Release the connection. Use TTY command in Part 2. Remove the test apparatus from the incoming trunk.
12	Restore the incoming trunk to service.
13	Remove the next trunk to be sampled from service and connect it to the outgoing trunk (or code 101 test circuit).
14	Repeat Steps 5 through 13 for each longest and shortest incoming trunk to be sampled.
15	When the last incoming trunk has been measured, remove the RLMS. If the trunk was a 4-wire facility, place 600-ohm terminations in EQ IN and EQ OUT jacks. If trunk was 2-wire facility, connect a 900-ohm 2.16 μF termination where the RLMS was connected.
16	Connect the RLMS to the EQ IN and EQ OUT jacks of the outgoing trunk (Fig. 1 and 2A). If the code 101 test circuit was used, to measure the incoming trunk, release it. Remove the first outgoing trunk to be sampled from service and connect it to an incoming trunk.
17	Repeat Steps 5 through 13 for all outgoing trunks in the samples.
18	When all trunks have been measured, remove all test apparatus and terminations.
19	Disconnect the trunks and return them to service.

STEP	PROCEDURE
20	Note the difference in capacitance between the longest and shortest incoming trunks and between the longest and shortest outgoing trunks. If the difference in either group exceeds 0.015 μF , DBOCs must be applied to the shorter trunks to make them equal to the longer trunks. Proceed to determine the office NBOC value as described in Part 5.
5. NBOC SELECTION AND APPLICATION	
5.01	The optimum value of capacitance to be strapped in the NBOC of a trunk would be one that would provide the best value of ERL and SRL. The method described below will produce the desired results. If a RLMS is connected as shown in Fig. 3 and a decade capacitor is connected to the NBOC of the trunk and the capacitance is increased in steps of 0.002 μF starting with zero μF , the ERL and SRL values shown in the graph may be obtained.
5.02	Once the longest incoming trunk and the longest outgoing trunk has been identified (Part 4), the NBOC capacitance can be determined by optimization. In some instances where a
	substantial difference in the length of the incoming and outgoing trunks exists, an NBOC value for each side of the switch may be required.
	5.03 A sample worksheet (Fig. 4) is provided and may be reproduced locally if desired. The data used to prepare the graph in Fig. 3 is shown in Fig. 5. It is not necessary to use a graph. Note that the optimum value of 0.006 μF produced ERL and SRL/H1 values of 25.5 dB.
	5.04 The following procedure is used to provide the transmission engineer or supervisor with the necessary information to determine the office NBOC value. Optimization is described in Section 852-405-101.

STEP	PROCEDURE
1	From the data obtained in Part 4, select the longest incoming trunk.
2	Remove the incoming trunk and the code 101 test circuit from service (use TTY codes in Part 2).
3	Connect the two trunks.
4	Connect the test apparatus as shown in Fig. 6.
5	Terminate the 4-wire ports of the 101 test hybrid with 600-ohm terminations.
6a	When measuring balance on 4-wire trunks using the Wiltron RLMS, compensate for transhybrid loss in the 4WTS of the trunk under test by doing the following steps: <ul style="list-style-type: none"> <li data-bbox="342 1776 1422 1829">— Place a short on the 2-wire port of the 4WTS (or connect the DBO cord from the lid and press the AC SHORT switch and hold it operated). <li data-bbox="342 1871 1024 1892">— Adjust the THL dB switch until meter reads zero.

STEP	PROCEDURE
	<ul style="list-style-type: none">— Remove the short (or release the AC SHORT switch). ERL and SRL readings are direct measurements.
6b	<p data-bbox="404 453 1549 512">When measuring balance on 4-wire trunks using a KS-20501 RLMS compensate for transhybrid loss in the 4WTS of the trunk under test by doing the following steps:</p> <ul style="list-style-type: none">— Place a short on the 2-wire port of the 4WTS.— Adjust the THL or ADD switch until the RLMS meter reads zero.— If a zero reading cannot be obtained set the ADD dB switch to the -10 position and readjust the THL OR ADD switch to obtain a zero reading. If this additional gain has to be used to overcome transhybrid loss, the 10 dB must be added to the reading.— Remove the short.
7	Starting with zero μF in the decade capacitor, make ERL, SRL/LO and SRL/HI measurements. Record these values on the worksheet (or equivalent).
8	Increase the decade capacitor value to $0.002\mu\text{F}$. Make ERL, SRL/LO and SRL/HI measurements and record the return loss obtained opposite the capacitance value on the form.
9	Continue increasing the capacitance by increments of $0.002\mu\text{F}$ and making the three measurements and recording them. When the decade capacitor value has reached $0.028\mu\text{F}$, stop testing.
10	Release the connection (see TTY command Part 2). Remove the test apparatus from the incoming trunk.
11	Restore the incoming trunk to service.
12	Remove the longest outgoing trunk from service. Connect it to the code 101 test circuit.
13	Connect the test apparatus as shown in Fig. 7.
14	Repeat Steps 5 through 9 for the outgoing trunk.
15	Remove all the test apparatus and release the connection.
16	Restore the outgoing trunk and the code 101 test circuit to service.
17	Give the results of the measurements to the transmission engineer or supervisor who will optimize the NBOC value.
18	Strap all NBOCs according to the values obtained in the optimization. Build out test circuits in accordance with procedures in Part 6.

6. CODE 101 TEST CIRCUIT—BUILD-OUT PROCEDURES

outgoing trunk. These hybrids are accessed through the code 101 test circuit either by patching them to the TM jack or operating a switch on the supplementary maintenance frame.

