

**Tektronix®**  
COMMITTED TO EXCELLENCE

**TR 503**  
**TRACKING**  
**GENERATOR**

**INSTRUCTION MANUAL**

**Tektronix, Inc.**  
**P.O. Box 500**  
**Beaverton, Oregon 97077**

Serial Number \_\_\_\_\_

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## WARNING

*THE FOLLOWING SERVICING INSTRUCTIONS ARE FOR USE BY QUALIFIED PERSONNEL ONLY. TO AVOID PERSONAL INJURY, DO NOT PERFORM ANY SERVICING OTHER THAN THAT CONTAINED IN OPERATING INSTRUCTIONS UNLESS YOU ARE QUALIFIED TO DO SO.*

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# OPERATORS SAFETY SUMMARY

The general safety information in this part of the summary is for both operating and servicing personnel. Specific warnings and cautions will be found throughout the manual where they apply, but may not appear in this summary.

## Terms In This Manual

**CAUTION** statements identify conditions or practices that could result in damage to the equipment or other property.

**WARNING** statements identify conditions or practices that could result in personal injury or loss of life.

## Terms As Marked on Equipment

**CAUTION** indicates a personal injury hazard not immediately accessible as one reads the marking, or a hazard to property including the equipment itself.

**DANGER** indicates a personal injury hazard immediately accessible as one reads the marking.

## Symbols In This Manual



This symbol indicates where applicable cautionary or other information is to be found.

## Symbols As Marked on Equipment



**DANGER** — High voltage.



Protective ground (earth) terminal.



**ATTENTION** — refer to manual.

## Power Source

The mainframe is intended to operate from a power source that does not apply more than 250 volts rms between the

supply conductors or between either supply conductor and ground. A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation.

## Grounding the Product

This mainframe is grounded through the grounding conductor of the power cord. To avoid electrical shock, plug the power cord into a properly wired receptacle before connecting to the product input or output terminals. A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation.

## Danger Arising From Loss of Ground

Upon loss of the protective-ground connection, all accessible conductive parts (including knobs and controls that may appear to be insulating) can render an electric shock.

## Do Not Operate in Explosive Atmospheres

To avoid explosion, do not operate this product in an explosive atmosphere unless it has been specifically certified for such operation.

## Do Not Remove Covers or Panels

To avoid personal injury, do not remove the product covers or panels. Do not operate the product without the covers and panels properly installed.

## Do Not Operate Without Covers (for TM 500 plugs only)

To avoid personal injury, do not operate this product without covers or panels installed. Do not apply power to the plug-in via a plug-in extender.

## **SERVICING SAFETY SUMMARY**

### **FOR QUALIFIED SERVICE PERSONNEL ONLY**

*Refer also to the preceding Operators Safety Summary.*

#### **Do Not Service Alone**

Do not perform internal service or adjustment of this product unless another person capable of rendering first aid and resuscitation is present.

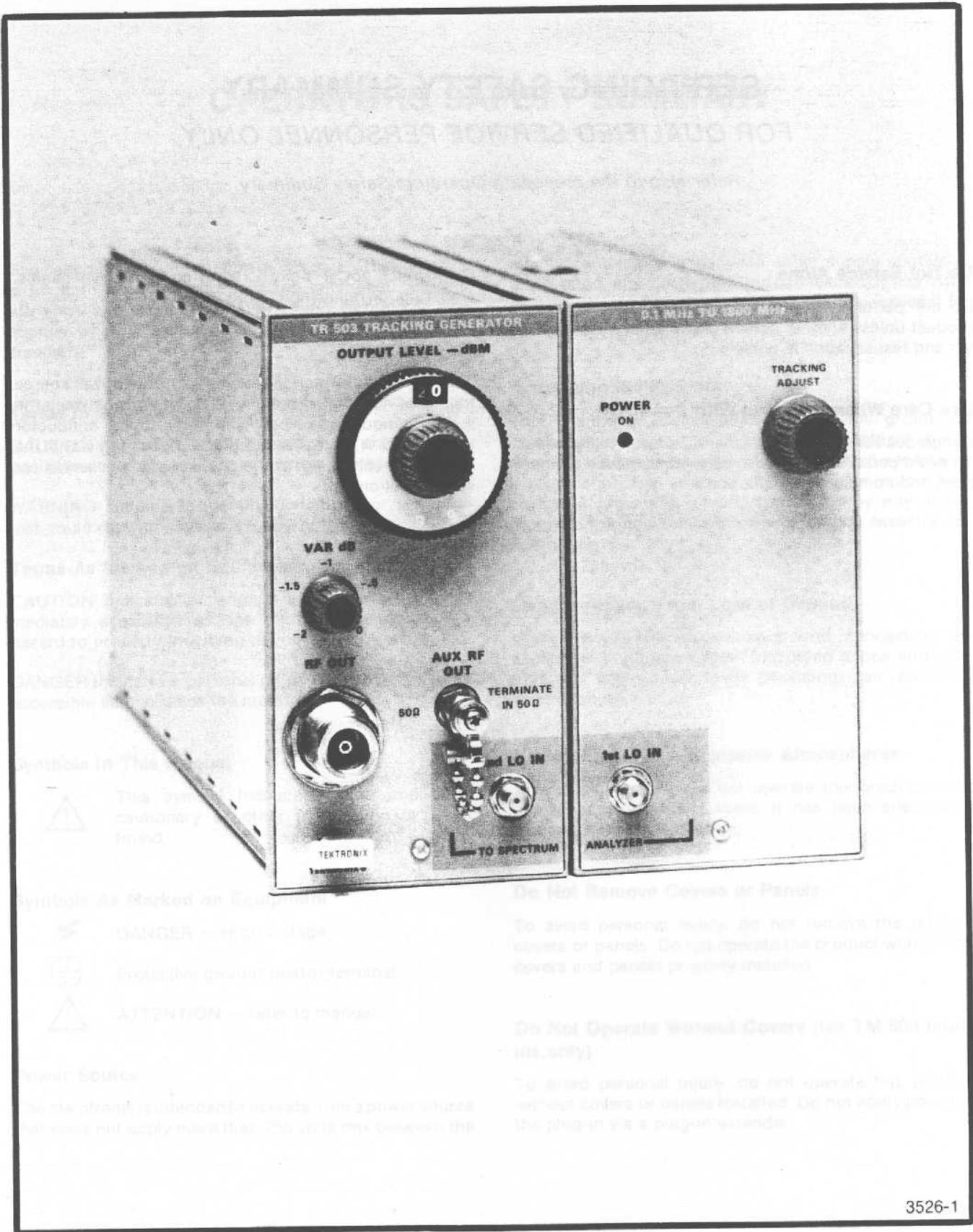
#### **Use Care When Servicing With Power On**

