TECHNICAL MANUAL

OPERATOR'S, ORGANIZATIONAL, INTERMEDIATE

DIRECT SUPPORT, AND GENERAL SUPPORT

MAINTENANCE MANUAL

DUAL TRACE AMPLIFIER

AM-6785A/U

(NSN 6625-01-132-0244)

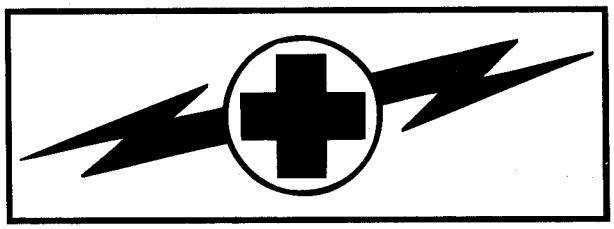
HEADQUARTERS, DEPARTMENT OF THE ARMY

1 JUNE 1988



5 SAFETY STEPS TO FOLLOW IF SOMEONE IS THE VICTIM OF ELECTRICAL SHOCK

1. **DO NOT TRY TO PULL OR GRAB THE INDIVIDUAL**
2. **IF POSSIBLE, TURN OFF THE ELECTRICAL POWER**
3. **IF YOU CANNOT TURN OFF THE ELECTRICAL POWER, PULL, PUSH, OR LIFT THE PERSON TO SAFETY USING A DRY WOODEN POLE OR A DRY ROPE OR SOME OTHER INSULATING MATERIAL**
4. **SEND FOR HELP AS SOON AS POSSIBLE**
5. **AFTER THE INJURED PERSON IS FREE OF CONTACT WITH THE SOURCE OF ELECTRICAL SHOCK, MOVE THE PERSON A SHORT DISTANCE AWAY AND IMMEDIATELY START ARTIFICIAL RESUSCITATION**



WARNING

HIGH VOLTAGE

is used in the operation of this equipment

DEATH ON CONTACT

may result if personnel fail to observe safety precautions

Never work on electronic equipment unless there is another person nearby who is familiar with the operation and hazards of the equipment and who is competent in administering first aid. When the technicians are aided by operators, they must be warned about dangerous areas.

Be careful not to contact high-voltage connections of 115-volt ac input connections when installing or operating this equipment.

Whenever the nature of the operation permits, keep one hand away from the equipment to reduce the hazard of current flowing through vital organs of the body.

WARNING

Do not be misled by the term "low voltage". Potentials as low as 50 volts may cause death under adverse conditions.

For Artificial Respiration, refer to FM 21-11.

WARNING

A periodic review of safety precautions in TB 385-4, Safety Precautions for Maintenance of Electrical/Electronic Equipment, is recommended. When the equipment is operated with covers removed, DO NOT TOUCH exposed connections or components. MAKE CERTAIN you are not grounded when making connections or adjusting components inside the test instrument.

WARNING

Hot equipment parts can cause serious burns. Before working on equipment that has just been shut down, allow equipment to cool.

TECHNICAL MANUAL

No. 11-6625-3190-14

HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington, DC, 1 June 1988

OPERATOR'S, ORGANIZATIONAL, DIRECT SUPPORT, AND GENERAL SUPPORT MAINTENANCE MANUAL

DUAL TRACE AMPLIFIER
AM-6785A/U
(NSN 6625-01-132-0244)

REPORTING ERRORS AND RECOMMENDING IMPROVEMENTS

You can help improve this manual. If you find any mistakes or if you know of a way to improve the procedures, please let us know. Mail your letter, DA Form 2028 (Recommended Changes to Publications and Blank Forms), or DA Form 2028-2 located in the back of this manual direct to: Commander, US Army Communications-Electronics Command and Fort Monmouth, ATTN: AMSEL-ME-MP, Fort Monmouth, New Jersey 07706-5000.

In either case, a reply will be furnished direct to you.

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INSTRUCTIONS

0-1. SCOPE.

This manual contains instructions for the operation and maintenance of the Dual Trace Amplifier, AM-6785A/U. Throughout this manual the Dual Trace Amplifier AM-6785A/U is referred to as either the instrument or AM-6785/U.

0-2. CONSOLIDATED INDEX OF ARMY PUBLICATIONS AND BLANK FORMS.

Refer to the latest issue of DA Pam 25-30 to determine whether there are new editions, changes, or additional publications pertaining to this equipment.

0-3. MAINTENANCE FORMS, RECORDS, AND REPORTS.

a. Report of Maintenance and Unsatisfactory Equipment. Department of the Army forms and procedures used for equipment maintenance will be those prescribed by DA PAM 738-750 as contained in Maintenance Management Update.

b. Report of Packaging and Handling Deficiencies. Fill out and forward SF 364 Report of Discrepancy (ROD) as prescribed in AR 73S-11-2/DLAR 4140.55/ NAVMATINST 4355.73B/AFR 400-54/MCO 4430.3H.

c. Discrepancy in Shipment Report (DISREP) (SF 361). Fill out and forward Discrepancy in Shipment Report (DISREP) (SF 361) as prescribed in AR 55-38/ NAVSUPINST 4610.33C/AFR 75-18/MCO P4610.19D/ DLAR 4500.15.

0-4. REPORTING OF EQUIPMENT IMPROVEMENT RECOMMENDATIONS (EIR).

If your Dual Trace Amplifier needs improvement, let us know. Send us an EIR. You, the user, are the only one who can tell us what you don't like about the design. Put it on an SF 368 (Quality Deficiency Report). mail it to Commander, US Army Communications Electronics Command and Fort Monmouth, New Jersey 07703-5000. We'll send you a reply.

0-5. ADMINISTRATIVE STORAGE.

Administrative storage of equipment issued to and used by Army activities will have preventative maintenance performed in accordance with PMCS charts before storing. When removing the equipment from administrative storage the PMCS should be performed to assure operational readiness.

0-6. DESTRUCTION OF ARMY ELECTRONICS MATERIEL.

Destruction of Army electronics materiel to prevent enemy use shall be in accordance with TM 750-244-2.

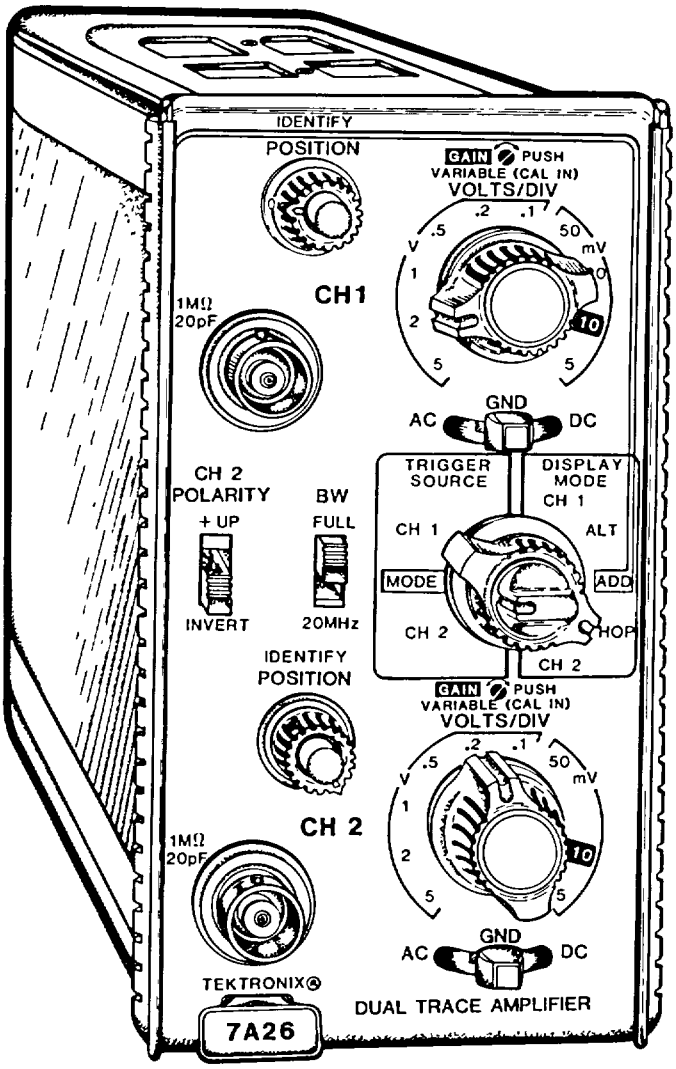


Fig. 1-1. AM-6785A/U 7A26 Dual Trace Amplifier.

Section 1

OPERATING INSTRUCTIONS

AM-6785A/U Features

The Dual Trace Amplifier plug-in unit is designed for use with TEKTRONIX 7000-Series Oscilloscopes. The AM-6785/U is a dual-channel wide-bandwidth amplifier. Internal gain and compensation circuits are automatically switched to correspond to the setting of the VOLTS/DIV switch. Channel 2 can be inverted for differential measurements.

PRELIMINARY INFORMATION

Installation

The AM-6785/U is calibrated and ready for use as received. It can be installed in any compartment of TEKTRONIX 7000-Series Oscilloscopes, but is intended for principal use in vertical plug-in compartments. To Install, align the upper and lower rails of the AM-6785/U with the oscilloscope tracks and fully insert it. The front will be flush with the front of the oscilloscope when the instrument is fully inserted, and the latch at the bottom-left corner of the instrument will be in place against the front panel. See Fig. 1-2.

To remove the AM-6785/U, pull on the latch (which is inscribed with the unit identification "7A26") and the instrument will unlatch. Continue pulling on the latch to slide the instrument out of oscilloscope.

GENERAL OPERATING INFORMATION

Introduction

For single-trace operation, either of the two identical amplifier channels can be used independently by setting the DISPLAY MODE and TRIGGER SOURCE switches to CH 1 or CH 2 and connecting the signal to be observed to the appropriate input. In the discussions to follow, single-trace operations using CH 1 only apply equally to CH 2 only.

Signal Connections

In general, probes offer the most convenient means of connecting a signal to the input of the AM-6785/U. 10X attenuation probe offers a high input impedance and allows the circuit under test to perform very close to normal operating conditions.

Vertical Gain Check and Adjustment

To check the gain of either channel, set the VOLTS/DIV switch to 10mV and connect 40mV, 1 kHz signal from the oscilloscope calibrator to the input connector of the channel being checked. The vertical deflection should be exactly four divisions. If not, adjust the front panel GAIN for exactly four divisions of deflection. The GAIN adjustment is engaged by pressing in the GAIN control knob and turning the knob with a narrow-blade screwdriver (see Fig. 1-3 Front Panel Controls and Connectors). Turn the knob clockwise, then counterclockwise, until the GAIN control is engaged, the vertical deflection will change as the knob is turned. Turn the GAIN control knob with the screwdriver until the deflection is set to exactly four divisions, then remove the screwdriver.

Input Coupling

The Channel 1 and Channel 2 coupling (AC-GNDDC) switches allow a choice of input coupling methods. The type of display desired and the applied signal will determine the coupling to use.

The DC coupling position must be used to display the DC component of the signal. It must also be used to display AC signals below about 30 Hz (10 Hz with a 10X probe) and square waves with low frequency components as these signals are attenuated in the AC position.

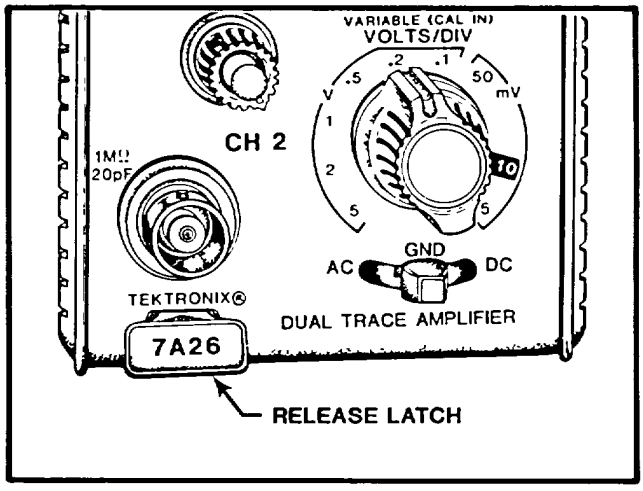


Fig. 1-2. Release Latch

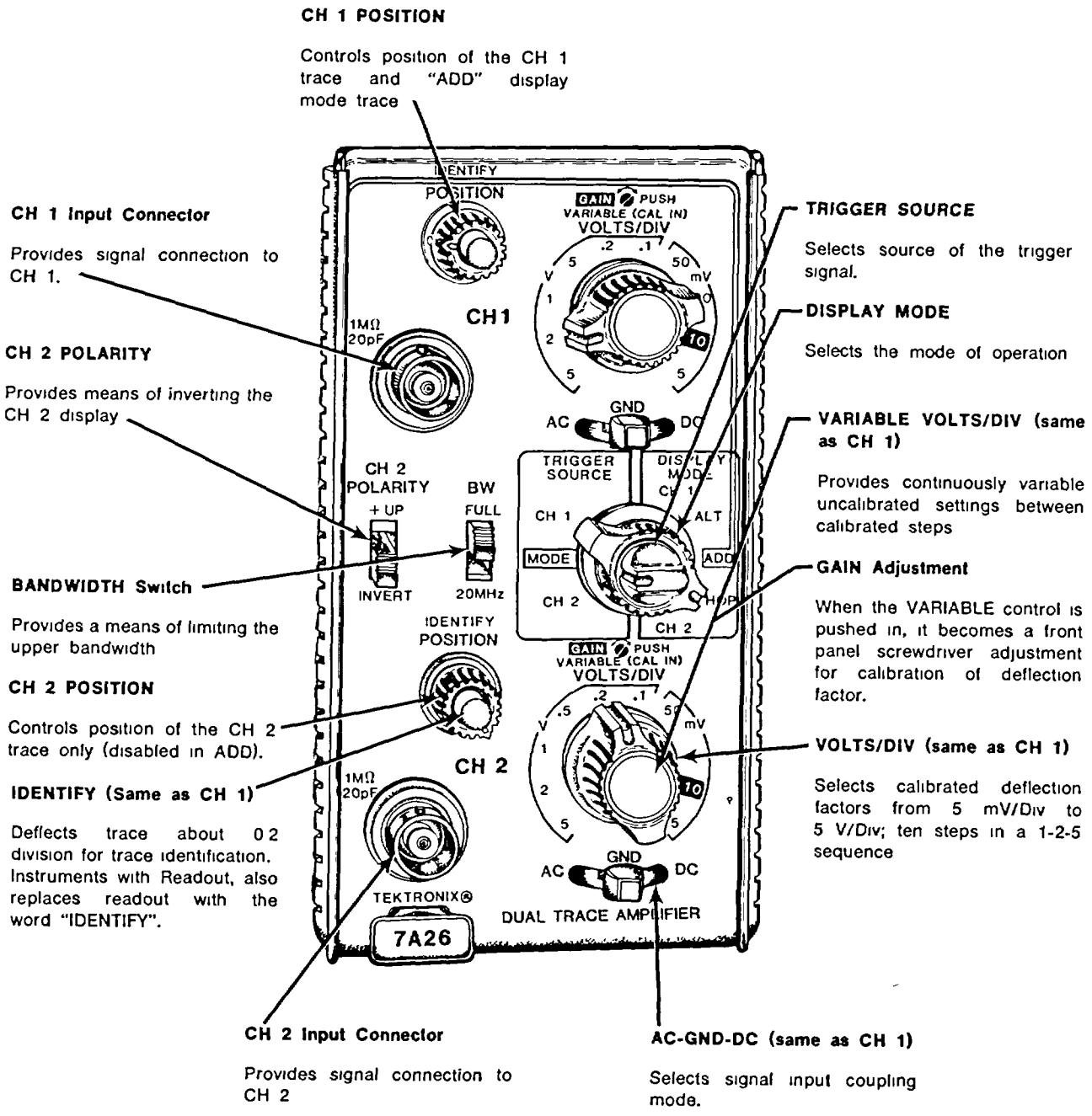


Fig. 1-3. AM-6785/U front-panel controls and connectors.

In the AC coupling position, the DC component of the signal is blocked by a capacitor in the input circuit. The AC coupling position provides the best display of signals with a DC component much larger than the AC components. The precharge feature should be used with large DC inputs. To use this feature, first set the coupling to GND. Connect the probe to the circuit and wait about two seconds for the coupling capacitor to charge. Then set the coupling to AC.

The GND position provides a ground reference at the input of the amplifier without externally grounding the input connectors. However, the signals connected to the inputs are not grounded, and the same DC load is presented to the signal source.

VOLTS/DIV and VARIABLE Controls

The amount of vertical deflection produced by a signal is determined by the signal amplitude, the attenuation factor of the probe, the setting of the VOLTS/DIV switch, and the setting of the VARIABLE control. Calibration deflection factors indicated by the settings of the VOLTS/DIV switch apply only when the VARIABLE control is in the calibrated (CAL IN) position.

The VARIABLE control provides variable, uncalibrated settings between the calibrated steps of the VOLTS/DIV switch. With the VARIABLE control fully counterclockwise and the VOLTS/DIV set to 5 volts/division the uncalibrated vertical deflection factor is extended to at least 12.5 volts/division. By applying a calibrated voltage source to the input connector, any specific deflection factor can be set within the range of the VARIABLE control.

CH 2 POLARITY Switch

The CH 2 POLARITY switch may be used to invert the displayed waveform of the signal applied to the CH 2 input. This is particularly useful in added operation of the AM-6785/U when differential measurements are to be made. The CH 2 POLARITY switch has two positions, +UP and INVERT. In the +UP position, the displayed waveform will have the same polarity as the applied signal and a positive DC voltage will move the CRT trace up. In the INVERT position, a positive-going waveform at the CH 2 input will be displayed on the CRT in inverted form and a positive DC voltage will move the trace down.

CH 2 POLARITY Switch

For single-trace operation, apply the signal either to the CH 1 input or the CH 2 input and set the DISPLAY MODE switch to the corresponding position: CH 1 or CH 2. To display a signal in one channel independently when a signal is also applied to the other channel, simply select the desired channel by setting the DISPLAY MODE switch to the appropriate CH 1 or CH 2 position.

Alternate Mode. The ALT position of the DISPLAY MODE switch produces a display which alternates between channel 1 and channel 2 with each sweep on the CRT. Although the ALT mode can be used at all sweep rates, the CHOP mode provides a more satisfactory display at sweep rates below about 0.5 millisecond/division. At slow sweep rates alternate mode switching becomes visually perceptible.

Add Mode. The ADD position of the DISPLAY MODE switch can be used to display the sum or difference of two signals, for common-mode rejection to remove an undesired signal. The overall deflection factor in the ADD mode with both VOLTS/DIV switches set to the same position is the deflection factor indicated by either VOLTS/DIV switch. However, if the CH 1 and CH 2 VOLTS/DIV switches are set to different deflection factors, the resultant amplitude is difficult to determine from the CRT display. In this case, the voltage amplitude for the resultant display can be determined accurately only if the amplitude of the signal applied to one channel is known. In the ADD mode, positioning of the trace is controlled by the channel 1 POSITION control only.

Chop Mode. The CHOP position of the DISPLAY MODE switch produces a display which is electronically switched between channels at approximately a 500 kHz rate (controlled by mainframe). In general the CHOP mode provides the best display at sweep rates slower than about 0.5 millisecond/division or whenever dual-trace, non-repetitive phenomena is to be displayed.

TRIGGER SOURCE Switch

CH 1. The CH 1 position of the TRIGGER SOURCE switch provides a trigger signal obtained from the signal applied to the CH 1 input connector. This provides a stable display of the signal applied to the CH 1 input connector.

CH 2. The CH 2 position of the TRIGGER SOURCE switch provides a trigger signal obtained from the signal applied to the CH 2 input connector. This provides a stable display of the signal applied to the CH 2 input connector.

MODE. In this position of the TRIGGER SOURCE switch, the trigger signal for the time-base unit is dependent on the setting of the DISPLAY MODE switch.

The trigger source for each position of the DISPLAY MODE switch is as follows:

MODE	TRIGGER SIGNAL SOURCE
CH 1	Channel 1
CH 2	Channel 2
ADD	Algebraic sum of channel 1 and channel 2
CHOP	Algebraic sum of channel 1 and channel 2
ALT	Alternates between channel 1 and channel 2

Trace Identification

When the IDENTIFY button is pressed, the trace is deflected about 0.2 division to identify the AM-6785/U trace. This feature is particularly useful when multiple traces are displayed. When the IDENTIFY button is pressed on instruments with readout, the deflection factor readout is replaced with the word "IDENTIFY".

BW Switch

Provides a means of limiting the upper bandwidth. FULL: Allows the AM-6785/U to operate at full bandwidth. 20 MHz: Reduces the upper bandwidth of the instrument to about 20 MHz.

BASIC APPLICATIONS

General

The following information describes the procedures and techniques for making basic measurements with the AM-6785/U and the associated oscilloscope and time-base. These applications are not described in detail since each application must be adapted to the requirements of the individual measurements.

Peak-to-Peak Voltage Measurements (AC)

To make peak-to-peak voltage measurements, use the following procedure:

1. Apply the signal to either input connector.
2. Set the DISPLAY MODE and TRIGGER SOURCE switches to display the channel used.
3. Set the coupling switch to AC.

NOTE

For low frequency signals below about 30 Hz, use the DC position to prevent attenuation of the signal.

4. Set the VOLTS/DIV switch to display about five divisions of the waveform vertically.
5. Set the time-base Triggering controls for a stable display. Set the time-base unit to a sweep rate which displays several cycles of the waveform.
6. Turn the AM-6785/U POSITION control so the lower portion of the waveform coincides with one of the graticule lines below the center horizontal line, and the top of the waveform is within the viewing area. With the time-base Position control, move the display so one of the upper peaks lies near the center vertical line (see Fig. 1-4).
7. Measure the divisions of vertical deflection peak-to-peak. Check that the VARIABLE (VOLTS/DIV) control is in the CAL IN position.

