

164C2, 164C3, AND 164C4 TELEGRAPH  
TRANSMISSION MEASURING SETS  
CALIBRATION AND TEST METHODS

CONTENTS	PAGE
1. GENERAL .....	1
2. CALIBRATION .....	2
A. Primary Adjustment .....	2
B. Routine Adjustment .....	5
3. OPERATION .....	5
4. MAINTENANCE .....	6
5. REFERENCES .....	6

1. GENERAL

1.01 This section describes the calibration, operation, and maintenance of the 164C2, 164C3, and 164C4 telegraph transmission measuring sets. The sets will be hereafter referred to as the measuring set unless a particular type of measuring set must be specifically identified.

1.02 Section 103-823-101 provides the physical descriptions for this series of measuring sets, describes the displays obtained with the equipment, and describes the method of forming the displays.

1.03 The measuring sets are portable and can be patched into working teletypewriter circuits to measure the distortion present in the signals, without interrupting the service. The measuring sets can be used to measure the total distortion of miscellaneous teletypewriter signals or of repeated test characters. Depending upon the positions of the controls on the set, the transitions in the teletypewriter signals will be indicated on the cathode-ray tube (CRT) by the appearance of a bright spot with a superimposed vertical line (peak) or by a vertical deflection followed or preceded by a curved portion of trace which returns to the horizontal trace (pip). The vertical length of the pip has no significance. The greater the distortion in the signals, the farther to the right this pip or peak will appear. The distortion value can be read directly upon a horizontal scale which is

mounted in front of the CRT and shows per cent distortion of the signals up to 50 per cent. Error in scale readings can ordinarily be neglected; it will not exceed  $\pm 3$  per cent distortion.

1.04 The 164C2 measuring set measures distortion of 5- or 6-level teletypewriter signals at nominal speeds of 60, 75, 100, or 200 wpm. The 164C3 measuring set has an 8-level CODE position added. This is a 10-element code consisting of eight intelligence levels, one start level, and one stop level which was made available for experimental use with commercial equipment. In addition, the 200 SPEED position is arranged to permit conversion to higher signaling speeds (up to 750 bauds) when and if required in future systems. The 164C4 measuring set has a 100/8 SPEED and an 8/100 CODE position to measure the 11-element, 8-level code.

1.05 The electrical operations controlling the CRT exhibit are started by the first mark-to-space transition (beginning of the START pulse) in a teletypewriter character and stopped during the STOP pulse of the teletypewriter character.

1.06 A pip which points downward indicates that the corresponding signal transition is from mark to space. A pip pointing upward shows a signal transition from space to mark.

1.07 When the controls are set to show pips, the beam sweeps once from the extreme left to the extreme right across the face of the CRT during the first half of a signal element, and then returns to the extreme left side during the second half. Thus the extreme left side of the sweep indicates both the beginning and the end of a signal element, for the cathode-ray beam appears as a continuous trace on the face of the tube.

1.08 When the DISPLAY switch is operated to PK, a bright spot with a superimposed vertical line marks the greatest distortion which occurred during the series of teletypewriter signals received.

## 2. CALIBRATION

## A. Primary Adjustment

2.01 Primary adjustment (complete calibration) of the 164C2, 164C3, or 164C4 transmission measuring sets should be performed only when electron tubes have been changed or the set has not been used for a long period of time, say six months. It should not be performed on new sets since the factory calibrates all sets before shipment.

Note: Readjustment of the MV BAL and ELEMENT adjustments will ordinarily not be required after tube changes unless tube V3 has been changed.

2.02 The primary adjustment must be made at a test room or maintenance center where the following auxiliary equipment is available:

- (a) A dummy loop (either 62.5 or 20 ma).
- (b) A cathode-ray oscilloscope equivalent to the DuMont 208 or 304 type.
- (c) Signal sources which are listed below in descending order of preference:
  - (1) 1A teletypewriter test set, sending a standard test message. For highest precision, the set should have sharply cut, woven-wire brushes, a smooth surface on the distributor face, and adequate separation between the segments.
  - (2) POLAR CAL signals from a 110C1 multiple sender, if available.
  - (3) 100A teletypewriter test distributor, sending first repeated LTRS (MMMMM) and then repeated character R (SMSMS) to refine the tuning. The wire brushes of the teletypewriter test distributor should be new and sharply cut to ensure the precision of the calibration.
  - (4) 110A1 automatic multiple sender, 110B1 automatic multiple sender, or 110C1 multiple sender. If a No. 2 electronic hub arrangement, 110C1 multiple sender, and a spare 144B1 coupling unit are available, it is preferable to use the loop output of the coupling unit to provide the calibrating signals.
  - (5) 14-type transmitter-distributor. These signals are reliable only if the trans-

mitter-distributor is in good condition and properly adjusted. Otherwise, clutch slip-page will cause serious speed error.