Dangerous voltages exist at several points in this product. To avoid personal injury, do not touch exposed connections and components while power is on.

Disconnect power before removing protective panels, soldering, or replacing components.

#### **Power Source**

The mainframe is intended to operate from a power source that does not apply more than 250 volts rms between the supply conductors or between either supply conductor and ground. A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation.



TR 503 Tracking Generator

3526-1

# GENERAL INFORMATION AND SPECIFICATIONS

## Introduction

The TR 503 may be used to measure the frequency response of a device or component over a 100 kHz to 1.8 GHz range. It is used in conjunction with a TM 500 mainframe and a 492 Spectrum Analyzer. The tracking generator/spectrum analyzer method of response measurement has intrinsically greater rejection of device or environmental noise than the alternate swept sine-wave method.

The greater noise rejection is gained by having the 492 Spectrum Analyzer track the TR 503 output. Noise rejection is improved as the Resolution Bandwidth of the 492 is decreased; this is due to the 492 being immune to noise outside of the VR (Variable Resolution IF) bandwidth.

The TR 503 uses the 1st and 2nd LO (local oscillator) outputs of the 492 to generate a frequency that tracks the input of the 492. The TRACKING ADJUST control of the TR 503 allows fine adjustment of this frequency.

Points on the 492 display may have their frequencies measured by adding a frequency counter, such as the DC 508, to the TR 503/492 system. Measurements may be made directly from an external rf spectrum or obtained from the response curve of a device under test.

## Overview

The Operators part of the manual is intended to help the user obtain maximum performance from the TR 503/492 system. This part covers General Information and the Operating Instructions.

The Service part of the manual covers the Theory of Operation, the Calibration section, and other service information, including the block and schematic diagrams of the TR 503.

The eight sections of the manual are:

### Operators

Section 1—General Information and Specifications; contains the instrument description, a list of accessories, and a listing of the TR 503 Characteristics and Performance Requirements.

Section 2—Operating Instructions; introduces the user to the TR 503/492 system and demonstrates a series of measurement procedures.

### Service

Section 3—Theory of Operation; describes all major circuits of the TR 503.

Section 4—Calibration, Part 1: Performance Check; this subsection is used to verify all of the Performance Requirements in the Specification, and to determine the need for recalibration (adjustment) of the TR 503.

Section 4—Calibration, Part 2: Adjustment Procedure; this subsection is used to return the TR 503 to conformance with the Performance Requirements. The procedure is arranged in functional blocks to facilitate referencing from the Performance Check and the Maintenance Instructions.

Section 5—Maintenance Instructions; describes routine and corrective maintenance procedures with detailed instructions for replacing assemblies, sub-assemblies, and individual components. An exploded drawing is part of Section 8.

Section 6—Replaceable Electrical Parts; provides information necessary to order replaceable parts and assemblies related to the electrical functions of the instrument.

Section 7—Diagrams; provides functional block diagram and circuit schematics. Pictorial layout drawings which show subassembly and component locations are adjacent to the diagram (usually on the back of the preceding diagram). Voltage and signal levels are included to aid in troubleshooting.

Section 8—Replaceable Mechanical Parts; provides information necessary in order to replace mechanical parts. This list is cross-referenced to the replaceable electrical parts list where appropriate. The Exploded Drawing shows the assembly sequence and identifies the assemblies. The Accessories page lists the standard and optional accessories.

Changes and Corrections; provides updating information for the manual in the form of inserts. These inserts are incorporated into the manual text and diagrams when the manual is updated.

**Standards**

The abbreviations and graphic symbols used in the text and diagrams of this manual are based on ANSI Y1.1-1972, ANSI Y32.2-1970, and ANSI Y32.14-1973 (American National Standards Institute, 345 East 47 Street, New York, N.Y. 10017).

# SPECIFICATIONS

The following specifications apply to the TR 503 Tracking Generator and the TR 503/492 Spectrum Analyzer system. Allow at least 30 minutes warmup unless noted otherwise.

