STELMA, INCORPORATED

Designers and Manufacturers of Quality Communications Equipment

190 HENRY STREET • STAMFORD, CONNECTICUT

TELEGRAPH DISTORTION ANALYZER

MODEL TDA-2

INSTRUCTION MANUAL

(Serial No. 400 and Up)

Patent Pending

Printed in U.S.A.

CONTENTS

LIST OF FIGURES

GENERAL DESCRIPTION
of the
TELEGRAPH DISTORTION ANALYZER MODEL TDA-2

The STELMA TELEGRAPH DISTORTION ANALYZER Model TDA-2 is a self-contained portable unit designed to measure the bias and distortion of start-stop telegraph signals. Indications of distortion are in the form of vertical pips displayed in a rectangular pattern on the face of a cathode-ray tube. The various components of distortion making up the total distortion are clearly indicated. The percent distortion is read directly on a calibrated scale mounted in front of a standard three inch cathode-ray tube.

Measurements can be made while regular traffic is being transmitted or received without interrupting service.

The TDA-2 provides for accurately measuring distortion of telegraph signals operating at speeds of 60, 75, and 100 wpm on 20 or 60 ma neutral circuits or on 30 ma polar circuits. The range of distortion measurement is from 0% to 50% with an accuracy normally under ± 2% bias.

The TDA-2 is patched in series into a d-c loop circuit. It can be carried conveniently into the field and readily plugged into working circuits at various repeater or terminal points in order to check the distortion characteristics of circuits and equipment.

As adjustments are made on terminal equipment to correct for distortion, the TDA-2 immediately and automatically indicates the new signal characteristics.

No special skill or technical knowledge is required to operate the TDA-2. Accurate measurements can be made after only a few minutes' instruction.

Model TDA-2E Analyzer is designed for measurements at speeds of 60, 66, 75 wpm. The 66 wpm input speed is 50 bauds (CCIT standard) 7.5 unit intervals, 400 opm.

Model TDA-2W is designed for measurements at speeds of 60, 65, 75, and 100 wpm.

The STELMA TELEGRAPH DISTORTION ANALYZER can be ordered for different speeds on special request.

APPLICATIONS
of the
STELMA TELEGRAPH DISTORTION ANALYZER, MODEL TDA-2

A partial list of uses to which the TDA-2 may be applied is presented below. In all cases measurements can be made of:

Bias Distortion – Spacing and Marking
Characteristic Distortion
Fortuitous Distortion
End Distortion – Spacing and Marking
Peak Distortion
Mechanical Distortion

a) Measurements of distortion at the receiving end of a d-c loop can be made and adjustment of line constants varied while observing the Analyzer, in order to minimize bias distortion at the end of the line.

b) Measurements at the transmitting end of a d-c loop can be made to indicate the condition of the transmitted signal. Defects in relays or commutators can be discovered and tracked down with the Analyzer and transmitting conditions optimized.

c) Line or terminal repeaters can be checked and adjusted for optimum operation.

d) Telegraph carrier equipment can be lined up properly for minimum distortion output. Distortion under 5% is clearly indicated by the TDA-2.

e) Frequency shift converters can be adjusted for minimum output distortion.

f) Radio Telegraph Systems can be lined up and maintained properly for minimum distortion. The TDA-2 will indicate when distortion is due to radio path and/or telegraph circuits or equipment.

g) The mechanical adjustment of transmitter distributors, keyboards, and relays can be checked and defects traced down to a particular location.

With the TDA-2 the particular segment or cam that is dirty or defective can be determined rapidly.

h) Adjustments of teleprinters can be checked. The orientation range of a specific teleprinter should correspond with measured distortion indicated on the TDA-2.

SPECIFICATIONS

of the

STELMA TELEGRAPH DISTORTION ANALYZER MODEL TDA-2

RANGE OF MEASUREMENT	0 to 50% marking or spacing bias and distortion
ACCURACY	± 2% bias
INDICATION	Rectangular pattern on 3" oscilloscope. Pips indicate type of distortion and amount is read on calibrated scale.
INPUT CURRENT	60 ma or 20 ma neutral 30 ma polar
INPUT IMPEDANCE	100 ohms for 60 ma neutral 300 ohms for 20 ma neutral 300 ohms for 30 ma polar
INPUT CIRCUIT	isolated from case of unit
# INPUT SPEED	60, 75, 100 words per minute — also teletypesetter speeds.
SPEED ADJUSTMENT	will accomodate for approx. ± 5% speed variations
POWER REQUIREMENTS	115/230 volts a-c, 50/60 cps, 45 watts
DIMENSIONS	8 x 8 x 13-3/4 inches
WEIGHT	17 lbs.
NO. OF TUBES USED	12

# MODEL TDA-2E	60, 66 (50 bauds, CCIT standard 7.5 code) and 75 words per minute.
MODEL TDA-2W	60, 65, 75, and 100 words per minute

NOTE: Special input speeds available on request.

THEORY OF OPERATION

The block diagram in Figure 1 indicates the general functions performed in the TELEGRAPH DISTORTION ANALYZER.

Input to the TDA-2 from the telegraph loop is connected through reversing switch S1 to a resistor network in the grid circuit of trigger tube V1. The 20-60 ma switch S2 provides 300 ohms input for 20 ma and 100 ohms input for 60 ma. A trigger adjust potentiometer R3 in the grid circuit of V1 provides adjustment of the trigger point of V1 for neutral inputs.

The telegraph loop circuit connects to the chassis of the TDA-2 only through a .05 uf capacitor, thereby providing d-c isolation between loop and cabinet.

The waveform drawing of Figure 2 illustrates the signal for the character Y at various points on the block diagram. The number opposite the waveforms of Figure 2 corresponds to the circled numbers for various circuit points in Figure 1. Input loop signals (1) are shown with slight rounding. Output of trigger tube V1 is shown squared up by that tube. See line 2. An optional filter utilizing capacitor C12 may be switched in or out by switch S4 to remove spikes from relay bounce that may be on the input loop signal. Action of the filter is shown in line 3. The filter adjust potentiometer R10 allows for adjustment to secure identical bias readings with filter in or filter out. Since the filter circuit is not located in the input loop circuit, variations in loop current will not change bias readings as would occur if the filter were located ahead of tube V1. Tube V3 is a clipping amplifier to square up the signal again (line 4) so that C2 and R21 may produce spikes as shown in line 5. These spikes drive the following sweep circuits and provide transition indications on the cathode-ray indicator tube.

For polar loop signals switch S3 makes connection from V3 back to tube V1 so that input polarity reversals are required to operate the TDA-2. Polar adjustment potentiometer R13 is adjusted so that triggering on polar signals occurs at equal but opposite loop currents.

The next group of circuits to be discussed are designed to set up a sweep voltage for the cathode-ray tube. The required sweep voltage is indicated in line 8 of Figure 2. When applied to the horizontal plates of the cathode-ray tube this supplies a horizontal line or trace on a time base against which the signal transitions are seen as vertical pips.

The signal at point 4 (Figure 1) is differentiated by C2, R21 to produce pulses as shown in line 5 (Figure 2). Negative pulses which may adversely affect the timing of tube V5 are suppressed by tube V4A and the first positive pulse (mark to space start transition) is used to operate character timer tube V5. Tube V5 is a monostable multivibrator and produces a waveform at its output as illustrated by line 6. Character timer V5 in turn operates multivibrator tube V6 to produce one cycle of output from V6 corresponding to each baud of input signal. See line 7, Figure 2. The character timer "gates" the baud timer on for 6-1/2 cycles of operation. Adjustments for timings in the character timer and baud timer are provided for 60, 75, and 100 wpm telegraph speeds. A means of perfectly balancing the duration of each half cycled signal from tube V6 is provided by a BAL control in the circuit of V6. The output of tube V6 is not a perfect square wave so that tube V7A is used as a squaring amplifier to make a perfect square wave signal to operate the cathode-ray tube circuits.

An RC integrating circuit of long time constant employing R47, R48, R58 and C14 is connected to the output of V7A to produce the desired sawtooth voltage for operation of the cathode-ray tube. If the output of V7A were a continuous square wave voltage, a perfectly uniform continuous sweep voltage would result across C14. The relation between the square wave voltage and sawtooth voltage would be as indicated at line 9 where E1 equals E2. The telegraph signal is not continuous, however, but is start-stop where the stop interval is unequal to the baud intervals. In order to secure a proper sawtooth waveform across C14, therefore, it is necessary to hold the voltage across C14 at the value of E3 (see line 10) during the stop mark when the baud oscillator is stopped. This is done by feeding output from character timer V5 through the clamp amplifier tube V7B (for squaring and proper signal phase) to a diode clamp tube V4B which applies the voltage E3 to capacitor C14 during the stop mark cycle of tube V5. During the operating cycle of V5, potentials are such that diode V4B is not conducting and the sawtooth sweep voltage is unhampered in wave shape. A CLAMP control is provided between tubes V7B and V4B so that the exact amplitude of voltage E3 may be established.

The sawtooth sweep voltage across C14 is amplified by d-c amplifier tube V8 which applies a push-pull output to the cathode-ray tube V9 horizontal plates.

Two signals are applied to the vertical plates of tube V9. Capacitor C13 and R70 differentiate the signal from trigger tube V3 to apply a signal as shown in line 5 to the upper vertical plate. A square wave signal taken from tube V7A (line 7) is applied to the lower plate of V9.

In Figure 1 the power transformer T1 supplies a high voltage to rectifier V10, the output of which is filtered and fed to voltage regulators V11 and V13 to secure a regulated +255 volts and +150 volts. A selenium rectifier CR supplies a negative high voltage for the cathode-ray tube and also feeds tube V12 to secure a regulated negative 105 volts.