(6) Signals from a distant office transmitted over a carrier facility. The distant office must use one of the approved sources.

(7) Effective polar signals obtained from an approved source transmitted over a dc facility of not over 10 miles of 19-gauge cable. The use of a poorer facility (such as a longer dc loop) might introduce fortuitous distortion, and the downward-pointing pips would jitter, affecting the accuracy of the set. In this case at least 10 seconds would be required for every observation while tuning to obtain the smallest amount of scattering of the downward-pointing pips.

(8) A keyboard sending repeated SPACE signals may be used as a last resort, but the indications may be in error by as much as 5 per cent distortion.

2.03 Remove the screws which hold the chassis in the case. In the 164C2 measuring set there are four of these screws located at the front corners of the top and bottom surfaces of the case. The chassis of the 164C3 or 164C4 measuring set is held in place by four screws on the bottom surface of the case. On some sets there is a fifth screw on the top surface of the case. Remove the chassis from the case and place it on a support, which is not grounded, with the electron tubes facing upward.

2.04 Set the controls as follows depending upon the type of signals to be used for calibration.

	164C2	164C3	164C4
LOOP on	ADJ	ADJ	ADJ
DISPLAY on	PIP	PIP	PIP
SPEED on	100	100	100
CODE on	5	5	5 or 8/100

Set the SWEEP AM, SWEEP LEVEL, BIAS, and all other controls in the centers of their range of rotation.

2.05 Connect the power cord to a source of 105 to 125 volts, 60-cycle ac. The front panel should not be grounded. Therefore, for the 164C2 set, do not use a 3-wire receptacle but

use the Hubbell 5273-L adapter provided with the set, and tape (do not use) the auxiliary lead from the adapter. For the 164C3 and 164C4 measuring sets, a 3-wire receptacle may be used since the front panel and case are made of insulating material and hence have no connection to building ground.

**CAUTION: POTENTIALS AS HIGH AS 800 VOLTS ARE PRESENT IN THE SET. EVERY PRECAUTION SHOULD BE TAKEN TO AVOID CONTACT WITH CIRCUIT ELEMENTS OR TERMINALS OTHER THAN AS SPECIFIED.**

Operate the power switch to ON and allow the set to warm up for one minute.

2.06 Adjust FOCUS, INT, V-CENT, and HOR CENTER controls to give a small fluorescent spot on the face of the CRT at about the vertical center and at approximately 10 on the horizontal scale.

2.07 Slowly rotate the BIAS control until the spot moves intermittently back and forth across the face of the tube to form a horizontal line. Each time the BIAS control is moved back and forth through this point, one or more sweeps should appear. This point is the final setting, but a discrepancy of as much as one-tenth turn would not be important.

Note: A small vertical display may be superimposed on the horizontal line.

2.08 Operate the power switch to OFF. Connect the vertical input (Y-axis) of a cathode-ray oscilloscope to the MV BAL and NEUT test pin jacks with the NEUT pin jack connected to the return or ground side of the oscilloscope input circuit. On the 164C2 measuring set, the MV BAL and NEUT test pin jacks are located near tube V3 at the center of the chassis; on the 164C3 and 164C4 measuring sets, the MV BAL jack is located just behind RESET switch S5 on the chassis and the NEUT jack is in the upper right-hand portion of the front panel.

Note: For this test the ground side of the oscilloscope must not be connected to building ground. Such grounding occurs in some commercial designs of test oscilloscopes if the oscilloscope is resting on a grounded framework or has a connection to building ground through a third wire in its power cord. Care must be taken to avoid this condition.