NOTE

This technique can also be used to make measurements between two points on the waveform, rather than peak-to-peak.

8. Multiply the deflection measured in step 7 by the VOLTS/DIV switch setting. Include the attenuation factor of the probe if used.

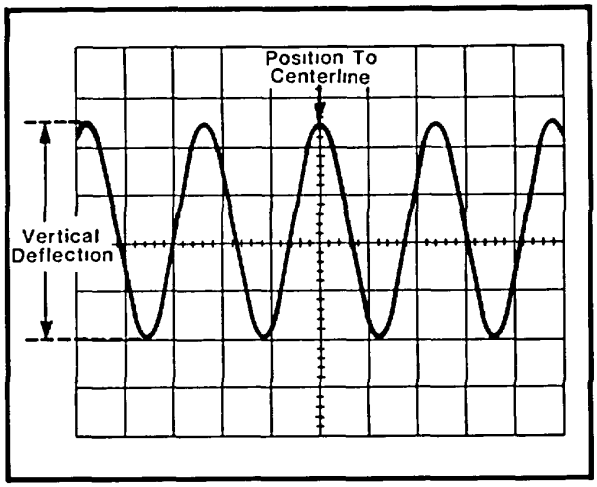


Fig. 1-4. Measuring the peak-to-peak voltage of a waveform.

EXAMPLE: Assume that the peak-to-peak vertical deflection is 4.5 divisions (see Fig. 1-4) using a 10X attenuator probe, and the VOLTS/DIV switch is set to 1 V.

Volts Peak-to-Peak	=	vertical deflection (divisions)	x	VOLTS/DIV setting	x	probe attenuation factor

Substituting the given values:
Volts Peak-to-Peak = 4.5 X 1 x 10
The peak-to-peak voltage is 45 volts.

Instantaneous Voltage Measurements (DC)

To measure the DC level at a given point on a waveform, proceed as follows:

1. Connect the signal to either input connector.
2. Set the DISPLAY MODE and TRIGGER SOURCE switches to display the channel used.
3. Set the VOLTS/DIV switch to display about five divisions of waveform.
4. Set the coupling switch to GND and position the trace to the bottom graticule line or other reference line. If the voltage is negative with respect to ground, position the trace to the top graticule line. Do not move the POSITION control after this reference line has been established.

NOTE

To measure a voltage level with respect to a voltage other than ground, make the following changes to step 4. Set the coupling switch to DC and apply the reference voltage to the input connector. Then position the trace to the reference line.

5. Set the coupling switch to DC. The ground reference line can be checked at any time by switching to the GND position.
6. Set the time-base Triggering controls for a stable display. Set the time-base sweep rate for an optimum display of the waveform.
7. Measure the distance in divisions between the reference line and the point on the waveform at which the DC level is to be measured. For example, in Fig. 1-5 the measurement is between the reference line and point A.
8. Establish the polarity of the waveform. With the CH 2 POLARITY switch in the +UP position, any point above the reference line is positive.
9. Multiply the distance measured in step 7 by the VOLTS/DIV setting. Include the attenuation factor of the probe, if used.

EXAMPLE: Assume the vertical distance measured is 3.6 divisions (see Fig. 1-5) and the waveform is above the reference line using a 10X probe with a VOLTS/DIV setting of 0.5 V.

Using the formula:

Instantaneous Voltage	=	vertical distance (divisions)	X	polarity	X	VOLTS/DIV setting	X	probe attenuation factor

Substituting the given values:

Instantaneous Voltage	3.6	X	+1	X	0.5V	X	10

The instantaneous voltage is 10 volts.

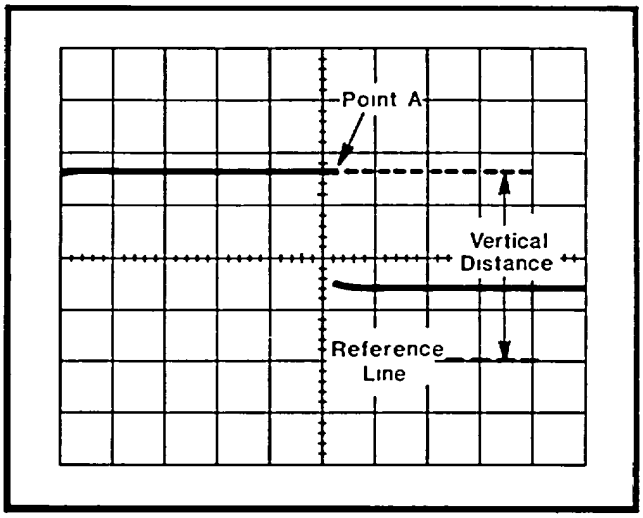


Fig. 1-5. Measuring instantaneous voltage with respect to some reference.

Comparison Measurements

In some applications it may be desirable to establish arbitrary units of measurement other than those indicated by the VOLTS/DIV switch. This is particularly useful when comparing unknown signals to a reference amplitude. One use for the comparison measurement technique is to facilitate calibration of equipment where the desired amplitude does not produce an exact number of divisions of deflection. The adjustment will be easier and more accurate if arbitrary units of measurement are established so that the correct adjustment is indicated by an exact number of divisions of deflection. The following procedure describes how to establish arbitrary units of measure for comparison measurements.

To establish an arbitrary vertical deflection factor based upon a specific reference amplitude, proceed as follows:

1. Connect the reference signal to the input connector. Set the time-base unit sweep rate to display several cycles of the signal.

2. Set the VOLTS/DIV switch and the VARIABLE control to produce a display which is an exact number of vertical divisions in amplitude. Do not change the VARIABLE control after obtaining the desired deflection.

3. To establish an arbitrary vertical deflection factor so the amplitude of an unknown signal can be measured accurately at any setting of the VOLTS/DIV switch, the amplitude to the reference signal must be known. If it is not known, it can be measured before the VARIABLE VOLTS/DIV control is set in step 2.

4. Divide the amplitude of the reference signal (volts) by the product of the vertical deflection (divisions) established in step 2 and the setting of the VOLTS/DIV switch. This is the vertical conversion factor.

$$\text{Vertical Conversion Factor} = \frac{\text{reference signal amplitude (volts)}}{\text{vertical deflection (divisions)} \times \text{VOLTS/DIV switch setting}}$$

5. To measure the amplitude of an unknown signal, disconnect the reference signal and connect the unknown signal to the input connector. Set the VOLTS/DIV switch to a setting that provides sufficient vertical deflection to make an accurate measurement. Do not readjust the VARIABLE control.

6. Measure the vertical deflection in divisions and calculate the amplitude of the unknown signal using the following formula.

$$\text{Signal Amplitude} = \text{VOLTS/DIV setting} \times \text{vertical conversion factor} \times \text{vertical deflection (divisions)}$$

EXAMPLE: Assume a reference signal amplitude of 30 V, a VOLTS/DIV setting of 5 V and the VARIABLE control adjusted to provide a vertical deflection of four divisions. Substituting these values in the vertical conversion factor formula (step 4):

$$\text{Vertical Conversion Factor} = \frac{30\text{V}}{4 \times 5\text{V}} = 1.5$$

Then with a VOLTS/DIV setting of 2 V, the peak-to-peak amplitude of an unknown signal which produces a vertical deflection of five divisions can be determined by using the signal amplitude formula (step 6):

$$\text{Signal Amplitude} = 2\text{V} \times 1.5 \times 5 = 15 \text{ volts}$$

Dual-Trace Phase Difference Measurements

Phase comparison between two signals of the same frequency can be made using the dual-trace feature of the AM-6785/U. This method of phase difference measurement can be used up to the frequency limit of the oscilloscope system. To make the comparison, use the following procedure:

1. Set the CH 1 and CH 2 coupling switches to the same position, depending on the type of coupling desired.

2. Set the DISPLAY MODE to ALT or CHOP. In general, CHOP is more suitable for low frequencies and ALT is more suitable for high frequencies. Set the TRIGGER SOURCE to CH 1.

3. Connect the reference signal to the CH 1 input and the comparison signal to the CH 2 input. Use coaxial cables or probes which have similar time delay characteristics to connect the signals to the input connectors.

4. If the signals are of opposite polarity, set the CH 2 POLARITY switch to invert the CH 2 display. (Signals may be of opposite polarity due to 1800 phase difference; if so, take this into account in the final calculation.)

5. Set the VOLTS/DIV switches and the VARIABLE controls of the two channels so the displays are equal and about five divisions in amplitude.

6. Set the time-base unit to a sweep rate which displays about one cycle of the waveforms. Set the Triggering controls for a stable display.

7. Center the waveforms on the graticule with the AM-6785/U POSITION controls.

8. Adjust the time-base Variable Time/Div control until one cycle of the reference signal occupies exactly eight horizontal divisions between the second and tenth vertical lines of the graticule (see Fig. 1-6). Each division of the graticule represents 45° of the cycle (360° 8 divisions = 45°/division). The sweep rate can now be stated in terms of degrees as 45°/division.

9. Measure the horizontal difference between corresponding points on the waveform.

10. Multiply the measured distance (in divisions) by 45^{o}/division to obtain the exact amount of phase difference.

EXAMPLE: Assume a horizontal difference of 0.3 division with a sweep rate of 450/division as shown in Fig. 1-6.

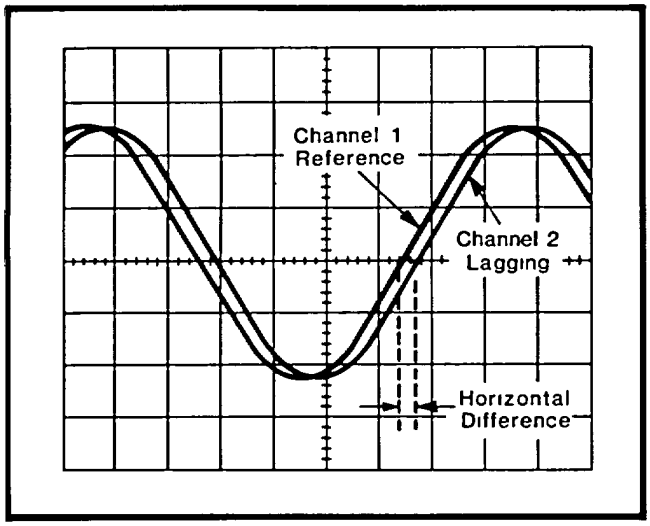


Fig. 1-6. Measuring phase difference between two signals.

Using the formula:

$$\text{Phase Difference} = \text{horizontal difference (divisions)} \times \text{sweep rate (degrees/division)}$$

Substituting the given values:

Phase Difference = 0.3 x 45°

The phase difference is 13.50.

High Resolution Phase Measurements

More accurate dual-trace phase measurements can be made by increasing the sweep rate (without changing the Variable Time/Div control). One of the easiest ways to increase the sweep rate is with the time-base Magnifier switch. Set the Magnifier to X10 and determine the magnified sweep rate by dividing the sweep rate obtained previously by the amount of sweep magnification.

EXAMPLE: If the sweep rate is increased 10 times by the Magnifier, the magnified sweep rate is 450/division ÷ 10 = 4.5°/division. Fig. 1-7 shows the same signals as used in Fig. 1-6 but with the Magnifier set to x10. With a horizontal difference of 3 divisions, the phase difference is:

$$\text{Phase Difference} = \text{horizontal difference (divisions)} \times \text{magnified sweep rate (degrees/division)}$$

Substituting the given values:

Phase Difference = 3 x 4.5°

The phase difference is 13.5°.

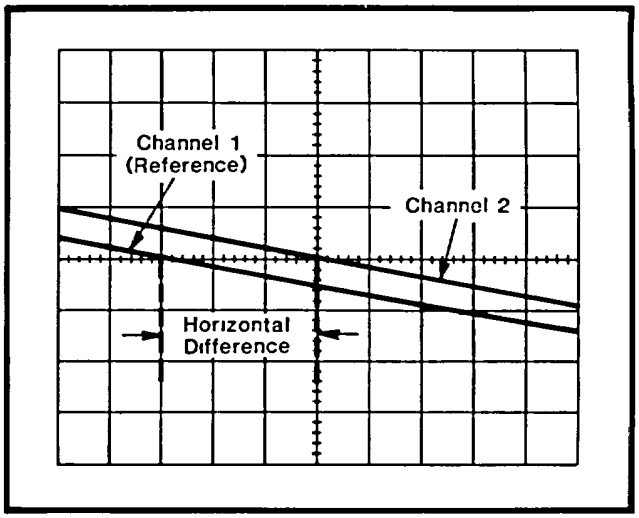


Fig. 1-7. High resolution phase measurement using time-base magnifier.

Common Mode Rejection

The ADD feature of the AM-6785/U can be used to display signals which contain undesirable components. These undesirable components can be eliminated through common mode rejection. The procedure is as follows:

1. Set the DISPLAY MODE switch to ALT or CHOP and the TRIGGER SOURCE switch to MODE.
2. Connect the signal containing both the desired and undesired information to the CH 1 input connector.
3. Connect a signal similar to the unwanted portion of the CH 1 signal to the CH 2 input connector. For example, in Fig. 1-8 a line-frequency signal is connected to Channel 2 to cancel out the line-frequency component of the Channel 1 signal.
4. Set both coupling switches to the same setting, DC or AC, depending on the applied signal.
5. Set the VOLTS/DIV switches so the signals are about equal in amplitude.

6. Set the DISPLAY MODE switch to ADD. Set the CH 2 POLARITY switch to INVERT so the common mode signals are of opposite polarity.

7. Adjust the Channel 2 VOLTS/DIV switch and VARIABLE control for maximum cancellation of the common mode signal. The signal which remains should be only the desired portion of the Channel 1 signal.

EXAMPLE: An example of this mode of operation is shown in Fig. 1-8. The signal applied to Channel 1 contains unwanted line-frequency components (Fig. 1-8A). A corresponding line-frequency signal is connected to Channel 2 (Fig. 1-8B). Fig. 1-8C shows the desired portion of the signal as displayed when common mode rejection is used.

The above procedure can also be used for examining a signal superimposed on some DC level when DC coupling is used. A DC voltage of the proper polarity applied to Channel 2 can be used to cancel out the DC portion of the signal applied to Channel 1.

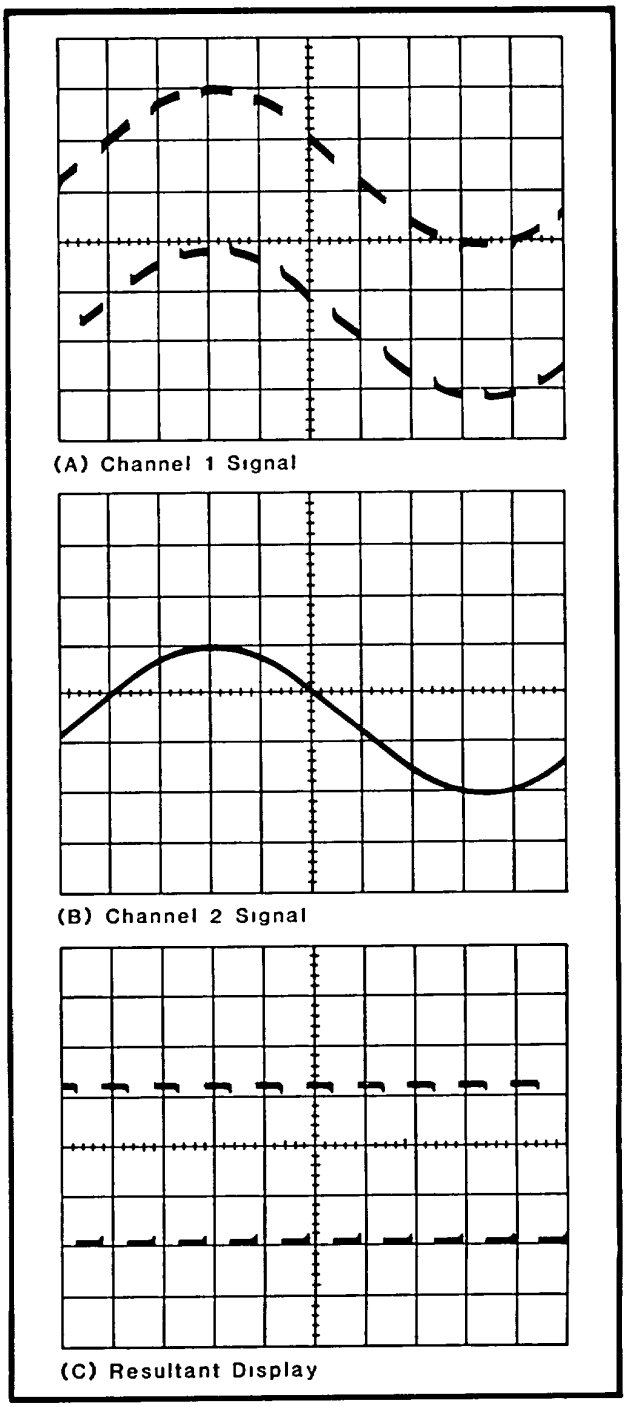


Fig. 1-8. Using the ADD mode for common mode rejection.

(A) Channel 1 signal contains desired information along with line frequency component. (B) Channel 2 contains line frequency only. (C) Resultant CRT display using common mode rejection.

Section 2

SPECIFICATION

Introduction

The following electrical characteristics are valid over the stated environmental range for instruments calibrated at an ambient temperature of +20°C to +30°C, and after a five-minute warmup unless otherwise noted.

TABLE 2-1
Electrical

Characteristic	Performance Requirement	Supplemental Information
Deflection Factor		
Calibrated Range	5 mV/Div to 5 V/Div; ten steps in a 1,2,5 sequence.	
Deflection Factor Accuracy	Within 2% with GAIN adjusted at 10 mV/Div.	
Uncalibrated (VARIABLE)		Continuously variable between calibrated steps; extends deflection factor to at least 12.5 volts per division.
GAIN Range		Permits adjustment of deflection factor for calibrated operation with all 7000-Series oscilloscopes.
Frequency Response		
Upper Bandwidth	Depends upon oscilloscope used	See the oscilloscope mainframe specifications or the current Tektronix, Inc. catalog
Lower Bandwidth (AC coupled)	10 Hz or less	
20 MHz Bandwidth		20 MHz, ±3 MHz.
Risetime		21 ns maximum.
Maximum Input Voltage		
DC Coupled		250 volts, (DC + Peak AC); AC component 500 volts peak-to-peak maximum, one kilohertz or less
AC Coupled		500 volts, (DC + Peak AC); AC component 500 volts peak-to-peak maximum, one kilohertz or less
Channel Isolation		50.1 display ratio up to 200 MHz.
Input R and C		
Resistance		
SN B208879-below SN B208880-up		1 M Ω ± 2% 1 M Ω ± 2%
Capacitance		
SN B208879-below SN B208880-up		20 pF ± 0.5 pF 22 pF ± 0.5 pF

TABLE 2-1 (Cont'd)

Characteristic	Performance Requirement	Supplemental Information
Overdrive Recovery Time		0.1 ms or less to recover to within one division after removal of overdrive signal of up to +75 divisions or -75 divisions regardless of overdrive signal duration.
Delay Time Difference Between Channels		200 picoseconds or less.
Common Mode Rejection Ratio	At least 10:1, DC to 50 MHz	
Display Modes	Channel 1 only.	
	Dual-trace, alternate between channels.	
	Added algebraically.	
	Dual-trace chopped between channels.	
	Channel 2 trace only.	
Trigger Source Selection	Channel 1 only.	
	Follows DISPLAY MODE selection.	
	Channel 2 only.	

TABLE 2-2
Environmental Characteristic

Refer to the specification for the associated mainframe.

TABLE 2-3
Physical

Size	Fits all 7000-Series plug-in compartments.
Weight	2 Pounds 9 Ounces (1.2 kilograms).

Section 3

THEORY OF OPERATION

Introduction

This section of the manual contains a description of the circuitry used in the AM-6785/U amplifier. The AM-6785/U description begins with a discussion of the instrument using the block diagram shown in the Diagrams section. Then, each circuit is described in detail using the block diagram to show the interconnections between stages in each major circuit and the relationship of the front-panel controls to the individual stages.

Complete schematics of each circuit are given in the Diagrams section. Refer to these schematics throughout the following circuit description for electrical values and relationship.

BLOCK DIAGRAM (Fig. FO-8)

The Channel 1 Amplifier circuit provides gain setting, variable gain control, and trace positioning. The Channel 2 Amplifier provides signal polarity inversion in addition to gain setting, variable gain control, and trace positioning.

The signal to be displayed on the CRT is applied to the CH 1 or CH2 INPUT connector. The signal passes through the input coupling switch, where the appropriate coupling is selected, to the attenuators. The VOLTS/DIV switch selects the correct amount of attenuation and the signal is passed to the Input Source Follower.

When the VOLTS/DIV switch is set to the 5 mV and 10 mV positions, the signal connected to the INPUT connector is passed through the attenuators without attenuation. When the VOLTS/DIV switch is set in the 5 mV position, the 2x Gain Amplifier operates at full gain. In all other positions of the VOLTS/DIV switch, the 2X Gain Amplifier's gain is reduced by two. Internal gain and balance adjustments are included in the 2x Amplifier.

Overall GAIN and VARIABLE gain is adjusted in the Gain Amplifier. Variable Balance and high frequency adjustments are also controlled in the Gain Amplifier. The output of the Gain Amplifier is connected to the Positioning circuitry where the POSITION and IDENTIFY functions are controlled. Channel 2 is identical to Channel 1, with the exception of the polarity inversion function in Channel 2.

The Display and Trigger Channel switch amplifiers provide differential signal outputs for the signal and trigger lines, from each channel, to a common display and trigger output. These stages also contain a bandwidth limiter that limits the upper frequency response to 20 MHz.