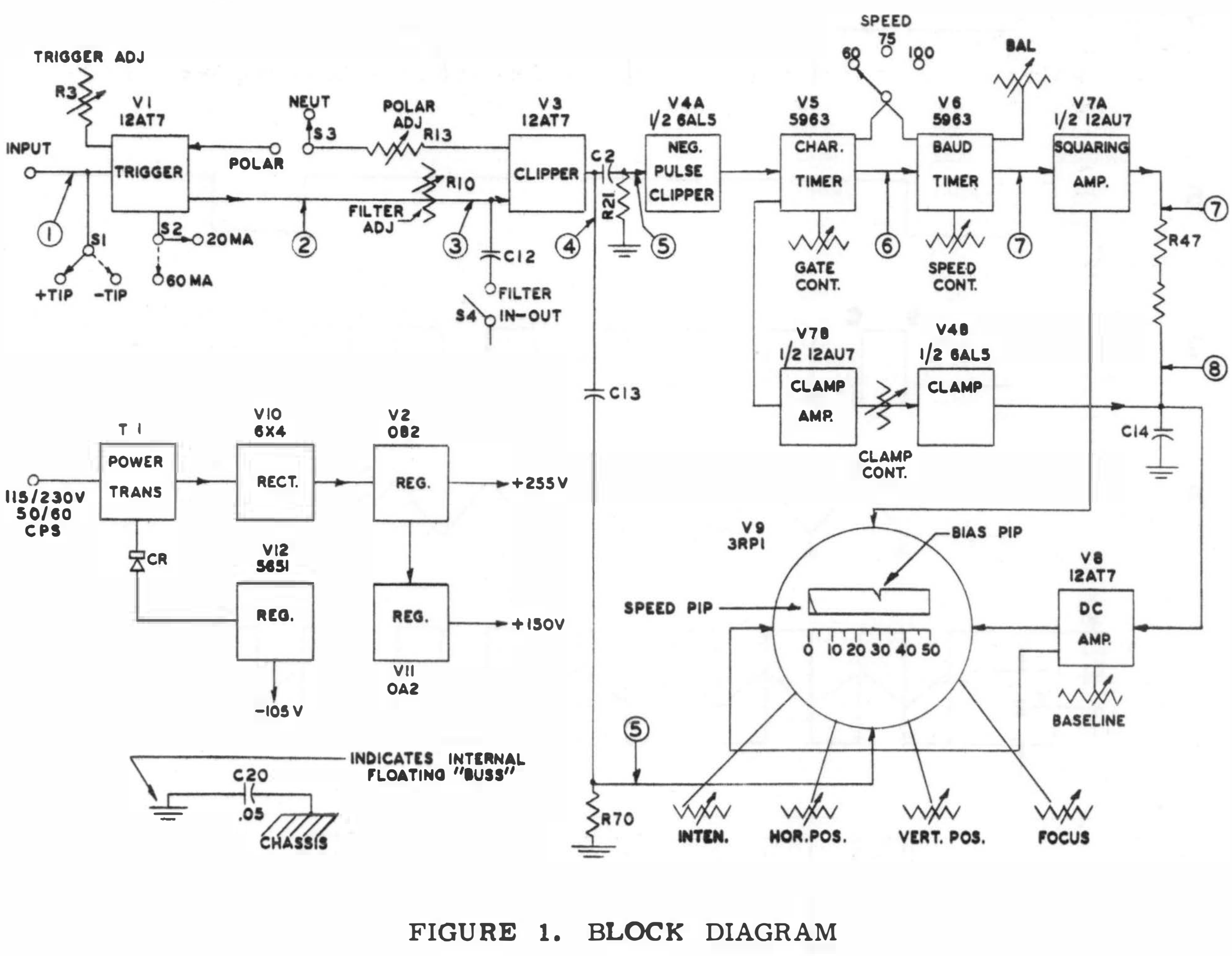


FIGURE 1. BLOCK DIAGRAM

STELMA TELEGRAPH DISTORTION ANALYZER

Model TDA-2

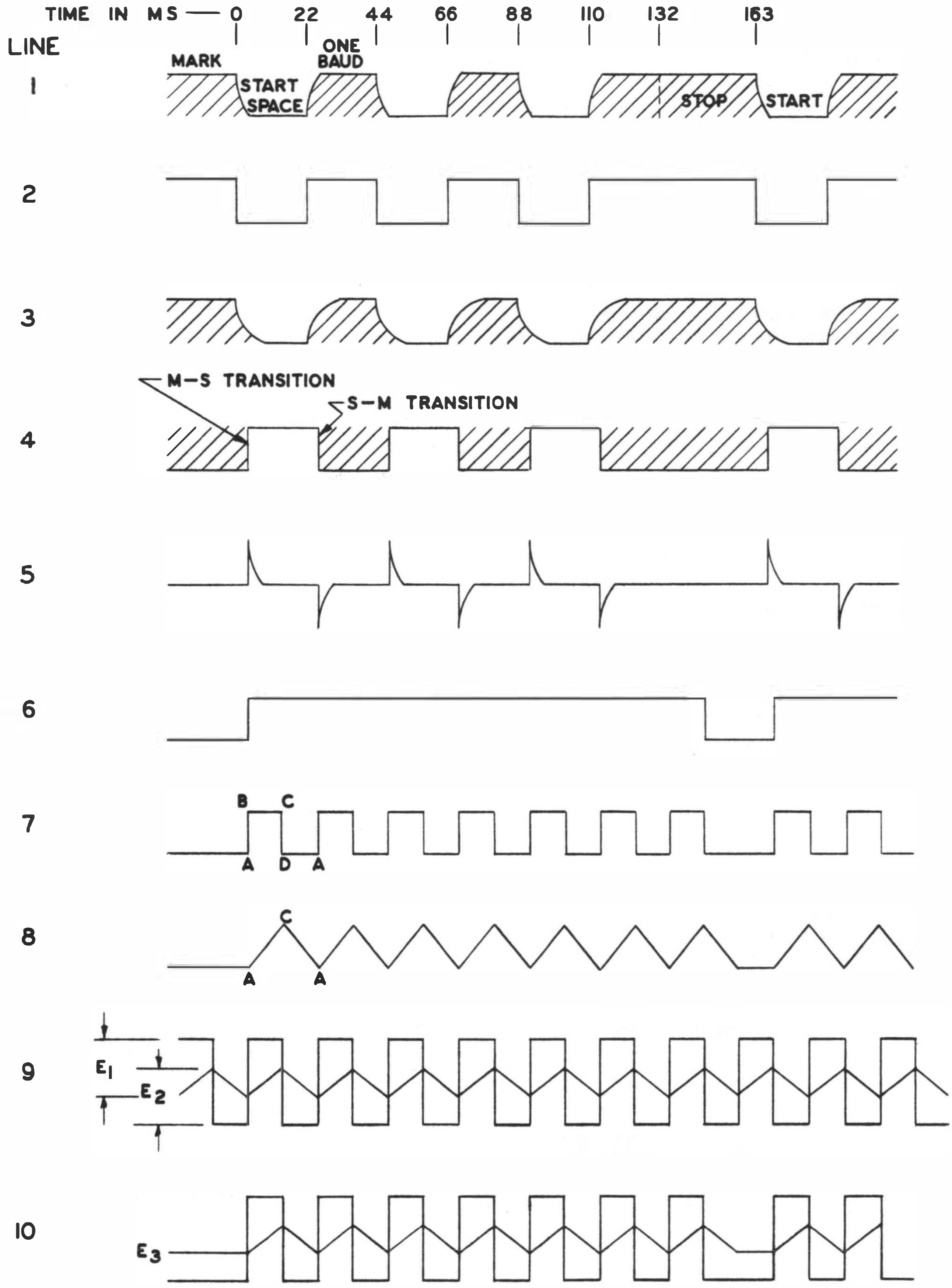


FIGURE 2 WAVEFORMS

DISCUSSION OF THE TDA-2 OSCILLOSCOPE PATTERNS

The action of distortion on a telegraph signal is to effectively advance or retard one or more of the s-m or m-s transitions with respect to the start pulse.

Bias distortion displaces the s-m transitions.

Fortuitous and characteristic distortion displace both the s-m and m-s transitions.

End distortion displaces the m-s transitions.

The STELMA Telegraph Distortion Analyzer measures distortion by sampling each of the transitions in a character on a time base. (It is immaterial which character is being transmitted.) A vertical pip on the baselines of the scope indicates a transition. If all the transitions of the telegraph signal are in their proper position, e.g., a perfect signal, the scope pips will line up at the zero percent distortion mark of the calibrated scale mounted in front of the scope.

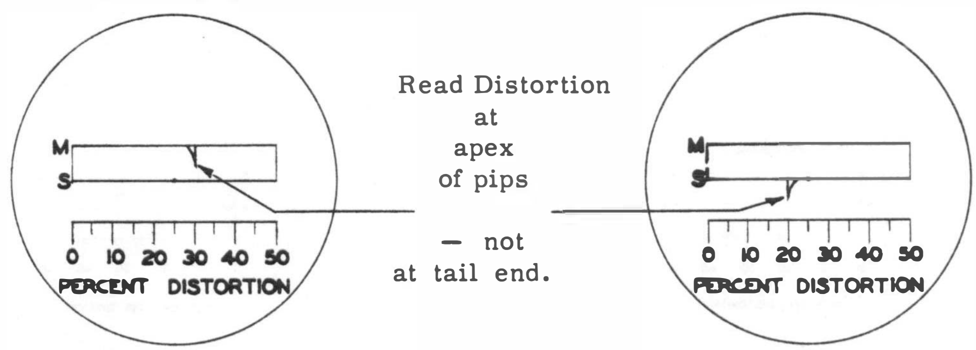
If any of the transitions are displaced with respect to the start impulse, the vertical pips on the scope will be displaced along the calibrated scale. The direct reading scale indicates the amount that the transition is displaced.

If all the s-m transitions are displaced an equal amount (as in bias distortion) a pip down from the baselines will be observed.

A pip going down from the top baseline is marking bias. Figure 3.

A pip going down from the bottom baseline is spacing bias. Figure 4.

FIGURE 3 FIGURE 4



30% Marking Bias 20% Spacing Bias

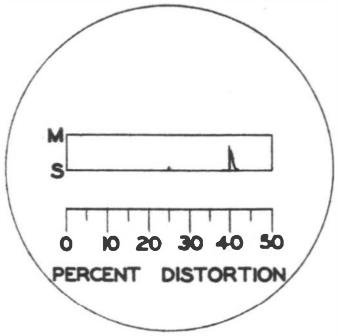
TYPICAL INDICATIONS OF DISTORTION ON FACE OF TDA-2

In the case of fortuitous and characteristic distortion when the transitions (s-m and m-s) may not be displaced equal amounts, the different displacements of each of the transitions is indicated on the scope. Thus, more than one pip will be seen along the baseline depending on which transitions and fortuitous distortion has affected. Figure 6.

The total distortion is simply the highest reading along the scale.

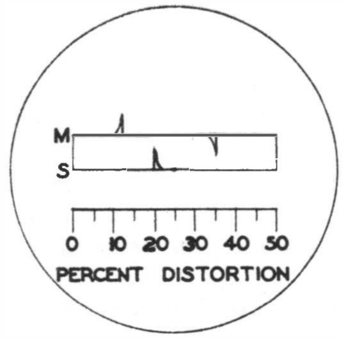
The Telegraph Distortion Analyzer will show the displacements of all transitions of the telegraph signal and thus will indicate any type of distortion that affects telegraph transmission.

FIGURE 5



40% End Distortion

FIGURE 6



Characteristic and Fortuitous Distortion
Peak 35%

TYPICAL INDICATIONS OF DISTORTION ON FACE OF TDA-2

Figures 7 and 8 illustrate traces on the face of the cathode-ray tube screen. When no signal is applied to the Analyzer, a spot will be seen on the CR tube screen at point A. On the first m-s start transition of the signal the trace moves from A to B, (see lines 7 and 8, Figure 2, refer also to Figure 7.). The trace moves then across the face of the CR tube from B to C, rapidly up to D, and then back to point A. Seven overlapping rectangular patterns are made on the screen for one character transmission.