2.09 Operate the power switch to ON. After a one-minute warmup, operate the DISPLAY switch to CAL for the 164C2 measuring set or to BEAM OFF for the 164C3 or 164C4 measuring sets.

2.10 Arrange the test oscilloscope for internal horizontal sweep with synchronizing control on 0, and carefully adjust the speed of sweep so that the pattern is stationary with each downward transition of the trace crossed by an upward transition. The speed of the sweep should be such that only one transition region appears in the pattern. With an insulated screwdriver, carefully adjust the MV BAL control until the region of intersection appears as an X with the point of intersection of the two branches of the X exactly halfway between the upper and lower horizontal lines of the oscilloscope pattern. (See Figure 1.) Remove the test connections to the oscilloscope.

2.11 Connect a source of undistorted test signals from either the 1A or 100A test set to a dummy loop, using the 2P31A cord. Insert the 359A plug (shorter one) into the INPUT jack of the measuring set and then insert the 347A plug into the NORMAL jack of the dummy circuit. If the circuit arrangements are such that the polarity of the voltage on the tip of the 359A plug is positive for a mark signal, set the NOR-REV switch to NOR. If negative, set the switch to REV. Set the LOOP switch to agree with the marking loop current. Set the SPEED switch to agree with that of the test signal source.

Note 1: A potential difference may exist between the front panel and the chassis of the

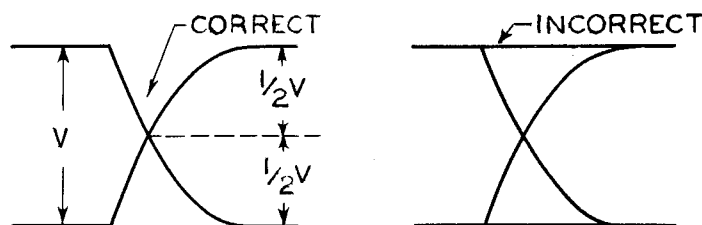


Figure 1 - Multivibrator Balance

164C2 measuring set when the set is connected to a telegraph loop. When the measuring set is to be used outside of its case, this potential hazard should be eliminated. This may be done by breaking the connection from the building ground to the front panel. To do so, use the power plug adapter furnished with the set. Tape (do not use) the auxiliary lead from the adapter.

Note 2: A potential difference will exist between the chassis of the 164C2, 164C3, or 164C4 measuring set and other grounded objects nearby when the set is connected to a telegraph loop. When the measuring set is to be used outside of its case, this potential hazard should be kept in mind and due caution exercised.

2.12 Disregarding the pips, adjust the SWEEP LEVEL control so that the horizontal trace almost touches the bright spot on the left.

2.13 Using the ELEMENT control which corresponds to the speed of the test signals (60, 75, or 100 wpm), try to bring all the pips somewhere near scale 0. If this cannot be done, try a different setting of the CHARACTER control corresponding to the speed of the test signals.

Note: If repeated characters such as those from a 100A teletypewriter test distributor are being used as a source of signals, first tune with repeated LTRS.

2.14 When the pips are stable and near scale 0, rotate the CHARACTER control clockwise until pips begin to appear at higher scale readings (10 to 40 percent). Back off one-third turn counterclockwise from this point. This one-third turn is important. If in attempting to do this the CHARACTER control reaches its counterclockwise stop before completing the one-third turn, refer to 4. of this section. If the higher reading pips do not appear, back off one-third turn from the clockwise end.

2.15 The set is now ready for more careful final adjustment.

Note: If repeated characters such as those from a 100A teletypewriter test distributor are being used as a source of signals, repeated character R should now be substituted for repeated LTRS.

2.16 Rotate the SWEEP LEVEL control on the front panel until the left end of the horizontal sweep line appears to separate from the bright spot at the left. Reverse the direction of rotation until this gap just closes. The bright spot usually appears slightly below the sweep.

2.17 Adjust the SWEEP AM and HOR CENTER controls on the front panel to make the horizontal trace extend from 0 to 50 on the scale.

2.18 Adjust the 60, 75, or 100 ELEMENT control (depending upon the speed of signals being used for calibration) until the downward vertical deflections of the trace all occur as near as possible to scale 0. For greatest accuracy the downward pips should barely turn around near scale 0, forming a small loop at their tips. If a 1A set is being used (with unworn face and sharply cut brushes), the upward pips as well as downward pips may be used in tuning. At 200 speed use upward pips only.