6.01 In an AIC office equipped with two test hybrids, one hybrid is built-out to be electrically equal to the longest incoming trunk and the other electrically equal to the longest

6.02 Proceed as follows.

STEP	PROCEDURE
1	Remove the code 101 test circuit from service (see TTY commands Part 2).
2	Connect the test hybrid that is to be equal to the longest incoming trunk to the code 101 test circuit.
3	Remove the longest incoming trunk from service.
4	Connect the longest incoming trunk to the code 101 test circuit.
5	At the 4-wire ports of the incoming trunk 4WTS, terminate the EQ IN and EQ OUT jacks in 600 ohms.
6	Connect the test apparatus as shown in Fig. 8.
7	Remove all strapping in the NBOC and DBOC of the code 101 test circuit. If a DBOC is not connected, connect one at this time.
8a	When measuring capacitance of the code 101 test circuit using the Wiltron RLMS, compensate for transhybrid loss in the test hybrid by doing the following steps: <ul style="list-style-type: none"> <li data-bbox="347 1209 1430 1268">— Place a short on the 2-wire port of the test hybrid (or connect the DBO cord from the lid and press the AC SHORT switch and hold it operated). <li data-bbox="347 1304 1081 1335">— Adjust the THL dB switch until the meter reads zero. <li data-bbox="347 1371 1430 1430">— Remove the short (or release the AC SHORT switch). ERL and SRL readings are direct measurements.
8b	When measuring capacitance of the code 101 test circuit using the KS-20501 RLMS, compensate for transhybrid loss in the test hybrid by doing the following steps: <ul style="list-style-type: none"> <li data-bbox="347 1556 1049 1587">— Place a short on the 2-wire port of the test hybrid. <li data-bbox="347 1623 1252 1654">— Adjust the THL OR ADD switch until the RLMS meter reads zero. <li data-bbox="347 1713 1430 1835">— If a zero reading cannot be obtained, set the ADD dB switch to the -10 position and readjust the THL OR ADD switch to obtain a zero reading. If this additional gain has to be used to overcome transhybrid loss, the 10 dB must be added to the reading. <li data-bbox="347 1871 615 1902">— Remove the short.

STEP	PROCEDURE
9	Starting with zero μF in the decade capacitor (or the NBO capacitor in the lid of the Wiltron Set), adjust the ADD dB switch on the RLMS and increase the capacitance in the decade capacitor until the maximum reading can be obtained on the RLMS meter.
10	Read the value in capacitance in the decade capacitor.
11	From the record made of capacitance measurements in Part 4, obtain the capacitance of the longest incoming trunk.
12	Subtract the value from Step 10 from the value in Step 11. Place this value in the DBOC of the code 101 test circuit.
13	Repeat Steps 9 and 10. The capacitance should now equal the capacitance of the longest incoming trunk. Due to manufacture tolerances, a slight adjustment may be required on the DBOC.
14	Strap the NBOC value determined in Part 5 in the code 101 test circuit hybrid.
15	Disconnect the first test hybrid. If two hybrids are provided, connect the second test hybrid to the code 101 test circuit. If only one hybrid is provided, remove the test apparatus, disconnect the trunks and restore them to service.
16	Repeat Steps 6 through 14, using in Step 11 the value of capacitance for the longest outgoing trunk.
17	Designate the test hybrids for incoming and outgoing tests. Remove test apparatus, disconnect the trunk from the code 101 test circuit, and restore them to service. Make balance verification test in accordance with the procedures presented in Section 660-479-301.

7. DBOC SELECTION AND APPLICATION

7.01 DBOCs are required on those trunks whose capacitance (measured in Part 4) is 0.015 μF less than the longest measured trunk in the incoming trunk or outgoing trunk groups.

7.02 Two methods may be used to determine which trunks require DBOC. The capacitance measurements described in Part 4 may be continued until all of the trunks are identified. This is a

time consuming method. In the second method when making balance verification tests, if the ERL and SRL values begin to measure marginal or below requirements, a quick capacitance check can be made by making one test apparatus connection. A decade capacitor is attached to the trunk and the required capacitance added until the trunk equals the longest trunk in either the incoming or outgoing trunk group in which the trunk is located. The following procedure describes this second method.

STEP	PROCEDURE
1	With the trunk under test connected through the AIC switch to a properly terminated trunk (see Fig. 9), attach a decade capacitor to the NBOC of the trunk under test.

STEP	PROCEDURE
2	Remove all strapping in the NBOC.
3	The transhybrid loss should be adjusted as the trunk was in the process of being verified for balance. If not, use the procedure described in Part 4, Steps 8a or 8b for the type of RLMS being used.
4	Adjust the dials on the decade capacitor and the ADD dB switch on the RLMS until the maximum on-scale reading on the RLMS meter is obtained.
5	Read the value in μF in the dial settings of the decade capacitor. This is the capacitance of the trunk.
6	Compare the value obtained in Step 4 with the capacitance of the longest trunk in the incoming or outgoing group of trunks.
7a	If the difference in capacitance between the two trunks is less than $0.015 \mu\text{F}$, another problem exists. Refer to trouble locating procedures in Section 660-479-301.
7b	If the difference in capacitance between the two trunks exceeds $0.015 \mu\text{F}$, attach a DBOC to the trunk under test.
8	Subtract the capacitance of the shorter trunk from the longer trunks. Strap this value in the DBOC and repeat Steps 4 and 5.
9	Strap the NBOC of the trunk under test for its proper value. Remove the decade capacitor.
10	Check ERL, SRL/LO and SRL/HI as described in the verification procedures of Section 660-479-301.
8. REFERENCES	660-479-101 AIS—Extended Range—General Balancing Considerations—Records and Forms
8.01 The following BSP sections are referenced in this section.	660-479-301 AIS-Extended Range—Balance Requirements and Verification Tests
250-402-501 Trunk Transmission Tests From AIC No. 1A—AIS	852-405-101 AIS-Extended Range—Engineering Considerations
660-479-100 General Balance Information	