Items listed in the Performance Requirements column are verified by completing the Performance Check in Section 4 of this manual. Items listed in the Supplemental Information column may not be verified in this manual; they are either explanatory notes or performance characteristics for which no limits are specified.

**Table 1-1  
ELECTRICAL CHARACTERISTICS**

Characteristic	Performance Requirement	Supplemental Information
Frequency Range	The TR 503 tracks the 492 tuned input frequency from 100 kHz to 1.8 GHz.	
Output Level		
Maximum Output	0 dBm $\pm$ 0.5 dB.	
Adjustment Steps	0 to 9 dB in 1 dB steps. 0 to 50 dB in 10 dB steps.	An additional 2 dB attenuation is provided by the front panel VAR dB control.
Attenuator Error	$\pm$ 0.2 dB for each 1 dB change. Total error over the 59 dB range is $\pm$ 2 dB.	
Output Impedance		50 $\Omega$ nominal, VSWR is 2:1 or less to 1.8 GHz.
Flatness		
TR 503	$\pm$ 0.75 dB from 100 kHz to 1.8 GHz, referred to 100 MHz.	
TR 503/492 System	$\pm$ 2.25 dB from 100 kHz to 1.8 GHz, referred to 100 MHz.	Typically $\pm$ 2 dB or better.
Dynamic Range		
TR 503/492 System		$\geq$ 110 dB
Residual FM (peak-to-peak)		
TR 503		$\leq$ 1 Hz
TR 503/492 System		$\leq$ 10 Hz or same as 492, whichever is greater.

Table 1-1 (cont)

Characteristic	Performance Requirement	Supplemental Information
Auxiliary Output Level	0.1 V rms minimum, into a 50 $\Omega$ load.	
Spurious Signals (100 kHz—1.8 GHz)		
Harmonic	−20 dB or better with respect to the fundamental.	
Non-Harmonic	−40 dB or better with respect to the fundamental.	

Table 1-2

## ENVIRONMENTAL CHARACTERISTICS

Characteristic	Description
Temperature Range	
Operating	0 to +50°C.
Non-Operating	−40 to +75°C.
Altitude Range	
Operating	To 15,000 feet.
Non-Operating	To 50,000 feet.

Table 1-3

## PHYSICAL CHARACTERISTICS

Characteristic	Description
Finish	Anodized aluminum panel and chassis. Front panel faced with matt plastic.
Net Weight	8 lbs (3.64 kg)
Overall Dimensions	5.28 in (134.1 mm) H X 12 in. (304.8 mm) D X 4.96 in (126 mm) H.

## STANDARD ACCESSORIES

Refer to tabbed pullout sheet at the end of the Replaceable Mechanical Parts section.

# OPERATING INSTRUCTIONS

## Introduction

This section describes the functions of the TR 503/492 system, the installation procedure, the controls and connectors, and the checkout procedure.

## About the Tracking Generator

The TR 503 Tracking Generator is a two-wide instrument that plugs into a TM 500 mainframe. It provides the 492 Spectrum Analyzer with a level-calibrated RF signal source that tracks the input frequency of the analyzer from 100 kHz to 1.8 GHz. The output of the TR 503 is adjustable from 0 to -59 dBm in 1 dB steps. The TR 503/492 system can be used to display the frequency response of various devices such as filters, amplifiers, two-way transmission lines, etc., by connecting the devices between the TR 503 output and the 492 input.

If the 492 has Digital Storage, it is possible to conveniently measure frequencies appearing on the screen of the 492 by using a DC 508 Frequency Counter connected to the AUX RF OUTPUT of the TR 503. These three instruments may be used to check frequencies appearing in RF spectra as well as making closed-loop response measurements.

## Installation

The TR 503 was inspected both mechanically and electrically before shipment. It should be free of marks or scratches and electrically meet or exceed all specifications. To confirm this, inspect the instrument for physical damage incurred in transit and test the electrical performance by following the Operators Checkout Procedure in this section. If there is a problem, contact your local Tektronix Field Office or representative.

Install the TR 503 by aligning its guide rails with the tracks of mainframe compartment and then pushing the TR 503 into the compartment until the instruments' front panel is flush with the front panel of the mainframe. To remove the TR 503, pull the release latch on the lower left front panel. Refer to Fig. 2-1.

## Repackaging

Save and re-use the TR 503 shipping container. If the original container is not available or damaged, repackage the TR 503 as follows:

1. Attach a tag to the TR 503 that shows: name and address of firm, name of person responsible for the TR 503, serial number, and a description of the service required.

2. Obtain a shipping container made of heavy corrugated cardboard or wood. To allow for cushioning, make sure that the inside dimensions are no less than 12 by 12 by 18 inches (300 by 300 by 450 mm). This container should have a carton test strength of no less than 275 pounds (605 kg).

3. To protect the finish of the TR 503, wrap it in heavy paper or polyethylene. Protect the front panel with urethane foam or strips of cardboard.

4. Cushion the TR 503 by tightly packing urethane foam or dunnage between the TR 503 and the shipping container. Allow at least 3 inches on all sides.

5. Seal the container with shipping tape or an industrial stapler.

If there are any questions, contact the nearest Tektronix Field Office or representative.