The output of the Display and Trigger Channel switch Amplifier is connected to the oscilloscope mainframe via the interface connector.

DETAILED CIRCUIT DESCRIPTION (Fig. FO-7)

NOTE

The CH 1 and CH 2 amplifier circuits are identical with the exception of the CH 2 GAIN stage U2450, which includes a POLARITY inverting circuit. Only CH 1 is described in detail throughout this discussion.

AC-GND-DC Switch

Input signals connected to the INPUT connectors can be AC-coupled, DC-coupled, or internally disconnected. S100A is a cam-type switch; a contact-closure chart showing the operation is given on the schematic diagrams. When the AC-GND-DC switch is in the DC position, the INPUT signal is connected directly to the attenuators. In the AC position, the INPUT signal passes through capacitor C10. The capacitor prevents the DC component of the signal from passing to the amplifier. The GND position opens the signal path and connects the input circuit of the amplifier to ground. This provides a ground reference without the need to disconnect the applied signal from the INPUT connector. Resistor R102, connected across the AC-GND-DC switch, allows C10 to be pre-charged in the GND position.

Input Attenuator

The effective overall deflection factor of the AM-6785/U is determined by the setting of the VOLTS/DIV switch, S100B. The basic deflection factor is 5 mV per division of CRT deflection. To increase the basic deflection factor to the values indicated on the front panel, precision attenuators are switched into the circuit. S100B is a cam-type switch and the dots on the contact-closure chart indicate when the associated contacts are

in the position shown (open or closed). In the 5 mV/Div and 10 mV/Div positions, the attenuators are not used; the input signal is connected directly to the Input Source Follower. The 10 mV/Div position decreases the gain of the 2X Gain Amplifier. For switch positions above 10 mV/Div, the attenuators are switched into the circuit singly or stacked to produce the deflection factor indicated on the front panel. These hybrid attenuators are frequency-compensated voltage dividers. For DC and low frequency signals, the attenuators act as resistance dividers; at high frequencies the attenuator acts as a capacitive divider.

In addition to providing constant attenuation at all frequencies within the bandwidth of the instrument, the input attenuators are designed to maintain the same input RC characteristics (one megohm X 20 pF). Each attenuator contains an adjustable series capacitor to provide correct attenuation at high frequencies, and an adjustable shunt capacitor to provide correct input capacitance.

Input Source Follower

Q150A is a source follower with Q150B providing a constant current. R132 limits the current drive to the gate of Q150A. Dual-diode CR130 provides circuit protection by limiting the voltage swing at the gate of Q150A to about +10 volts. C130, C134, and the capacitance of R130 provides low frequency compensation. Input capacitance for the 5 mV and 10 mV positions is set by C130. The output of the 2X Gain Amplifier (U1350) is from the source of Q150A. C134 and R134 form a negative resistance network for Q150A.

2X Gain Amplifier

T1301 is a balun transformer which provides differential drive to U1350 at high frequencies. U1350 is a paraphase type amplifier with dual differential output capabilities.

In the 5 mV position, full drive is provided from pins 5 and 9 of U1350 to the U1450 load resistors R1401 and R1403. In all other attenuator positions the signal path drive current through the load resistors is divided in half. The other half is diverted through pins 6 and 8 of U1350 and is dissipated in dummy load resistors R1343 and R1341.

CR1319 and R1319 maintain proper collector voltage while switching between the 5 mV and 10 mV positions. C1331, R1331, C1332 and R1332 are thermal compensations. C1334 and RT1334 provide high frequency temperature compensation. R1336, C1336, C1345, L1345 and R1345 are high frequency adjustments.

Fixed length inductors and capacitors are part of the Amplifier etched circuit board and provide T-coil peaking at the input of U1350.

Gain Amplifier

U1450 is a variable-gain cascode amplifier which sets the overall channel gain. The GAIN (R1423A) and VARIABLE (R1423B) controls determine the ratio of base currents through pins 11 and 12 of U1450. The base-current ratio determines the shared collector output levels between pins 5, 6 and 8, 9.

R1436 provides adjustable low frequency compension. Fixed components R1434, C1434, C1436, R1431, and C1431 are thermal compensations. R1435 and C1435 are adjustable high frequency compensations. U1450 Input T-coil peaking inductors and capacitors are part of the etched circuit board. DC balance over the variable range is adjusted by R1353.

Position Circuit

Positioning current is added to the signal current of U1450 output from the current sources Q1470 and Q1490. R1465 controls the voltage at the bases of the current sources, which in turn determines the amount of positioning current added. R1467, R1466, and CR1465 provide trace shift current for the IDENTITY function.

Display Channel Switch Amplifier

The third cascode amplifier, U1550 is used for controlling the channel 1 display modes. When the DISPLAY CH 1 ON Level at pin 12 is HI, the channel 1 signal passes through the transistor pair with outputs at pins 5 and 9 to the level shifters. At the same time the DISPLAY CH 1 OFF Level at pin 11 is LO, turning off the second transistor pair collectors, pins 6 and 8. When pin 12 is HI, channel 1 is displayed and when pin 11 is HI channel 1 is not displayed. Pins 11 and 12 are always in opposite states, the levels being selected by the DISPLAY MODE switch S30A. The signal is routed through T-coiled bases of U1550 to the trigger amplifier switch, U1750, which is also T-coiled. C1531 and R1531 are high frequency adjustments.

Trigger Channel Switch Amplifier

U1750 is a cascode amplifier used as the trigger switch, and operates similarly to the Display Channel Switch Amplifier, U1550. The TRIGGER SOURCE switch, S30B determines the base levels on pins 11 and 12 of U1750 for trigger selection.

Display Trigger Common Base Level Shifters

The Display Out Common Base Level Shifters, Q820, Q840, Q860, and Q880 are used to return the DC signal level to zero volts at the plug-in interface for display output. Bandwidth selection is obtained by controlling base currents with the BW switch, S32, 0820 and Q840 are shifters at FULL BANDWIDTH and Q860, Q880 are used at 20MHz. The level shifters also serve as a current summing point for CH 1 and CH 2 selection.

The pi filter is used in the collectors of Q860 and Q880. The pi filter is isolated from the output by CR860 and CR880 when the BW switch is in FULL.

The Trigger Output Common Base Level Shifters Q920, Q940, Q960, and Q980 operation is similar to the Display Output Shifters just discussed.

Channel 2 Gain-Polarity Amplifier

CH 2 operation is the same as CH 1. For circuit number reference the prefix number for CH 1 is 1 and CH 2 is 2. For instance, U2350 functions in CH 2 the same as does U1350 in CH 1. In CH 2 a Polarity feature is included in the second cascode amplifier U2450. S22A allows base drives to be reversed to U2450. Polarity Gain R2411, matches the gain in both polarity positions.

Translator

The translator, Q1050 and Q1070, increase the CHOP and ALT control logic DC levels from the mainframe to a usable level in the AM-6785/U. CR1060 and CR1062 keep 01050 and 01070 from going into saturation.

Readout Encoding

The Readout Encoding circuit consists of switching resistors and probe sensing stage Q620. This circuit encodes the Channel 1 and 2, Row and Column output lines for readout of deflection factor, uncalibrated deflection factor (VARIABLE) information, and signal inversion (Channel 2 only). Data is encoded on these output lines by switching resistors between them and the time-slot input lines, or by adding current through Q620.

R647-CR647 are switched between time-slot three (TS-3) and Column output line when the CAL IN switch is in the uncal position. This results in the symbol > (greater than) being displayed preceding the deflection factor readout. R648 (Channel 2 only) is switched between TS-2 and the Column output line when the CH 2 POLARITY switch is in the INVERT position. This results in the SYMBOL (inverted) being displayed preceding the deflection factor readout.

Switching resistors are used to indicate the setting of the VOLTS/DIV switch to the mainframe readout system. The dots on the contact-closure chart (see Diagram Section) indicate when the associated contacts on the VOLTS/DIV cam switch are closed. R633, R634, and R635 select the number 1, 2, or 5 depending on the combination that is switched in. R368 and R642 select the m (milli) prefix in the 5 mV through 0.5 V (500 mV) positions of the VOLTS/DIV switch. R639 and R643 select the V (volts) symbol in all ranges. R630, R631, and the output of the probe sensing stage (Q620) select the decimal point (number of zeroes), again depending on the resistor combination switched in by the VOLTS/DIV switch.

Probe sensing stage Q620 identifies the attenuation factor of the probe connected to the input connector by sensing the amount of current flowing from the current sink through the probe coding resistance. The output of this circuit corrects the mainframe readout system to include the probe attenuation factor. The third contact of the input connector provides the input to the probe sensing stage from the probe coding resistance (coded probes only; see Operating Instructions). The third contact is also used for the IDENTIFY input. The coding resistor forms a voltage divider with R621 through CR621 to the -15V supply. The resultant voltage sets the bias on Q620 and determines, along with emitter resistor R622, the collector current. When the -15 volt time-slot pulse is applied to Interface Connector B33, Q620 is interrogated and its collector current is added to the column current output through Interface Connector A37.

With a 1X probe (or no probe) connected to the input connector, Q620 is turned off. The deflection factor readout is determined by the VOLTS/DIV switch position. With a 10X probe connected, the bias on Q620 will allow 100 microamperes of collector current to flow. This increases the deflection factor readout by a factor of 10.

The IDENTIFY button (S1465 on CH 1 or S2465 on CH 2) does two things when pressed:

1. It causes the trace representing the appropriate channel of the AM-6785/U to move about 0.3 division (see the front panel controls and connectors, Fig. 1-3).

2. It forward biases CR 621 and Q620 to result in a sufficient amount of collector current which, when added to the column current output, replaces the deflection factor readout with the word "IDENTIFY".

These two actions aid in identifying the AM-6785/U trace when multiple traces are displayed. When the IDENTIFY button is released, the deflection factor readout and trace position are restored.

CR1465 in CH 1, and CR2465 in CH 2 isolate readout circuitry from the position circuitry. For further information on the operation of the readout system, see the oscilloscope instruction manual.

Section 4

MAINTENANCE

Introduction

This section of the manual contains maintenance information for use in preventive maintenance, corrective maintenance, and troubleshooting of the AM-6785/U.

PREVENTIVE MAINTENANCE

General

Preventive maintenance, consisting of cleaning, visual inspection, etc., performed on a regular basis, will improve the reliability of this instrument. Periodic checks of the semiconductor devices used in the unit are not recommended as a preventive maintenance measure.

Cleaning

CAUTION

Avoid the use of chemical cleaning agents which might damage the plastics used in this instrument. Special care should be taken when cleaning the Polyphenylene Oxide attenuator boards. Do not apply any solvent containing ketones, esters or halogenated hydrocarbons. To clean, use only water soluble detergents, ethyl, methyl or isopropyl alcohol.

Front Panel. Loose dust may be removed with a soft cloth or a dry brush. Water and mild detergent may be used; however, abrasive cleaners should not be used.

Interior. Cleaning the interior of the unit should precede calibration, since the cleaning process could alter the settings of the calibration adjustments. Use low-velocity compressed air to blow off the accumulated dust. Hardened dirt can be removed with a soft dry brush, cotton-tipped swab, or cloth dampened with a mild detergent and water solution.

Lubrication

Use a cleaning-type lubricant on shaft bushings, interconnecting plug contacts, and switch contacts. Lubricate switch detents with a heavier grease.

TROUBLESHOOTING

General

The following is provided to augment information contained in other sections of this manual when troubleshooting the AM-6785/U.

Troubleshooting Aids

Component and Wiring Color Code. Colored stripes or dots on resistors and capacitors signify electrical values, tolerances, etc., according to the EIA standard color code. Components not color coded usually have the value printed on the body.

The insulated wires used for interconnection in the AM-6785/U are color coded to facilitate tracing wires from one point to another in the unit.

Troubleshooting Procedure

This troubleshooting procedure is arranged in an order which checks the simple trouble possibilities before proceeding with extensive troubleshooting.

1. Check Control Settings. An incorrect setting of the AM-6785/U controls can indicate a trouble that does not exist. If there is any question about the correct function or operation of a control or front-panel connector, see the Operating Instructions section.

2. Check Associated Equipment Before proceeding with troubleshooting of the AM-6785/U check that the equipment used with this instrument is operating correctly. If possible, substitute an amplifier unit known to be operating correctly into the indicator unit and see if the problem persists. Check that the input signals are properly connected and that the interconnecting cables are not defective.

3. Visual Check. Visually check the portion of the instrument in which the trouble is suspected. Many troubles can be located by visual indications, such as unsoldered connections, broken wires, damaged circuit boards, damaged components, etc.

4. Check Instrument Performance. Check the calibration of the unit or the affected circuit, by performing Performance Check of Section 5.

5. Check Voltages. Often the defective component or stage can be located by checking the voltage in the circuit.

6. Check Individual Components. The following methods are provided for checking the individual components. Components which are soldered in place are best checked by disconnecting one end to isolate the measurement from the effects of surrounding circuitry.

A. TRANSISTORS. The best check of transistor operation is actual performance under operating conditions. If a transistor is suspected of being defective, it can best be checked by substituting a component known to be good; however, be sure that circuit conditions are not such that a replacement might also be damaged. If substitute transistors are not available, use a dynamic tester. Static-type testers may be used, but since they do not check operation under simulated operating conditions, some defects may go unnoticed. Be sure the power is off before attempting to remove or replace any transistor.

B. DIODES. A diode can be checked for an open or for a short circuit by measuring the resistance between terminals with an ohmmeter set to the R X 1k scale. The diode resistance should be very high in one direction and very low when the meter leads are reversed. Do not check tunnel diodes or back diodes with an ohmmeter.

CAUTION

Do not use an ohmmeter scale that has a high internal current. High currents may damage the diodes.

C. RESISTORS. Check resistors with an ohmmeter. Resistors normally do not need to be replaced unless the measured value varies widely from the specified value.

D. CAPACITORS. A leaky or shorted capacitor can be detected by checking resistance with an ohmmeter on the highest scale. Use an ohmmeter which will not exceed the voltage rating of the capacitor. The resistance reading should be high after initial charge of the capacitor. An open capacitor can best be detected with a capacitance meter, or by checking whether the capacitor passes AC signals.

6. Repair and Readjust the Circuit. Special techniques required to replace components in this unit are given under Component Replacement. Be sure to check the performance of any circuit that has been repaired or that has had any electrical components replaced

CORRECTIVE MAINTENANCE

General

Corrective maintenance consists of component replacement and instrument repair. Special techniques required to replace components in this instrument are given here.

Soldering Techniques

WARNING

Disconnect the instrument from the powersource before soldering.

Attenuator Circuit Board. The Attenuator Circuit Boards are made from polyphenylene oxide because of its excellent electrical characteristics. Use more than normal care when cleaning or soldering this material. The following rules should be observed when removing or replacing parts:

1. Use a low-wattage soldering Iron (not over 15 watts).
2. Do not apply more heat, or apply heat for a longer time, than is absolutely necessary.
3. Use some form of vaccum solder remover when removing multi-lead devices.
4. Do not apply any solvent containing ketones, esters or halogenated hydrocarbons.
5. To clean, use only water-soluble detergents, ethyl, methyl or isopropyl alcohol.

Circuit Boards. The components mounted on the circuit boards in the amplifier can be replaced using normal circuit board soldering techniques. Keep the following points in mind when soldering on the circuit boards:

1. Use a pencil-type soldering iron with a (wattage) rating from 15 to 50 watts.
2. Apply heat from the soldering iron to the junction between the component and the circuit board.
3. Heat-shunt the lead to the component by means of a pair of long-nose pliers.

4. Avoid excessive heating of the junction with the circuit board, as this could separate the circuit board wiring from the base material.

5. Use electronic grade 60-40 tin lead solder.

6. Clip off any excess lead length extending beyond the circuit board. Clean off any residual flux with a flux-removing solvent.

Metal Terminals. When soldering metal terminals (Potentiometers, etc.) use 60-40 tin-lead solder and a 15 to 50 watt soldering iron. Observe the following precautions when soldering metal terminals:

1. Apply only enough heat to make the solder flow freely.
2. Apply only enough solder to form a solid connection. Excess solder may impair the function of the part.
3. If a wire extends beyond the solder joint, clip off the excess.
4. Clean the flux from the solder joint with a flux-removing solvent.

Component Replacement

WARNING
Disconnect the equipment from the power source before replacing components.

Semiconductor Replacement. Transistors should not be replaced unless actually defective. If removed from their sockets during routine maintenance, return them to their original sockets. Unnecessary replacement of transistors may effect the calibration of this instrument. When transistors are replaced, check the performance of the part of the instrument which may be affected.

Circuit Board Removal

In general, the circuit boards used in the AM-6785/U need never be removed unless they must be replaced. Electrical connections to the boards are made by soldered connections. If it is necessary to replace a circuit board assembly, use the following procedures.

A. READOUT CIRCUIT BOARD REMOVAL

1. Disconnect the wires connected to the outside of the board.
2. Remove the screws holding the board to the mounting surface.
3. Disconnect the wires connected to the inside of the board.
4. Remove the board from the unit.
5. To replace the board, reverse the order of removal.

B. ATTENUATOR CIRCUIT BOARD REMOVAL

1. Remove the readout board for either channel as outlined in the previous procedure.
2. Disconnect the inductor, capacitor, power connector, and ground strap connected to the rear of the board.
3. Loosen the front set screw on the VARIABLE control shaft coupling (use a 0.050-inch hex-key wrench).
4. Remove the red VARIABLE control knob and glass rod from the control shaft.
5. Remove the knobs for either channel using a 1/16-inch hex-key wrench.
6. Remove the nut holding the positioning control using a 5/16-inch wrench.
7. Remove the attenuator shields.
8. Disconnect the wires and resistor from the INPUT BNC connector.
9. Remove the INPUT BNC connector.
10. Remove the attenuator board with cam switch from the instrument.
11. Replace by reversing the Removal Procedure.

C. AMPLIFIER CIRCUIT BOARD REMOVAL

1. Remove the plastic plug-in guide from the rear of the instrument.

2. Disconnect the wires connected to the amplifier board from the CH 1 and CH 2 readout board and all front panel controls, with the exception of the TRIGGER SOURCE/DISPLAY MODE switch.

3. Loosen the hex-socket screw in the coupling of both the VARIABLE control shafts using a 0.050-inch hex-key wrench. Pull both the VARIABLE knobs and shafts from the front of the instrument.

4. Loosen the hex-socket screws in both the TRIGGER SOURCE and DISPLAY MODE knobs. Remove knobs.

5. Disconnect the inductors, capacitors, power connectors, and ground straps from the front of the board.

6. Remove the screws and nuts securing the board to the chassis or other mounting surface.

7. Remove the board from the instrument.

8. To replace, reverse the order of removal.

Section 5

PERFORMANCE CHECKS

Preliminary Procedure for Performance Check

1. Remove the oscilloscope left side cover and side panel of plug-in.
2. Insert the AM-6785/U in the calibration oscilloscope Left Vertical compartment.
3. Insert the time-base unit into the calibration oscilloscope Horizontal compartment.
4. Turn oscilloscope on and allow 20 minutes warm-up before proceeding.

Preliminary Control Settings

Set the unit under test and time-base unit for a sharp, well-defined trace. Set the AM-6785/U controls as follows:

DISPLAY MODE	CH 1
TRIGGER SOURCE	MODE
CH 2 POLARITY	+UP
BW	FULL

CH 1 and CH 2

POSITION	Midrange
VOLTS/DIV	10 mV
AC-GND-DC	DC

1. Check/Adjust Channel 1 and 2 GAIN

a. Connect the standard amplitude calibrator to the CH 2 input connector with a BNC cable.

b. Set the standard amplitude calibrator for 20 millivolt square-wave output.

c. Position the display to the center of the graticule with the CH 2 POSITION control.

d. CHECK - CRT display for exactly four divisions in amplitude.

e. ADJUST - CH 2 GAIN adjustment (front panel) for exactly four divisions of deflection. To adjust, press in the GAIN knob with a screwdriver and turn until the GAIN control is engaged.

f. Set the CH 2 AC-GND-DC switch to AC.

g. CHECK--Shift the CH 2 POLARITY switch between +UP and INVERT. The trace amplitude should not change more than 0.05 division.

h. ADJUST - Polarity Gain R2411 for minimum gain change while shifting the CH 2 POLARITY switch between +UP and INVERT. Recheck CH 2 GAIN because of interaction between step e and h.

i. Set the CH 2 AC-GND-DC switch to DC.

j. Set the CH 2 VOLTS/DIV switch to 10 mV.

k. Set the standard amplitude calibrator for 50 millivolt square-wave output.

l. CHECK - CRT display for exactly five divisions in amplitude.

m. ADJUST--Channel 2 2x GAIN R2317 for exactly five divisions in amplitude.

n. Disconnect the standard amplitude calibrator from the CH 2 input connector and connect it to the CH 1 input connector.

o. Set the DISPLAY MODE switch to CH 1.

p. Set the standard amplitude calibrator for 20 millivolt square-wave output.

q. Position the display to the center of the graticule with the CH 1 POSITION control.

r. CHECK - CRT display for exactly four divisions in amplitude.

s. ADJUST - CH 1 GAIN adjustment (front panel) for exactly four divisions of deflection. To adjust, press in the GAIN knob with a screwdriver and turn until the GAIN control is engaged.

t. Set the CH 1 VOLTS/DIV switch to 10 mV.

u. Set the standard amplitude calibrator for 50 millivolt square-wave output.

v. CHECK - CRT dsplay for exactly five divisions in amplitude.

w. ADJUST-Channel 1 2x GAIN R1317 for exactly five divisions in amplitude.