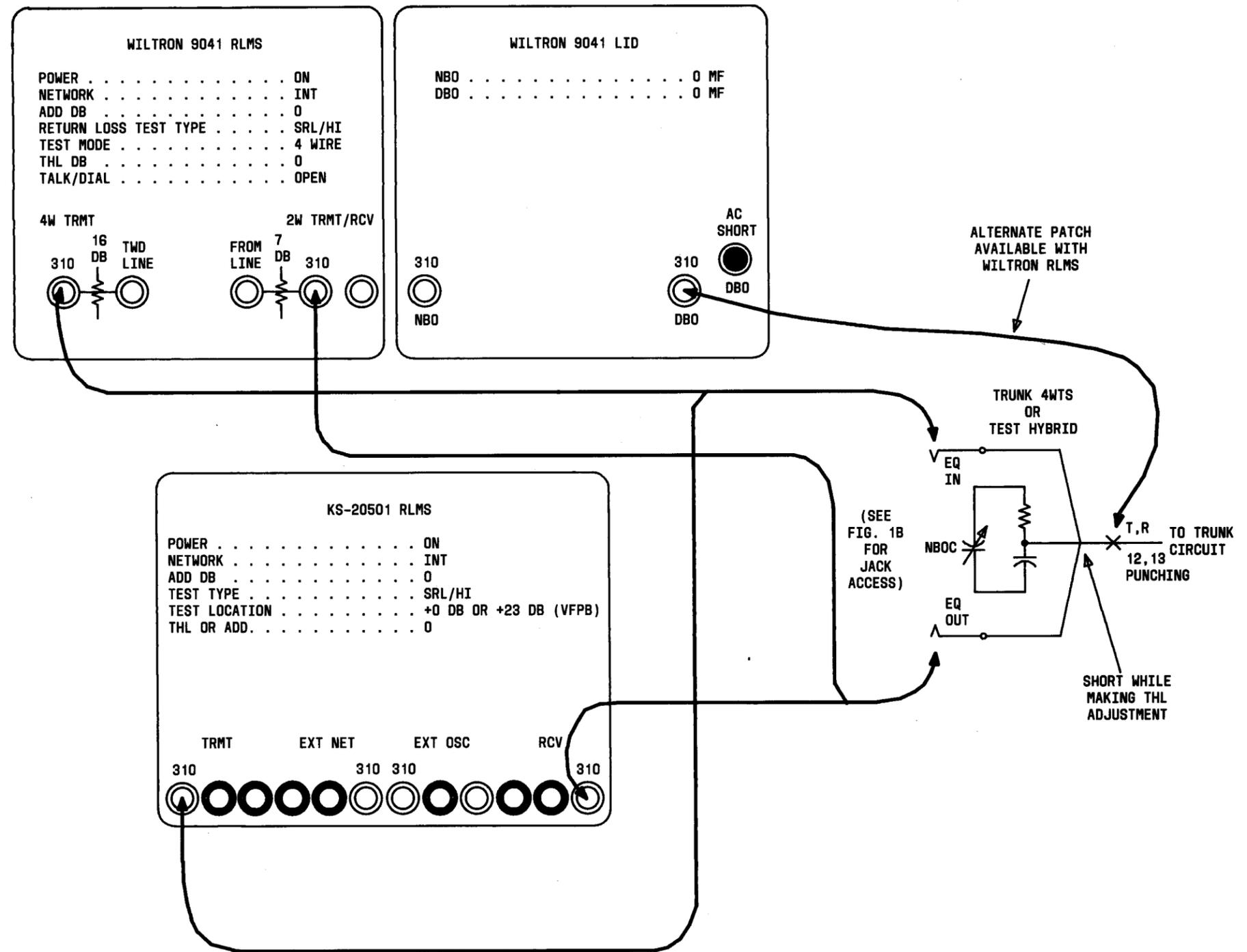


Fig. 1A—Method of Connecting RLMS to Trunk 4 WTS or to Test Hybrid

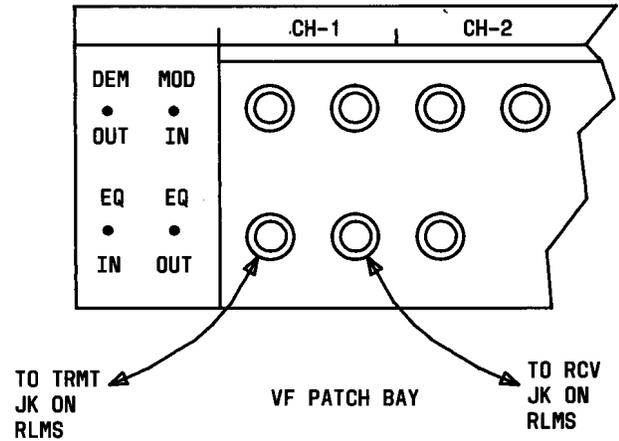
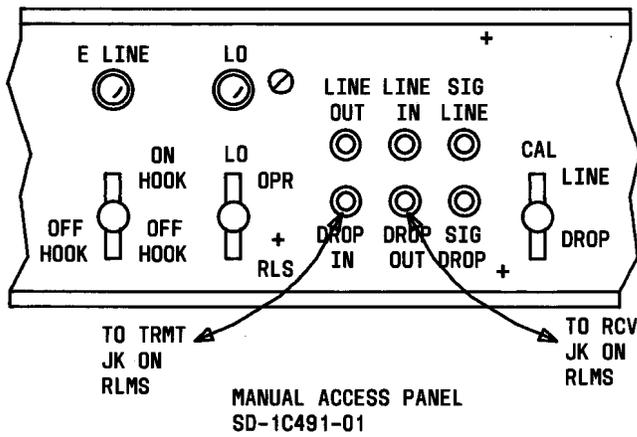
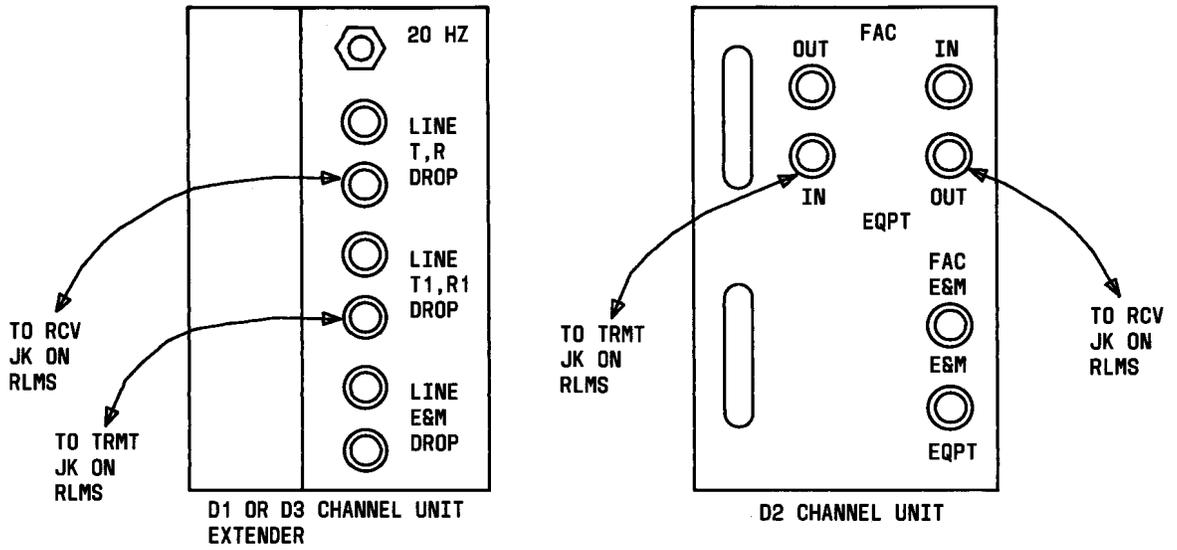