2.19 Repeat 2.12 through 2.18 for every speed of teletypewriter signals (other than 200 wpm) for which the set will be needed, using appropriate signals, switch settings, and CHARACTER and ELEMENT adjustments.

Note: Only minor adjustments of SWEEP AM and SWEEP LEVEL will be necessary.

2.20 Calibration for 200-speed signals is made as follows:

- (1) First calibrate the set at 100 speed.
- (2) Connect a 100-speed 1A or 100A set to the dummy loop. Set the signal source to send a repeated M (SSMMM), thus simulating a 200-speed signal.
- (3) Using the 200 ELEMENT and CHARACTER adjustments, follow the procedure given in 2.13, 2.16, 2.17, and 2.18.

Note: If calibration has just been made at another speed, only minor adjustments of SWEEP AM and SWEEP LEVEL will be necessary.

(4) When the 200 ELEMENT adjustment is completed, disconnect the set from the dummy loop and patch it to a neutral test signal jack associated with an electronic distributor known to be in good calibration. Set the electronic distributor to send a 200-speed test message.

(5) When the pips are stable and near scale 0, rotate the CHARACTER adjustment until pips begin to appear at higher scale readings (10 to 40 per cent). Back off one-third turn counterclockwise from this point. If the higher reading pips do not appear, back off one-third turn from the clockwise end.

2.21 When calibration is to be made for the 164C4 measuring set 100/8 speed signals, use the following procedure:

(1) Connect a 100-speed, 8-level code 1B teletypewriter test set to the dummy loop. Set the signal source to send undistorted teletypewriter signals.

(2) Using the 100/8 ELEMENT and CHARACTER adjustments, follow the procedure of 2.13, 2.14, 2.16, 2.17, and 2.18.

2.22 When calibration is completed at all speeds, operate the power switch to OFF. Restore the chassis to the case, fastening the mounting screws securely.

#### B. Routine Adjustment

2.23 Routine adjustment should be carried out approximately once a week (or less often if experience so indicates). It should also be performed if the downward pips indicate more than 3 per cent distortion, but less than 20 per cent, when undistorted signals are connected to the measuring set. If more than 20 per cent is indicated, the set requires either a primary adjustment or maintenance.

2.24 In making this routine adjustment, a source of signals (as given in preceding primary adjustment) and a resistance dummy loop are required.

2.25 Connect to power as follows: connect the power cord to a properly grounded 3-wire receptacle source of 105 to 125 volts, 60-cycle ac. If only a 2-wire receptacle is available, make connection by means of the Hubbell 5273-L adapter. The auxiliary lead from this adapter should be connected to a reliable ground source for safety. Operate the power switch to ON and allow the set to warm up for one minute.

2.26 Connect the set to a dummy loop as covered in 2.11 and carry out the procedures in 2.16, 2.17, and 2.18 for each speed, as required.

### 3. OPERATION

3.01 Connect the power cord to a properly grounded 3-wire receptacle source of 105 to 125 volts, 60-cycle ac. If only a 2-wire receptacle is available, make connection by means of the Hubbell 5273-L adapter. The auxiliary lead from this adapter should be connected to a

reliable ground source for safety. Operate the power switch to ON and allow the set to warm up for one minute.

3.02 Since the measuring sets are sensitive to temperature rise, do not operate a set on top of apparatus or cabinets which feel warm, and do not obstruct the heat vents.

3.03 In every use of the set, only minor adjustments of the HOR CENTER, SWEEP AM, and SWEEP LEVEL on the front panel should be necessary.

3.04 When a dc telegraph circuit is to be observed, connection is made between the circuit and the measuring set by the 2P31A cord or the 2P33A cord. The 2P31A cord is used when access to the dc telegraph circuit is by way of a tip-sleeve looping jack. The 2P33A cord is used when access is through a tip-ring-sleeve looping jack. The 359A plug of whichever cord is used is inserted into the INPUT jack of the measuring set. The 347A plug or 310 plug is inserted in series with the telegraph loop. Set the INPUT LOOP switch to NOR or REV so that circuit neutral is connected to that end of resistor R1 which is negative during the marking condition. Set LOOP, CODE, and SPEED switches to the values appropriate to the circuit being measured.