2. Check Channel 1 and 2 Deflection Factor Accuracy

a. CHECK--Using the CH 1 VOLTS/DIV and standard amplitude calibrator settings given in Table 5-1, check vertical deflection within 2% in each position of the CH 1 VOLTS/DIV switch.

b. Disconnect the standard amplitude calibrator from the CH 1 input connector and connect it to the CH 2 input connector.

c. Set the DISPLAY MODE switch to CH 2.

d. Repeat part a of this step for channel 2.

TABLE 5-1

Vertical Deflection Accuracy

VOLTS/DIV Switch Setting	Standard Amplitude Calibrator Output	Vertical Deflection in Divisions	Maximum Error for ±2% Accuracy (divisions)
5 mV	20 mV	4	±.08
10 mV	50 mV	5	Set In step 2
20 mV	0.1 V	5	±0.1
50 mV	0.2 V	4	±.08
.1 V	0.5V	5	±0.1
.2 V	1 V	5	±0.1
.5 V	2V	4	±.08
1V	5V	5	±0.1
2V	10V	5	±0.1
5V	20 V	4	±.08

3. Check Common-Mode Rejection Ratio

a. Set the CH 1 and CH 2 VOLTS/DIV switches to 5 mV.

b. Connect the medium-frequency generator to the CH 1 and CH 2 input connectors through the 50 Ω termination and the dual-input cable.

c. Set the constant-amplitude generator for an eight-division display (40 millivolts) at 50 MHz.

d. Change the following control settings:

DISPLAY MODE	ADD
CH 2 POLARITY	INVERT

e. CHECK - CRT display for 0.8 division or less deflection (common-mode rejection ratio 10:1 or better).

f. Disconnect all test equipment.

4. Check Alternate Operation

a. Set the DISPLAY MODE switch to ALT.

b. Position the traces about two divisions apart.

c. Turn the time-base unit time/division switch throughout its range.

d. CHECK - Trace alternation between channel 1 and 2 at all sweep rates. At faster sweep rates, alternation will not be apparent; instead display appears as two traces on the screen.

5. Check Chopped Operation

a. Set the DISPLAY MODE switch to CHOP.

b. CHECK- CRT display for two traces.

6. Check Trigger Source Operation

a. Change the following control settings:

DISPLAY MODE	ALT
TRIGGER SOURCE	CH 1

b. Connect the Indicator oscilloscope cal out connector to the CH 1 input connector.

c. Set the time-base unit for a stable display at a sweep rate of 0.5 millisecond/division.

d. Connect the square-wave generator through a 50 Ω termination to the CH 2 input connector. Set CH 2 to .2 V/div.

e. Set the square-wave generator for a one-division (200 millivolts) one-kilohertz signal.

f. CHECK- CRT display; CH 1 trace is stable and CH 2 trace cannot be triggered.

g. Set the TRIGGER SOURCE switch to CH 2.

h. Adjust the time-base triggering for a stable display.

i. CHECK - display; CH 2 trace is stable and CH 1 trace cannot be triggered.

j. Set the TRIGGER SOURCE switch to MODE.

k. CHECK-CRT display; CH 1 trace and CH 2 trace can both be triggered.

l. Disconnect all test equipment.

7. Check Channel 1 and 2 Bandwidth

a. Connect the high-frequency constant amplitude signal generator to the AM-6785/U CH 1 input through a 50 Ω termination.

b. Set the high-frequency constant amplitude signal generator to the reference frequency of 3 MHz and adjust the output amplitude to obtain a 6 division display.

c. Change the frequency of the high-frequency constant amplitude signal generator to the value given in Table 5-2 relative to the individual mainframe.

d. CHECK - That the amplitude of the display is 4.2 divisions or greater.

TABLE 5-2

System Bandwidth

Mainframe	Bandwidth
7900-Series	* 200 megahertz
7700-Series	* 150 megahertz
7600-Series	* 100 megahertz
7500-Series	* 90 megahertz
7600-Series	* 60 megahertz

* See part c of step 7.

e. Disconnect the high-frequency constant signal generator and 50 Ω termination from CH 1 and connect to CH 2 input.

f. Set the DISPLAY MODE switch to CH 2.

g. Repeat parts b, c, and d of this step for CH 2.

h. Disconnect all test equipment.

APPENDIX A

REFERENCES

A-1. SCOPE.

This appendix lists all forms, technical bulletins, technical manuals, and miscellaneous publications referenced in this manual.

A-2. FORMS.

Recommended Changes to Publications and Blank Form	DA Form 2028
Recommended Changes to Equipment Technical Manuals	DA Form 2028-2
Report of Discrepancy	Form SF 364
Quality Deficiency Report	Form SF 368

A-3. TECHNICAL MANUALS.

The Army Maintenance Management System (TAMMS)	DA Pam 738-750
Administrative Storage Procedures	TM 740-90-1
Procedures for Destruction of Electronics Materiel to Prevent Enemy Use Electronics Command	TM 750-244-2
Organizational, Direct Support, and General Support Repair Parts and Special Tools List for Dual Trace Amplifier AM-6785A/U	TM 11-6625-3190-24P

A-4. MISCELLANEOUS.

Common Table of Allowances	CTA 50-970
Consolidated Index of Army Publications and Blank Forms	DAPam 25-30
First Aid for Soldiers	FM 21-11
Abbreviations for Use on Drawings, Specifications, Standards and in Technical Documents	MIL-STD-12

APPENDIX D

MAINTENANCE ALLOCATION CHART

SECTION I. INTRODUCTION

D-1 GENERAL

This section provides a summary of the maintenance operations for the Dual Trace Amplifier AM-6785/U and AM-6785A/U. It authorizes categories of maintenance for specific maintenance functions on repairable items and components and the tools and equipment required to perform each function. This appendix may be used as an aid in planning maintenance operations.

D-2 MAINTENANCE FUNCTIONS

Maintenance functions will be limited to and defined as follows:

a. Inspect. To determine the serviceability of an item by comparing its physical, mechanical, and/or electrical characteristics with established standards through examination.

b. Test. To verify serviceability and to detect incipient failure by measuring the mechanical or electrical characteristics of an item and comparing those characteristics with prescribed standards.

c. Service. Operations required periodically to keep an item in proper operating condition; i.e., to clean (decontaminate), to preserve, to drain, to paint, or to replenish fuel, lubricants, hydraulic fluids, or compressed air supplies.

d. Adjust. To maintain, within prescribed limits, by bringing into proper or exact position, or by setting the operating characteristics to the specified parameters.

e. Aline. To adjust specified variable elements of an item to bring about optimum or desired performance.

f. Calibrate. To determine and cause corrections to be made or to be adjusted on instruments or test, measuring, and diagnostic equipments used in precision measurement. Consists of comparisons of two instruments, one of which is a certified standard of known accuracy, to detect and adjust any discrepancy in the accuracy of the instrument being compared.

g. Install. The act of emplacing, seating, or fixing into position an item, part, or module (component or assembly) in a manner to allow the proper functioning of the equipment or system.

h Replace. The act of substituting a serviceable like type part, subassembly, or module (component or assembly) for an unserviceable counterpart.

i. Repair. The application of maintenance services (inspect, test, service, adjust, aline, calibrate, replace) or other maintenance actions (welding, grinding, riveting, straightening, facing, remachining, or resurfacing) to restore serviceability to an item by correcting specific damage, fault, malfunction, or failure in a part, subassembly, module (component or assembly), end item, or system.

j. Overhaul That maintenance effort (service/action) necessary to restore an item to a completely serviceable/operational condition as prescribed by maintenance standards (i.e., DMWR) in appropriate technical publications. Overhaul is normally the highest degree of maintenance performed by the Army. Overhaul does not normally return an item to like new condition.

k. Rebuild. Consists of those services/actions necessary for the restoration of unserviceable equipment to a like new condition in accordance with original manufacturing standards. Rebuild is the highest degree of materiel maintenance applied to Army equipment. The rebuild operation includes the act of returning to zero those age measurements (hours, miles, etc.) considered in classifying Army equipments/components.

D-3 COLUMN ENTRIES

a. Column 1, Group Number. Column 1 lists group numbers, the purpose of which is to identify components, assemblies, subassemblies, and modules with the next higher assembly.

b. Column 2, Component/Assembly. Column 2 contains the noun names of components, assemblies, subassemblies, and modules for which maintenance is authorized.

c. Column 3, Maintenance Function. Column 3 lists the functions to be performed on the item listed in column 2. When items are listed without maintenance functions, it is solely for the purpose of having the group numbers in the MAC and RPSTL coincide.

d. Column 4, Maintenance Level. Column 4 specifies, by the listing of a "worktime" figure in the appropriate subcolumn(s), the lowest level of maintenance authorized to perform the function listed in column 3. This figure represents the active time required to perform that maintenance function at the indicated category of maintenance. If the number or complexity of the tasks within the listed maintenance function vary at different maintenance categories, appropriate "worktime" figures will be shown for each category. The number of task-hours specified by the "worktime" figure represents the average time required to restore an item (assembly, subassembly, component, module, end item, or system) to a serviceable condition under typical field operating conditions. This time includes preparation time, troubleshooting time, and quality assurance/quality control time in addition to the time required to perform the specific tasks identified for the maintenance functions authorized in the maintenance allocation chart. Subcolumns of column 4 are as follows:

C Operator/Crew
O Organizational
F Direct Support
H General Support
D Depot

e. Column 5, Tools and Equipment. Column 5 specifies by code, those common tool sets (not individual tools) and special tools, test, and support equipment required to perform the designated function.

f. Column 6, Remarks. Column 6 contains an alphabetic code which leads to the remark in Section IV, Remarks, which is pertinent to the item opposite the particular code.

D-4 TOOL AND TEST EQUIPMENT REQUIREMENTS (SECTION III)

a. Tool or Test Equipment Reference Code. The numbers in this column coincide with the numbers used in the tools and equipment column of the MAC. The numbers indicate the applicable tool or test equipment for the maintenance functions.

b. Maintenance Level. The codes in this column indicate the maintenance category allocated the tool or test equipment.

c. Nomenclature. This column lists the noun name and nomenclature of the tools and test equipment required to perform the maintenance functions.

d. National/NATO Stock Number. This column lists the National/NATO stock number of the specific tool or test equipment.

e. Tool Number. This column lists the manufacturer's part number of the tool followed by the Federal Supply Code for Manufacturers (5-digit) in parentheses.

B-5 REMARKS (SECTION IV)

a. Reference Code. This code refers to the appropriate item in Section II, Column 6.

b. Remarks. This column provides the required explanatory information necessary to clarify items appearing In Section II.

SECTION II. MAINTENANCE ALLOCATION CHART FOR DUAL TRACE AMPLIFIER AM-6785/U AND AM-6785A/U

(1) GROUP NUMBER	(2) COMPONENT/ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE LEVEL					(5) TOOLS AND EQPT	(6) REMARKS
			UNIT		INTERMEDIATE		DEPOT		
			C	O	F	H	D		
00	DUAL TRACE AMPLIFIER AM-6785/U AND AM-6785A/U TEKTRONIX 7A26	INSPECT	0.1						A
		TEST	0.2						B
		TEST				0.5			C
		CALIBRATE				1.0			D
		REPAIR		0.2					E
		REPAIR	1.0						F
01	CIRCUIT CARD ASSEMBLY AMPLIFIER (A2)	INSPECT				0.1			
		REPAIR				1.0			G

SECTION III. TOOL AND TEST EQUIPMENT REQUIREMENTS FOR DUAL TRACE AMPLIFIER AM-6785/U AND AM-6785A/U

TOOL OR TEST EQUIPMENT REF CODE	MAIN-TENANCE LEVEL	NOMENCLATURE	NATIONAL/NATO STOCK NUMBER	TOOL NUMBER
1	H	TOOL KIT, ELECTRONIC EQUIPMENT	4931-01-073-3845	JTK-17ALL
2	H	OSCILLOSCOPE CALIBRATION SYSTEM	6695-01-057-2207	6162M MIS 28714
3	H	OSCILLOSCOPE	6625-01-046-3712	TEK 5440
4	H	GENERATOR, PULSE	6625-01-103-9550	HP 214B MIS 10355
5	H	AMPLIFIER, DUAL TRACE	6625-01-008-1480	TEK 5A48
6	H	TIMEBASE, DELAYING	6625-01-008-1479	TEK 5B42
7	H	ATTENUATOR, VARIABLE	5985-00-763-7326	HP 355C 7010807
8	H	TESTER, SEMICONDUCTOR	6625-01-095-9344	520B 7915952
9	H	CAPACITANCE STANDARDIZER	6625-00-160-1325	7916146
10	H	EXTENDER	6625-00-577-1842	TEK 067-0616-00
11	H	PROBE, 1X	6695-00-901-5575	TEK 010-0076-00
12	H	DUAL INPUT COUPLER	6695-01-058-2187	TEK 067-0525-01
13	H	CABLE, BNC, 50 Ω, RG-58/U	6625-00-495-4831	TEK 012-0057-01
14	H	CABLE, GR, 50 Ω, RG-58/U	5995-01-208-8946	TEK 017-0515-00
15	H	TERMINATION, GR TO BNC MALE, 50 Ω	5985-00-087-4953	TEK 017-0083-00

SECTION IV. REMARKS
FOR
DUAL TRACE AMPLIFIER AM-6785/U AND AM-6785A/U

REFERENCE CODE	REMARKS
A	VISUAL INSPECTION
B	OPERATIONAL TEST
C	TEST BY PERFORMANCE CHECKS
D	CALIBRATE USING TECHNICAL BULLETIN LISTED IN TB 43-180
E	REPAIR BY REPLACEMENT OF KNOBS
F	REPAIR BY REPLACEMENT OF FRONT PANEL SWITCHES, Al AND A3 ASSEMBLIES
G	REPAIR BY REPLACEMENT OF COMPONENTS

APPENDIX E

Section 1

INTRODUCTION

E-1. Scope

This appendix lists expendable supplies and materials you will need to operate and maintain the AM-6785/U. These items are authorized to you by CTA 50-70, Expendable Items (Except Medical, Class V, Repair parts, and Heraldic Items).

E-2. Explanation of Columns

a. Column (1) - Item Number. This number is assigned to the entry in the listing and is referenced in the narrative instructions to identify the material (e.g., "Use cleaning compound, item 1, App. E").

b. Column (2) - Level. This column identifies the lowest level of maintenance that requires the listed.

C - Operator/Crew
O - Organizational Maintenance
F - Direct Support Maintenance
H - General Support Maintenance

c. Column (3) - National Stock Number. This is the National stock number assigned the item; use it to request or requisition the item.

d. Column (4) - Description. Indicates the Federal item name and, if required, a description to identify the item. The last line for each item indicates the Federal Supply Code for Manufacturer (FSCM) in parentheses followed by the part number.

e. Column (5) - Unit of Measure (U/M). Indicates the measure used in performing the actual maintenance function. This measure Is expressed by a two-character alphabetical abbreviation (e.g., ea, in, pr). If the unit of measure differs from the unit of issue, requisition the lowest unit of issue that will satisfy your requirements.

Section 2

EXPENDABLE SUPPLIES AND MATERIALS LIST

(1) ITEM NUMBER	(2) LEVEL	(3) NATIONAL STOCK NUMBER	(4) DESCRIPTION	(5) U/M
1	O	6810-00-753-4993	ALCOHOL, ISOPROPYL, 8 OZ CAN MIL-A-10428, GRADE A (81349)	OZ
2	C	8305-00-267-3015	CLOTH, CHEESECLOTH, COTTON, LINTLESS, CCC-C-440, TYPE II, CLASS 2 (81348)	YD
3	C	7930-00-531-9716	DETERGENT, MILD LIQUID	OZ

SUBJECT INDEX

START

POWER ON UNIT CONTROL SETTINGS PER CHART "A"

DO TRACE AND READOUT APPEAR ON SCREEN?

NO → CHECK OSCILLOSCOPE AND/OR TIME BASE UNIT

YES

PRESS FRONT PANEL "IDENTIFY" BUTTON

DOES TRACE MOVE?

NO → DOES "IDENTIFY" READOUT APPEAR ON SCREEN?

NO → CHECK FOR −15V AT TP24 ON A2 BOARD (FO−5)

YES → IS −15V PRESENT?

NO → CHECK INTERCONNECTING PLUGS AND/OR OSCILLOSCOPE POWER SUPPLY

YES → PRESS FRONT PANEL "IDENTIFY" BUTTON

CHECK FOR 0.0V AT TP24 ON A2 BOARD (FO−5)

IS 0.0V PRESENT?

NO → REPLACE "IDENTIFY" SWITCH (S1465)

YES → CHECK TP1 ON A3 BOARD FOR −15V (FO−6)

IS −15V PRESENT?

NO → CHECK INTERCONNECTING PLUGS AND/OR OSCILLOSCOPE POWER SUPPLY

YES → CHECK TP2 ON A3 BOARD FOR WAVEFORM "A" (FO−6)

IS WAVEFORM "A" PRESENT?

NO → CHECK INTERCONNECTING PLUGS AND/OR OSCILLOSCOPE MAIN FRAME

YES → PRESS "IDENTIFY" BUTTON. CHECK FOR WAVEFORM "B" AT TP2 OF A3 BOARD (FO−6)

IS WAVEFORM "B" PRESENT?

NO → REPLACE A3 BOARD

YES → CHECK OSCILLOSCOPE MAIN FRAME

YES → ROTATE FRONT PANEL "POSITION" CONTROL

DOES TRACE MOVE?

YES → GO TO ③ ON FO−3

NO → CHECK INTERCONNECTING PLUGS

ARE PLUGS OK?

NO → GO TO ④ ON FO−3

NO → REPLACE/REPAIR PLUGS AS NECESSARY

YES → DOES "IDENTIFY" READOUT APPEAR ON SCREEN?

