BSP # 773 B

COMPLETION TESTS OF EXCHANGE-AREA CABLES

TESTING

1. GENERAL

1.01 If the tests covered in this section indicate that faults are present in the cable, a second set of tests shall be made on the pairs concerned, after the faults have been cleared. Results of the latter tests shall supersede the results of the initial tests on those pairs in computing averages, making tallies, etc.

1.02 The order of the tests, that is, Resistance first, Return Loss next, and Transmission Loss last, has been selected purposely. If poor contacts should occur at pick-up shoes, the resistance test should reveal them before they have a chance to cause false measurements of return loss or transmission loss. Similarly, if impedance irregularities exist, they are detected before they have a chance to cause false transmission loss measurements. It is important, therefore, not to disturb the pick-up shoes between the start of resistance measurements and the finish of transmission loss measurements on a "shoe-full" of pairs. If shoes are reset during resistance measurements in an attempt to eliminate possible high-resistance contacts, discard the measurements already made on that shoe-full and start over.

1.03 In the following parts of this section, detailed guidance in each kind of test is followed by a concise step-by-step procedure. It is expected that after a crew of testers have become thoroughly familiar with the details, they will usually follow the concise outline. If needed, however, the details are always at hand.

2. RESISTANCE

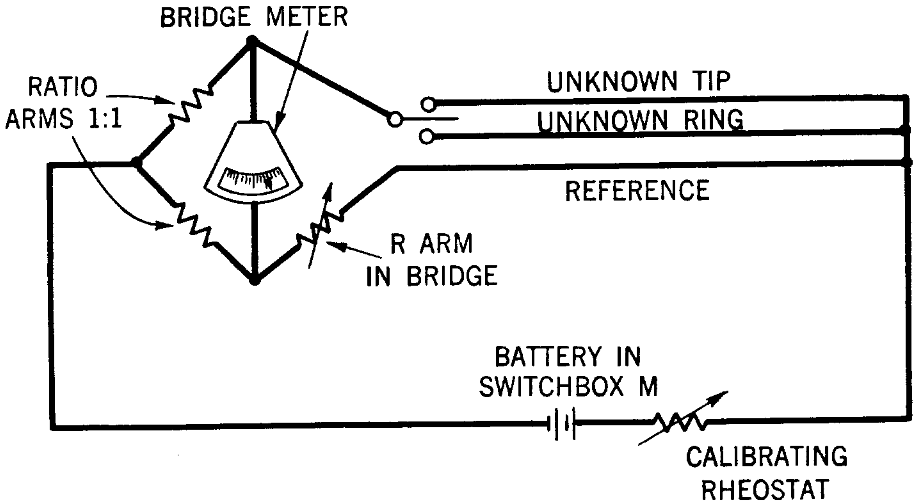
2.01 After a reference wire has been selected and the bridge has been calibrated, resistance in ohms is shown by the motion of the galvanometer pointer from the middle of the scale. If the pointer moves "x" divisions to the right, the wire being measured has "x" ohms more resistance than the reference wire; if to the left, it has "x" ohms less resistance than the reference. Be sure the 10-ohm rheostat is turned all the way counterclockwise (zero resistance) at the start of each measurement.

2.02 If the galvanometer pointer comes to rest off-scale at the right-hand side, it can be brought back on-scale to the right of zero by adjusting the "tens" dial of the bridge. The resistance of the wire being measured is then greater than that of the reference wire by "x" ohms plus the number of ohms shown by the dial setting. For example, if the tens dial is set on 1, and the pointer rests on the seventh division to the right of the middle, the unknown wire has $7+(1x10)=17$ ohms greater resistance than the reference wire.

2.03 If the pointer comes to rest off-scale at the left-hand side, temporarily cut in the 10-ohm rheostat. If the pointer then rests on-scale, "x" divisions to the left of the midpoint, the resistance of the wire being measured is less than that of the reference wire by $(x+10)$ ohms. If the pointer cannot be brought on-scale by cutting in the 10-ohm rheostat, the wire in question must be measured by triangulation as illustrated in the 502 section. The reference wire, the "unknown" wire, and any other wire may be used. After these three have been measured, the deviation of the "unknown" from the reference is easily computed. Enter this deviation on the form, and cut out all the resistance in the 10-ohm rheostat in preparation for the next measurement.

2.04 Be sure to enter a "zero" for the resistance of the reference wire itself. Also, from the triangulation measurements as outlined in the 502 section, enter the deviation of the mate of the reference wire.