If the signal being measured has zero distortion and the speed adjustment of the Analyzer is correct, the application of the signal transitions (line 5, Figure 2) to the lower vertical plate of the CR tube will show a positive and negative pulse leading off the lower baseline as shown at point B, Figure 8 (pulses H and J). The positive pulse is due to the m-s transitions while the negative going pulse is due to the s-m transitions. All the pulses overlap and line up at the 0% distortion point.

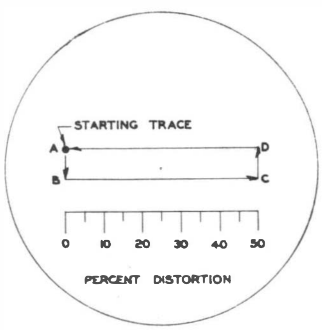


FIGURE 7

FORMATION OF RECTANGULAR PATTERN

1. The starting trace makes one complete rectangular pattern within the time of one baud. 22 ms. (60 wpm.)

Seven overlapping rectangular patterns are made on the screen for one character transmission.

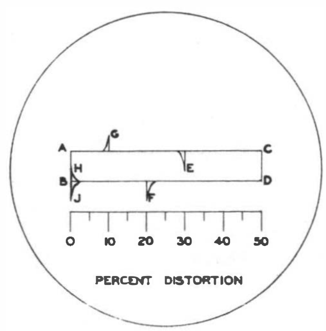


FIGURE 8

TDA-2 OSCILLOSCOPE PRESENTATION

1. Speed of TDA-2 is adjusted when Pip H is steady up against line A-B. Pip H is speed pip and is always present on lower baseline.

2. Front panel SPEED knob permits TDA-2 to accomodate for variation in telegraph trans — mission speeds.

3. Downward pips are bias pips or displacements of the s-m transitions.

4. Upward pips are caused by displacement of m-s transitions.

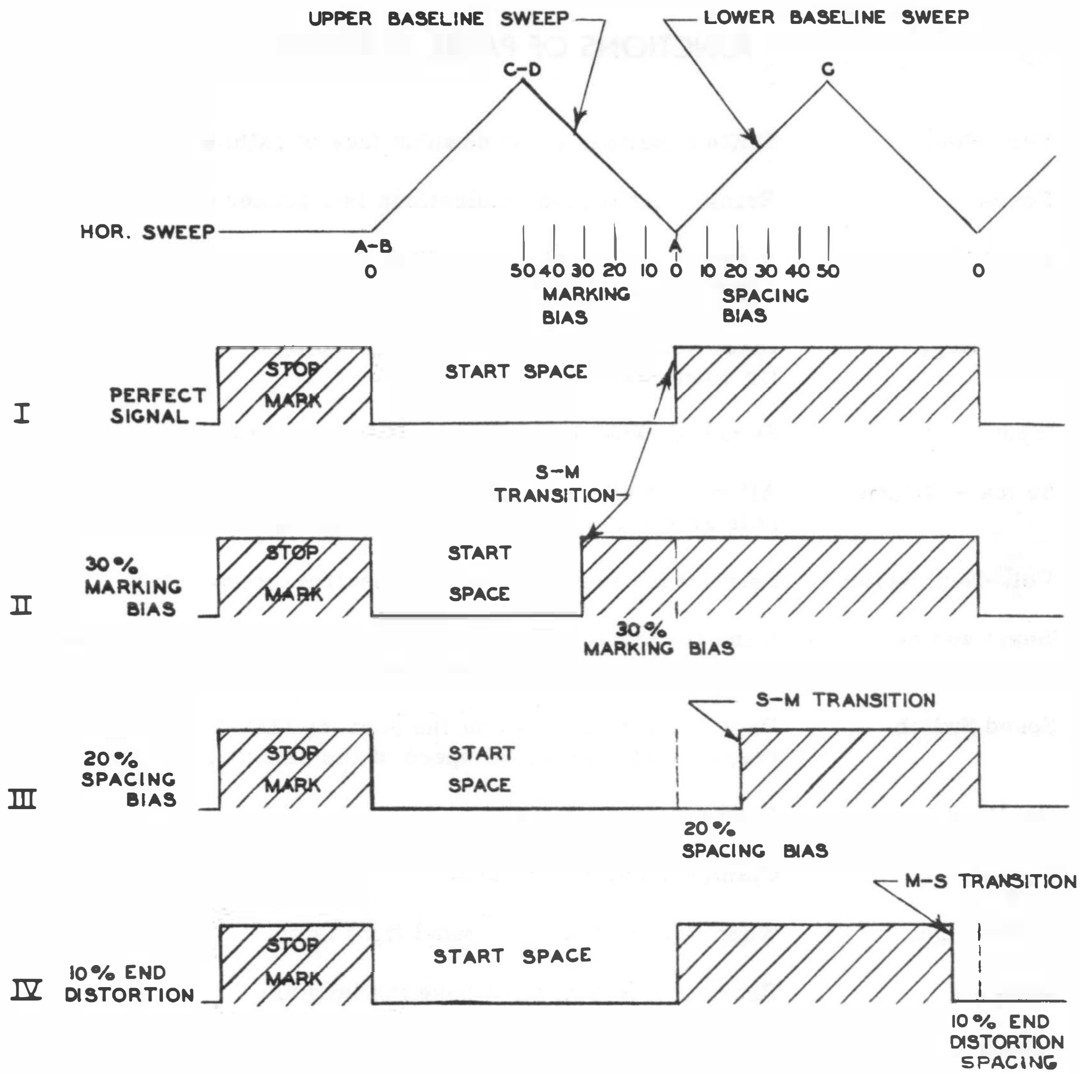


FIGURE 9 — TDA-2 ANALYZES ALL SIGNAL TRANSITIONS

The method by which the **TDA-2** analyzes each transition of a telegraph signal is illustrated in Figure 9. Only the first two bauds of a character are shown since transitions at later bauds are treated in the same fashion as for the first two bauds. Line I illustrates a perfect telegraph signal with no distortion. Note that all transitions, m-s and s-m, line up at the 0% distortion point of the calibrated scale. Line II illustrates a shortened start space due to marking bias. The s-m transition occurs during the C to A part of the sweep and would therefore produce a pip as shown at point E in Figure 8. Line III in Figure 9 illustrates a signal with spacing bias where the s-m transition occurs during a sweep from A to C. An indication of this bias is seen at point F in Figure 8; Line IV, in Figure 9, shows a m-s transition which occurs during the C to A sweep period and is displayed as a pip at point G in Figure 8.

If the speed of the Analyzer is set too fast, a series of upward pips will be seen along the bottom baseline close to the B side of the sweep. If the speed is too slow, upward pips will be seen along the top baseline close to point A. When speed is just right, upward pips will be seen as one pip going upward from point B. (Pip H, Figure 8.)

NOTE: When making speed adjustments the downward bias pips are completely disregarded.

Fortuitous distortion will cause all pips to jitter back and forth on both baselines. The maximum peak distortion will be indicated by that pip which may appear at any time farthest toward the D-C side of the baselines.

FUNCTIONS OF PANEL CONTROLS

1.	Ver. Pos.	Shifts baselines up or down on face of cathode-ray tube.
2.	Focus	Brings oscilloscope indications into proper focus.
3.	Speed Knob	A vernier control of the TDA-2 speed circuits. Accomodates for signals whose speeds are not exactly 60, 75, or 100 wpm.
4.	Pos. -Neg.	Input polarity switch allows input plug to have positive or negative tip connection.
5.	Input	Standard two-conductor telephone jack input.
6.	60 ma — 20 ma	Allows for 60 ma or 20 ma d-c neutral input signals. On polar signals 20 ma position is used. (Polar signal of 30 ma).
7.	Pol. -Neut Switch	Sets TDA-2 input for polar or neutral loops.
8.	Beam switch	Removes spot or trace from face of cathode-ray tube to prevent burning when measurements are not being made.
9.	Speed Switch	Provides for selection of the correct TDA-2 speed circuits to correspond with the signal speed of the circuit to be checked.
10.	On-Power	Power on and off switch.
11.	Clamp	Clamps horizontal sweep.
12.	Panel Light	When power is on, red panel light is on.
13.	Baseline	Provides adjustment of baseline lengths.
14.	Intensity	Varies brightness of TDA-2 oscilloscope indications.
15.	Horiz. Pos.	Shifts baselines to right or left on face of cathode-ray tube.
16.	Filter In and Out Switch	Located at rear of cabinet. Provides a quick means of determining if mechanical defects are present in transmission equipment or relays. The filter switch is normally in OUT position.

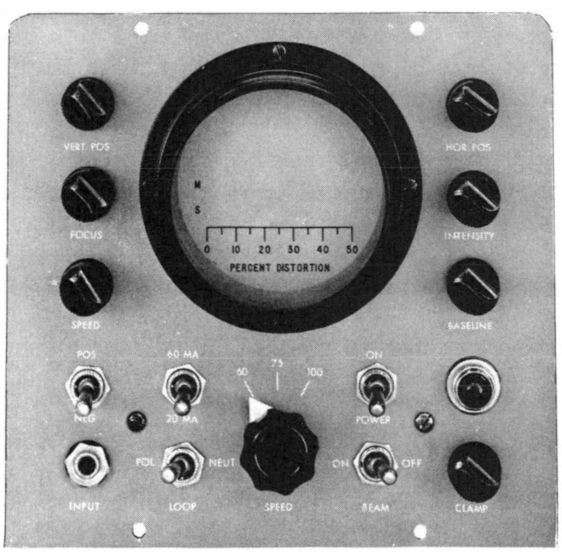


FIGURE 10 — Front View, TDA-2

OPERATING INSTRUCTIONS

The following steps indicate the procedure to be followed in order to put the TDA-2 into operation. The total calibration time, after a brief warmup period, should not take more than a minute or two. Once set up at a particular speed, the TDA-2 is ready for continuous and automatic operation.

1. Plug power cord into 105-125 V 50/60 cycle a-c source and turn POWER switch to ON position. For 230 volt operation refer to schematic at rear of manual indicating input power transformer connections.

2. Allow unit to warm up for about 10 minutes.

3. Switch SPEED control to speed of signals to be tested — 60, 75, or 100 wpm.

4. Operate 20 ma—60 ma toggle switch to current value of circuit to be checked. Use 20 ma position for 30 ma polar loops.

5. Set POL-NEUT switch to correspond to loop.

NOTE: FILTER switch at rear of TDA-2 should normally be in OUT position (down). Refer to pages 14-16 for use of FILTER switch.

6. Set input polarity switch to NEG or POS depending on polarity of patch cord inserted into TDA-2 INPUT jack. POS. or NEG. refers to the tip of the jack. Check that BEAM switch is on.

7. Adjust TDA-2 oscilloscope controls until a round green dot is visible and move dot close to letter M at left center of cathode-ray tube. Figure 11. This is done by using the HOR., VERT., and INTENSITY controls. Intensity of green dot should be kept low and increased later when signals are fed to TDA-2.