Fig. 1B—Typical Jack Access on AIS Trunks

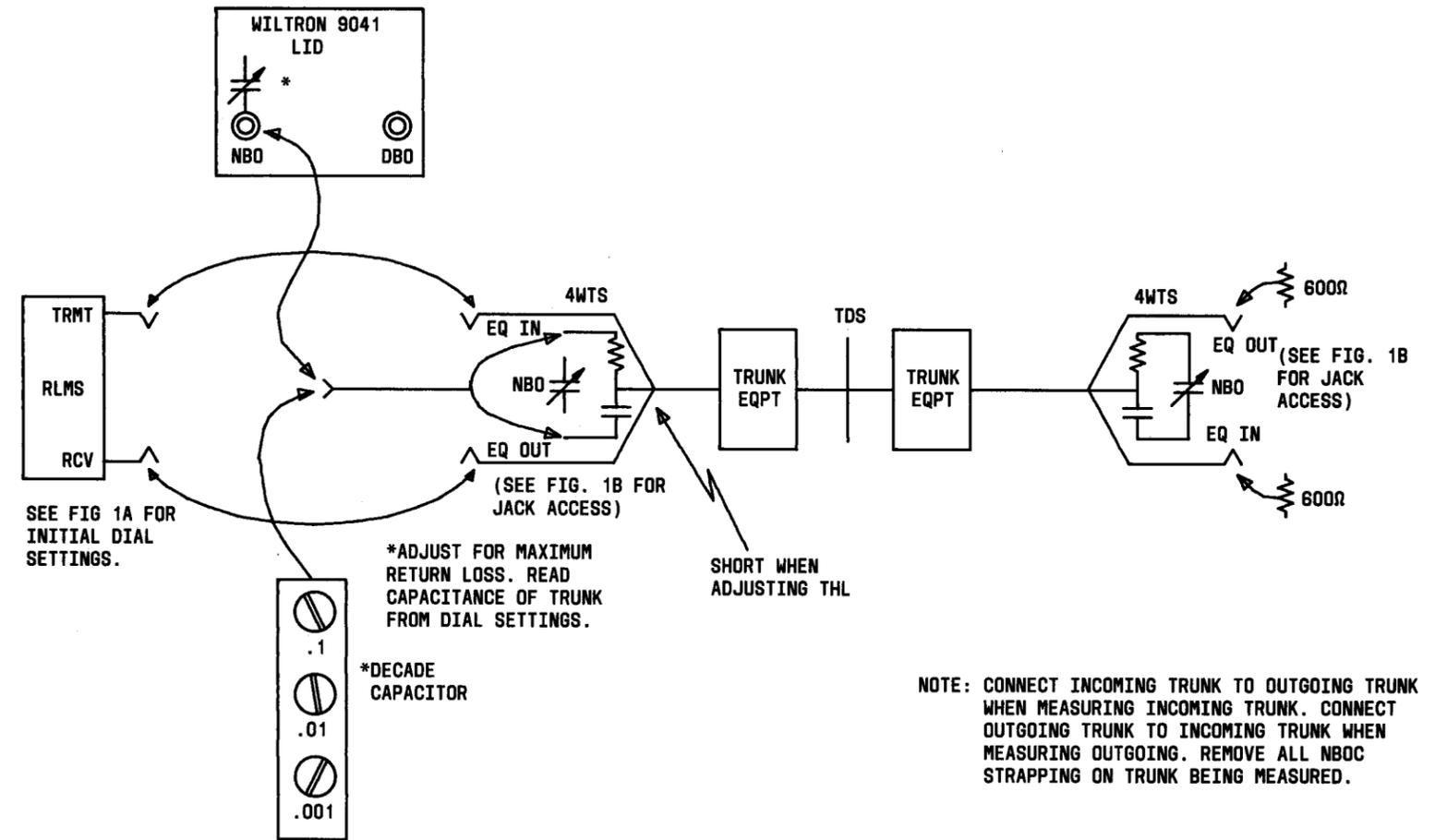


Fig. 2A—Capacitance Measurements 4W Trunks