2.05 Be sure to fill in the data for each pair on the data form. Make the tallies after each group of 10 or 20 pairs is measured, in order to get a continuing picture of the results. Do not attempt to make tallies directly from meter indications, omitting the recording of data, since all identity of data with pairs would then be lost.



Circuit for Resistance Measurements

STEP-BY-STEP PROCEDURE

STEP	MEASURING END	STEP	TERMINATING END
21.	Place pick-up shoes on the first 10 or 20 pairs.	21.	Place pick-up shoes on the first 10 or 20 pairs.
22.	Set FUNCTION switch to RESISTANCE and PAIR switch to Pair 1.	22.	Set FUNCTION switch to RESISTANCE and PAIR switch to Pair 1.
23.	Set TIP-RING switch to TIP.		
24.	Depress the BATTERY and GAL keys of the Wheatstone bridge.		
25.	Observe the direction and extent of the pointer deflection: right (+); left (−).		
26.	Read the observation to the tester at the terminating end. Example: "Plus 4."	26.	Write down the observation on the data form in the space for Pair 1, Tip.
27.	Operate TIP-RING key to RING and repeat 24 through 26.	27.	Write down the observation on the data form in the space for Pair 1, Ring.
28.	Set the PAIR switch to Pairs 2 through 10, in turn, and measure as in 23 through 27. Proceed to the return-loss tests on the same 10 pairs.	28.	Set the PAIR switch to Pairs 2 through 10, in step with the measuring end, and write down the observations as in 26 and 27.
29.	About once an hour, check the condition of the bridge battery. Choose a wire having a positive deviation from the reference wire. While holding down the BATTERY and GAL keys of the bridge, increase the 10's dial of the bridge by one step. The pointer should swing 10 divisions to the left of the first position. A smaller swing indicates a deteriorating battery.		

3. RETURN LOSS (Loaded pairs only)

3.01 At the measuring end, the loaded pair must be connected to the 54C return-loss set. At the terminating end, it must be connected to a termination. Both of these connections are easily made by operating the FUNCTION switches of Switchboxes M and T to RETURN LOSS or RL, and by operating the PAIR switches to the proper pair number.

3.02 The loaded pair must be properly "built out." The BOC for the terminating end was computed in Line (e) of the "preparations" data sheet in the 502 section. Adjust BOC in Switchbox T to this value.

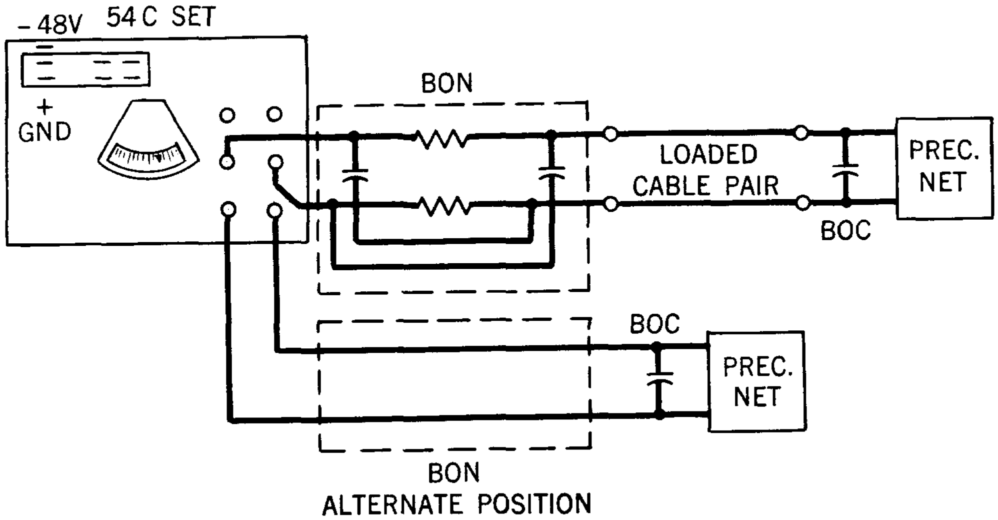
3.03 To build out at the measuring end, adjust the BON network to the average resistance and capacitance values shown at the bottom of the table on the "Preparations" data sheet. Set the BON switch to correspond to the sign of the average capacitance: Line for (−); Network for (+). As a result, the pair will be built out if the end section is less than one-half loading section; the network will be built out if the end section is more than one-half loading section.

3.04 Calibration consists of adjusting the effective output of the 54C-set oscillator to give a zero reading on the meter-plus-dial-switch. It should be done once for every 10 pairs, and also after any pause in the procedure.