CAUTION: Do not let a dot of high intensity remain stationary on the face of the cathode-ray tube for any long period of time. Face may be burned. BEAM switch may be turned to OFF when measurements are not being made.

This is pattern on TDA Oscilloscope when Unit is not being keyed by telegraph signals.

To determine if there is a steady mark signal in the loop or an open circuit, flip POS-NEG switch on front panel ... a momentary rectangular trace indicates steady mark. No trace - indicates open circuit.

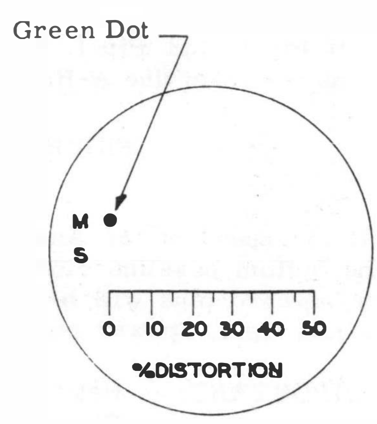
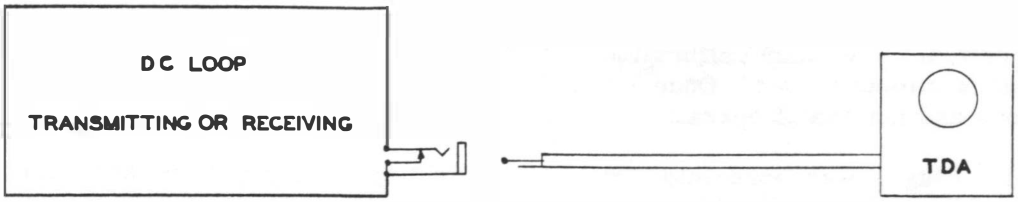


FIGURE 11

8. Connect a standard two-conductor patch cord from INPUT jack of TDA-2 to a jack in series with the d-c circuit to be checked. Figure 12. In order not to interrupt traffic the patch cord should be first plugged into the TDA-2 INPUT jack and then into the circuit to be checked.



The TDA is simply patched in series into a DC loop.

FIGURE 12

9. If the loop circuit is being keyed a rectangular pattern will be seen on the TDA-2 oscilloscope. This pattern may be jittering sideways.

10. Adjust the CLAMP control knob to steady the rectangular pattern whose ends may be jumping back and forth. Observe the right end of the pattern while doing this.

11. Operate the BASELINE and HOR.POS. knobs until the length of the rectangular pattern is equal to the length of the calibrated scale on the face of the TDA-2 oscilloscope.

12. Adjust INTENSITY and FOCUS controls for maximum clarity of pips and trace.

13. Adjust the SPEED knob until the speed of the Analyzer is set to the desired signal speed.

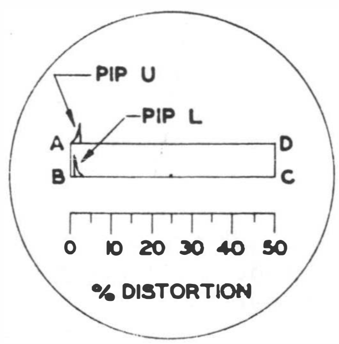
The speed adjustment of the TDA-2 is correct when the upward pip on the top baseline disappears into line A-B (Figure 13, pip U) and the upward pip on the bottom baseline (Figure 13, pip L) is up against the left end (A-B) of the rectangular pattern.

NOTE: Disregard the downward bias pips in setting speed.

Speed of TDA-2 is adjusted correctly when Pip U disappears in line A-B and Pip L is steady up against line A-B.

Speed of TDA-2 is also adjusted correctly if Pip U and Pip L move out equal distances from line A-B.

FIGURE 13



If the speed of the Analyzer is set too fast, a series of upward pips will be seen along the bottom baseline close to the B side of the rectangular sweep. If the speed is too slow, upward pips will be seen along the top baseline close to point A. When the speed is just right, upward pips will be seen as one steady pip going upward at point B.

IMPORTANT: Read page 13. Alternate Methods of Speed Adjustment and Discussion of Speed Adjustment and Fortuitous Distortion.

14. Readjust the CLAMP control to steady the movement of right end (C-D) of the rectangular pattern.

15. Retouch adjustment of HOR. POS. and BASELINE controls so that length of rectangular pattern coincides with calibrated scale.

The TDA-2 is now calibrated.

Any pip or pips along the rectangular pattern indicate distortion and the amount is read directly along the calibrated scale.

The interpretation of the various distortion pips is explained in this Instruction Manual.

ALTERNATE METHODS OF TDA-2 SPEED ADJUSTMENT

The SPEED knob adjustment of the Analyzer can be accomplished in two ways depending on the user's preference.

a) The SPEED knob of the Analyzer can be adjusted to the speed of a standard local signal of known speed. It does not matter if the local signal contains bias as the speed adjustment is made only on the upward pips (m-s transitions).

Once adjusted to a particular speed the SPEED knob should not be touched. When distortion measurements of extreme accuracy are required this SPEED adjustment can be checked periodically and readjusted slightly if necessary. The initial speed adjustment should be made after the unit has been ON for 15 minutes.

b) The SPEED knob of the Analyzer can also be adjusted to the speed of the incoming signal on the circuit being tested. When synchronous motors are used in telegraph transmission, variations in speed are not usually sources of distortion and this simplified method of speed adjustment may be preferred.

DISCUSSION OF SPEED ADJUSTMENT AND FORTUITOUS DISTORTION

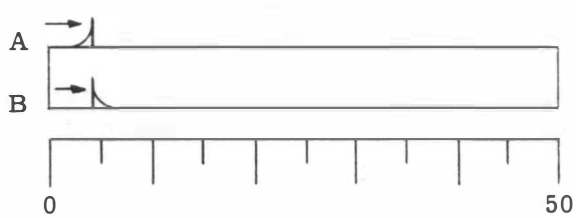
There are occasions when the speed adjustment of the Analyzer cannot be set exactly as indicated on page 12, step 13. This occurs when fortuitous distortion causes the upward pips to be unsteady near the left end line A-B of the rectangular pattern, Figure 13. With this type of fortuitous distortion (which may be due to slight speed variations among other things) the upward pip U, Figure 13, cannot be made to just disappear into line A-B while pip L remains steady against the line A-B. Pip U and pip L may be bouncing back and forth near line A-B and cannot be steadied by adjusting the SPEED knob.

Under the above conditions of fortuitous distortion the Model TDA-2 SPEED knob is adjusted in the following manner:

1. Follow the Operating Instructions steps 1 - 12 as outlined on pages 11 and 12 of this Instruction Manual.

2. Substitute the following procedure for step 13:

Adjust the SPEED knob so that the upward pips on the top and bottom baselines appear to move out equal distances from the zero distortion point. See Figure 14 below. This is the optimum position of the SPEED knob. Steps 14 and 15 of the Instruction Manual can now be followed and the Analyzer is ready for measurements.



SPEED knob adjusted until upward pips appear equidistant from zero distortion point.

FIGURE 14 -

PROCEDURE FOR LOCATING MECHANICAL DEFECTS

in

TELEGRAPH KEYING EQUIPMENT

1. Introduction

The TDA-2 can be a valuable aid to operations and maintenance personnel by providing a means of

a) Immediately discriminating between distortion due to defective mechanical keying equipment and ordinary bias distortion.

b) Tracking down the location of defects or bounce in mechanical keying equipment.

Use is made of the FILTER IN-OUT switch at the back of the TDA-2 to do this job.

Mechanical defects in keying equipment due to relay bounce, dirty contacts, pitted commutators, defective cams, etc., usually cause transient spikes or holes in the telegraph loop signals.

With the FILTER switch in the normal OUT position these spikes or holes in the signal will show up as spurious or erratic pips on the rectangular pattern of the TDA-2 scope, Figure 15. When the FILTER switch is thrown to the IN position, the spurious pips on the TDA-2 scope will disappear indicating they were caused by transient spikes and holes in the telegraph signals.

Thus, when the operator sees spurious or erratic pips on the TDA-2 scope, which disappear when the FILTER switch is thrown to the IN position, he knows that the telegraph loop signals contain spikes or holes. The source of this distortion can be tracked down in the manner indicated on the following pages.

At the same time that the operator discovers the loop signals contain spikes or holes, he can make his ordinary bias and distortion readings on the TDA-2 with the FILTER switch at the IN position. There is no appreciable change in the accuracy of the TDA-2 bias readings with the FILTER in the IN or OUT position on neutral d-c signals.

2. Use of Filter Switch

In order to provide a convenient means of analyzing telegraph loop circuits and equipment where distortion may be due to mechanical reasons, a FILTER switch is provided at the rear of the STELMA Telegraph Distortion Analyzer Model TDA-2.

By operating the FILTER switch the operator can immediately detect defective mechanical operation of transmission equipment or relays.

If pips on the TDA-2 scope disappear when the FILTER is switched to the IN position (up), the operator knows that those pips were caused by extraneous pulses in the d-c loop circuit normally due to mechanical defects such as relay bounce, ragged distributor brushes, defective commutators, etc.

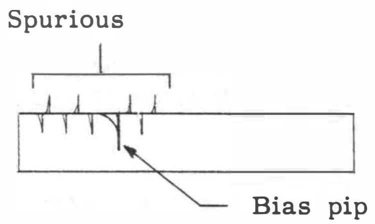
Once it is determined that there are extraneous pulses in the loop circuit, the operator can track down the reasons for their presence. Refer to Figures 15 - 19.

The following example, namely the location of a defective commutator segment in a transmitter distributor, will outline the general procedure for such application of the TDA-2.

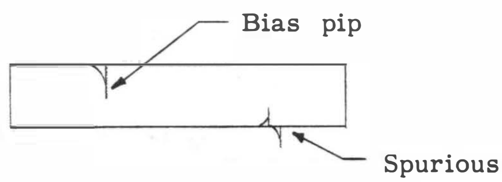
When spurious pips are seen on the TDA-2 screen, throw the FILTER switch to the IN position (up).

If the spurious pips disappear, it is an indication that they were probably caused for one of the reasons listed below:

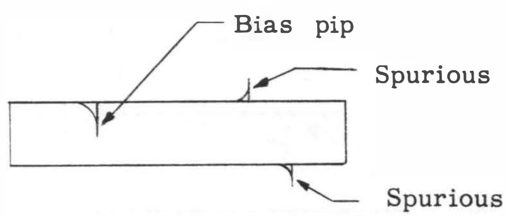
PATTERN ON TDA-2 SCREEN	Spurious Pips May Be Caused By:



1. Relay bounce
2. Dirty contacts
3. Ragged brushes
4. Noise on radio circuits



1. Defective or dirty segment Refer to pages 14 and 15 TDA-2 Instruction Manual.



1. High inductance kicks
2. Narrow holes in marking pulse
3. Narrow mark spikes in spacing pulse.

The extraneous narrow pulses which cause the spurious pips on the TDA-2 screen may be of such short duration that they do not affect teleprinter operation. They do indicate, however, the presence of mechanical defects which may lead to future deterioration of loop signals.