## Functions of the Controls and Connectors

### Front Panel Controls:

**OUTPUT LEVEL:** Selects 0 to 59 dB of attenuation in 1 dB steps. Controls the level of the RF OUTPUT but does not affect the AUX RF OUTPUT.

**VAR dB:** Provides a 0 to 2 dB range of attenuation that is continuously variable. Controls the level of both the RF OUTPUT and the AUX RF OUTPUT.

**TRACK ADJUST:** Adjusts the frequency offset between the TR 503 RF OUTPUT and the input frequency of the 492 Spectrum Analyzer.

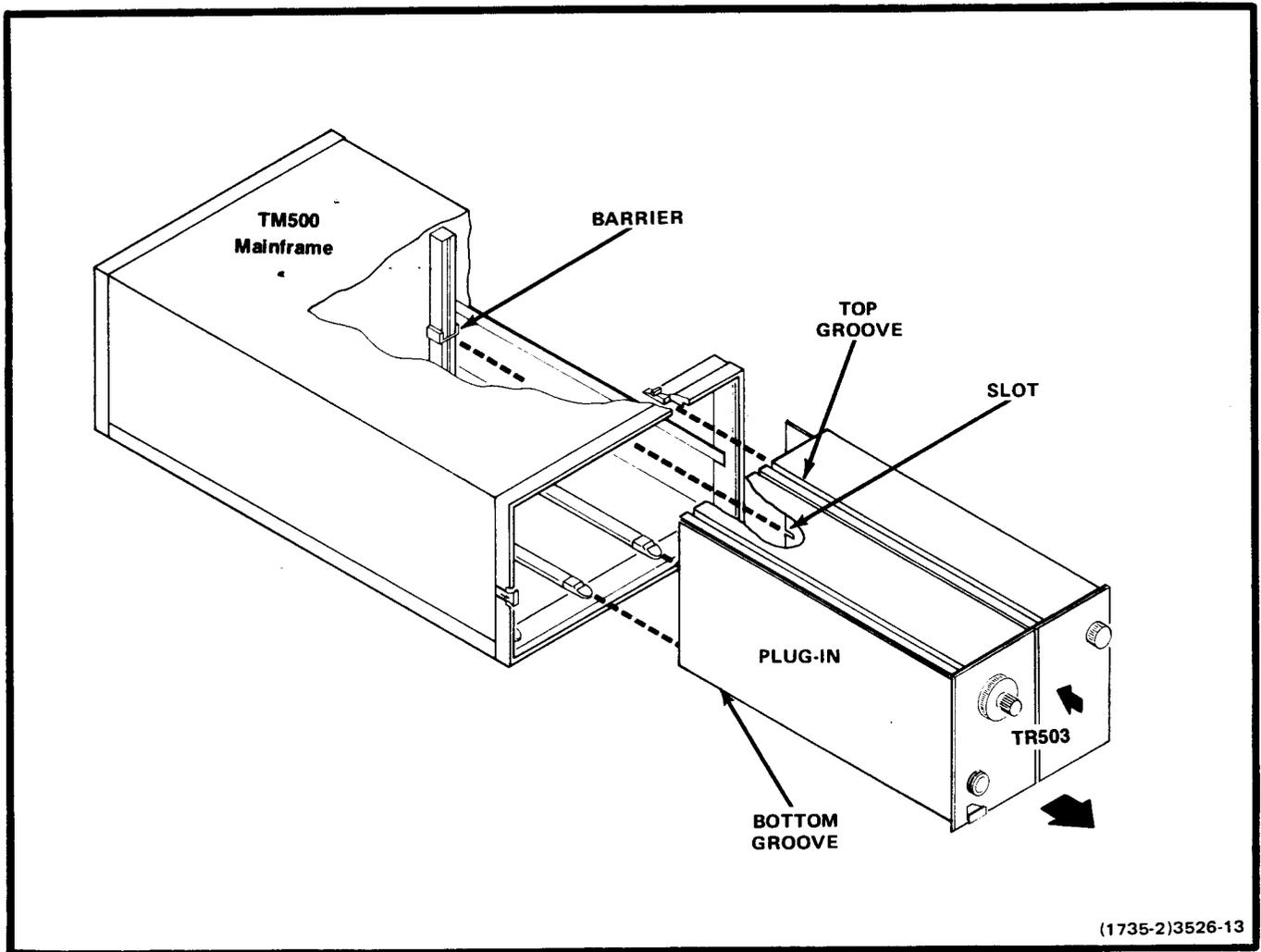


Fig. 2-1. Plug-in module Installation.

**Output Connectors:**

**RF OUT.** A 0 to -61 dBm RF signal source that tracks the input frequency of the spectrum analyzer. This must be terminated in 50  $\Omega$  to maintain flat response.

**AUX RF OUT:** A RF signal source for auxiliary equipment such as a frequency counter. This must be terminated in 50  $\Omega$  to maintain flat response.