NO → CHECK OSCILLOSCOPE MAIN FRAME

YES → B

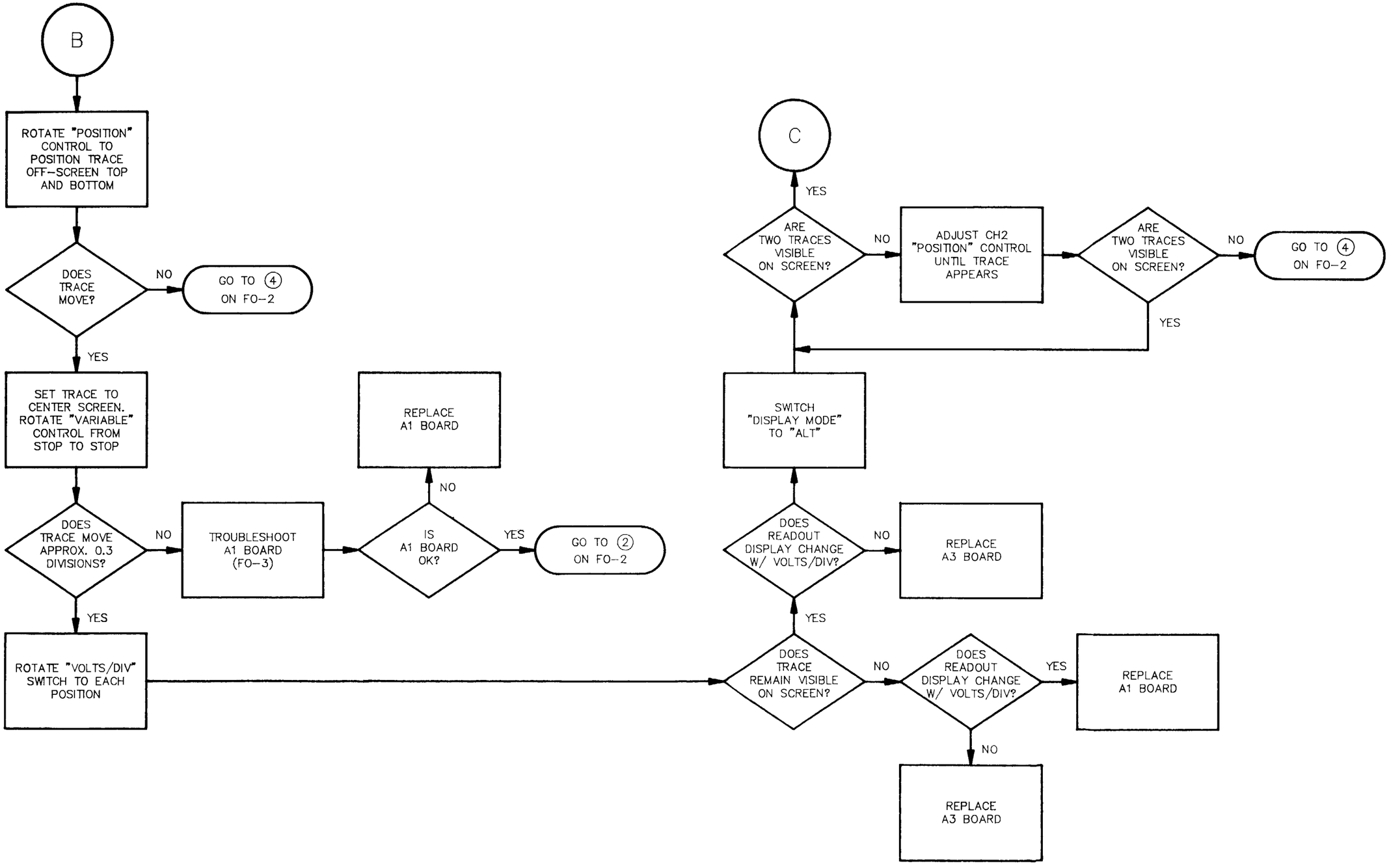
CHART A

Unit Control Settings

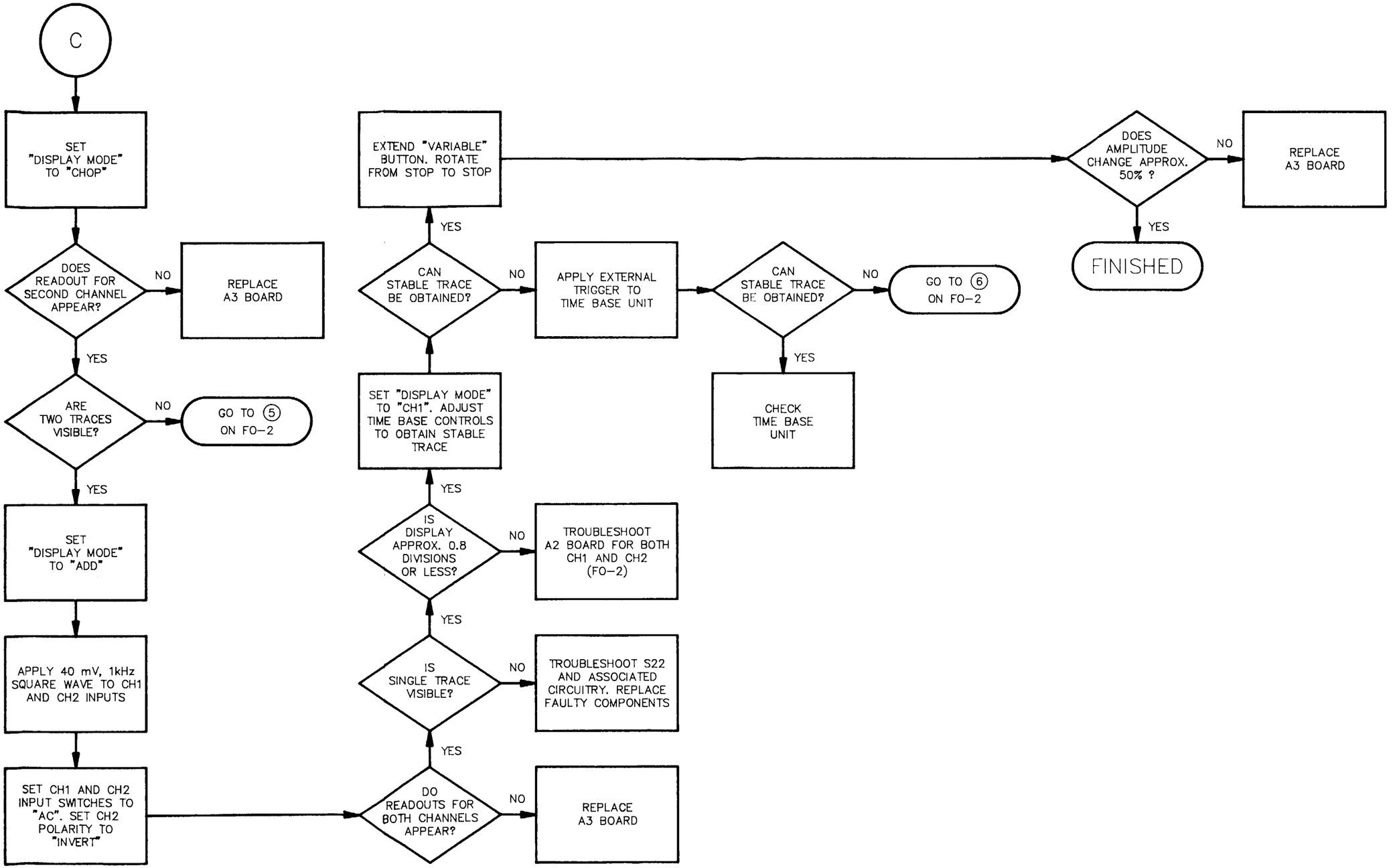
CH 1 & CH 2 VOLTS/DIV	**5 mV**
CH 1 & CH 2 INPUT SWITCHES	**DC**
CH 1 & CH 2 POSITION	**Center Trace on Graticule**
DISPLAY MODE	**CH 1**
TRIGGER SOURCE	**MODE**
CH 2 POLARITY	**+UP**

Unit is connected to one of the vertical compartments of the oscilloscope mainframe through plug-in extender.

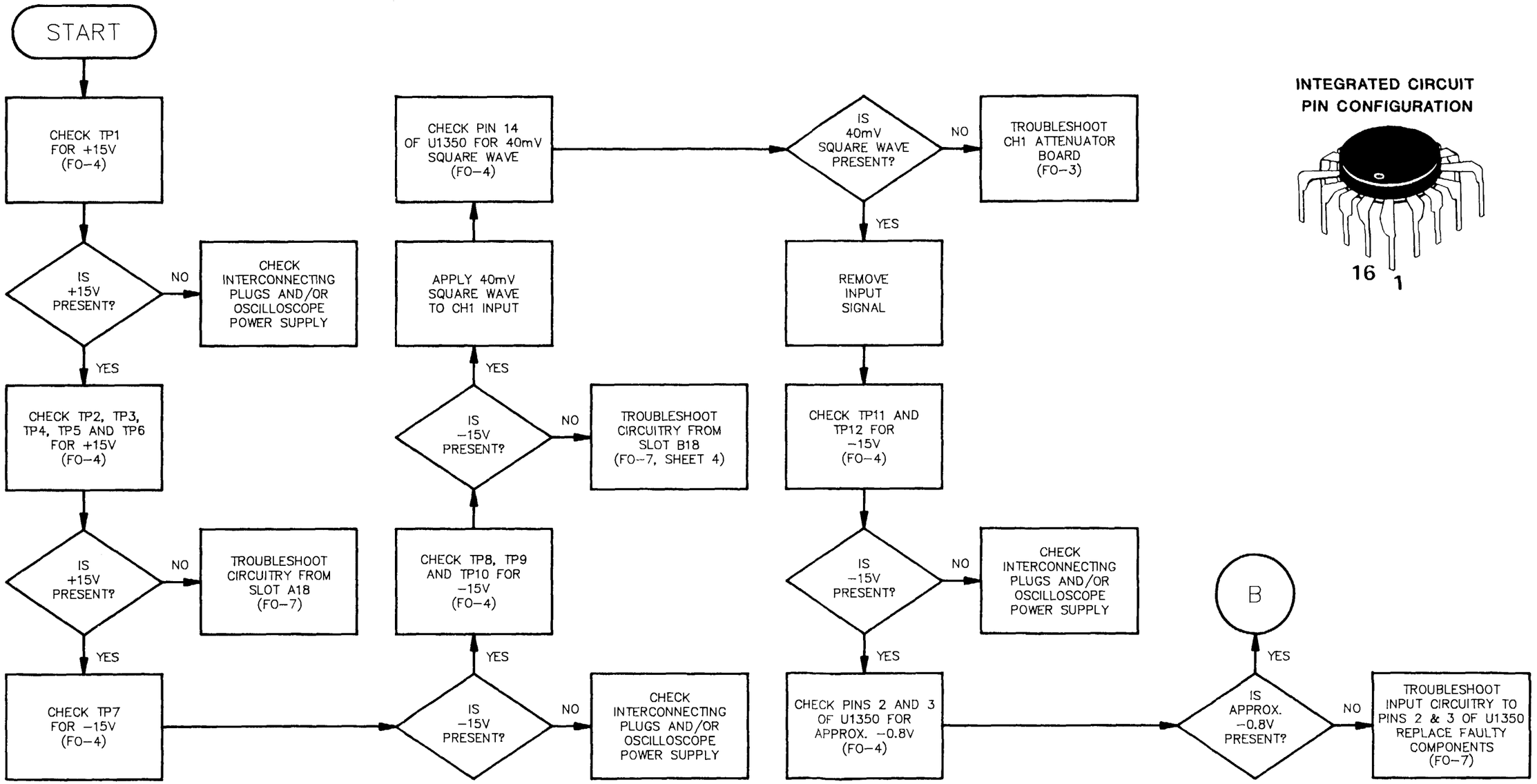
Unit Troubleshooting (1 of 3) Figure FO-1



Unit Troubleshooting (2 of 3) Figure FO-1

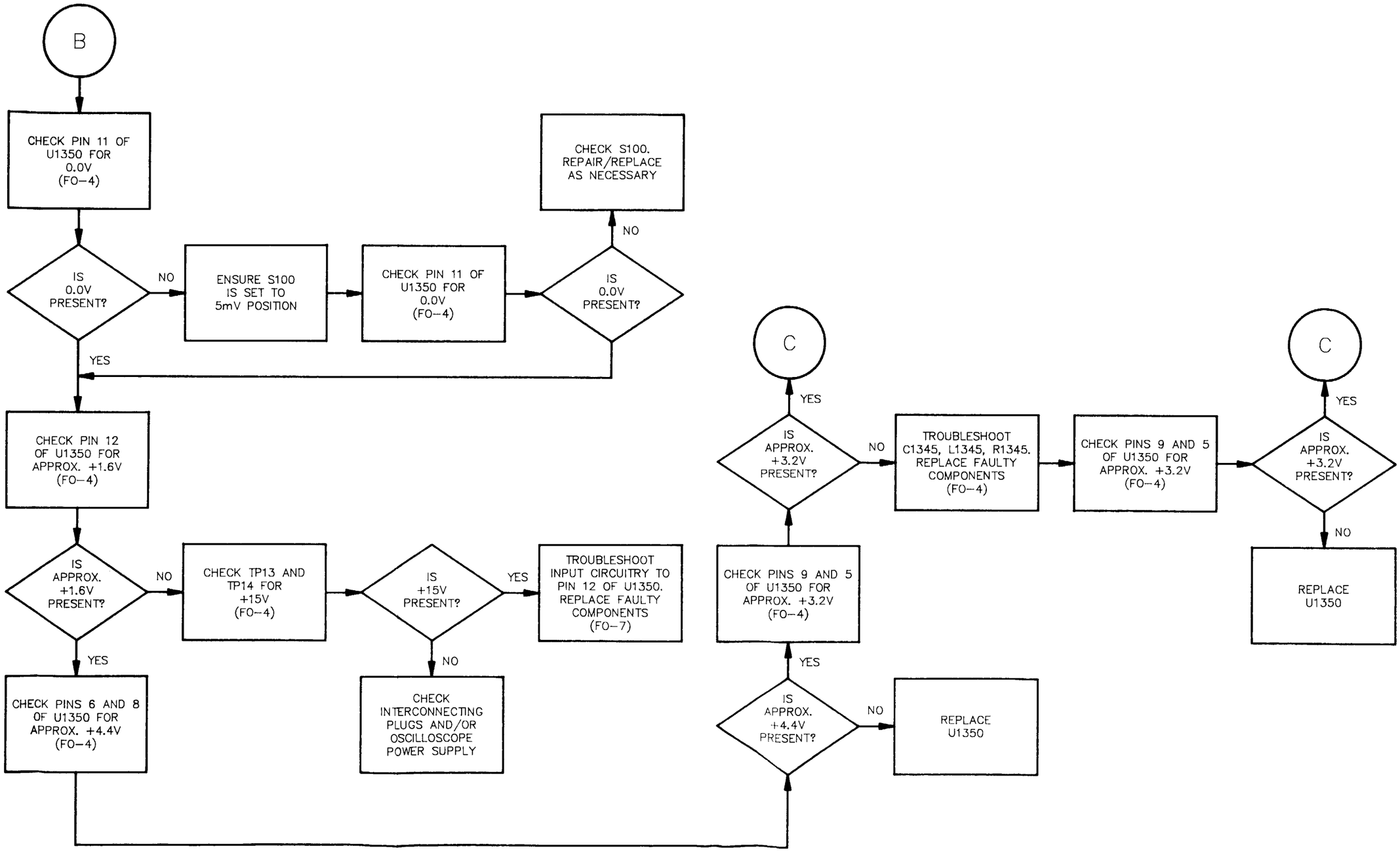


Unit Troubleshooting (3 of 3) Figure FO-1

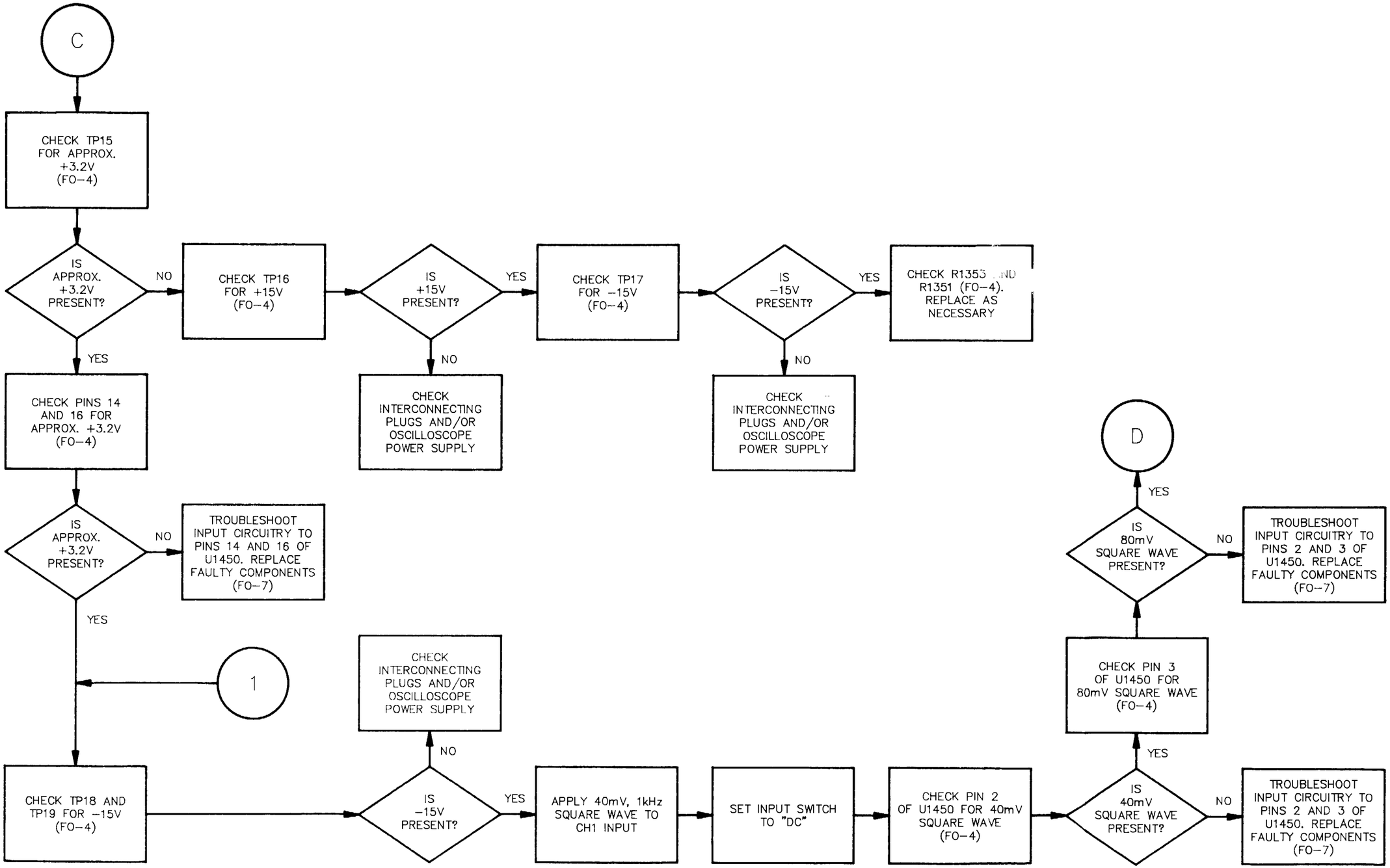


INTEGRATED CIRCUIT PIN CONFIGURATION

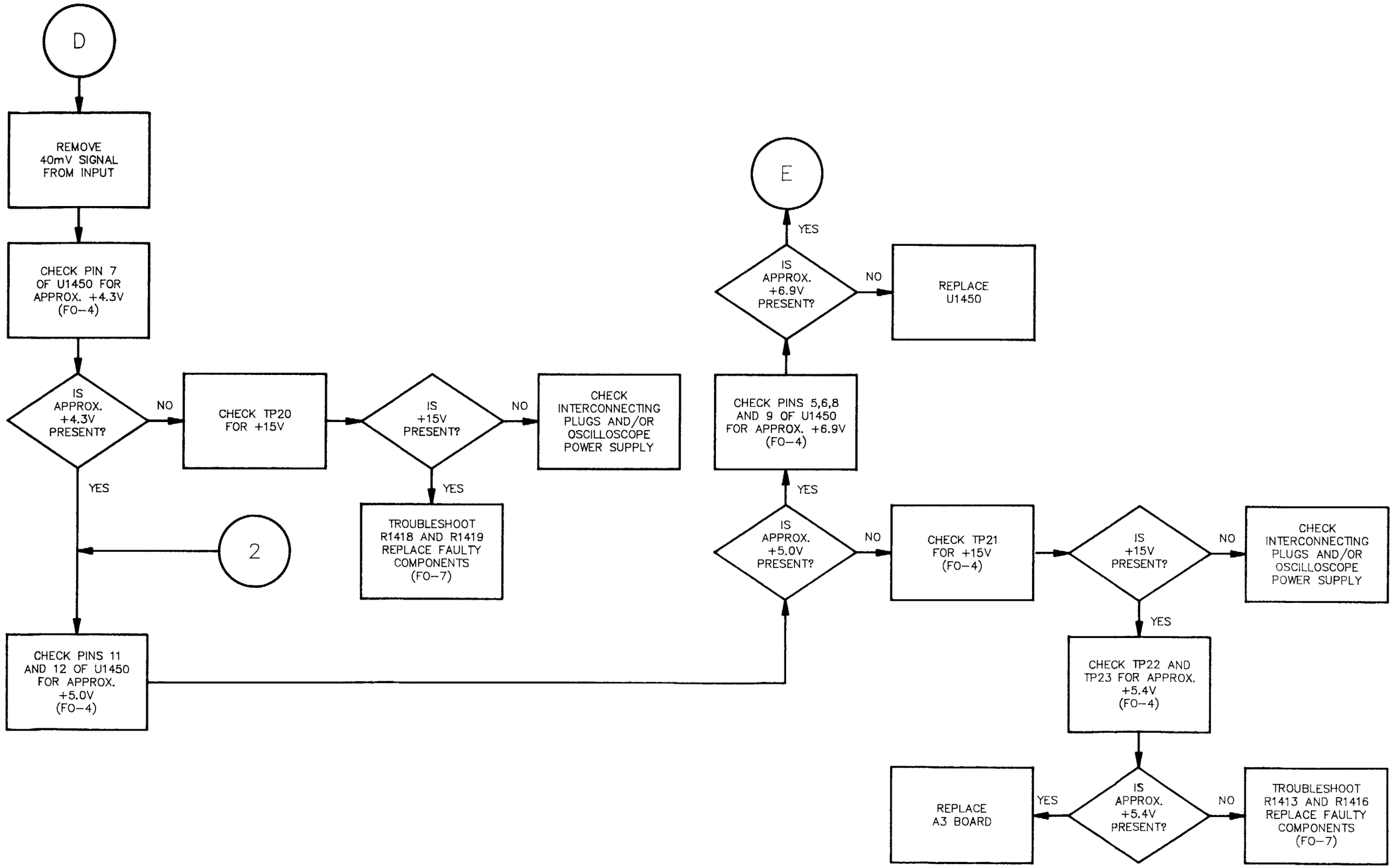
A2 Amplifier Board Troubleshooting (1 of 11) Figure FO-2



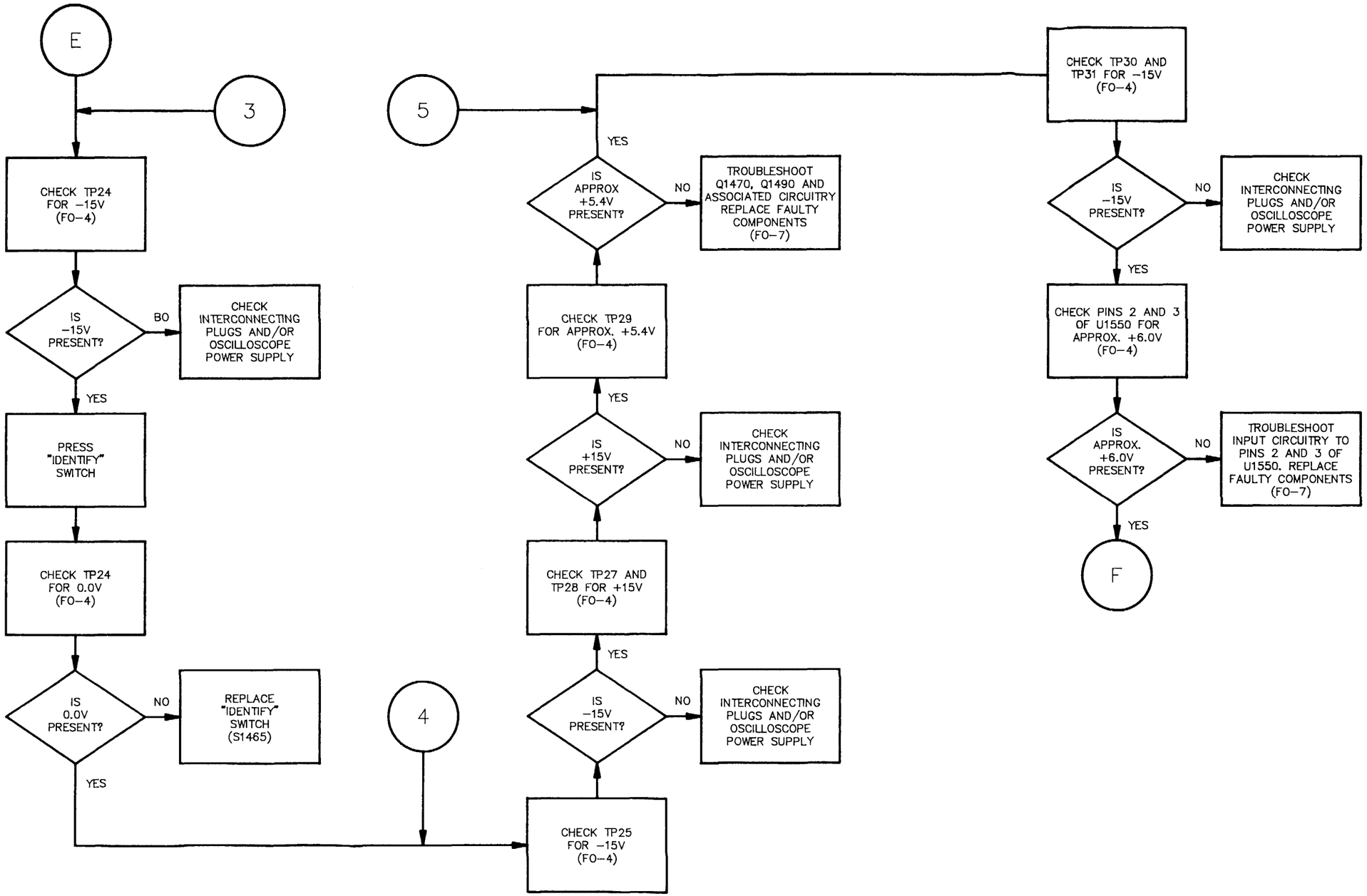
A2 Amplifier board Troubleshooting (2 of 11) Figure FO-2