The illustrations above are general examples of the patterns that may be seen when conditions other than bias (or in addition to bias) are present in the d-c loop. The actual patterns seen by the operator may vary but the important fact to remember is that when the spurious pips disappear (on throwing the FILTER switch to the IN position) it is a definite indication that conditions other than bias exist in the loop and that the source of these extra pulses can be tracked down with the aid of the STELMA Telegraph Distortion Analyzer.

FIGURE 15 - ILLUSTRATIONS ON USE OF FILTER SWITCH

Let us suppose that segment number 3 of Figure 16 has a defect as illustrated. This defect may be due to pitting or dirt, etc. By sending individual repeated signals, i.e., Blank, T, O, M, V, Letters, (Figure 17), a mark pulse can be placed on each segment separately. When the mark pulse is on segment 3 it is mutilated as shown in Figure 18. Thus the Telegraph Distortion Analyzer will see an additional m-s transition which will show up on the scope as an upward pip, and a s-m transition which will show up on the scope as a downward pip. (Figure 19.) The distance between the pips will depend on the width of the defect on the segment.

The indication shown in Figure 19 due to the defective segment will not show up when a mark pulse is on the other segments but only when the mark pulse is on segment 3, i.e., when the letter "m" is transmitted.

In this manner various types of mechanical defects or adjustments can be conveniently checked with the TDA-2.

Normally, readings of bias are made with the FILTER switch in the OUT position. Accurate bias readings can also be taken, however, with the FILTER at the IN position and this is done when it is desired to disregard pips due to bounce.

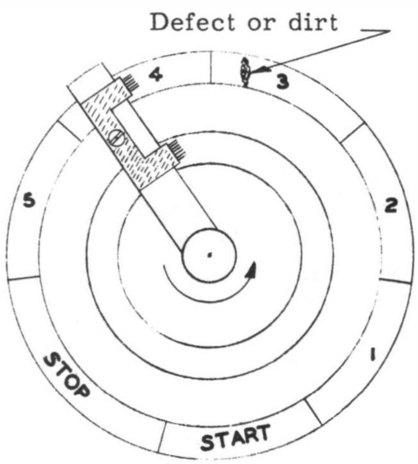


FIGURE 16.

Commutator of Transmitter Distributor with defective segment.

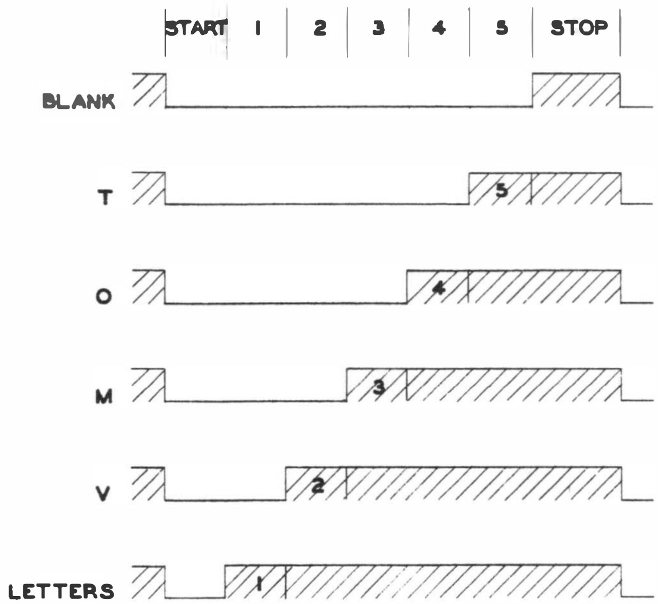


FIGURE 17. Repeated Signals for Placing a Mark Pulse on Each Segment Separately.

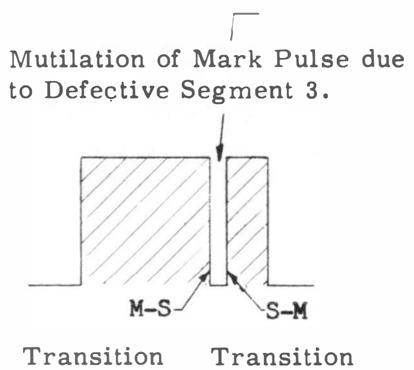


FIGURE 18. Mutilated Mark Pulse on Segment 3.

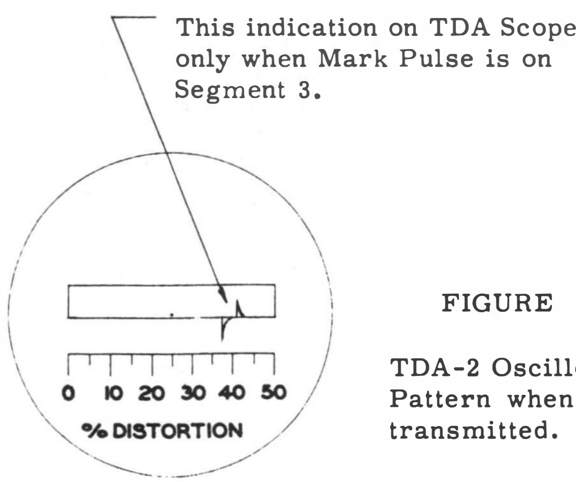


FIGURE 19.

TDA-2 Oscilloscope Pattern when M is transmitted.

ADJUSTMENT AND MAINTENANCE

1. Adjustment

Adjustments in the Analyzer are most often required after tube or component replacement has been made. Change in tube characteristics due to age may also necessitate adjustment. Maintenance adjustments are located at the right side, at the back, and on the chassis of the Analyzer and are functionally indicated by stampings on the chassis. Figures 20, 21, and 22. No markings are on the cabinet. The control functions on the side are listed as follows (starting at the front panel and going toward the rear):

(1) Speed - 60 wpm, (2) Speed - 75 wpm, (3) Speed - 100 wpm, (4) Gate - 60 wpm, (5) Gate - 75 wpm, (6) Gate - 100 wpm, (7) Balance. In cases of special units, different speed adjustments are provided.

Two additional potentiometers are located at the back of the chassis and may be adjusted from the back of the cabinet. They are labeled Trigger Adj. and Filter Adj. See Figure 21.

The Trigger Adj. is set so that the input trigger circuit operates at the half current point. The Filter Adj. is set so that there is no difference in bias measurement with the Filter Switch in the IN or OUT positions. The Polar Adj. control between V1 and V3 is set so that triggering occurs at equal but opposite loop currents.

The last potentiometer control is the Clamp Set screwdriver adjustment located on the top of the chassis in front of V4 behind the front panel. Figure 22.

The Clamp Set control provides for optimum operation and range of the following front panel controls and affects all three simultaneously:

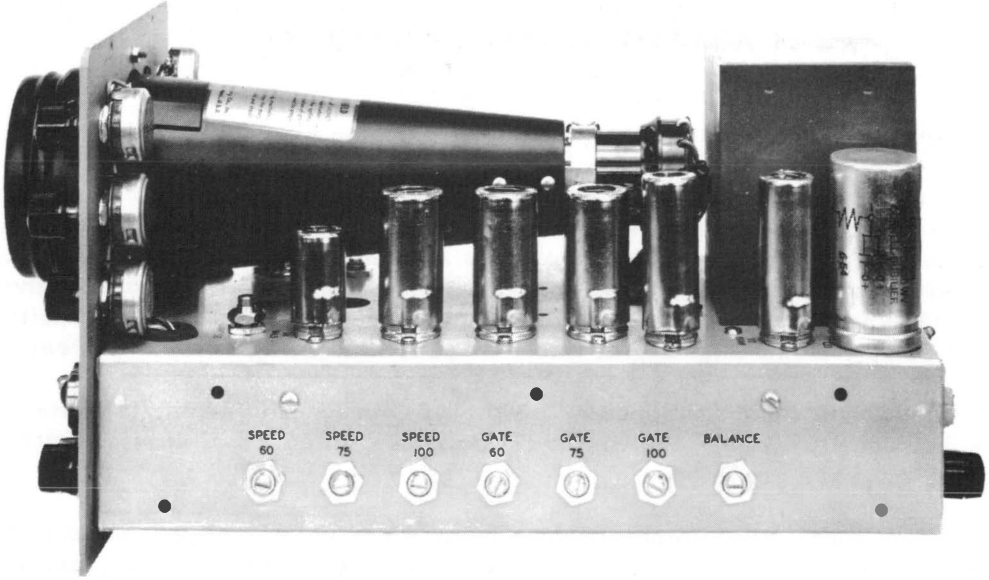
a) CLAMP
b) BASELINE
c) FOCUS

NOTE: No attempt should be made to adjust any of these controls unless tubes or components have been replaced or unless trouble exists as outlined in part 2 of this chapter. To remove the TDA-2 chassis from the enclosing cabinet, unscrew the two screws underneath the rear of the cabinet (near the two rear rubber feet). Also unscrew the two large screws at the top edge of the front panel and the two at the bottom edge.

If it is found impossible to make proper adjustment of the front panel SPEED control as outlined in OPERATING INSTRUCTIONS on pages 18-22, (upward going pulses cannot be grouped near the zero distortion point), proceed as follows: (1) Set the front panel SPEED control one-quarter turn clockwise from its extreme counterclockwise position; (2) place a screwdriver in the side speed control corresponding to the speed of the signal at the input of the Analyzer; (3) adjust the speed control in the direction necessary to cause the positive (speed) pips on the cathode-ray tube face to move toward and line up at zero as outlined in OPERATION, pages 18 - 22.

NOTE: In all cases where SPEED or BALANCE adjustments are made the front panel CLAMP control will require readjustment as will the HOR. POS. control.