**Input Connectors:**

**1st LO IN:** This accepts a signal from the 1st local oscillator (LO) of the 492 Spectrum Analyzer.

**2nd LO IN:** This accepts a signal from the 2nd local oscillator of the 492 Spectrum Analyzer.

**Operators Checkout Procedure**

Prepare the TR 503/492 system as follows:

- a. Insert the TR 503 and frequency counter into a TM 500 mainframe.
- b. Using the coaxial cables supplied with the standard accessories, connect the 1st LO output port of the 492 to the 1st LO IN of the TR 503. Connect the 2nd LO output port of the 492 to the 2nd LO IN of the TR 503.
- c. If a frequency counter such as the DC 508 is used, connect the AUX RF OUTPUT of the TR 503 to the 50  $\Omega$  input of the counter.
- d. Compare the connections with Fig. 2-2. The dotted lines are used to show the connections used in the

Frequency Measuring Procedure at the end of this section. The 492 Spectrum Analyzer is shown connected to either an antenna or a device under test.

e. Switch on power to all units. Warm up the instruments for at least a half-hour. (Procedure 4, Measuring Frequency, requires a two-hour warmup.) Set the Time/Div control on the 492 to Auto.

**1. Check Flatness**

a. Set the 492 Reference Level to 0 dBm, the Frequency to 100 MHz, the Span/Div to 1 MHz, and the Vertical Display to 2 dB/Div.

b. Adjust the TR 503 OUTPUT LEVEL and VAR dB controls so the 492 display lies on the -4 dBm line (2 divisions below the top of the screen).

c. Increase the 492 Span/Div to Max. Confirm that the response of the TR 503/492 system is within  $\pm 2.25$  dB with reference to 100 MHz over the 100 kHz to 1.8 GHz span.

d. Reset the 492 Vertical Display to 10 dB/Div.

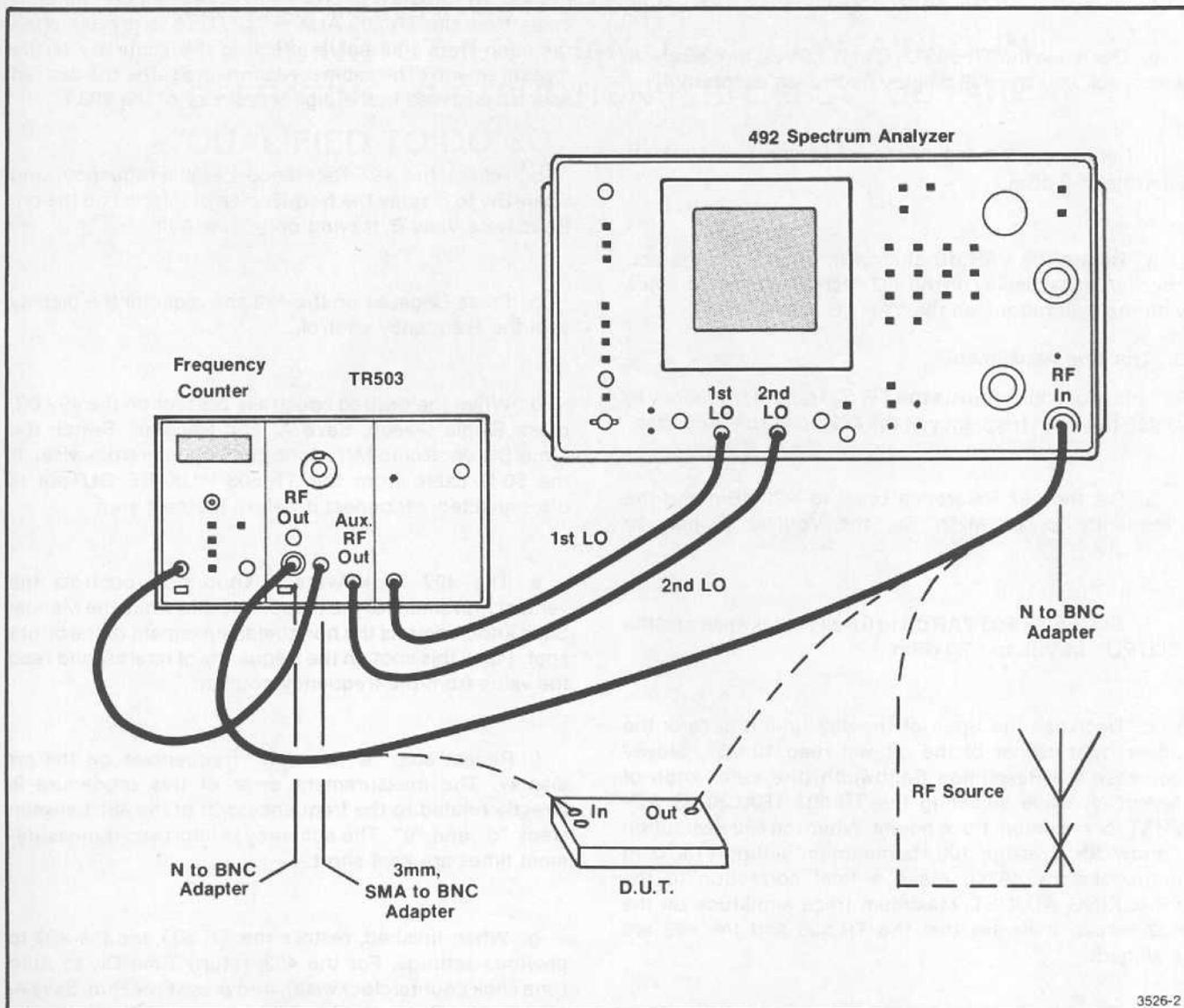


Fig. 2-2. TR 503/492 System with Frequency Counter.