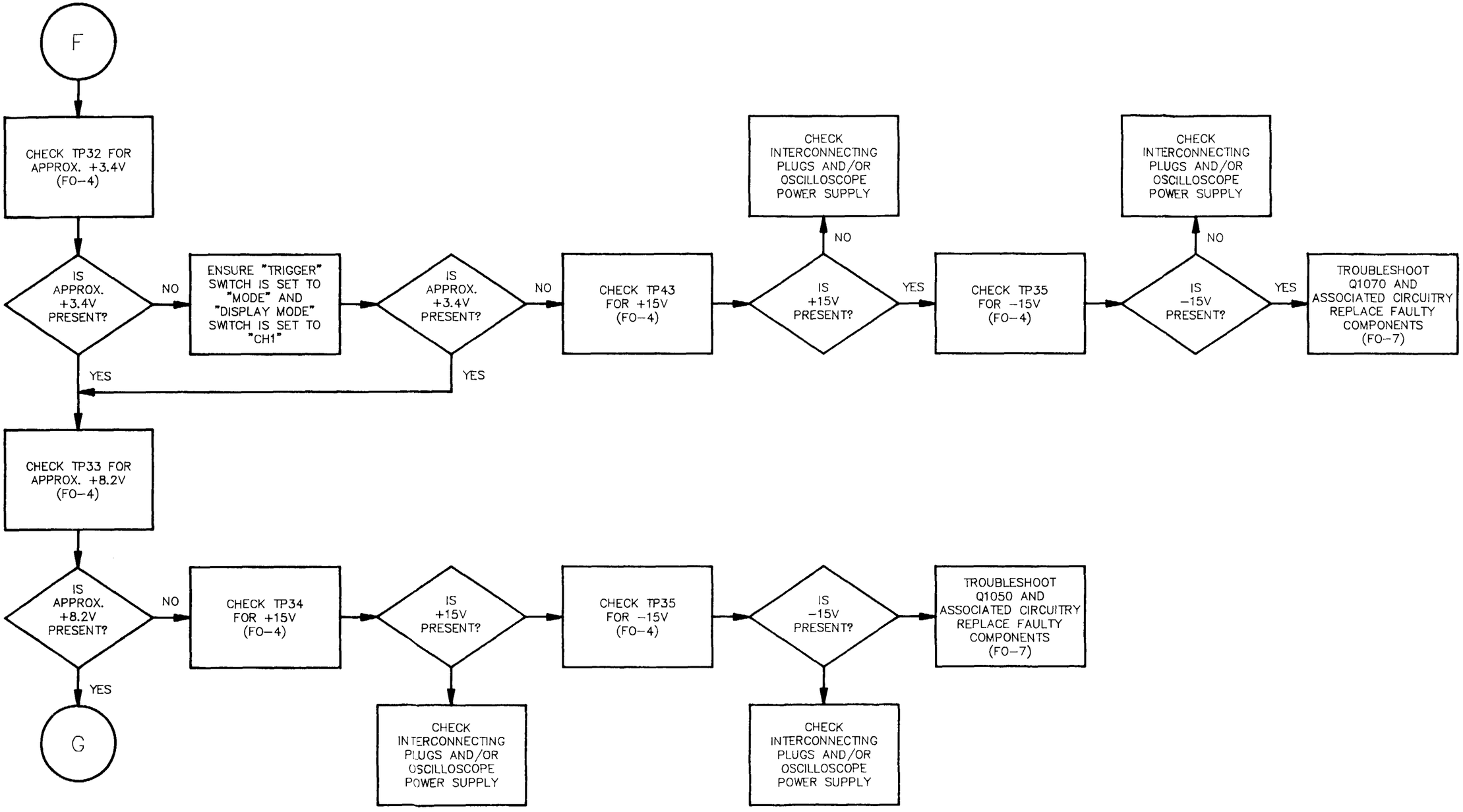
A2 Amplifier Board Troubleshooting (3 of 11) Figure FO-2



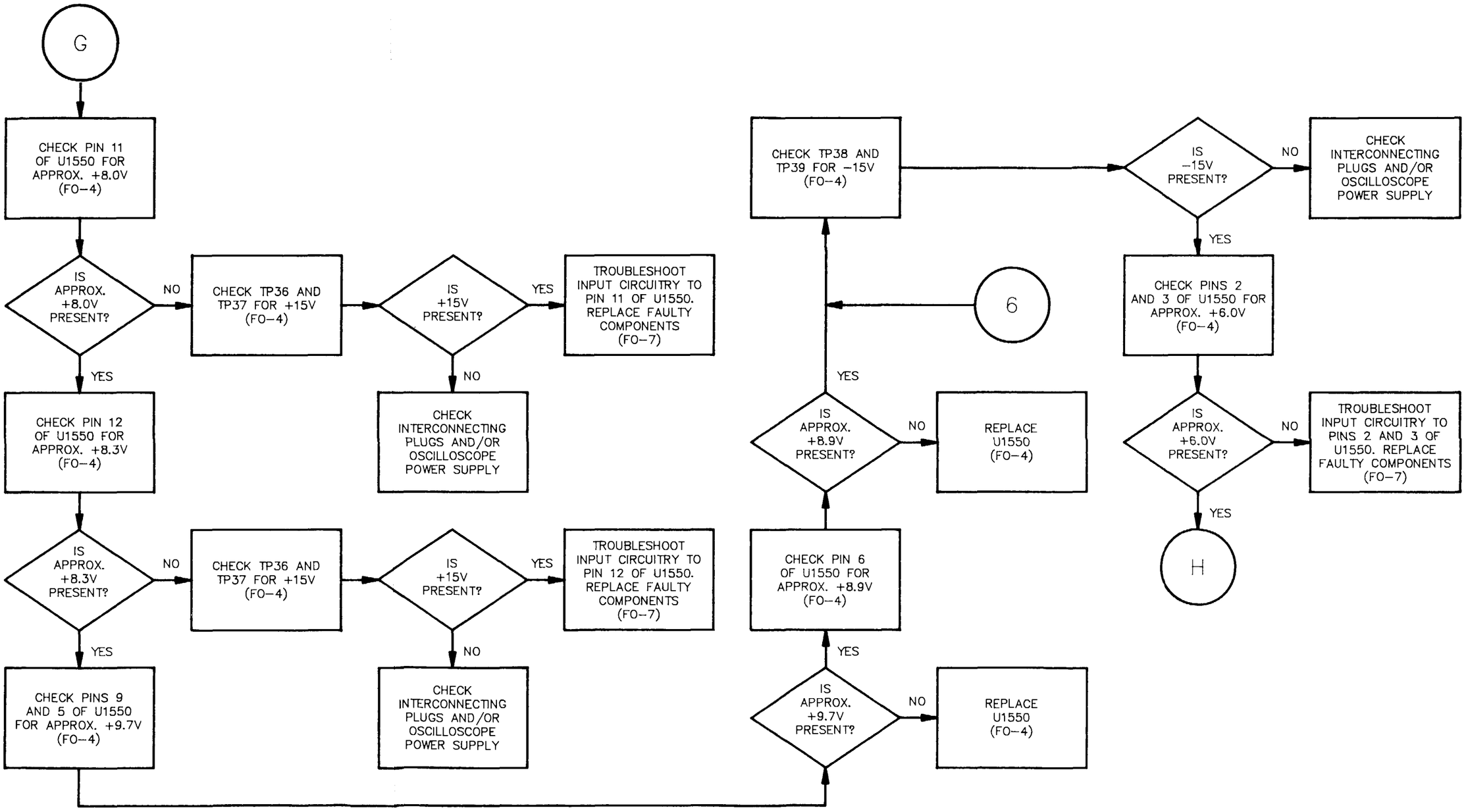
A2 Amplifier Board Troubleshooting (4 of 11) Figure FO-2



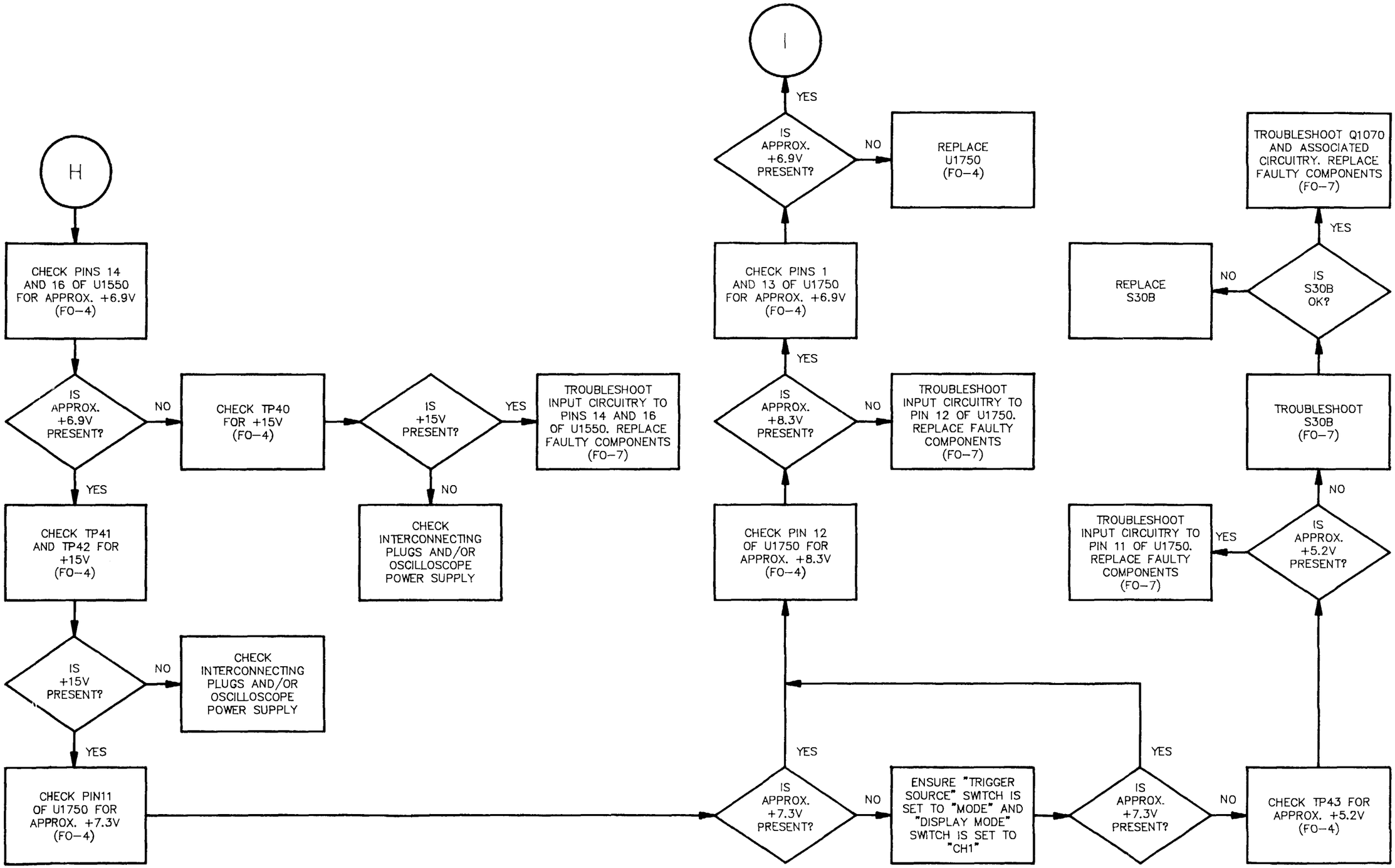
A2 Amplifier Board Troubleshooting (5 of 11) Figure FO-2



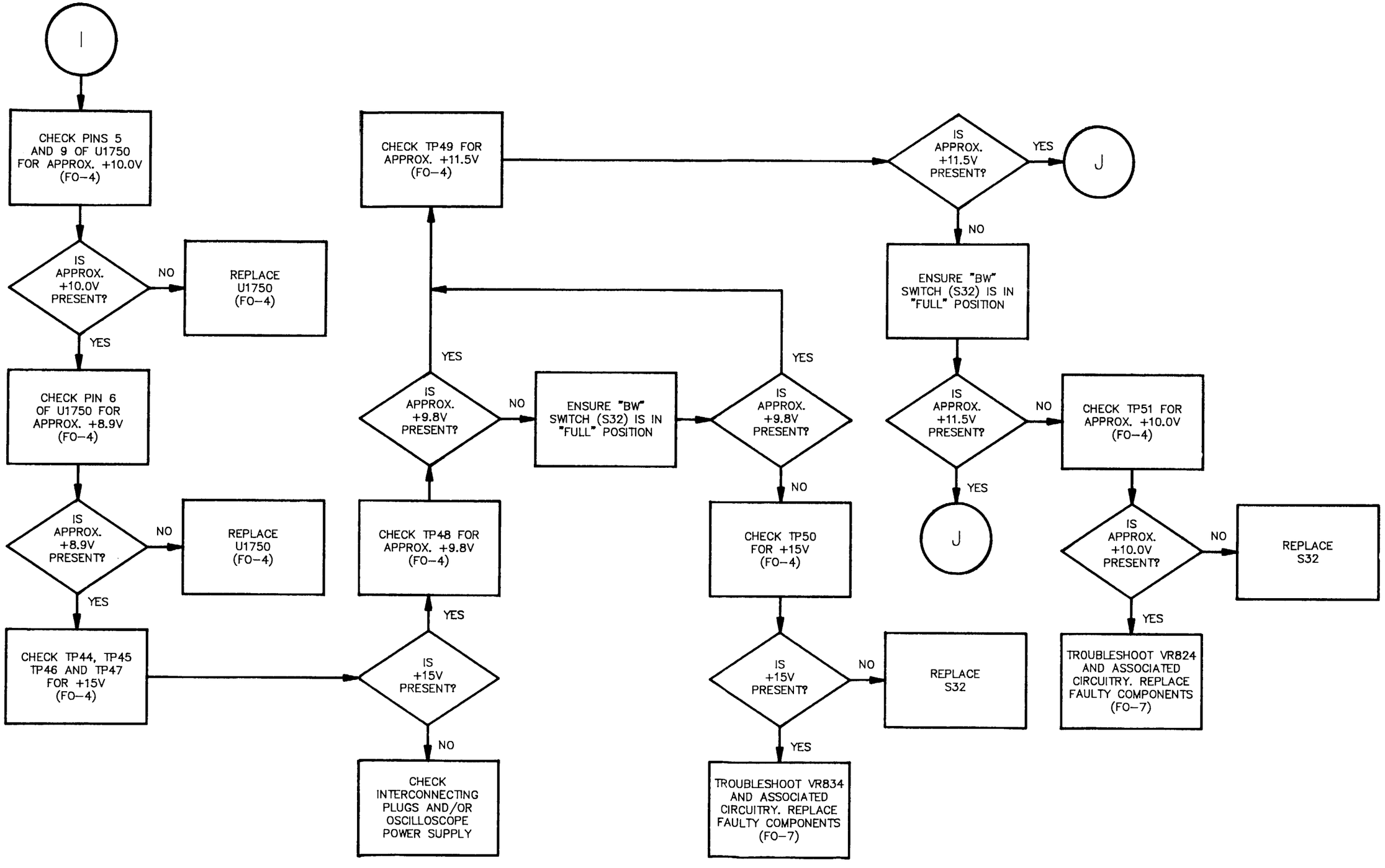
A2 Amplifier Board Troubleshooting (6 of 11) Figure FO-2



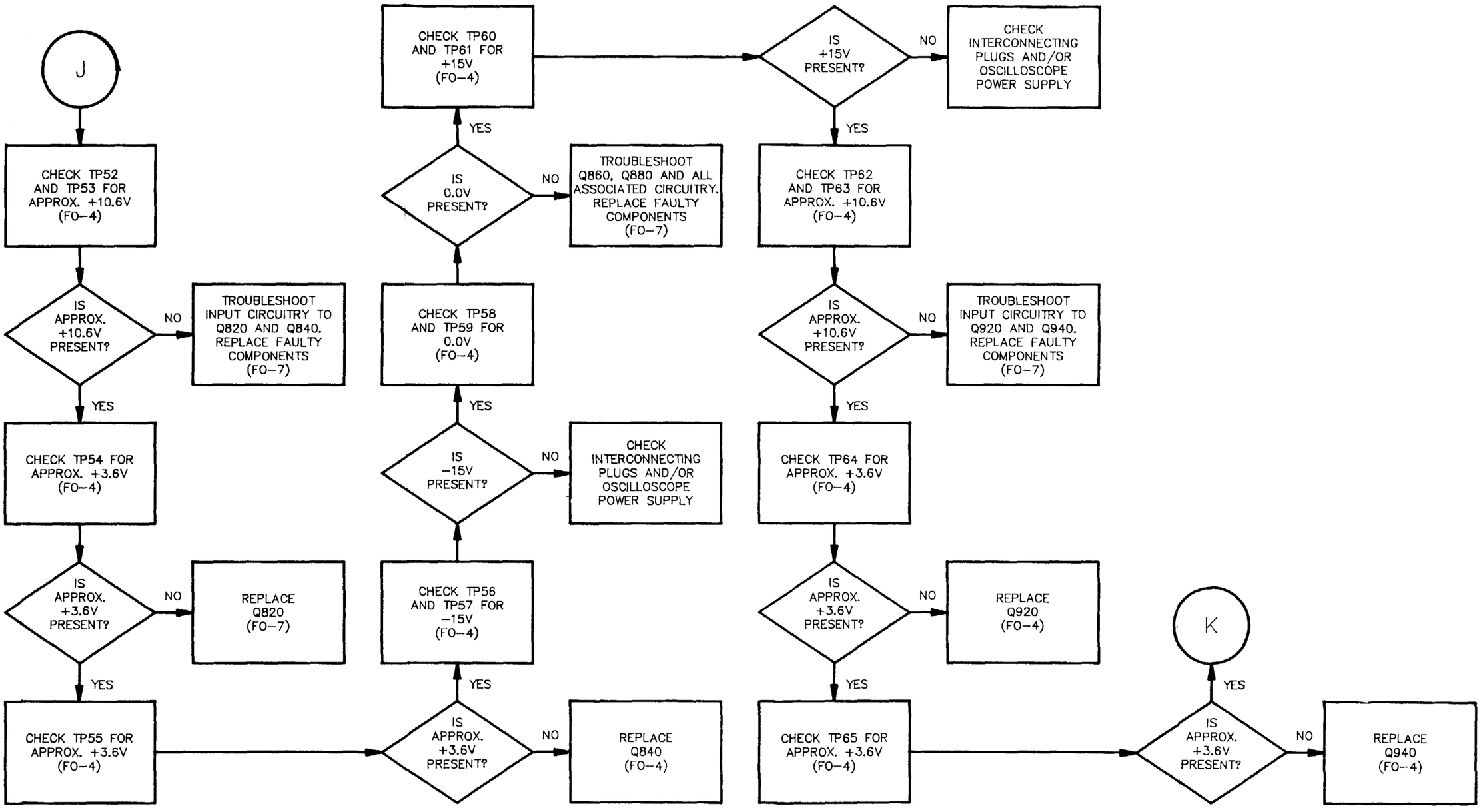
A2 Amplifier Board Troubleshooting (7 of 11) Figure FO-2