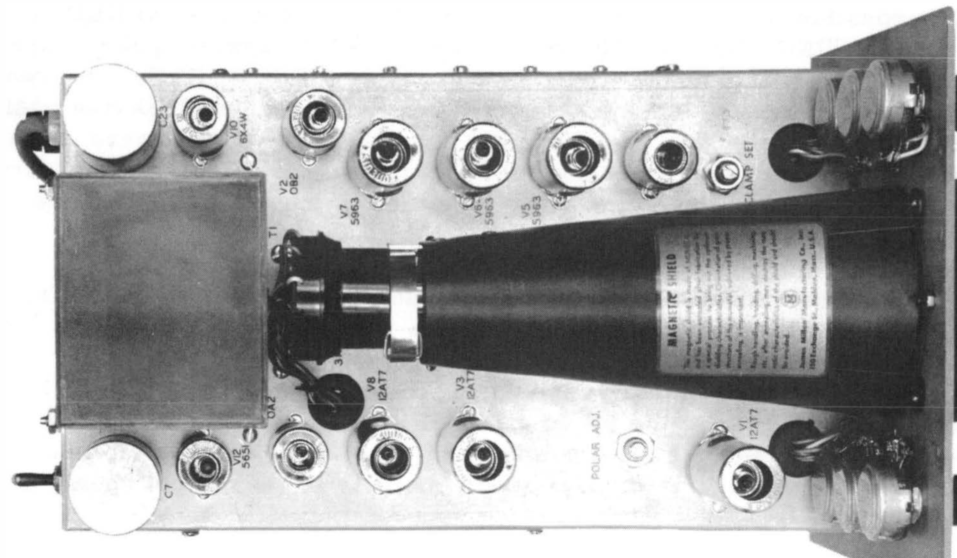
If the pips cannot be brought to the zero point completely, turn the side SPEED Control to secure further positioning of the speed pips. If it is impossible to get proper SPEED adjustment using adjustment of both side and front panel SPEED controls, tube V6, a type 5963 tube, should be replaced and the side speed controls aligned to get speed pips at the zero point.



Above
FIGURE 20 - SIDE VIEW TDA-2

Center
FIGURE 21 - REAR VIEW TDA-2

Below
FIGURE 22 - TOP VIEW TDA-2



NOTE: If tube V6 is replaced, adjustment of the BALANCE control will probably be necessary. Proper adjustment of the BALANCE control can be made using an oscilloscope with low frequency sweeps such as the Dumont 208 or 304. The BALANCE control provides for proper setting of the sweeps in the TDA-2 to secure the maximum accuracy of bias reading on the TDA-2. It provides for perfectly balanced output from the timing oscillator tube V6.

B. Balance Control Adjustment

Do not adjust this control unless tube V6 is replaced. If V6 has been replaced, proceed as follows:

1) Connect the vertical terminals of an oscilloscope to test point "X". (see Figure 23, 39K resistor on terminal board) and terminal 8 of power transformer. Connect hot vertical input of oscilloscope to point "X". Signal at test point "X" shows the output of squaring amplifier V7A.

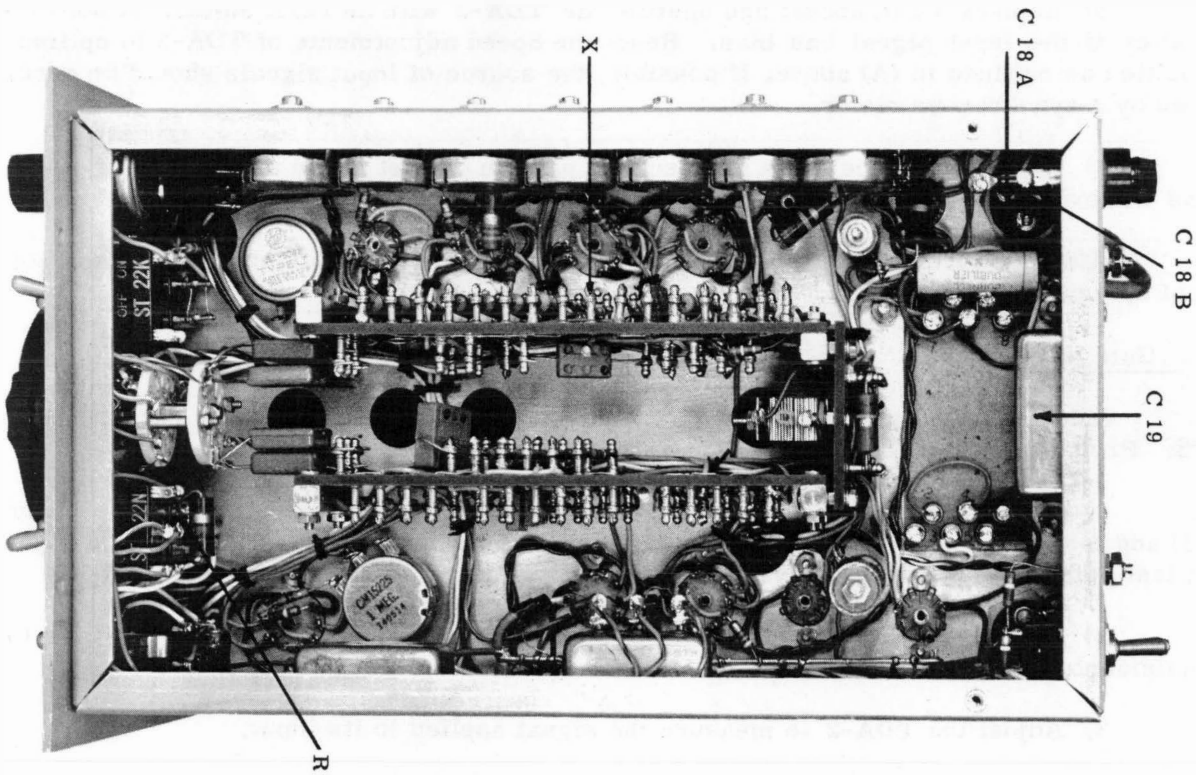
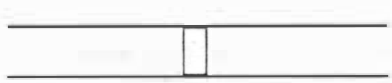


FIGURE 23. BOTTOM VIEW TDA-2

2) Turn power switch of TDA-2 ON and allow a five minute warmup time for equipment.

3) Remove V5 Gate tube from socket of TDA-2. Adjust the test oscilloscope to see the signal at point "X". Use no sync on scope. Vary the sweep of the test scope from slow toward an increasing direction until one overlapping cycle of V7A output is observed. See Figure 24.

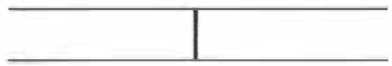


One cycle overlapping, tube V3 removed.

FIGURE 24 — BALANCE PATTERN

Make this pattern stationary using only test scope fine sweep control — no sync. It will probably be necessary to keep your hand on the sweep control of the test scope to hold the pattern still by minute adjustment of this control.

4) Adjust Balance control on side of TDA-2 chassis to obtain zero bias pattern on test scope. See Figure 25.



Zero Bias Pattern

Balance control adjusted correctly, tube V3 removed.

FIGURE 25 — BALANCE ALIGNMENT

5) Replace V5 in socket and operate the TDA-2 with an input signal. It does not matter if the input signal has bias. Reset the Speed adjustments of TDA-2 to optimum position as outlined in (A) above. If possible, the source of input signals should be generated by a synchronous motor.

6) Remove V5 once again and recheck pattern on test scope as outlined in steps 3 and 4 above. If necessary, make slight adjustment in Balance control.

After balance control adjustment is made, a slight readjustment of the speed control may be required.

C. Gate Adjustments

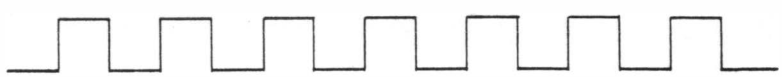
Side chassis Gate control adjustments are usually required after replacing tube V5. Proceed as follows to adjust Gate controls:

1) Connect the vertical terminals of an oscilloscope to test point "X" (see Figure 23) and terminal 8 of power transformer. Connect hot vertical input to point "X". Signal at test point "X" shows the output of squaring amplifier V7A.

2) Operate the TDA-2 with an input signal. Allow a five minute warmup time for equipment.

3) Adjust the TDA-2 to measure the signal applied to its input.

4) Adjust the test oscilloscope to see the signal at point "X". Use no sync on the test scope. Vary the sweep of the test scope from slow toward an increasing direction until one character of V7A output is seen. See Figure 26.



One character

Gate control adjusted correctly, 7 pulses.

FIGURE 26 — GATE ADJUSTMENT PATTERN

5) Make this pattern stationary using only the test scope fine sweep control — no sync.

6) Observe that the speed setting of the TDA-2 is correct. There should be exactly seven positive pulses visible. If there are more (or less), or if the last pulse is not the same duration as other pulses,

7) Place screwdriver in the slot of the GATE control corresponding to the speed of the input signal.

8) Adjust the GATE control until exactly seven pulses are observed. A normal pattern should now be visible on the TDA-2 when its controls are properly adjusted. It should be possible to adjust the panel SPEED control on the TDA-2 over a range sufficient to properly align the speed pips without changing the number of pulses (7) in the gate cycle. If this is not so, make further adjustment of the GATE control until this is possible.

D. Trigger and Filter Adjustments

Two potentiometers at the rear of the TDA-2 allow for trigger and filter adjustments. These should be set if tubes V1 or V3 are changed. The Trigger Adj. potentiometer is set as follows: Refer to Figure 21.

1) Connect a milliammeter in the input loop to the TDA-2.

2) Reduce the loop current so that the current is cut below the half current value. As the current is reduced below the half current value, one trace should occur on the TDA-2 screen.

3) Increase the loop current observing the "spot" on the screen carefully. As the current is being increased a small spike will suddenly dart below the spot for an instant.

4) Adjust the potentiometer so that the one trace occurs at slightly below the half current value and the small spike occurs at slightly above the half current value.

5) After the above adjustment is made, operate the TDA-2 on a loop giving an indication of low bias on the TDA-2.

6) Set the Filter Adj. potentiometer so that the same bias reading is secured with the Filter switch IN as is observed with the Filter switch OUT. The current in the d-c loop should be set to 60 or 20 ma for this adjustment.

E. Polar Adjustment

1) Locate the Polar Adj. potentiometer on the chassis between tubes V1 and V3.

2) Provide a polar loop signal to the TDA-2 input.

3) Set the polar loop for equal mark and space currents of 4.0 ma each by means of a potentiometer and milliammeter in the loop.

4) Key the polar loop with a test signal.

5) Set the POLAR ADJ. control so that a rectangular trace is secured on the cathode-ray tube. There will be a small range on the control where this is possible. Set the control to the center of this range.

F. Clamp Set Adjustment

It will seldom be necessary to readjust the Clamp Set control. It is reset only under the following conditions.

(Located on top of chassis in front of V4.)

a) Front panel CLAMP control is turned fully clockwise and cannot clamp the rectangular pattern steady.

b) The BASELINE control does not have enough range to set the rectangular pattern from 0% to 50% along the calibrated scale. (May also require change of V8).

c) The FOCUS control does not have enough range to properly focus the pattern on the cathode-ray tube. (May also require change of V8).

It should be noted that the Clamp Set control affects all three front panel controls, mentioned above, simultaneously. All three front panel controls should be checked to reach the optimum Clamp Set adjustment.

2. Maintenance

Maintenance of the TDA-2 may be divided into the following categories:

a) Trouble shooting

b) Tube replacement

c) Component replacement

A. Trouble Shooting

The Schematic Diagram, Fig. 28, Waveform, Fig. 2, Diagrams and Voltage Chart, Fig. 27, will be helpful in trouble shooting the TDA-2. Make the following checks:

1) Check a-c line voltage — 105 to 125 volts.

2) Check power fuse at rear of cabinet. If red pilot lamp lights, check if all tubes light.