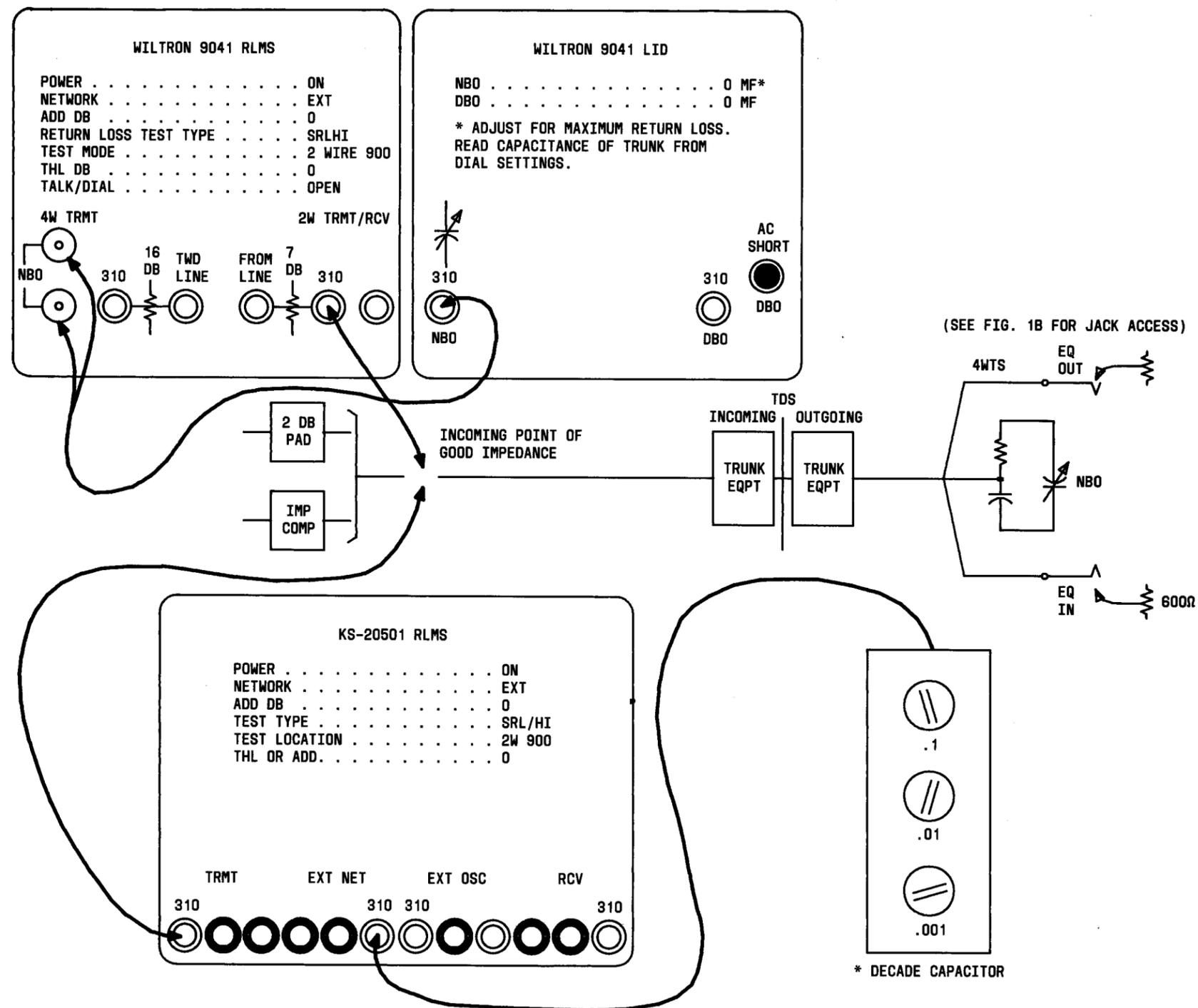


Fig. 2B—Capacitance Measurements 2W Trunk

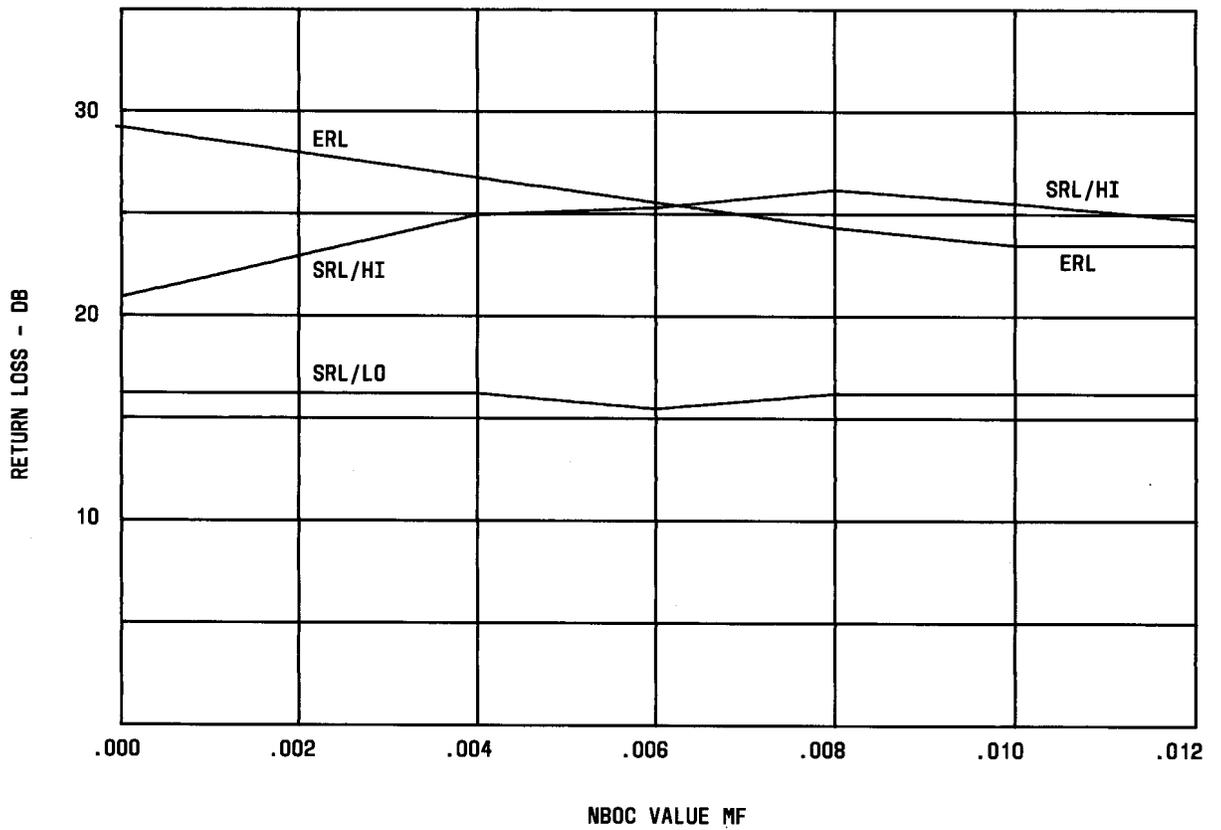
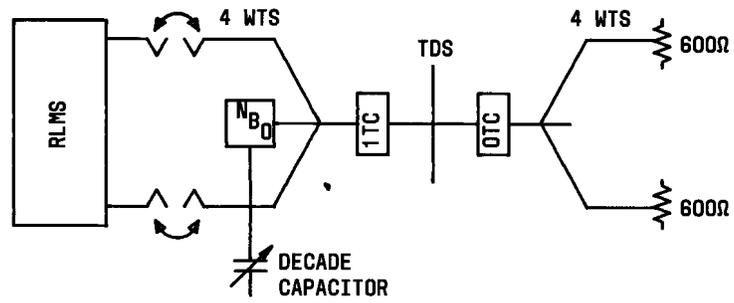