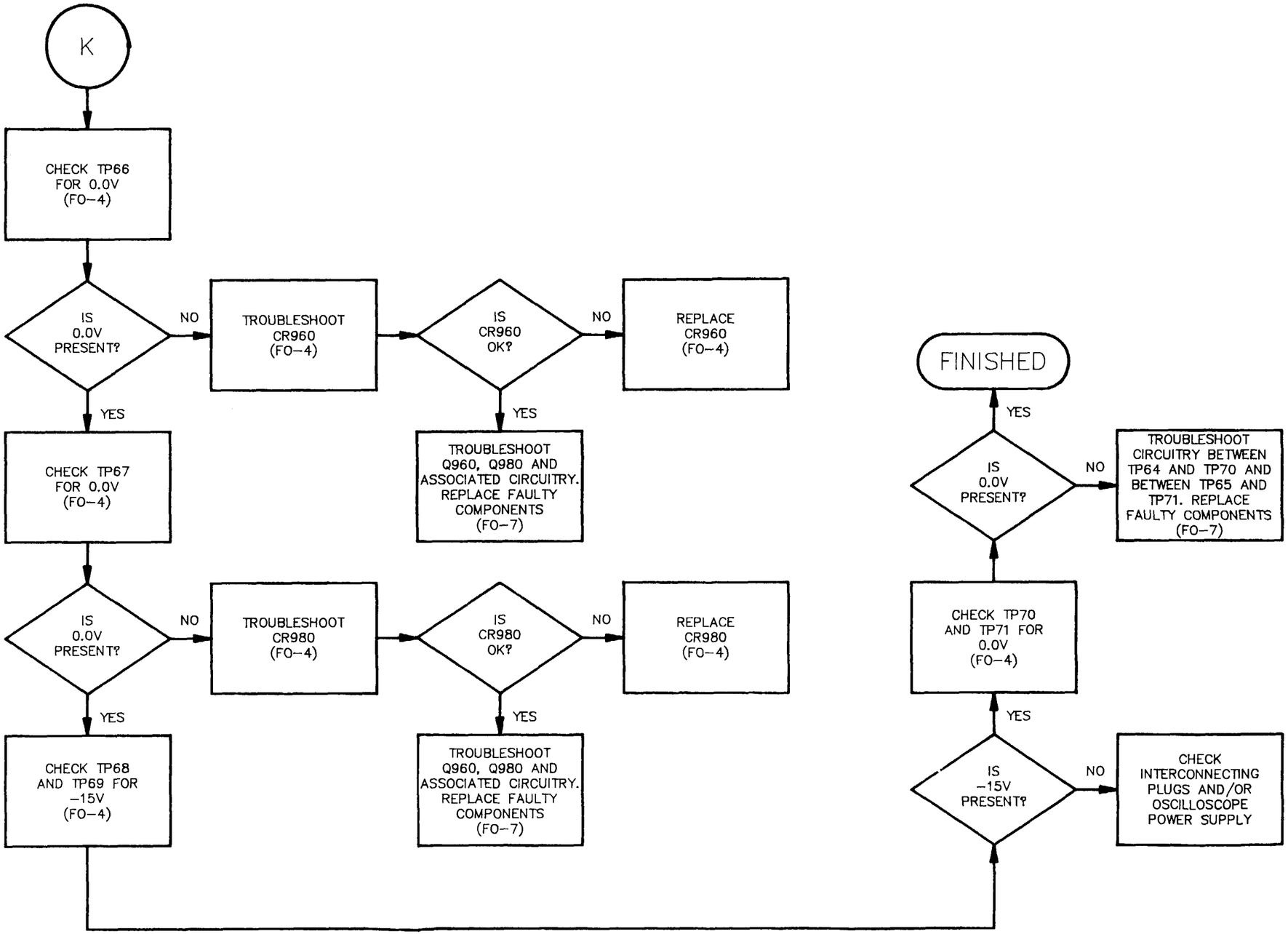
A2 Amplifier Board Troubleshooting (8 of 11) Figure FO-2



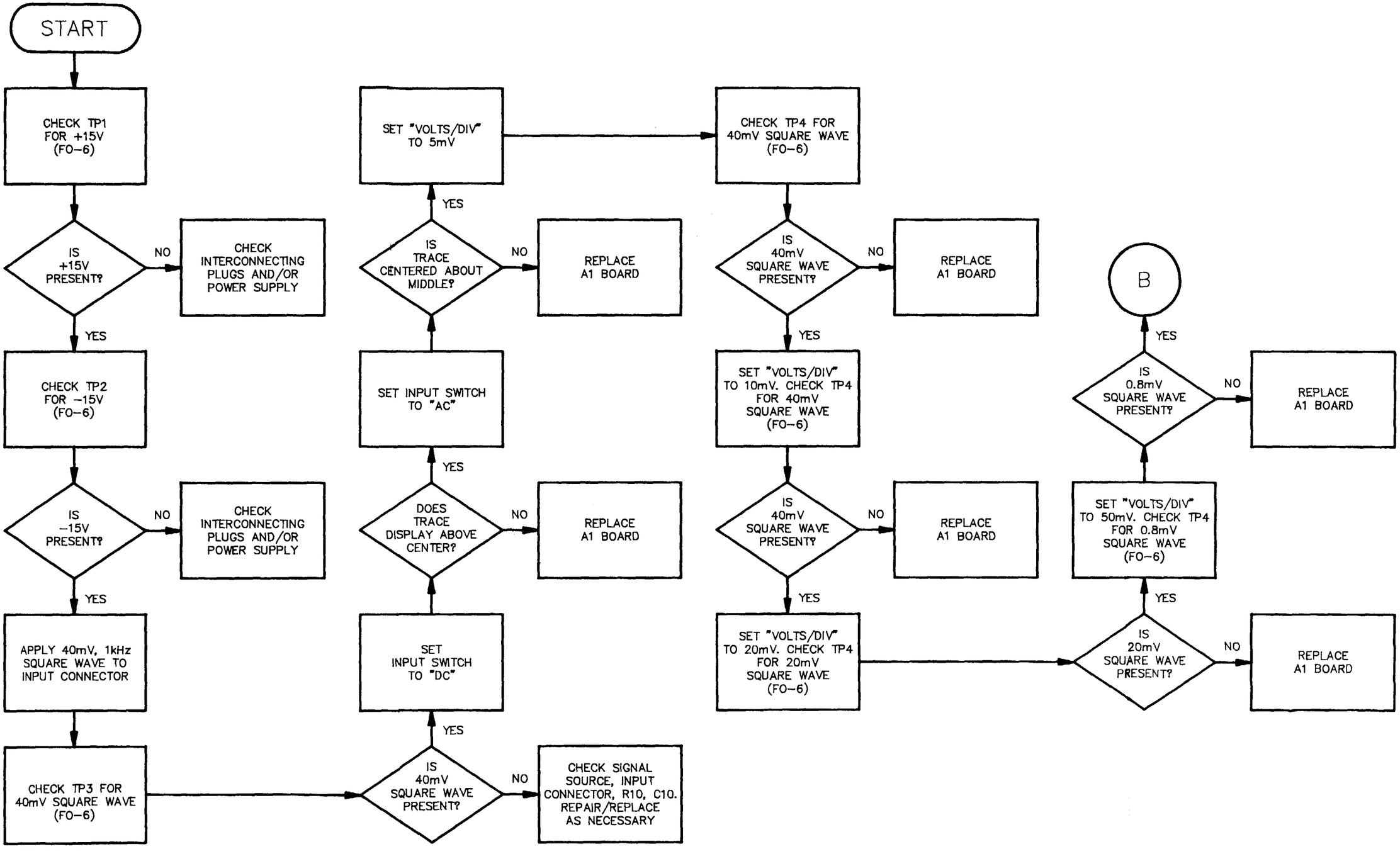
A2 Amplifier Board Troubleshooting (9 of 11) Figure FO-2



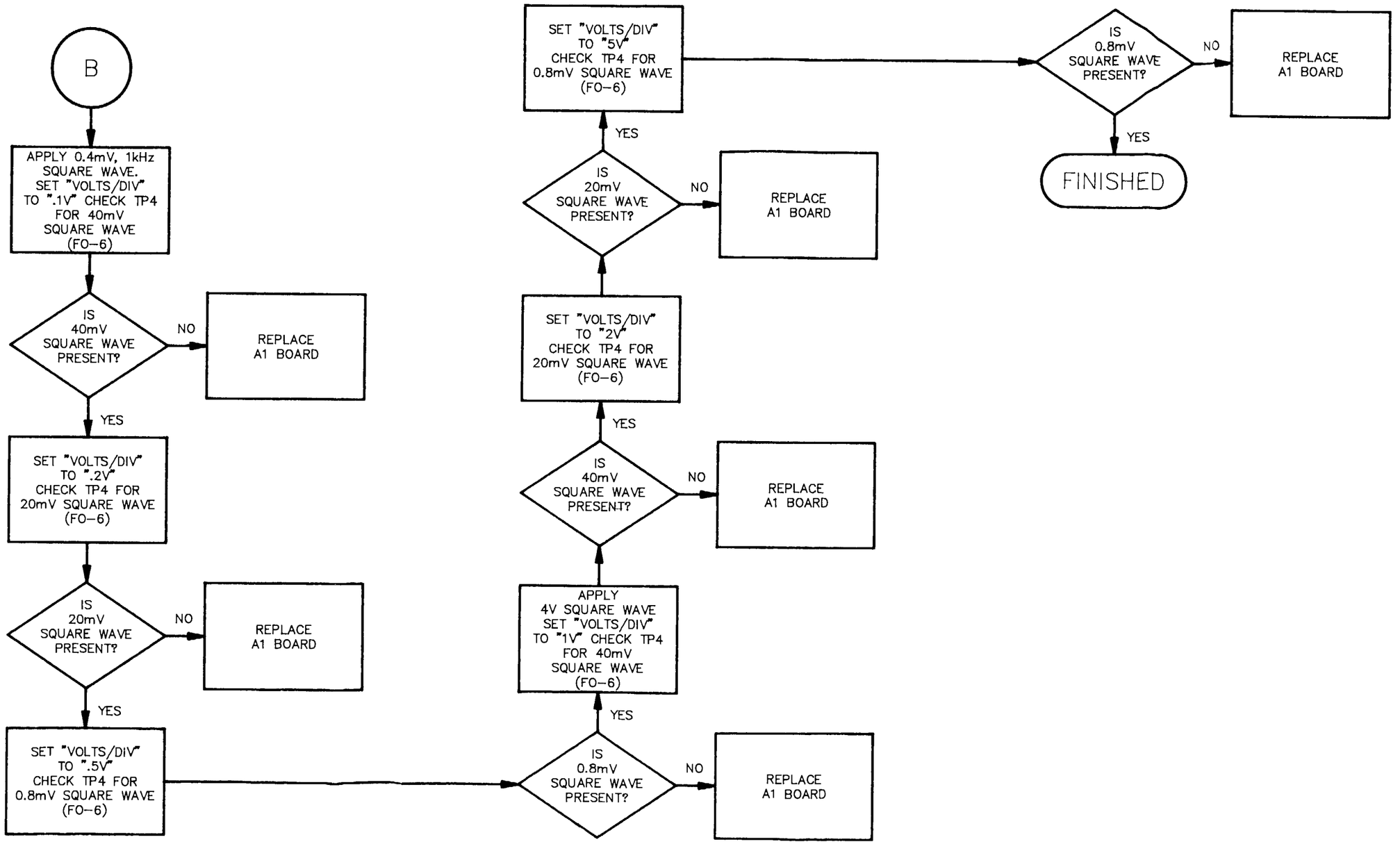
A2 Amplifier Board Troubleshooting (10 of 11) Figure FO-2



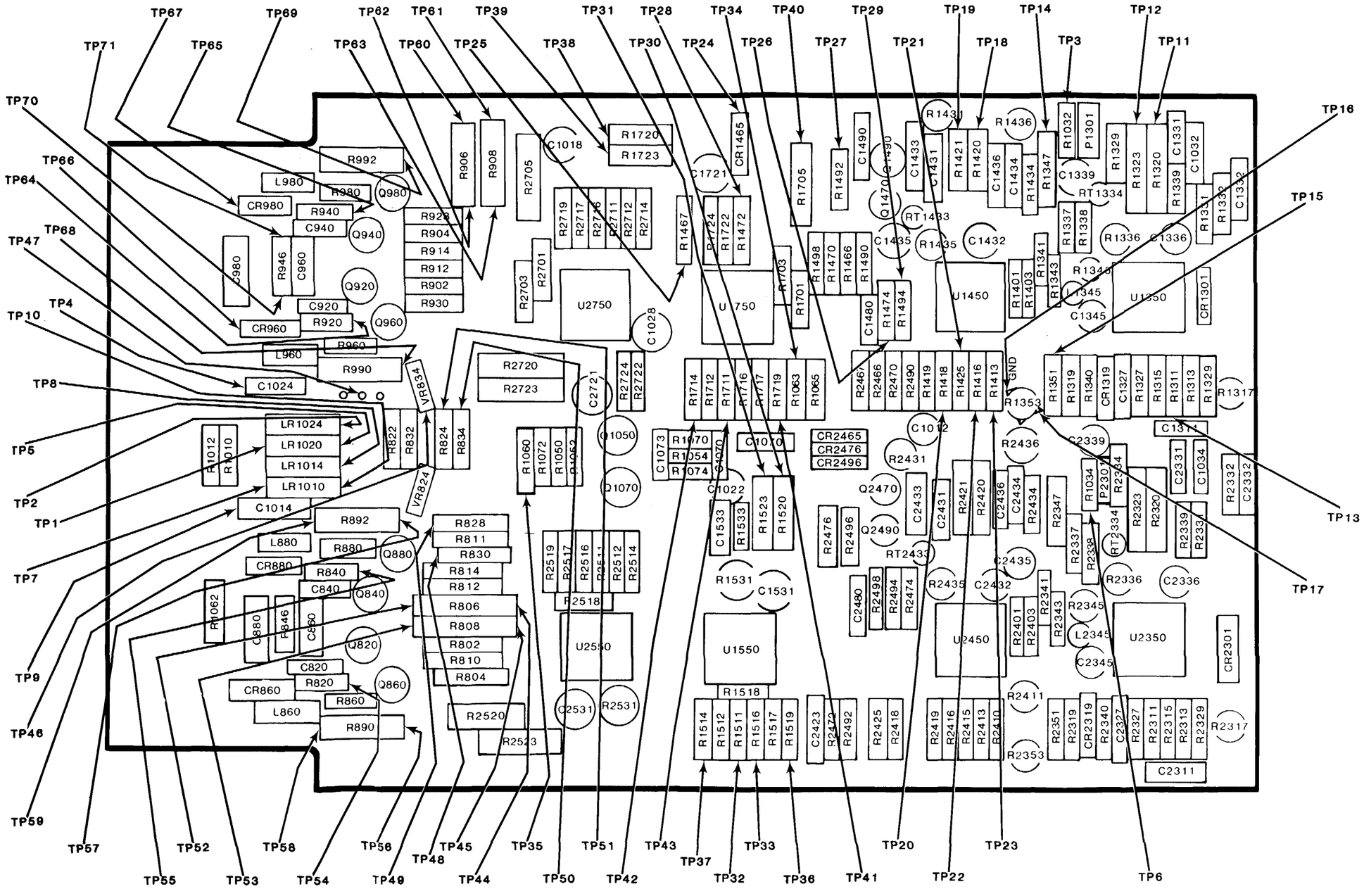
A2 Amplifier Board Troubleshooting (11 of 11) Figure FO-2



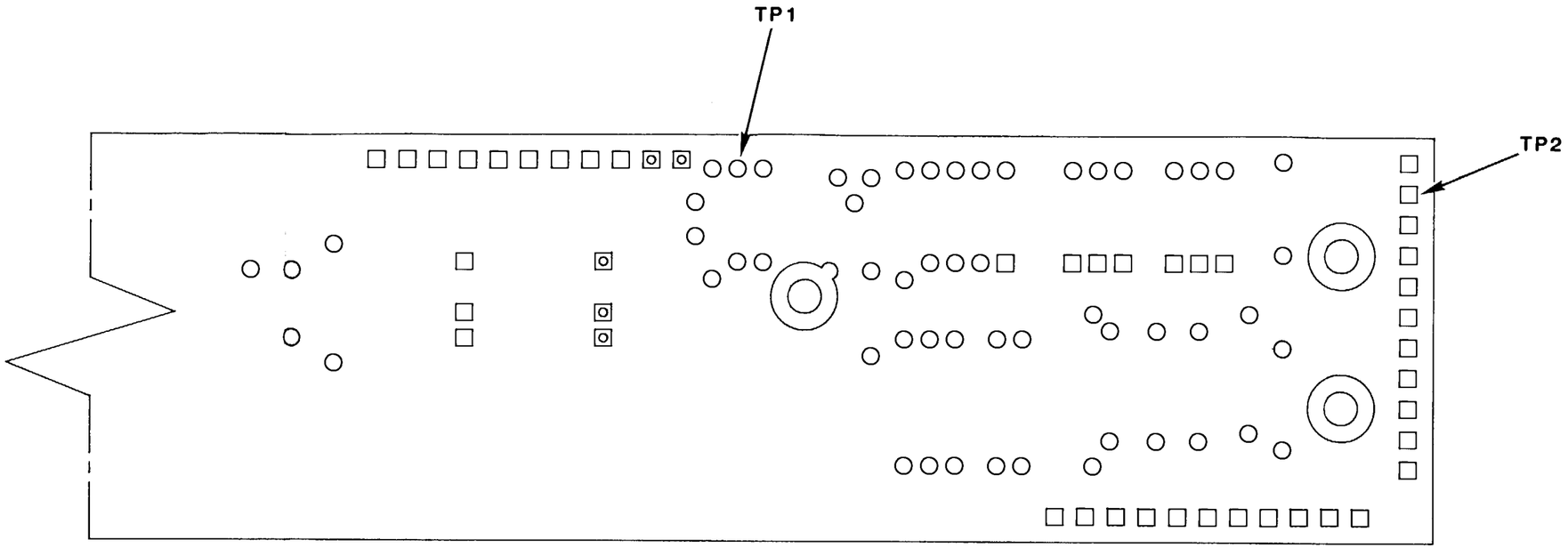
A1 Attenuator Board Troubleshooting (1 of 2) Figure FO-3



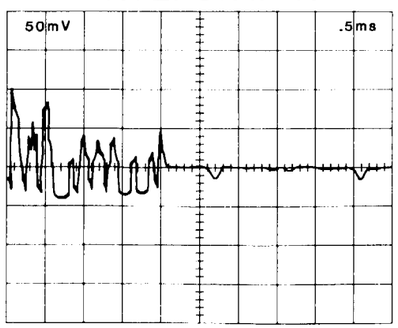
A1 Attenuator Board Troubleshooting (2 of 2) Figure FO-3



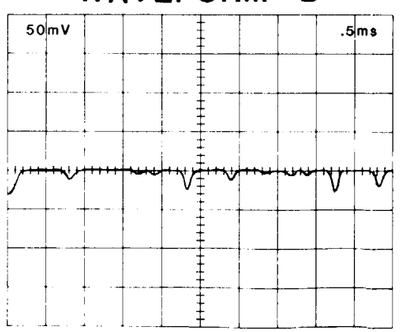
A2 Amplifier Board Test Point Layout Figure FO-4



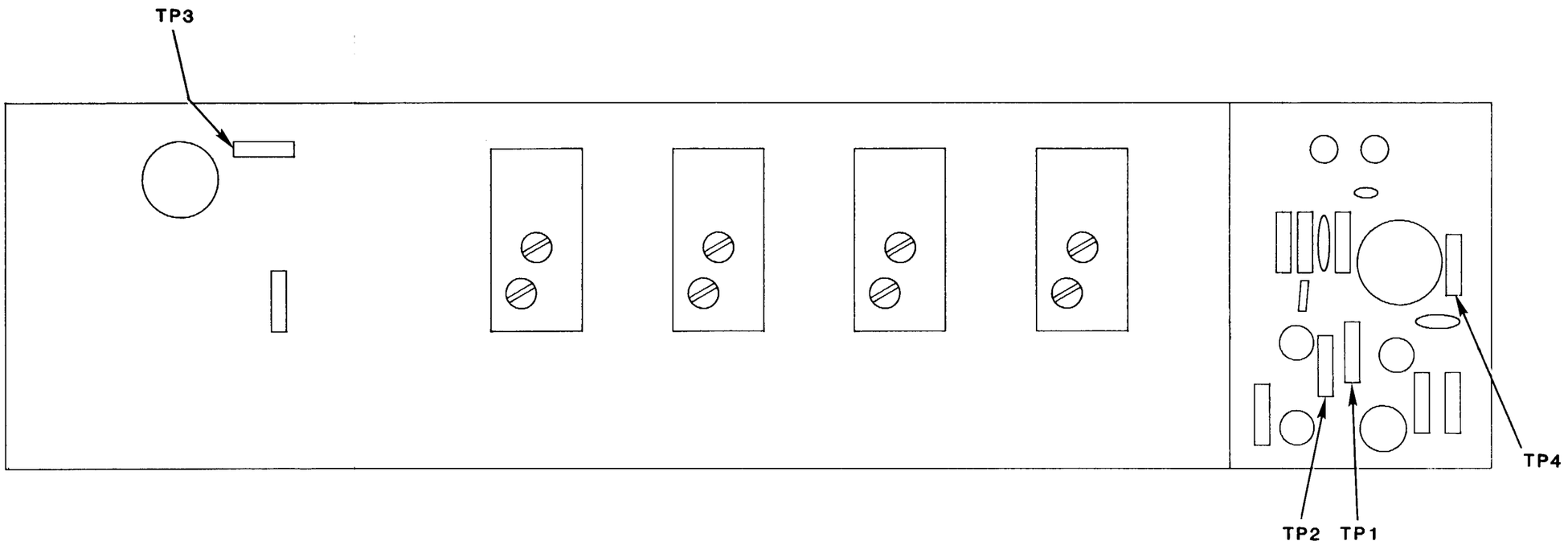
WAVEFORM "A"