3) Check the B+ voltages. Refer to Schematic Diagram and Fig. 23. Make checks with at least 1000 ohms per volt voltmeter.

WARNING: High voltages are utilized in the TDA-2 which may be dangerous to life. Use caution in testing the unit.

4) Check across capacitor C19 to secure 400 volts $\pm$ 10%.

5) Check across terminals 2 and 5 of tube V12 for 90 volts $\pm$ 5%.

6) Check across terminals 2 and 5 of tube V11 for 150 volts $\pm$ 5%.

7) Check from terminal 5 of tube V13 to ground (chassis) for 255 volts $\pm$ 5%.

8) Check across capacitor C18A for 415 volts and across C18B for 385 volts $\pm$ 10%.

If the voltages are correct, a quick check of the operation of the unit may be made by feeding a signal to the input of the TDA-2 and using an oscilloscope for checking the signal at various points in the unit.

Proceed as follows:

a) Apply a test signal to the input of the TDA-2. Use the character Y if possible.

b) Set controls of TDA-2 to attempt to secure proper TDA-2 operation.

c) Check for waveforms of Fig. 2 as follows:

d) Check across resistor R1, 430 ohms, on switch S1 to secure waveform of line 1.

e) Check pin 6 of V1 to chassis for line 2 waveform.

f) Check pin 6 of V3 to * negative buss for line 4 waveform.

g) Check pin 7 of V4A to negative buss for line 5 waveform.

h) Check pin 6 of V5 to negative buss for line 6 waveform.

i) Check pin 1 of V7A to negative buss for line 7 waveform.

j) Check pin 1 of V8 to negative buss for line 8 waveform.

k) Check pin 6 of V7B to negative buss for line 6 waveform inverted.

l) Check pin 6 of V8 to negative buss for line 8 waveform inverted.

Failure to secure the required waveforms at any point indicates trouble in the circuit just prior to that point and a check of the tubes in the circuits should be made. If tubes test good, a voltage analysis using the enclosed voltage analysis chart, Fig. 27, should be made.

B. Tube Replacement

Tubes in the TDA-2 may be checked for light. If no signal can be observed at a tube output and circuit voltages are present, check the tube in a tube tester for emission or transconductance.

CAUTION: Always replace a tube in the socket from which it was removed if it has tested good.

Changing tubes in the TDA-2 may necessitate a readjustment of controls.

The following tubes are related to the controls listed:

1) Trigger Adj. (R3) - V1, Filter Adj. (R10), Polar Adj. (R13) - V1, V3.

2) Gate controls - 60 wpm (R29), 75 wpm (R28), 100 wpm (R27) - tube V5.

3) Speed controls, and Balance control - 60 wpm (R53), 75 wpm (R55), 100 wpm (R56), Speed panel control (R37), Balance control (R46) - tube V6.

4) BASELINE control, VERT. and HOR. POS. control and to some extent, FOCUS control and Chassis Clamp Set control - tube V8.

In some cases a tube may test good and not work satisfactorily in the TDA-2 due to the tube sections being badly unbalanced.

The 3RP1 cathode-ray tube may be checked for filament light. If signals and voltages are present at all tubes and no signal is seen on V9, replacement of this tube may be made and an operational check conducted with the new tube.

* Negative buss on TDA-2 runs under capacitor C14 and connects to terminal 8 of the power transformer.

A chart showing tube voltages follows: generally the voltages should be within 10% of the values listed if a 1000 ohm per volt meter is used. These measurements are made from the indicated tube socket pins to the negative buss.

C. Component Replacement

Defective components in the TDA-2 may normally be located by making the voltage analysis or a resistance analysis using the Schematic Diagram as a guide. Components in the TDA-2 which may not be marked by symbol numbers may be traced by starting from the pins of sockets and tracing the wiring. In some cases components are wired directly to the tube sockets. An ohmmeter may be used to check resistors for value, capacitors for short, and windings of transformers for continuity. Values of components are listed on the Schematic Diagram.

Note: In the event of any major difficulty in repairing the TDA-2 it is highly recommended that the unit be returned postpaid to Stelma, Incorporated, 190 Henry Street, Stamford, Conn., and all repairs will be made in our specially equipped laboratories. Any components (other than tubes) which are found to have gone bad due to original defect will be replaced free of charge within a period of six months. Any difficulties due to defective workmanship will be repaired free of charge within a six-month period. A complete description of the difficulty should accompany the unit when returned.

Pin No.	Tube No.										
	V1	V2	V3	V4	V5	V6	V7	V8	V10	V11	V12
	12AT7	OB2	12AT7	6AL5	5963	5963	5963 12AU7	12AT7	6X4	OA2	5651
1	+38	-	+29	+6.4	+125	+131	+27	+137	*330		
2	0	258	small	+6.5	+22	+.8	-.3	+2.2			+5.0
3	+.75	-	0	-	+43	+47	0	+12			
4	-	-	-	-	-	-	-	-			
5	-	150	-	+6.5	-	-	-	-		+150	
6	120	-	+142	-	+94	+78	+38	+114	*330		
7	-20	-	-17	0	+.2	+1.2	-.5	+6.5	420		
8	+.75	-	0	-	+43	+47	0	+12	-		
9	-	-	-	-	-	-	-	-	-		

* A.C. Voltage

FIGURE 27 TUBE VOLTAGE CHART

1000 Ohm Per Volt Meter Used

STELMA, Incorporated

TELEGRAPH DISTORTION ANALYZER MODEL TDA-2
(Serial No. 400 and Up)
PARTS LIST

CIRCUIT REF. SYMBOL	DESCRIPTION	MFGR. PART NO. OR JAN DESIGNATION	MFGR.
C1	Capacitor, metalized paper 0.1 µf, 200 v,	MP2P1	A
C2	Capacitor, mica .001 µf, ± 5%, 500 v	CM30C102J	A
C3	Capacitor, paper, metal cased .03 µf, ± 2%	MyR6003G	A
C4, C11	Capacitor, mica, 270 µµf, ± 5%, 500 v	CM20C271J	A
C5, C9	Capacitor, mica, .002 µf, ± 2%, 500 v	CM30D202G	A
C6, C10	Capacitor, mica, .0018 µf, ± 2%, 500 v	CM30D182G	A
C7	Capacitor, mica, .0062 µf, ± 2%, 500 v	CM35D622G	A
C8	Same as C7		
C9	Same as C5		
C10	Same as C6		
C11	Same as C4		
C12	Capacitor, mica, .0043 µf, ± 5%, 500 v	CM35C432J	A
C13	Capacitor, mica, 150 µµf, ± 5%, 500 v	CM20C151J	A
C14	Capacitor, polystyrene, .030-.0091-.0098 µf, ± 1%, 100 v	A1153	B
C15	Capacitor, mica, 510 µµf, ± 5%, 500 v	CM20C511J	A
C16	Capacitor, electrolytic, 15 µf, 450 v	CE41E150R	C
C17	Capacitor, mica, 820 µµf, ± 5%, 300 v	CM20C821J	A
C18	Capacitor, electrolytic, 20-20 µf, 450 v	CE42E200R	C
C19	Capacitor, electrolytic, 8 µf, 600 v	BS91	D
C20	Capacitor, steatite-cased, paper, .05 µf, 600 v, Budroc	ST6S5	A
CR1	Rectifier, selenium, 25 ma	16Y1	E
CR2	Same as CR1		
E1 thru E7	Knob, round	1700	F
E8	Knob, pointer	4100Z	F
F1	Fuse, 2 amp, 250 v	3AG2	G

CIRCUIT REF. SYMBOL	DESCRIPTION	MFGR. PART NO. OR JAN DESIGNATION	MFGR.
I1	Lamp, incandescent 6-8 v	47	H
J1	Jack, open circuit	JJ034	I
R1	Resistor, fixed comp., 430 Ω, ± 5%, 2 w	RC42BF431J	J
R2	Resistor, fixed comp., 150 Ω, ± 5%, 2 w	RC42BF151J	J
R3	Resistor, variable comp., 1000 Ω, ± 10%, C.T.S. type 651, LT2 shaft	X3532	K
R4, R5, R16, R17, R61, R71	Resistor, fixed comp., 100 K, ± 5%, 1/2 w	RC20BF104J	J
R5	Same as R4		
R6, R67	Resistor, fixed comp., 750 K, ± 5%, 1/2 w	RC20BF754J	J
R7, R14, R15,R21	Resistor, fixed comp., 560 K, ± 5%, 1/2 w	RC20BF564J	J
R8	Resistor, fixed comp., 820 Ω, ± 5%, 1/2 w	RC20BF821J	J
R9	Resistor, fixed comp., 470 K, ± 5%, 1/2 w	RC20BF474J	J
R10	Resistor, variable comp., 500 K, ± 10%, C.T.S. type 65, LT2 shaft	X3540	K
R11, R19, R20	Resistor, fixed comp., 1.1 m, ± 5%, 1/2 w	RC20BF115J	J
R12, R43, R49,R52	Resistor, fixed comp., 1.0 m, ± 5%, 1/2 w	RC20BF105	J
R13, R27	Resistor, variable comp., 1.0 m, ± 20%, 3/8 bushing, 1/8 shaft with SD slot	CM15225	L
R14	Same as R7		
R15	Same as R7		
R16	Same as R4		
R17	Same as R4		
R18, R66, R75	Resistor, fixed comp., 47 K, ± 5%, 1/2 w	RC20BF473J	J
R19	Same as R11		
R20	Same as R11		
R21	Same as R7		
R22	Resistor, fixed comp., 68 K, ± 5%, 1/2 w	RC20BF683J	J
R23	Resistor, fixed comp., 8.2 K, ± 5%, 1 w	RC32BF822J	M
R24	Resistor, fixed comp., 270 K, ± 5%, 1/2 w	RC20BF274J	J
R25	Resistor, fixed comp., 33 K, ± 5%, 1 w	RC32BF333J	J
R26	Resistor, fixed comp., 10 K, ± 5%, 1 w	RC32BF103J	J
R27	Same as R13		
R28, R29	Resistor, variable comp., 2.5 m, ± 20%, 3/8 bushing, 1/8 shaft with SD slot	CM15223	L
R30	Resistor, fixed comp., 1.5 m, ± 5%, 1/2 w	RC20BF155J	J
R31	Resistor, fixed comp., 3.9 m, ± 5%, 1/2 w	RC20BF395J	J

