16B1 TELEGRAPH REPEATER TESTS AND ADJUSTMENTS

CONTENTS

1. GENERAL

1.01 This section covers the methods of testing and operating the 16B1 Telegraph Repeater. It applies to operation over one line circuit on a grounded basis or over two line circuits on a metallic basis for all methods of operation for which the repeater is suitable.

2. DESCRIPTION OF TESTS AND ADJUSTMENTS

Additional Apparatus Required

2.01 The following additional apparatus will be required in making some of the tests:

163A1 Test Unit
3-1/2" Cabinet Screwdriver
165C Plug (dummy) or equivalent open plug
8 - Test Clips

(A) Telegraph Relays

2.02 The relays shall be tested and adjusted in accordance with B.S.P. sections covering the relays and the relay test set.

(B) Loop Current Adjustment

2.03 Adjust the loop currents of the sending and receiving loops in accordance with Table 1 below by turning the rheostats by means of the screwdriver. Turning the loop rheostat in a clockwise direction increases the resistance of the loop circuit and reduces the current.

Table 1

Battery Voltage	Loop Current
270	65
260	62.5
250	60

(C) Adjustment of Line Current Limiting Resistances

2.04 For polarential operation using one line circuit strap each of the resistances (D) and (E) to provide the series resistance value indicated in Table 2.

2.05 For polarential operation over two line circuits strap each of the resistances (D), (E), (F) and (G) to agree with Table 2.

2.06 For differential duplex operation using one or two line circuits strap resistances (D), (E), (F) and (G) to give zero resistance.

Table 2

*Total Line Resistance	Line Current Limiting Resistance
0- 400 ohms	450 ohms
400- 800 ohms	300 ohms
800-1200 ohms	150 ohms
1200 ohms or more	0

* The measured or computed resistance from testboard to testboard or from testboard to line terminal of a 128B2 set including entrance cables and composite or simplex coils.

(D) Artificial Line Adjustment

2.07 After the repeater has been strapped in accordance with the method of operation to be used, proceed as follows:

(1) Connect the line to the repeater.

(2) The distant end of the line should be connected to the repeater which is to be used and this distant repeater should be in a marking condition.

(3) Operate the (CX IN) key for all composited lines and for all other lines on which the balance is improved by its use. The composite balancing set is connected when the key marking is vertical.

(4) Insert the meter plug of the 163A1 test unit in the (BAL 1) jack.

(5) Insert the key and sounder plug in the (S LOOP) jack.

(6) Make the d-c balance when required as follows. Send slow reversals (dashes) by operating the telegraph key. Adjust the (BAL RES) rheostat by means of the screwdriver until the steady deflection of the milliammeter needle is the same with the key opened or closed. If the 163A1 Test Unit is not equipped with a key and sounder the loop may be opened and closed at the (S LOOP) jack by insertion and removal of the 165C (dummy) plug or its equivalent.

(7) Make the capacity balance by varying the capacity of the artificial line through manipulation of the (C BAL) keys until the meter kick is reduced to a minimum when the loop is repeatedly opened and closed. When the key markings are vertical the capacities are connected.

(8) Attempt to reduce the kicks still further by adjusting the (TIM RES) rheostat by means of the screwdriver.

(9) Repeat (7) and (8) alternately until the kicks are reduced to a minimum.

(E) Apex Resistance Adjustment

2.08 Procedure:

(1) Set up the repeater in accordance with 2.07 (1) and (2).

(2) Insert the meter plug of the 163A1 Test Unit into the (LINE) jack.

(3) Adjust the apex resistance by means of the apex keys in accordance with instructions for the method of operation to be used. When the key marking is vertical the resistance is in.

(F) Continuity and Balance of Neutralizing Line Circuit

2.09 Procedure:

(1) Set up the repeater in accordance with 2.07 (1) and (2).

(2) Have the attendant at the telegraph line board check the continuity of the neutralizing line circuit in both directions, that is, over the line circuit and through the distant repeater or set to ground and also through the home repeater to ground.

(3) Have the line board attendants at both ends of the line interchange the regular and neutralizing line circuits.

(4) Repeat the line balance in accordance with 2.07 (4), (5) and (6). Send slow reversals (dashes) while observing the meter. If the test indicates that the two lines are different, make a further investigation to determine the cause.

(5) If the neutralizing line balance is satisfactory restore the line circuits to their original assignments.