3.05 If it is suspected that relay chatter or other medium high-frequency disturbance is present on the circuit being measured, this can be checked by depressing the INPUT FILTER OUT switch. Erratic indications by the measuring set will then be observed if there is disturbance on the circuit.

3.06 When the dc telegraph circuit to be observed does not have a looping jack, use the looping jacks in the cover of the measuring set to connect the set in series with the telegraph loop. To do this, open one side of the loop and connect the test clips of the 2W44A cord to the ends of the open loop. Insert the 347A plug of the cord into the J2 LINE jack of the jack strip. Using the 2P31A cord insert the 347A plug into J3 or J4 LPG jacks or the J5 REV jack and the 359A plug into the INPUT jack of the measuring set.

Note: It may be necessary to operate the measuring set INPUT LOOP switch to REV in order to obtain a display.

3.07 When measurements are to be made of telegraph signals sent from a subscriber

into a 43A1 carrier channel terminal, connection is made which results in a measurement of the combined distortion effect of the sending station, the loop, and the carrier terminal modulator. Insert the 310 plug of the 2P32A cord into the INPUT jack of the measuring set. Insert the red phone tip of the cord into the MD jack of the 43A1 carrier terminal and the black phone tip into the C jack of the terminal. Operate INPUT LOOP switch to NOR and the LOOP switch to 62.5. Set CODE and SPEED switches to the values appropriate to the circuit being measured.

Note: The LOOP switch setting is always 62.5 here and bears no relation to the current in the dc loop.

3.08 When the carrier channel is terminating a long telegraph loop, there is a tendency for the tails of the signal pips to display small loops caused by the carrier frequency. These loops do not affect the accuracy of the set and should be ignored if they occur.

3.09 When the measuring set is turned on, but is not being supplied with input signals, it is expected that the DISPLAY switch will be turned to the BEAM OFF (CAL for 164C2 measuring set) position to avoid burning the phosphor surface on the face of the CRT. However, there may be extended periods, during certain tests, when it is desired to have the beam on during a steady circuit marking condition. Under this circumstance, the circuit is so arranged as to produce a small downward deflection of the spot when viewed at the face of the tube. Thus if any damage occurs due to burning, it will not be on a part of the screen used for regular measurements.

3.10 If it is suspected that relay chatter or other medium high-frequency disturbance is present on the circuit being measured, this can be checked on either the 164C3 or 164C4 measuring set by depressing the INPUT FILTER OUT switch which will reduce the input filtering action. Erratic indications on the set will then be observed if there is disturbance present.

3.11 When the measuring set is in use, only minor adjustments of the HOR CENTER, SWEEP AM, and SWEEP LEVEL on the front panel should be necessary.

#### 4. MAINTENANCE

4.01 If maintenance information is required, refer to Section 103-823-500. This section refers to the 164C1 measuring set. However, the test information given also applies in general to the 164C2, 164C3, and 164C4 measuring sets. The sets differ only in equipment layout and in a few features of the character and element timing circuits.

#### 5. REFERENCES

5.01 The following references provide additional information that may be required in connection with this section.

<u>Subject</u>	<u>Reference</u>
100A Teletypewriter Test Distributor — Description	103-804-100
100A Teletypewriter Test Distributor — Test Methods	103-804-500
1A and 1B Teletypewriter Test Sets — Description and Principles of Operation	103-800-100
1A and 1B Teletypewriter Test Sets — Test Methods	103-800-500
1A and 1B Teletypewriter Test Sets — Requirements and Adjustments	103-800-700
110A1 Automatic Multiple Sender	103-806-100
110B1 Automatic Multiple Sender	103-806-101
110C1 Multiple Sender	103-806-102
164C1 Telegraph Transmission Measuring Set — Description and Principles of Operation	103-823-100
164C1 Telegraph Transmission Measuring Set — Calibration and Test Methods	103-823-500
Schematic Diagrams:	
164C1	SD-70698-01
164C2	SD-70865-01
164C3 and 164C4	SD-70886-01
Circuit Descriptions:	
164C1	CD-70698-01
164C2	CD-70865-01
164C3 and 164C4	CD-70886-01