Fig. 3—Optimization of NBOC Value in AIS Connection

NBOC SELECTION WORKSHEET

DECADE CAPACITOR MF	ERL dB	SRL/LO dB	SRL/HI dB
0.000			
0.002			
0.004			
0.006			
0.008			
0.010			
0.012			
0.014			
0.016			
0.018			
0.020			
0.022			
0.024			
0.026			
0.028			

OFFICE _____

TRUNK _____

NBOC VALUE USED _____ #F

DATE _____ TESTER _____

Fig. 4—Sample Worksheet

NBOC SELECTION WORKSHEET

DECADE CAPACITOR MF	ERL dB	SRL/LO dB	SRL/HI dB
0.000	28	17	22
0.002	27	17	23.5
0.004	26	17	25
0.006	25.5	16.5	25.5
0.008	24.5	16.5	26
0.010	23.5	16.5	25.5
0.012	23	16.5	24.5
0.014			
0.016			
0.018			
0.020			
0.022			
0.024			
0.026			
0.028			

OFFICE ALPHATRUNK 1 BETANBOC VALUE USED 0.006 #FDATE 12/7/77 TESTER H

Fig. 5—Test Results NBOC Selection

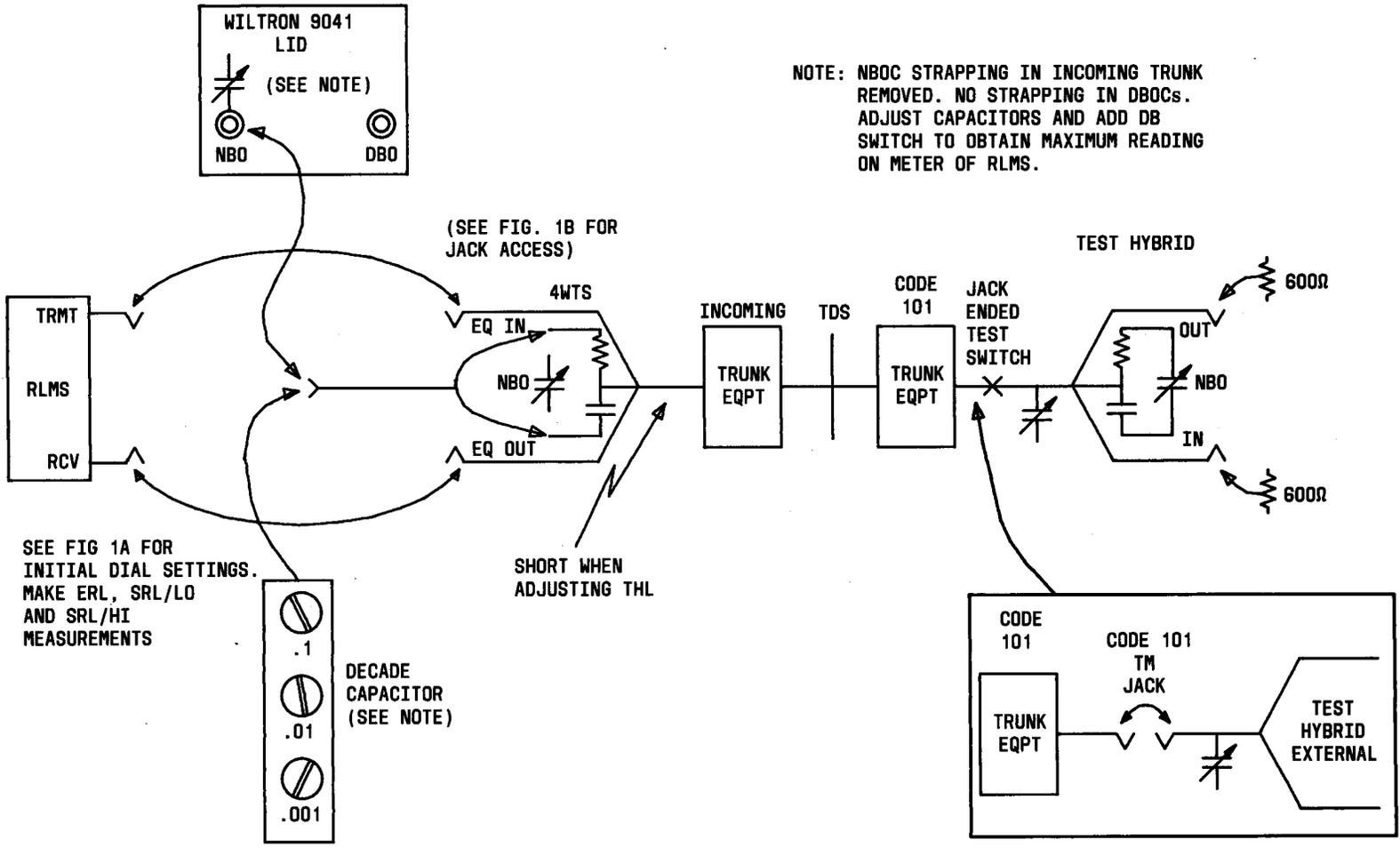


Fig. 6—NBOC Selection Incoming Trunk

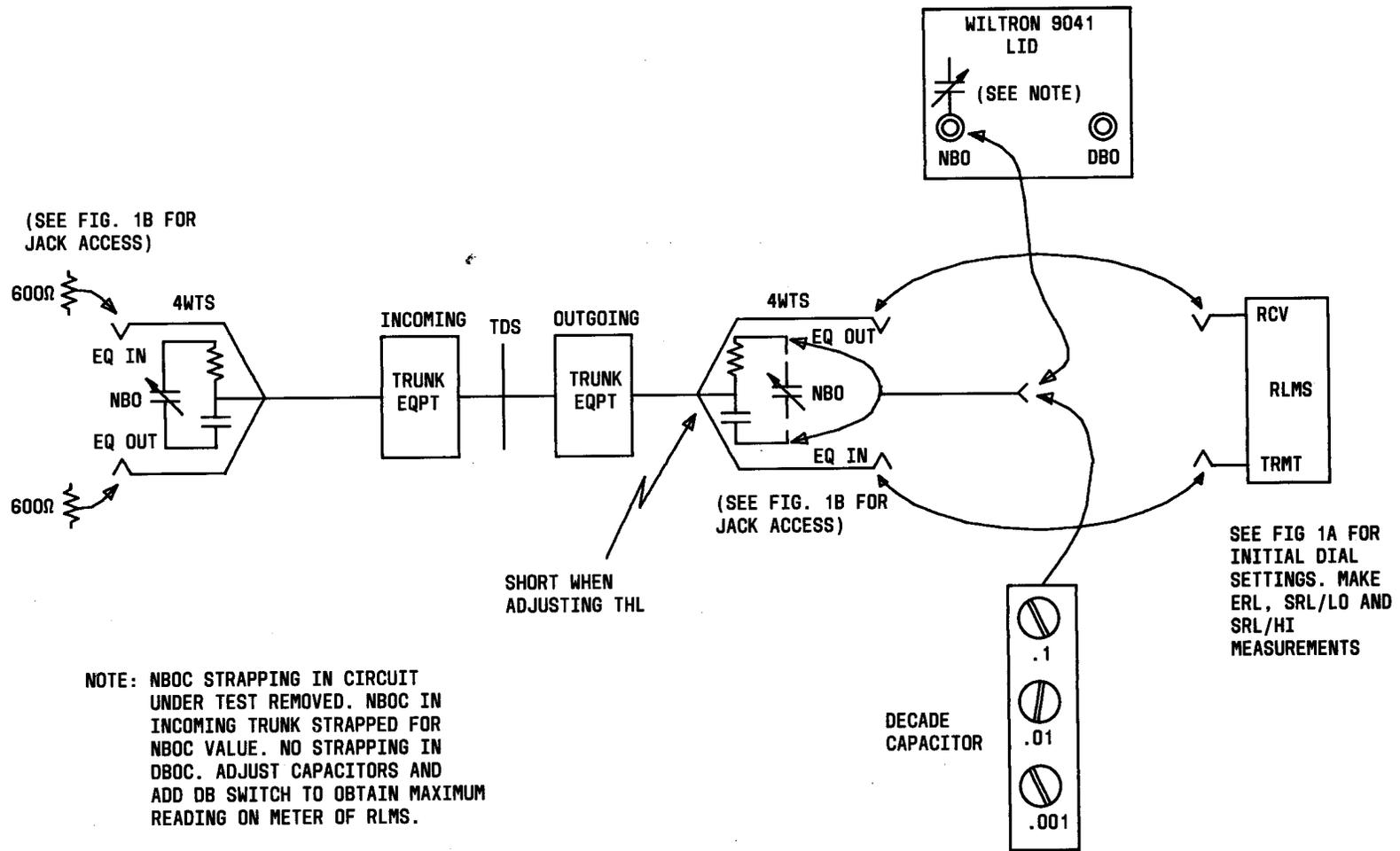
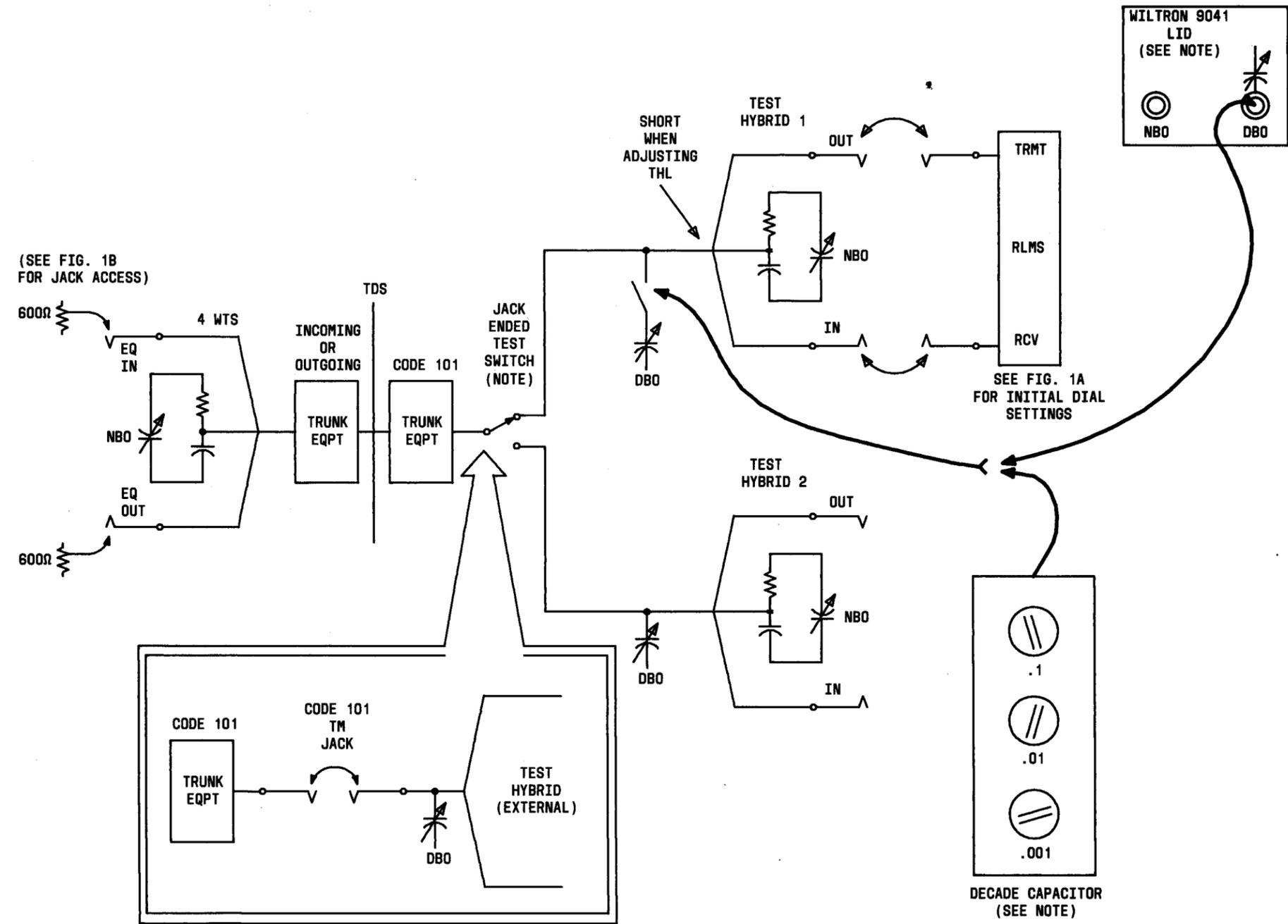