3.05 After the 54C set has been calibrated, measurement consists simply of adjusting a dial-switch to bring the meter pointer on the black scale between 0 and 10 db loss, and then observing the position of the pointer to the nearest whole number of db. The dial-switch setting and the pointer position are recorded on the form. If the pointer moves rapidly back and forth, estimate the midpoint of its range.

3.06 In recording and tallying data, follow the method of Par. 2.05.

3.07 It is unusual for noise to interfere with accuracy of return-loss measurements but it can happen. Strong noise might cause the pointer to deflect to the right of zero, thus preventing proper calibration. A sure way to detect noise that is strong enough to interfere with measurements is to replace the oscillator with a short circuit during a measurement. If the dial-switch-plus-pointer position does not change by at least 15 db, the noise is causing false measurements. Testing should be stopped until the noise can be cleared.



Circuit for Return-Loss Measurements

STEP-BY-STEP PROCEDURE

STEP	MEASURING END	STEP	TERMINATING END
31.	Set the FUNCTION switch to RETURN LOSS and the PAIR switch to Pair 1.	31.	Set the FUNCTION switch to RETURN LOSS and the PAIR switch to Pair 1.
32.	On the 54C set, operate S2 to CAL, S1 to 500-2500 cps, and adjust SEND LEVEL ADJ knob for 500-2500 cps for zero reading on the black scale. If this adjustment can be made, proceed to Step 33. If it cannot be made, noise may be interfering. In the latter case, report the condition to your supervisor.		
33.	Operate S2 to MEAS, and adjust the db dial-switch to obtain a reading between 0 and 10 db on the black scale.		
34.	Observe the setting of the dial-switch and the pointer reading, the latter to the nearest whole number of db, and read to the terminating end.	34.	Record the dial-switch setting and the pointer reading in the space for Pair 1.
35.	Replace the oscillator of the 54C set with a short circuit. To do this, insert a "shorting" plug in the single jack marked EXT OSC (external oscillator), or insert a "shorted" double banana plug in the corresponding double banana jacks and a dummy plug in the single jack.		

STEP-BY-STEP PROCEDURE

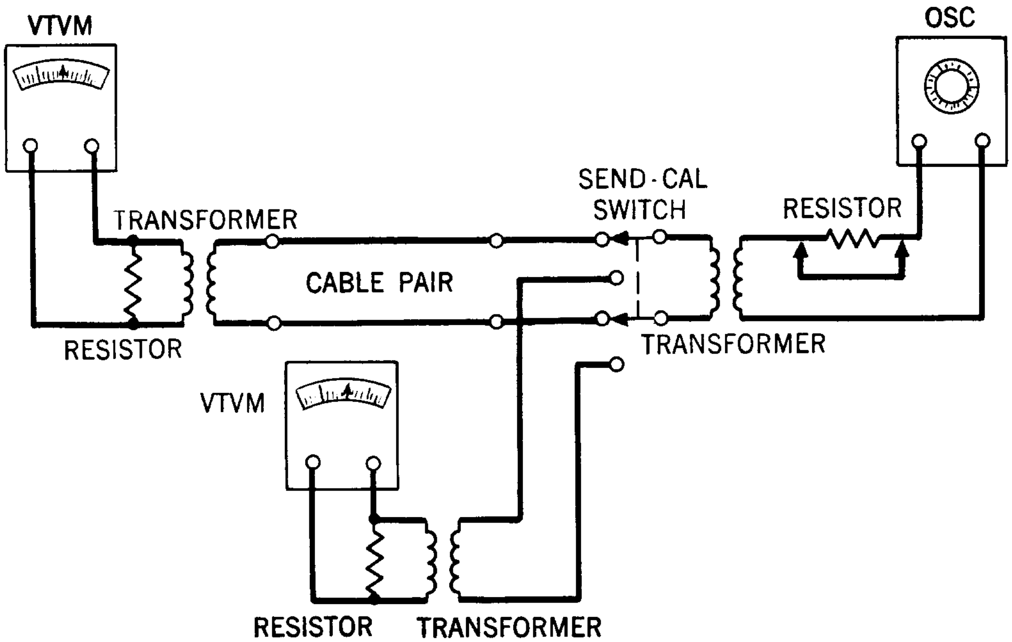
STEP	MEASURING END	STEP	TERMINATING END
36.	Adjust the dial-switch again to obtain a reading between 0 and 10 db on the black scale. Calculate roughly whether or not the dial-plus-meter total (loss) increased by 15 db or more. If it did, noise is not interfering, and the tests may be continued. If it did not, the noise is strong enough to cause errors in the measurements, and the tests should be discontinued until the noise can be cleared. Report such a condition to your supervisor.		
37.	Set the PAIR switch to Pairs 2 through 10, in turn, and measure each pair as in 33 and 34. Proceed to the transmission-loss tests.	37.	Set the PAIR switch to Pairs 2 through 10, in step with the measuring end, and record the data as received.