CIRCUIT REF. SYMBOL	DESCRIPTION	MFGR. PART NO. OR JAN DESIGNATION	MFGR.
R32	Resistor, fixed comp., 6.8 m, ± 5%, 1/2 w	RC20BF685J	J
R33, R40	Resistor, fixed comp., 1.8 m, ± 5%, 1/2 w	RC20BF185J	J
R34, R45	Resistor, fixed comp., 910 K, ± 5%, 1/2 w	RC20BF914	J
R35	Resistor, fixed comp., 2.7 K, ± 5%, 1/2 w	RC20BF272J	J
R36	Resistor, fixed comp., 13 K, ± 5%, 1 w	RC32BF133J	M
R37, R57	Resistor, variable comp., 5 k, ± 10%, 1/2 bushing, 1/2 shaft	59969	M
R38, R39, R54	Resistor, fixed comp., 22 K, ± 5%, 1 w	RC32BF223J	M
R39	Same as R38		
R40	Same as R33		
R41	Resistor, fixed comp., 6.2 K, ± 5%, 1/2 w	RC20BF622J	J
R42	Resistor, fixed comp., 39 K, ± 5%, 1/2 w	RC20BF393J	J
R43	Same as R12		
R44, R50	Resistor, fixed comp., 680 K, ± 5%, 1/2 w	RC20BF684J	J
R45	Same as R34		
R46	Resistor, variable comp., 250 K, ± 20%, 3/8 bushing, 1/8 shaft with SD slot	CM15224	L
R47, R48	Resistor, fixed comp., 2.4 m, ± 5%, 1/2 w	RC20BF245J	J
R48	Same as R47		
R49	Same as R12		
R50	Same as R44		
R51	Resistor, fixed comp., 82 K± 5%, 1 w	RC32BF823J	M
R52	Same as R12		
R53, R55, R56	Resistor, variable comp., 5 K, ± 10%, 3/8 bushing, 1/8 shaft with SD slot	CM15222	L
R54	Same as R38		
R55	Same as R53		
R56	Same as R53		
R57	Same as R37		
R58	Resistor, variable comp., 500 K, ± 10%, 3/8 bushing, 1/8 SD shaft	J59974	M
R59	Resistor, fixed comp., 5.6 m, ± 5%, 1/2 w	RC20BF565J	J
R60	Resistor, variable comp., 500 K, ± 10%, 1/2 bushing, 1/2 shaft	J59972	M
R61	Same as R4		
R62, R63	Resistor, fixed comp., 120 K, ± 5%, 1/2 w	RC20BF124J	J

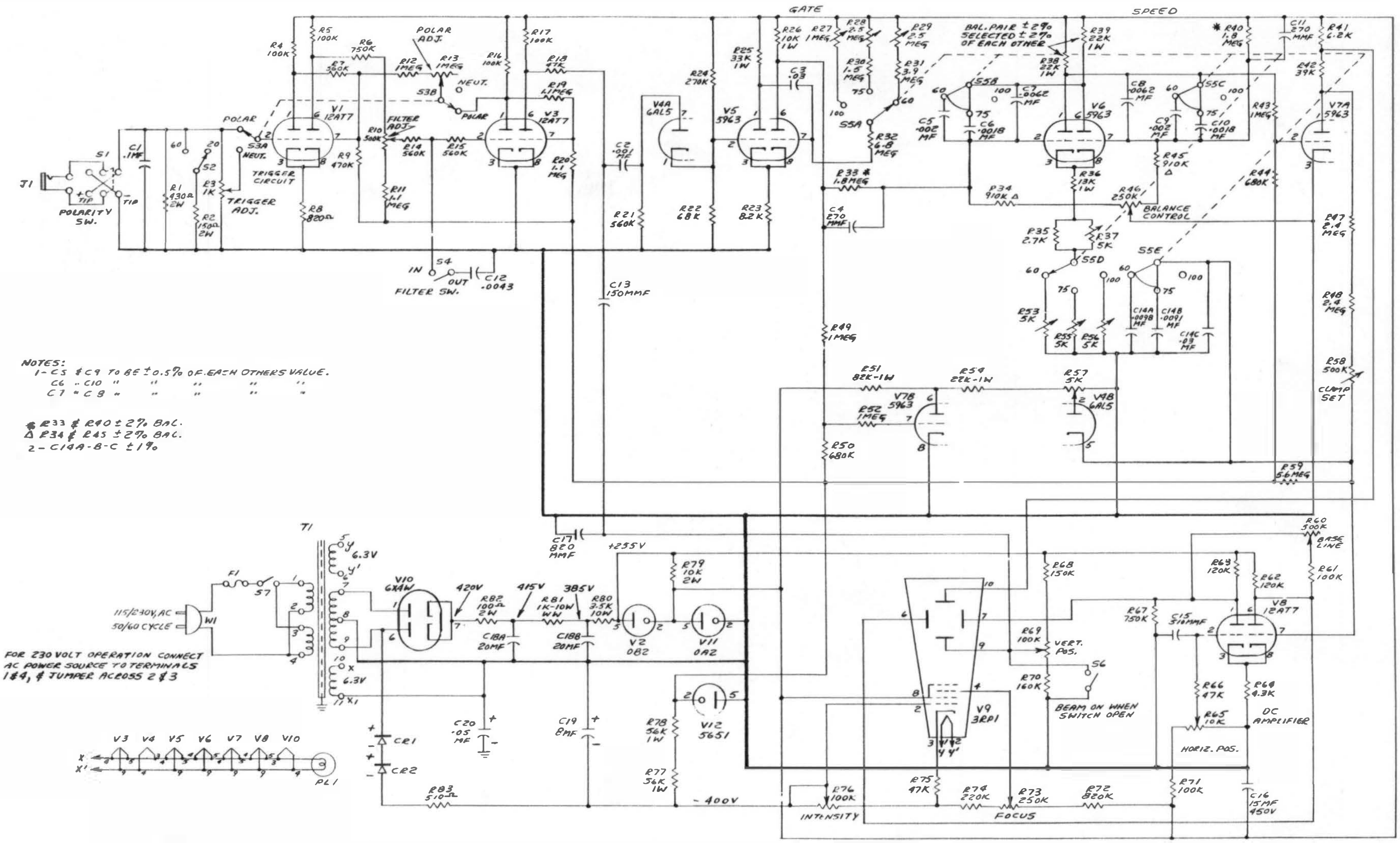
CIRCUIT REF. SYMBOL	DESCRIPTION	MFGR. PART NO. OR JAN DESIGNATION	MFGR.
R63	Same as R62		
R64	Resistor, fixed comp., 4.3 K, ± 5%, 1/2 w	RC20BF432J	J
R65	Resistor, variable comp., 10 K, ± 10%, 1/2 bushing, 1/2 shaft	59971	M
R66	Same as R18		
R67	Same as R6		
R68	Resistor, fixed comp., 150 K, ± 5%, 1/2 w	RC20BF154J	M
R69, R76	Resistor, variable comp., 100 K, ± 10%, 1/2 bushing, 1/2 shaft	59970	M
R70	Resistor, fixed comp., 160 K, ± 5%, 1/2 w	RC20BF164J	J
R71	Same as R4		
R72	Resistor, fixed comp., 820 K, ± 5%, 1/2 w	RC20BF824J	J
R73	Resistor, variable comp., 250 K,±10%, 1/2 bushing, 1/2 shaft	J59973	M
R74	Resistor, fixed comp., 220 K, ± 5%, 1/2 w	RC20BF224J	J
R75	Same as R18		
R76	Same as R69		
R77, R78	Resistor, fixed comp., 56 K, ± 5%, 1 w	RC32BF563J	M
R78	Same as R77		
R79	Resistor, fixed comp., 10 K, ± 10%, 2 w	RC42BF103K	M
R80	Resistor, fixed WW, 3.5 K, 12 w	RW32G352	N
R81	Resistor, fixed WW, 1 K, 8 w	RW30G102	N
R82	Resistor, fixed comp., 100 Ω, ± 10%, 2 w	RC42BF101K	M
R83	Resistor, fixed comp., 510 Ω, ± 5%, 1/2 w	RC20BF511J	J
S1, S3	Switch, toggle D.P.D.T.	ST22N	O
S2, S4, S6, S7	Switch, toggle D.P.S.T.	ST22K	O
S3	Same as S1		
S4	Same as S2		
S5	Switch, rotary, 5 pole, 3 pos., 2 section	A1543	B
S6	Same as S2		
S7	Same as S2		
T1	Transformer, power per MIL-T-27	2195B1468	B
V1, V3, V8	Tube, electron	12AT7	P
V2	Tube, electron	OB2	Q
V3	Same as V1		

CIRCUIT REF. SYMBOL	DESCRIPTION	MFGR. PART NO. OR JAN DESIGNATION	MFGR.
V4	Tube, electron	6AL5	P
V5, V6, V7	Tube, electron	5963	Q
V6	Same as V5		
V7	Same as V5		
V8	Same as V1		
V9	Tube, electron C.R.T.	3RP1	Q
V10	Tube, electron	6X4W	P
V11	Tube, electron	OA2	Q
V12	Tube, electron	5651	Q
XF1	Holder, fuse	HKP-H	G
XI1	Holder, lamp, red jewel, dull white nickel	81410-111	R
XV1, XV3, XV5, XV6, XV7, XV8	Socket, electron tube, 9 pin	TS103P01	S
XV2, XV4, XV10, XV11, XV12	Socket, electron tube, 7 pin	TS102P01	S
XV3	Same as XV1		
XV4	Same as XV2		
XV5	Same as XV1		
XV6	Same as XV1		
XV7	Same as XV1		
XV8	Same as XV1		
XV9	Socket, electron C.R.T.	9464-12	T
	Shield, electron tube for V1, V3, V5, V6, V7, V8	TS103U02	S
	Shield, electron tube for V2, V10, V11	TS102U03	S
	Shield, electron tube for V4	TS102U01	S
	Shield, electron tube for V12	TS102U02	S
	Shield, electron tube for 3RP1	80067-25	S

TELEGRAPH DISTORTION ANALYZER MODEL TDA-2

MANUFACTURERS' CODE

A	Cornell-Dubilier Electric Corp., South Plainfield, N.J.
B	Stelma, Inc., Stamford, Conn.
C	Aerovox Corp., New Bedford, Mass.
D	P. R. Mallory Co., Indianapolis, Ind.
E	Radio Receptor Co., New York, N.Y.
F	Harry Davies Molding Co., Chicago, Ill.
G	Bussmann Mfg. Co., St. Louis, Mo.
H	General Electric Co., Schenectady, N.Y.
I	Switchcraft, Inc., Chicago, Ill.
J	International Resistance Co., Philadelphia, Pa.
K	Chicago Telephone Supply Co., Elkhart, Ind.
L	Clarostat Mfg. Co., Dover, N.H.
M	Allen-Bradley Co., Milwaukee, Wis.
N	Ward Leonard Electric Co., Mt. Vernon, N.Y.
O	Arrow-Hart & Hegeman Electric Co., Hartford, Conn.
P	Tungsol Electric Co., Newark, N.J.
Q	Radio Corporation of America, New York, N.Y.
R	Dialight Corporation, Brooklyn, N.Y.
S	Cinch Mfg. Co., Chicago, Ill.
T	James Millen Co., Malden, Mass.



31

FIGURE 28. TELEGRAPH DISTORTION ANALYZER MODEL TDA-2
(Serial No. 400 and up)