## Operating Instructions—TR 503

### 2. Check Output Level

a. Set the TR 503 OUTPUT LEVEL and VAR dB to 0 dBm (VAR dB is fully clockwise).

b. Decrease the OUTPUT LEVEL to -50 dBm in -10 dB increments while decreasing the 492 Reference Level in equal increments. Check that the display level remains constant.

c. Return the OUTPUT LEVEL to 0 dBm.

d. Set the 492 Reference Level to 0 dBm, the Span/Div to 1 MHz, and the Vertical Display to 2 dB/Div. Set the 492 display on a horizontal line by slowly adjusting the TR 503 VAR dB control.

e. Decrease the TR 503 OUTPUT LEVEL in 1 dB steps and check that the 492 display decreases accordingly.

f. Return the TR 503 OUTPUT LEVEL and VAR dB controls to 0 dBm.

g. Rotate the VAR dB control through its range and check that the display on the 492 decreases in accordance with the calibrations on the VAR dB scale.

### 3. Tracking Adjustment

This procedure adjusts the TR 503 output frequency to match the input frequency of the 492 Spectrum Analyzer.

a. Set the 492 Reference Level to -20 dBm and the Frequency to 100 MHz. Set the Vertical Display to 2 dB/Div.

b. Set the TR 503 VAR dB to 0 (fully clockwise) and the OUTPUT LEVEL to -20 dBm.

c. Decrease the Span of the 492 until it is zero; the upper right corner of the crt will read 10 MS/. Slowly decrease the Resolution Bandwidth (the outer knob of Span/Div) while adjusting the TR 503 TRACKING ADJUST for maximum trace height. When the 492 Resolution Bandwidth is at the 100 Hz minimum setting (1 kHz in non-phaselock 492s), make a final correction to the TRACKING ADJUST. Maximum trace amplitude on the 492 screen indicates that the TR 503 and the 492 are matched.

d. The TRACKING ADJUST is now set for the 492 in the test set-up. If a different 492 is substituted, the TRACKING ADJUST will have to be reset.

e. On the 492, press Auto Resolution and rotate Span/Div clockwise into the MHz range. Set the Reference Level to 0 dBm. Set the TR 503 OUTPUT LEVEL to 0 dB.

### 4. Measuring Frequency

A 492 Spectrum Analyzer with digital storage (option 2) is recommended for this procedure. Referring to Fig. 2-2, connect and operate the system as follows:

a. To measure the frequency response of a device under test (DUT), close the circuit between the spectrum analyzer and the tracking generator by connecting the DUT between the 492 RF Input and the TR 503 RF OUTPUT. The DUT must have 50  $\Omega$  terminations on both input and output for this measurement to be valid.

To measure frequencies in an RF spectrum, connect the 492 RF Input to the RF source. Disconnect the 50  $\Omega$  cable from the TR 503 AUX RF OUTPUT to prevent stray radiation from this cable affecting the accuracy of the measurement. (The cable is reconnected after the desired spectra is stored in the digital memory of the 492.)

b. Adjust the 492 Reference Level, Frequency, and Span/Div to display the frequencies of interest on the crt. Deactivate View B, leaving only View A lit.

c. Press Degauss on the 492 and recenter the display with the Frequency control.

d. When the desired spectra is present on the 492 crt, press Single Sweep, Save A, and Readout. Switch the Time/Div control to MNL (one click counterclockwise). If the 50  $\Omega$  cable from the TR 503 AUX RF OUTPUT is disconnected, reconnect it before the next step.

e. The 492 Peak/Average knob now controls the vertical movement of the cursor line and while the Manual Scan knob controls the horizontal movement of the bright spot. Place this spot on the frequency of interest and read the value from the frequency counter.

f. Repeat step "e" for other frequencies on the crt display. The measurement error of this procedure is directly related to the frequency drift of the 492 between steps "d" and "e". The accuracy is improved if measurement times are kept short.

g. When finished, restore the TR 503 and the 492 to previous settings. For the 492, return Time/Div to Auto (one click counterclockwise), and press Free Run, Save A, View B, and Readout. Move the cursor to either the top or bottom of the screen, depending on choice of average or peak detection.

# THEORY OF OPERATION

This section describes the functions of the major circuits and their relationships to each other. The descriptions are intended for the knowledgeable user and for the technician servicing the instrument.

The section begins with the general description, followed by the block diagram description, and ending with a detailed analysis of the major circuits. Voltage data, signal levels, and frequencies are provided in the diagrams to clarify understanding of circuit functions.

## GENERAL DESCRIPTION

This subsection begins with a quick review of the signal flow through a 492 Spectrum Analyzer. The next two paragraphs "freeze" the swept output of the TR 503 at 500 MHz and describe the signals appearing at the major points of the TR 503/392 system. The last paragraph discusses details not immediately apparent from the preceding discussion. This subsection is intended to be used with Fig. 3-1, the System Diagram.

The 492 Spectrum Analyzer mixes the input signal with the 1st LO (local oscillator) frequency, obtaining a 1st IF (intermediate frequency) of 2.072 GHz. This IF is then mixed with the 2nd LO, obtaining a 2nd IF at 110 MHz. This product is then mixed with the 100 MHz 3rd LO, obtaining a final IF at 10 MHz. This signal is passed through a VR (variable resolution) stage, a log amplifier, and a peak/average detector. The detector output is either digitized and stored or sent directly to the video amplifier of the crt.