4. TRANSMISSION LOSS

4.01 At the terminating end, each oscillator is adjusted to send the correct amount of power at the beginning of each group of measurements, that is, for each ten or twenty pairs. The adjustment is made while the oscillator is feeding a dummy load at the terminating end. For load resistors, see Part 4 of the 502 section.

4.02 When the correct amount of power is being fed to the dummy load, the latter is removed, and the cable pair is inserted between the oscillator and an exactly similar load at the measuring end. The difference between the power received via the cable pair and the power received at the dummy load (all measured in db) is the insertion loss of the line. It is measured directly on the measuring-end VTVM.

4.03 If noise is present in sufficient strength to interfere with the transmission-loss measurements, it can be detected by disconnecting the oscillator and observing how much the VTVM indication changes at the measuring end. If it does not change at least 20 db (more loss), it is likely that noise is causing errors. Testing should be stopped until the noise can be cleared.



Circuit for Transmission-Loss Measurements

STEP-BY-STEP PROCEDURE — LOADED PAIRS

STEP	MEASURING END	STEP	TERMINATING END
41.	Set the FUNCTION switch to TRANSMISSION LOSS-1 KC and the PAIR switch to Pair 1. For load resistors at both measuring and terminating ends, see Part 4 of the 502 section.	41.	Set the FUNCTION switch to TRANSMISSION LOSS-1 KC and the PAIR switch to Pair 1.
		42.	Operate the SEND-CAL switch to CAL and hold it there while adjusting the output of the 1-kc oscillator so that the pointer of the VTVM rests at the 1-kc mark on the paper label.
		43.	Operate the SEND-CAL key to SEND.
44.	Set the VTVM dial-switch to bring the pointer on scale between 0 and −10 db. Observe the position of the pointer to the nearest 0.1 db, estimating if necessary. Read this and the position of the dial-switch to the terminating end.	44.	Record the observations in the space for Pair 1.
45.	Set the PAIR switch to Pairs 2 through 10, in turn, and measure each pair as in 44. If the pairs are loaded, proceed to Step 50.	45.	Set the PAIR switch to Pairs 2 through 10, in step with the measuring end, and write down the observations in the proper spaces. If the pairs are loaded, proceed to Step 50.

STEP-BY-STEP PROCEDURE — NON-LOADED PAIRS

STEP	MEASURING END	STEP	TERMINATING END
46.	Set the FUNCTION switch to TRANSMISSION LOSS-60 KC, and the PAIR switch to Pair 1.	46.	Set the FUNCTION switch to TRANSMISSION LOSS-60 KC, and the PAIR switch to Pair 1.
		47.	Operate the SEND-CAL switch to CAL and hold it there while adjusting the output of the 60-kc oscillator so that the pointer of the VTVM rests at the 60-kc mark on the paper label.
48.	Set the dial-switch to bring the pointer on scale between 0 and −10 db. Read the setting and pointer position to the terminating end.	48.	Operate the SEND-CAL key to SEND.
49.	Reset the dial-switch to bring the pointer on scale again. Calculate roughly whether the change from the measurement of 48 amounts to 20 db or more. If it does, the noise is low enough not to interfere. If it does not, noise is probably interfering. In the latter case, discontinue the tests and report the condition to your supervisor.	49.	Operate the SEND-CAL key to CAL. This cuts off the power, so that the measuring end observes the level of noise alone.
50.	If noise is not interfering, proceed to measure Pairs 2 through 10, as in Steps 46, 47 and 48.	50.	Continue to measure Pairs 2 through 10, in step with the measuring end.
51.	Set the PAIR switch to Pairs 2 through 10, in turn. Measure each pair as in 48, and read the data to the other end.	51.	Set the SEND-CAL key to SEND and the PAIR switch to Pairs 2 through 10, in step with the measuring end, and record the data as received.

ALL PAIRS

STEP	MEASURING END	STEP	TERMINATING END
52.	Proceed to set up the next 10 pairs, and continue with Step 21.	52.	Proceed to set up the next 10 pairs, and continue with Step 21.