(G) Bias Current Adjustment

2.10 Procedure:

(1) This adjustment is used when the repeater is operated as a polar sending repeater for polarential operation.

(2) Set up the repeater in accordance with 2.07 (1) and (2).

(3) Insert the meter plug of the 163A1 Test Unit in the (BAL 1) jack.

(4) Have the repeater attendant at the distant end of the line send a steady spacing signal from the polar receiving repeater or set and record the meter reading while the signal is being received.

(5) Insert the meter plug into the (BIAS) jack and adjust the (BIAS) rheostat by means of the screwdriver until the meter reading is the same but opposite in direction to that recorded in (4). This adjustment is only approximate but permits communication over the circuit.

(6) Make a more accurate adjustment of the bias current as follows. Have the repeater attendant at the distant end of the line send unbiased miscellaneous test signals. Receive these signals by means of a 118-type telegraph transmission measuring set if available or take orientation ranges with a monitoring teletypewriter. Make further adjustment of bias current to remove any bias indicated by the measuring device.

(H) Equalizer Adjustment

2.11 Procedure:

(1) Set up the repeater and balance it in accordance with 2.07.

(2) Set the equalizer resistances (K), (K1), (K2) and (K3) to 300 ohms in the case of open wire operation and 500

ohms for cable operation. This may conveniently be done by means of short wires equipped with test clips.

(3) Adjust the bias current as described under 2.10 (1), (2), (3), (4), (5) and (6).

(4) Have the telegraph repeater attendant at the distant end of the line send miscellaneous signals. Receive them on either a 118 set or a monitoring teletypewriter.

(5) Try different resistance values in the equalizer branches (K), (K1), (K2) and (K3) and readjust the bias current per 2.10 (6) for each change, finally strapping to the value of the equalizer resistance which reduces the distortion of the test signals to a minimum.

3. METHODS OF OPERATION

3.01 The various methods of operation which may be provided are indicated in the following Tables A and B:

Table A

Line Conditions

Differential Duplex - line battery normal - line normal.

Differential Duplex - line battery reversed - line reversed.

Differential Duplex - line battery normal - line reversed.

Differential Duplex - line battery reversed - line normal.

Type A (polar sending).

Type A (polar receiving).

Type B (polar sending).

Type B (polar receiving).

Table B

Loop Conditions

Half Duplex - loop normal.

Half Duplex - loop reversed.

Full Duplex - loop normal.

Full Duplex - loop reversed.

The specific cross-connections on the repeater terminal strips are shown in the corresponding Tables A and B which appear on the SD-drawing.

4. PLACING THE REPEATER IN SERVICE

4.01 Differential Duplex Operation:

(1) Select the particular method of operation and have the proper connections made in accordance with Tables A and B of Section 3. In case of operation over one line circuit where 60-cycle interference is present, use the 60-cycle filter.

(2) Connect the line current limiting resistances for zero resistance except when the repeater is used for upset operation in which case some resistance may be beneficial.

(3) Operate the battery key.

(4) Adjust the currents in one or both loops in accordance with 2.03.

(5) Strap the equalizers as covered in 2.11.

(6) Balance the repeater in accordance with 2.07.

(7) Adjust the apex resistances as covered in 2.08 until the line current is 65 mils. The apex resistance at the two ends of the circuit should be approximately the same.

(8) The distant repeater attendant should follow the same procedure as above after which a rebalance should be made.

(9) Readjust the equalizers as covered in 2.11. For differential duplex operation best results may in some cases be obtained when the equalizers are not used.

(10) Repeat (6) and (7).

(11) If operation is over two line circuits make continuity and balance tests of the neutralizing circuit as covered in 2.09.

(12) Recheck the equalizer adjustment as covered in 2.11.

4.02 Polarential Operation:

(1) Select the particular method of operation of the line and loop circuit and have the proper connections made in accordance with Tables A and B. In case of operation over one line circuit where 60-cycle interference is encountered connect the 60-cycle filter.

(2) Adjust the line current limiting resistances in accordance with Table 2.

(3) Operate the battery key.

(4) Adjust the loop current as covered in 2.03.

(5) Connect the equalizer to the trial values as covered in 2.11.

(6) Balance the polar sending type A or type B repeaters in accordance with 2.07. Balance the polar receiving type A repeater as in 2.07. Do not balance the polar receiving type B repeater but adjust the (C BAL) and (TIM RES) keys in accordance with Table 3.