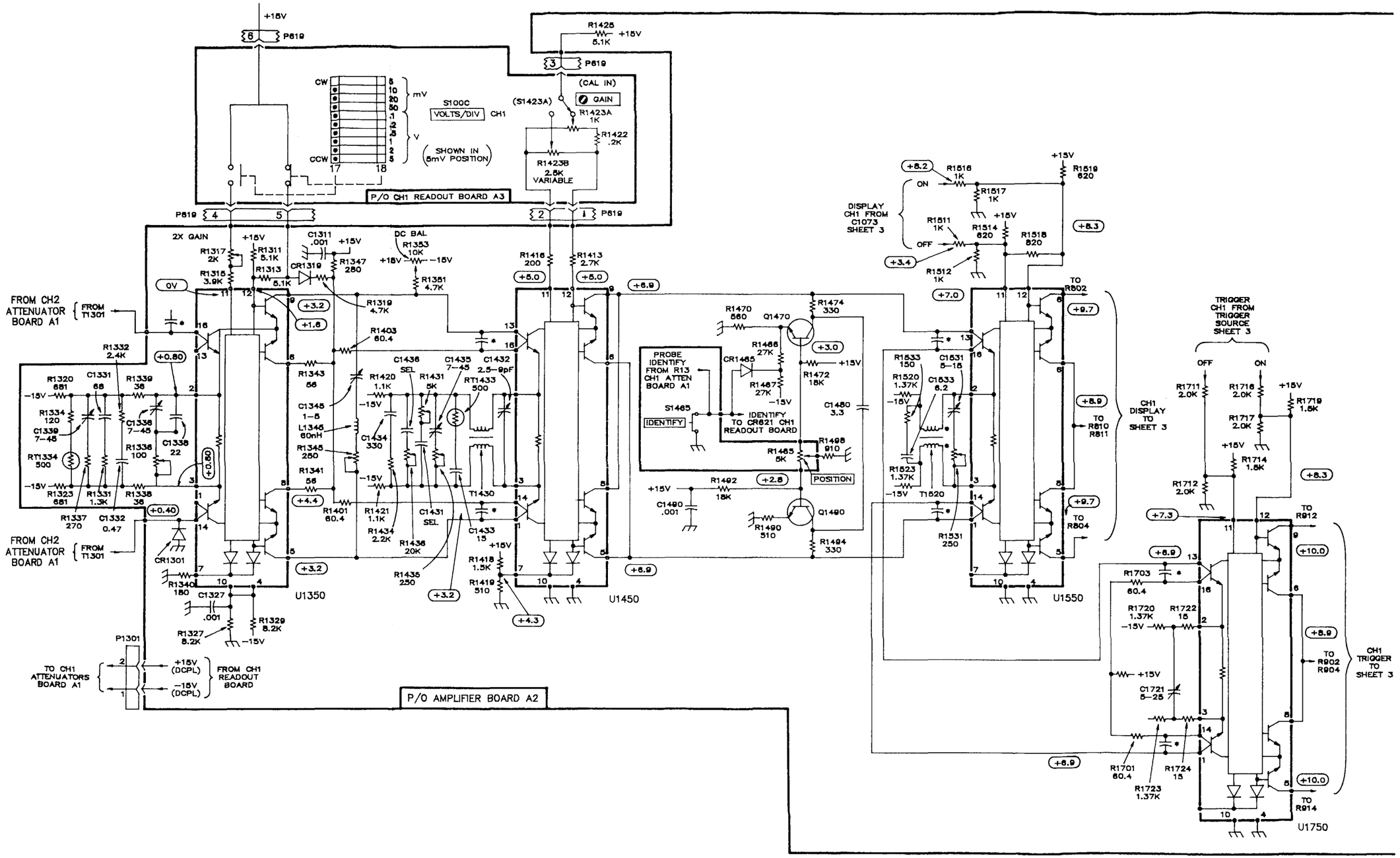
WAVEFORM "B"



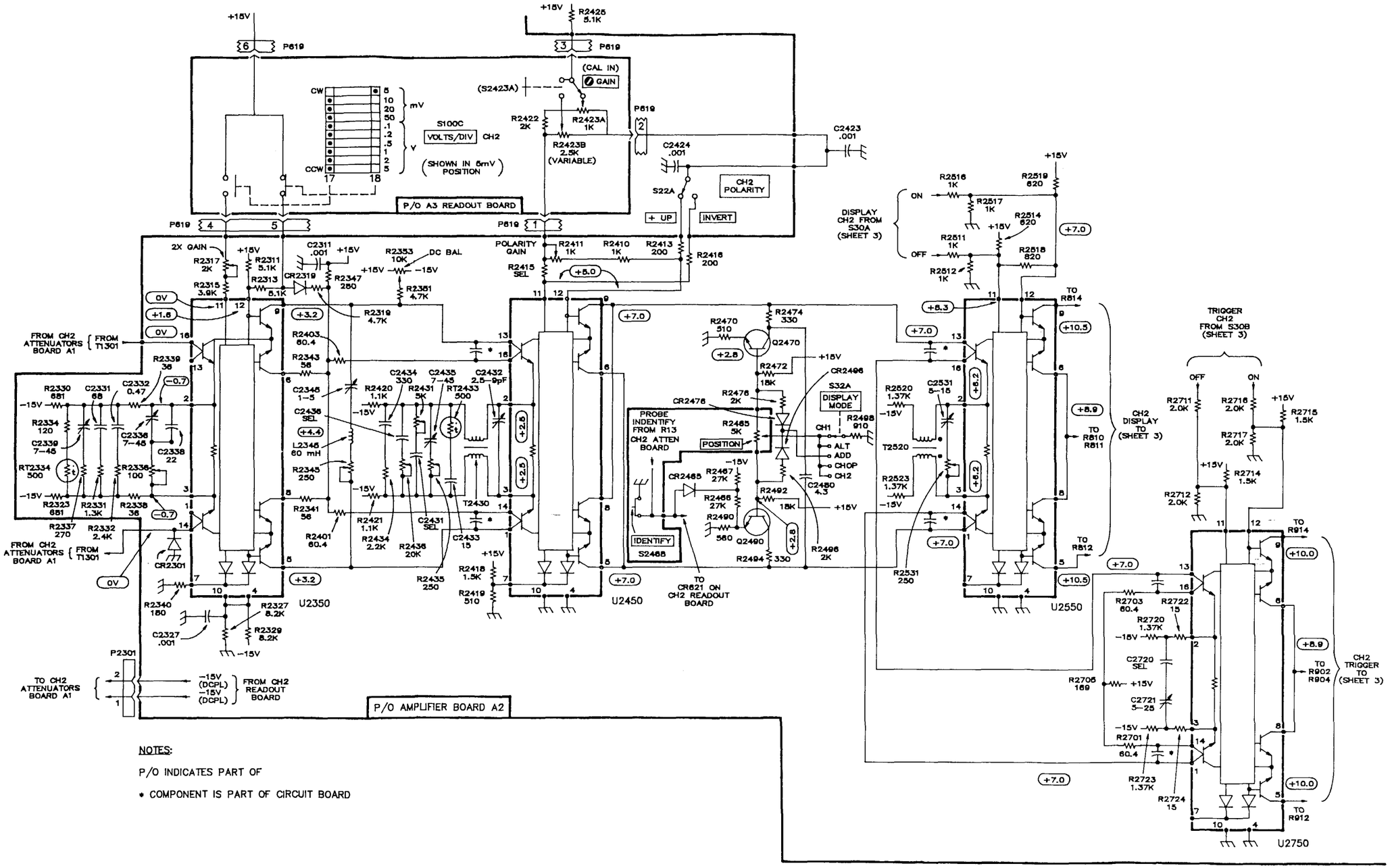
A3 Readout Board (Rear View) Figure FO-5



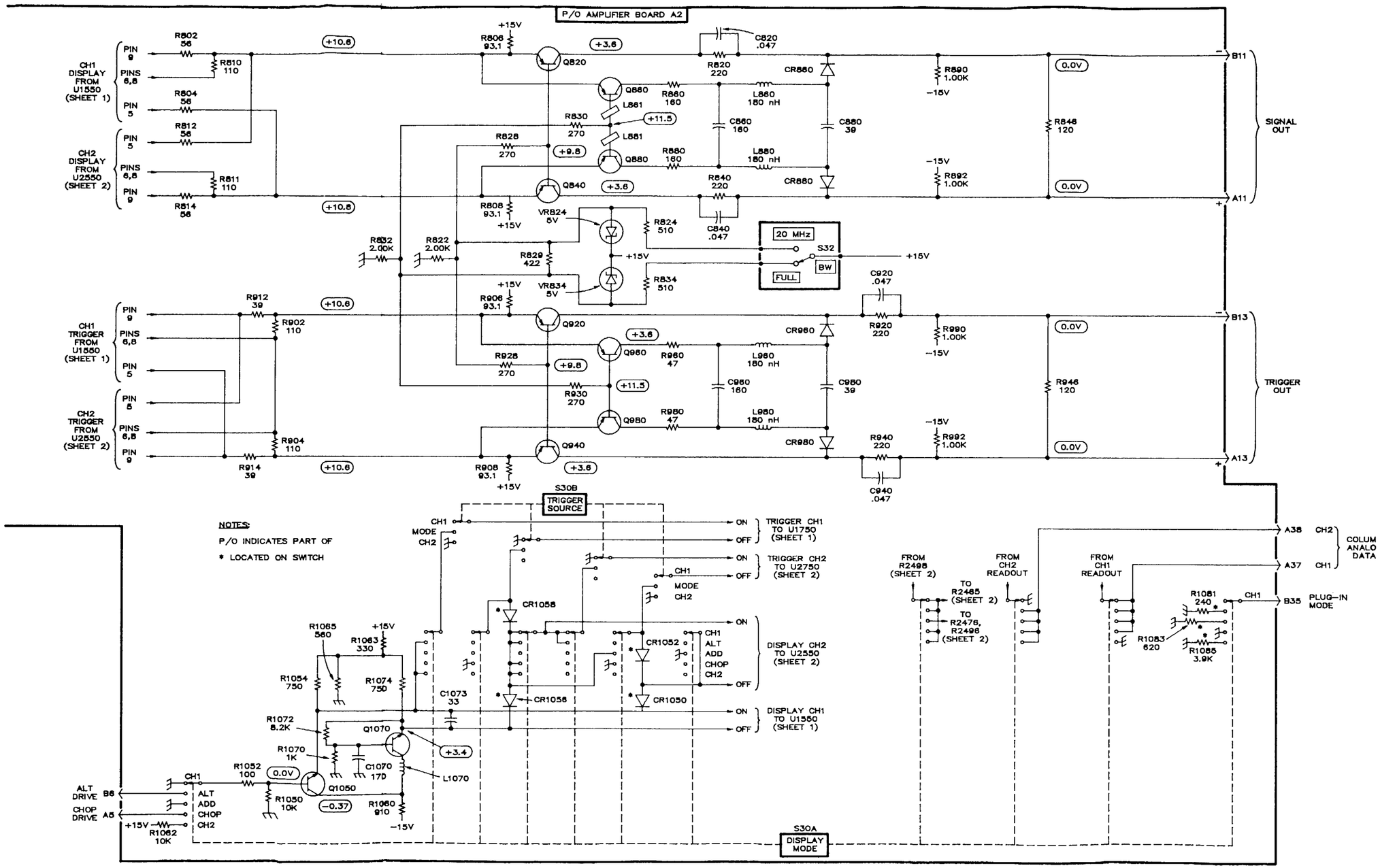
A1 Attenuator Board Figure FO-6



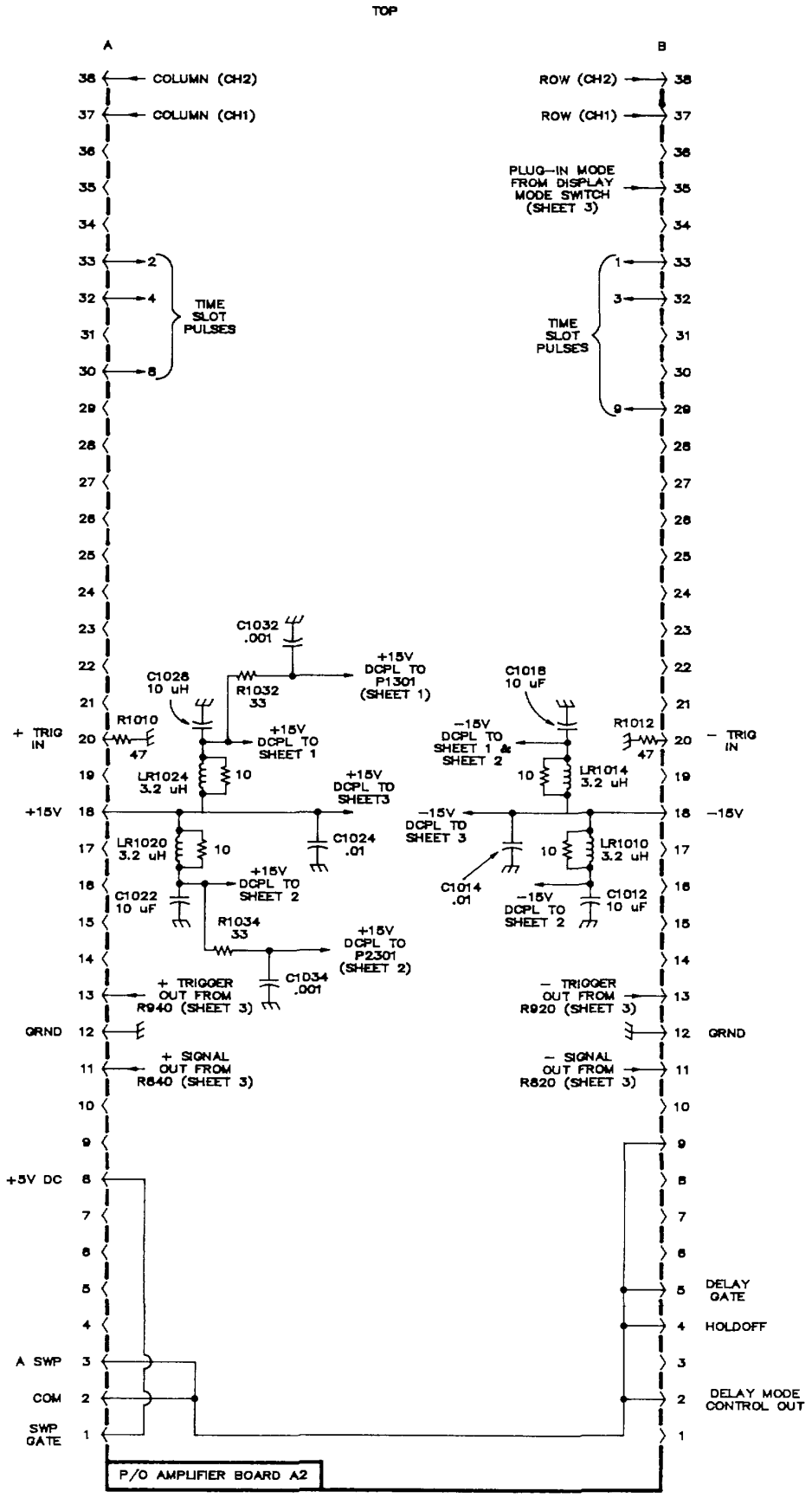
A2 Board (Ch1 Amplifier) (1 of 4) Figure FO-7



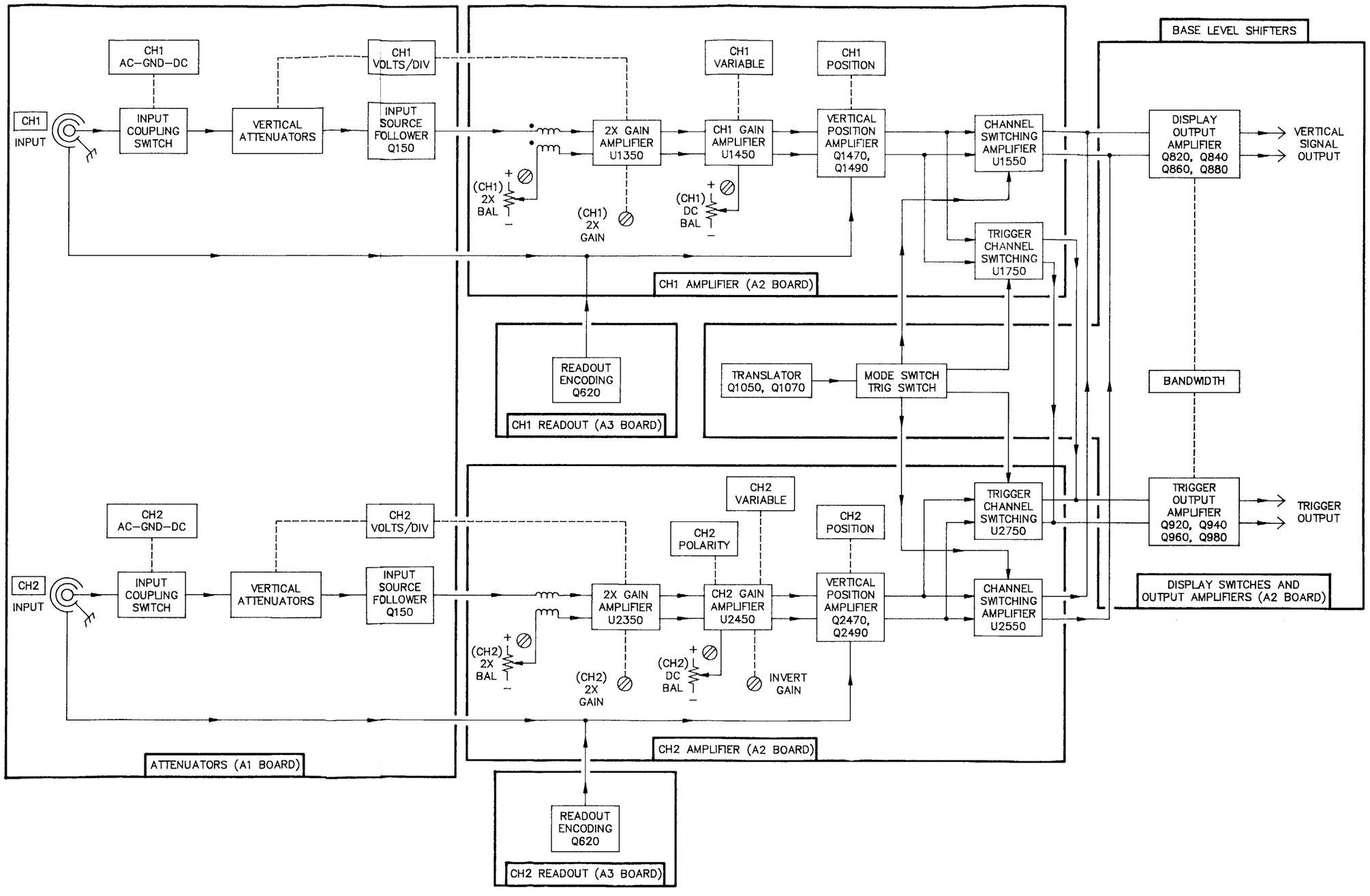
A2 Board (CH2 Amplifier) (2 of 4) Figure FO-7



A2 Board (Display Switching and Output) (3 of 4) Figure FO-7



A2 Board (Interface Connections) (4 of 4) Figure FO-7



Block Diagram Figure FO-8

RECOMMENDED CHANGES TO EQUIPMENT TECHNICAL PUBLICATIONS

SOMETHING WRONG WITH THIS PUBLICATION?

FROM (PRINT YOUR UNIT'S COMPLETE ADDRESS)
Commander
Stateside Army Depot
ATTN: AMSTA-US
Stateside, N.J. 07703-5007

DATE SENT
10 July 1975

PUBLICATION NUMBER	PUBLICATION DATE	PUBLICATION TITLE
TM 11-5840-340-12	23 Jan 74	Radar Set AN/PRC-76

BE EXACT PIN-POINT WHERE IT IS

PAGE NO	PARA-GRAPH	FIGURE NO	TABLE NO
2-25	2-28		
3-10	3-3		3-1
5-6	5-8		
		F03	

IN THIS SPACE TELL WHAT IS WRONG AND WHAT SHOULD BE DONE ABOUT IT:

Recommend that the installation antenna alignment procedure be changed throughout to specify a 2^{o} IFF antenna lag rather than 1^{o}.

REASON: Experience has shown that with only a 1^{o} lag, the antenna servo system is too sensitive to wind gusting in excess of 25 knots, and has a tendency to rapidly accelerate and decelerate as it hunts, causing strain to the drive train. Hunting is minimized by adjusting the lag to 2^{o} without degradation of operation.

Item 5, Function column. Change "2 db" to "3db."

REASON: The adjustment procedure for the TRANS POWER FAULT indicator calls for a 3 db (500 watts) adjustment to light the TRANS POWER FAULT indicator.

Add new step f.1 to read, "Replace cover plate removed in step e.1, above."

REASON: To replace the cover plate.

Zone C 3. On J1-2, change "+24 VDC to "+5 VDC."

REASON: This is the output line of the 5 VDC power supply. +24 VDC is the input voltage.

PRINTED NAME GRADE OR TITLE AND TELEPHONE NUMBER
SSG I. M. DeSpiritof 999-1776

SIGN HERE
I. M. DeSpiritof

DA FORM 1 JUL 79 2028-2

PREVIOUS EDITIONS ARE OBSOLETE.

P.S.--IF YOUR OUTFIT WANTS TO KNOW ABOUT YOUR RECOMMENDATION MAKE A CARBON COPY OF THIS AND GIVE IT TO YOUR HEADQUARTERS

TEAR ALONG PERFORATED LINE

REVERSE OF DA FORM 2028-2

TEAR ALONG PERFORATED LINE

FILL IN YOUR UNIT'S ADDRESS

FOLD BACK

DEPARTMENT OF THE ARMY

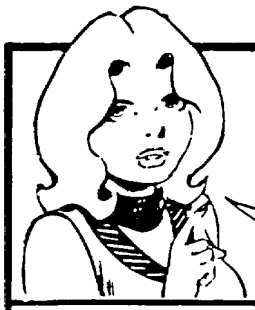
POSTAGE AND FEES PAID
DEPARTMENT OF THE ARMY
DOD 314

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE $300

SAMPLE

Commander
US Army Communications-Electronics Command
and Fort Monmouth
ATTN: AMSEL-PA-ME-MP
Fort Monmouth, New Jersey 07703-5000

RECOMMENDED CHANGES TO EQUIPMENT TECHNICAL PUBLICATIONS



THEN...JOT DOWN THE DOPE ABOUT IT ON THIS FORM. CAREFULLY TEAR IT OUT, FOLD IT AND DROP IT IN THE MAIL.

SOMETHING WRONG WITH THIS PUBLICATION?

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