The following signals are found within the 492 Spectrum Analyzer when 500 MHz is applied to the input. The 2.572 GHz signal of the 1st LO is mixed with the input, obtaining a 1st IF of 2.072 GHz. This IF is then mixed with a 2.182 GHz signal from the 2nd LO, obtaining a 2nd IF at 110 MHz. This IF is sent to the remaining stages of the 492 (described above).

The following signals are found within the TR 503 Tracking Generator when it produces a 500 MHz output. The TR 503 accepts the 2.182 GHz 2nd LO signal and generates a phase-locked signal 110 MHz lower—at 2.072 GHz. This signal is then mixed with the 1st LO signal of 2.572 GHz, obtaining a 500 MHz output. This signal is levelled and sent to the RF OUTPUT, the DUT (device under test), and the 492 Spectrum Analyzer.

In practice, the TR 503 RF OUTPUT is a swept, rather than fixed, frequency. In addition, when the 492 is set to spans of 100 kHz/Div or more, the 1st LO is controlled by the Frequency and Span voltages while the 2nd LO is set to 2.182 GHz. When spans of 50 kHz/Div or less are chosen, the 1st LO is phase-locked (in instruments that have this option) and the 2nd LO is controlled by the Frequency and Span voltages. When the 2nd LO exceeds its tune range, the 1st LO is re-locked to a different frequency, permitting the 2nd LO to recenter its tune range.

## BLOCK DIAGRAM DESCRIPTION

The 2.072 GHz oscillator is phase-locked 110 MHz below the 2nd LO frequency. The 110 MHz difference is maintained by dividing it down to 55 MHz and comparing it to a 55 MHz crystal-controlled oscillator. A voltage that is proportional to the phase difference is fed back as an error signal to the 2.072 GHz oscillator, keeping it locked 110 MHz below the 2nd LO input signal.

The 2.072 GHz signal is passed through a directional coupler which couples some of the signal to the phase-locked loop and directs the remaining energy through a leveling attenuator (setting the desired amplitude), a 2.2 GHz low-pass filter (attenuating harmonics and upper sidebands from the output mixer), a second leveling attenuator, an isolation amplifier, and a 6 dB attenuator feeding into the output mixer. The isolation amplifier assists the low-pass filter in preventing energy from the output mixer from leaking into the 2.072 GHz oscillator and the phase-locked mixer circuit.

At spectrum analyzer frequencies near zero, the 1st LO is near 2.072 GHz. This frequency will disable the phase-lock if leakage from the output mixer is present. The 6 dB attenuator serves to smooth the output impedance of the isolation amplifier, improving the load seen by the output mixer.

The conversion loss through the output mixer is essentially constant with frequency. The amplitude level of the IF signal tracks the amplitude level of the rf signal with 6 to 8 dB of loss. The IF level is set by controlling the rf level input level. A constant output level is maintained by a feedback loop that controls the attenuation of the 2.072 GHz signal path. The forward signal path through the attenuator affects the amplitude at the level detector. The feedback path applies this amplitude to the leveling attenuator as a correction signal so the output remains constant over the frequency range of the TR 503.