Table 3

Type of Line	(TIM RES)	(C BAL)
For Composited Open-Wire Lines Greater than 100 Miles in Length	Max.	7 mf.
For Simplexed Cable Lines Greater than 100 Miles in Length	Max.	7 mf.
For Simplexed Phantom Cable Lines Greater than 70 Miles in Length	Max.	7 mf.
All Other Lines	Max.	4 mf.

(7) Apex Resistance Adjustment.

Polar Sending Repeater

Type A

Adjust the apex resistance keys as covered in 2.08 until a line current of 30 ± 2 mils is obtained.

Type B

Operate the (APEX) keys to provide the apex resistance called for in Tables 4 and 5. Use Table 4 if operating to another polarential repeater. Use Table 5 if operating to a 128B2 set. If the line circuit is not susceptible to leakage as in the case of a cable line circuit type A operation should normally be used. However, if for other reasons type B operation is necessary over cable circuits, adjust the (APEX) keys to produce a line current of 30 ± 2 mils and disregard Tables 4 and 5.

Polar Receiving Repeater

Type A and Type B

Adjust the apex resistance to zero by restoring the (APEX) keys to normal in which condition the white key marking is horizontal.

(8) The distant repeater attendant should follow the same procedures as above after which a rebalance should be made as covered in 2.07.

(9) If operation is over two line circuits make continuity and balance tests of the neutralizing circuit as covered in 2.09.

(10) Adjust the bias current of the polar sending repeater to the approximate value in accordance with 2.10 (1), (2), (3), (4) and (5). The polar receiving repeater requires no bias current.

(11) Attempt to improve the adjustment of the equalizer resistances and the bias current in the manner covered in 2.11 (4) and (5).

Table 4

Apex Resistance Adjustment When Operating to Another Polarential Repeater Type B Polarential

*Total Line Resistance	Apex Resistance	
0- 500 ohms	800 ohms)	
500- 800 ohms	900 ohms)	See Notes
800-1000 ohms	1000 ohms)	1, 2 and
1000-1200 ohms	1200 ohms)	3.
1200-1400 ohms	1300 ohms)	
1400-1650 ohms max.	1500 ohms)	

* The measured or computed resistance from testboard to testboard including entrance cables and composite or simplex coils.

Table 5

Apex Resistance Adjustment When Operating to a 128B2 Set Type B Polarential

*Total Line Resistance	Apex Resistance	
0- 500 ohms	500 ohms)	
500-1000 ohms	600 ohms)	See Notes
1000-1200 ohms	800 ohms)	1, 2 and
1200-1400 ohms	900 ohms)	3.
1400-1650 ohms max.	1200 ohms)	

* The measured or computed resistance from the testboard to the line terminal of the 128B2 set including entrance cables and composite or simplex coils.

Note 1: When the resistance of the entrance cable at the near end of an open-wire line is appreciably greater (50 ohms or more) than that at the distant end the differences in the resistance of the cables at the two ends should be subtracted from the values given in Tables 4 and 5 to determine the value of the

apex resistance required. When the resistance of the cable at the near end is less than that at the distant end the resistance differences should be added to the values given in Tables 4 and 5 for the apex resistances. Where practicable it is better to have the polar sending repeater at the end of the circuit having the highest resistance of entrance cable. In making corrections for large differences in cable resistance, care should be taken to avoid reducing the line current below the allowable value by too great an increase in apex resistance. In 2-wire operation a line current considerably lower than that for 1-wire can be tolerated owing to the lower interference levels.

Note 2: After the repeater has been lined up properly under dry weather conditions no readjustments should be required to compensate for variations in leakage due to weather conditions. If in the event some bias is observed under extreme wet weather conditions the bias may be eliminated by readjustment of the apex resistance at the polar sending repeater. Upon a return to dry weather conditions the apex resistance need not be restored to its original setting as an apex which is satisfactory for wet weather conditions is also satisfactory for dry weather operation. Marking bias accompanying an increase in leakage indicates too large an apex resistance whereas spacing bias indicates too small an apex resistance.

Note 3: If it has been necessary to balance a polar sending type B repeater during wet weather the repeater should be rebalanced and the bias current readjusted upon a return to dry weather conditions. Thus, for proper operation the repeater should be balanced when there is no leakage on the line. When the leakage reappears, further refinements in apex resistance adjustment can be undertaken when required in the manner described in Note 2.