Fig. 7—NBOC Selection Outgoing Trunk



- NOTES:
1. ALL NBOCS STRAPPED FOR OFFICE NBOC VALUE. ADJUST CAPACITORS AND ADD DB SWITCH FOR MAXIMUM RETURN LOSS READING ON RLMS METER.
 2. IF SWITCH IS NOT PROVIDED, PATCH REQUIRED FOR CONNECTION OF THE TWO TEST HYBRIDS. IF ONLY ONE TEST HYBRID IS USED, MAKE IT EQUAL TO THE LONGEST TRUNK.

Fig. 8—Buildout of Code 101 Test Circuit

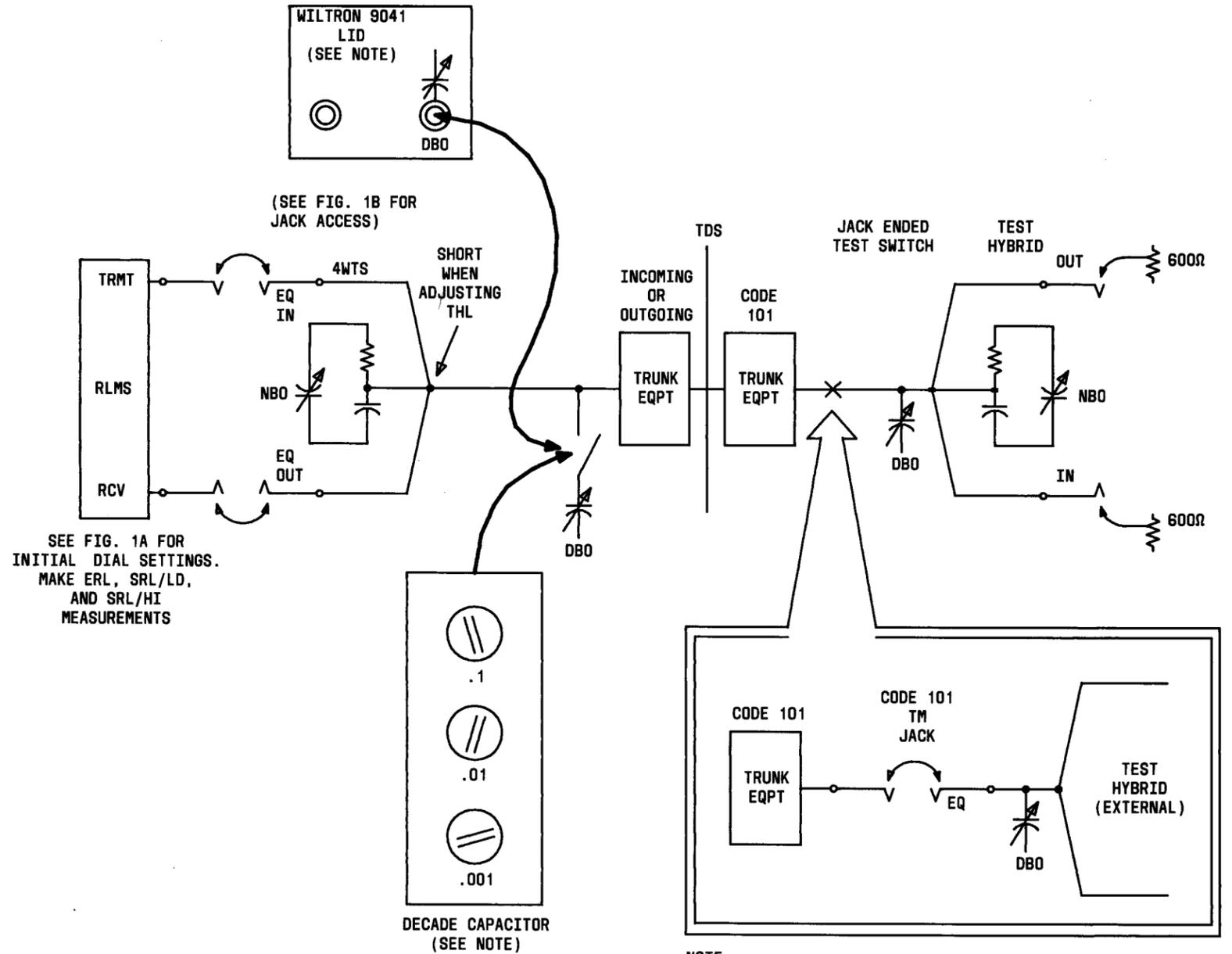


Fig. 9—DBOC Selection