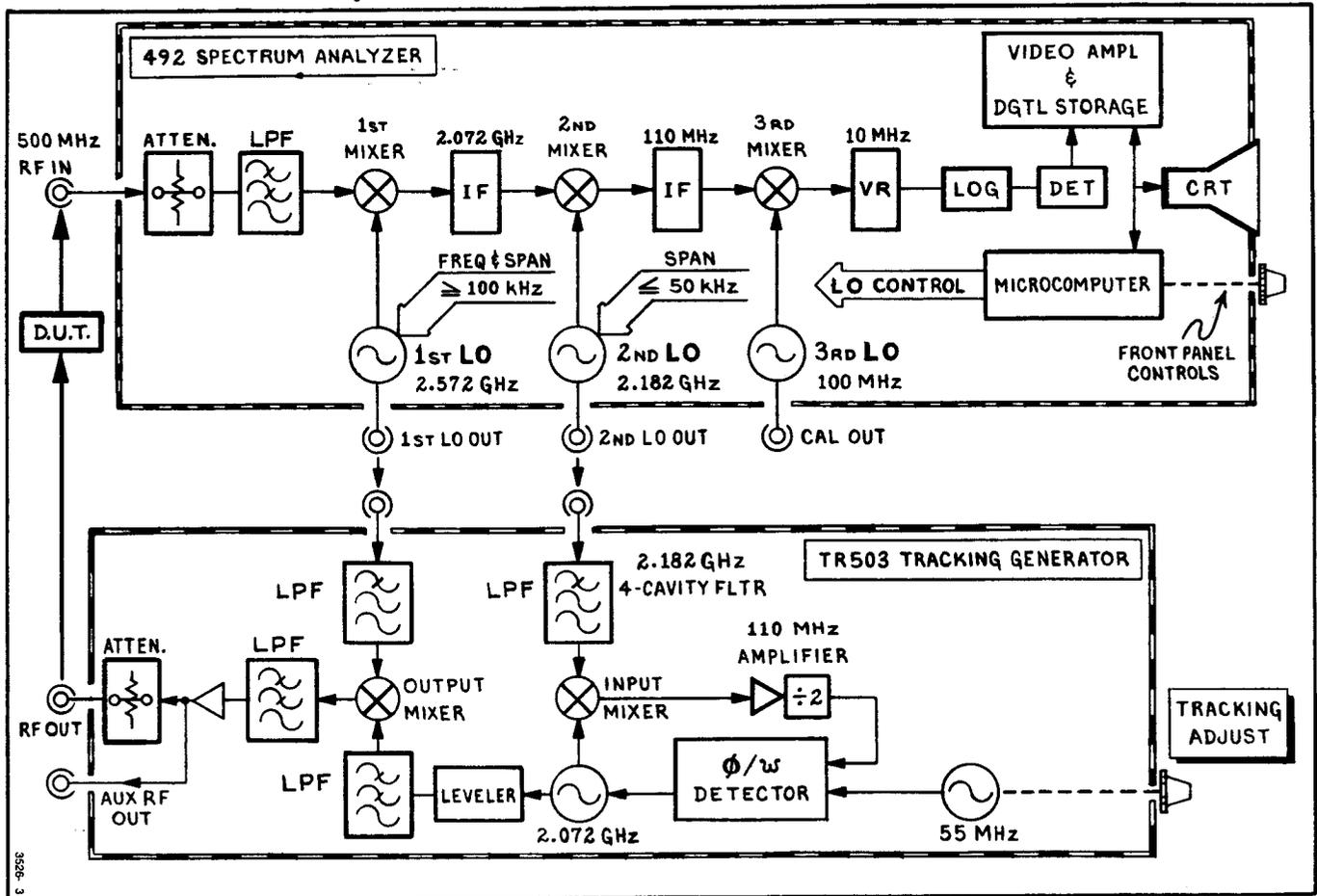


Fig. 3-1. TR 503/492 System Diagram.

The input signal from the 1st LO is 4 dBm or more. This is amplified by the 2.1 GHz to 3.9 GHz amplifier so the level into the LO port of the output mixer is between 7 dBm and 10 dBm. Harmonics of the input signal are attenuated by the 2.1 GHz to 3.9 GHz bandpass filter. Re-entrant modes of this filter are eliminated by a low-pass filter. Two ferrite isolators provide correct termination for the

amplifier and bandpass filter. These isolators and the amplifier prevent interaction between the output mixer and the 1st LO. This isolation and a filter prevent signals in the 0 to 1.8 GHz and 4.2 to 6 GHz range from entering the spectrum analyzer. Leakage from these signals would degrade the sensitivity of the analyzer and lift the display baseline.

## DETAILED DESCRIPTION

### RF and Microwave Circuits

The RF section consists of microwave assemblies that include microwave integrated circuits in metal enclosures. Because repair of these assemblies requires special techniques and equipment we recommend replacing the entire assembly if failure should occur. The diagrams for these assemblies show only basic configurations and illustrate functions and dc paths between external connectors.

The input signal from the spectrum analyzer is amplified to a level of 10 mW by the 2.1 GHz to 3.9 GHz amplifier. The nominal gain of the amplifier is 6 dB. Because of gain characteristics, this amplifier operates as a limiter and provides a relatively constant output over a wide range of signal levels. This limiting action provides a constant LO signal level to the output mixer.

The 2 to 4 GHz isolators have less than 0.4 dB loss in the forward direction and more than 20 dB loss in the reverse direction. The 4.5 GHz tubular low-pass filter attenuates the re-entrant mode of the interdigitated bandpass filter (at the third multiple of its passband). This bandpass filter attenuates harmonics of the 2.1 to 3.9 GHz signals that are generated by the spectrum analyzer and the saturated 2.1 to 3.9 GHz amplifier. This filter also attenuates 0 to 1.8 GHz and 4.2 to 6 GHz signals that return from the output mixer of the TR 503.

The mixer requires about 5 mW into the LO port and a nominal -24 dBm into the rf port. The IF output of the mixer is about -30 dBm over the frequency range of 0 to 1.8 GHz.

The 2nd LO signal from the spectrum analyzer is applied through a 20 dB attenuator, a 2.2 GHz low-pass filter, and a four-cavity bandpass filter to the mixer. The 2.2 GHz low-pass filter attenuates or blocks re-entrant modes (at 6.546 and 10.91 GHz) from the four-cavity bandpass filter. The passband of this filter is narrow enough to attenuate the 2.072 GHz oscillator signal, preventing this signal from entering the spectrum analyzer. Four tuning screws, one for each cavity, serve to adjust the response of the bandpass filter. The signal then passes through a two-diode balanced mixer, where it is mixed with the signal from the 2.072 GHz oscillator. The position of the mixer affects the response of the filter by controlling mixer balance and coupling.

The 110 MHz IF signal from the mixer is passed through a directional coupler and an all-pass network to the 110 MHz amplifier. The all-pass network provides correct termination for the directional filter.

The 2.072 GHz oscillator sets the frequency by coupling a resonant micro-strip transmission line to the collector of the common-base oscillator. 20 MHz of tuning is available by varying the collector voltage, which in turn alters the collector-base capacitance of the oscillator transistor.

The 2.072 GHz signal is fed from the directional coupler to a PIN diode attenuator with the diode operating as a variable resistor. The circuit is a "T" attenuator with the resistance of the diode inversely proportional to the current. As the current increases (from 0 to 5 mA) the resistance changes from open-circuit to 5  $\Omega$ . This variable allows initial adjustment of operating range.

The 2.2 GHz low-pass filter attenuates harmonics of the 2.072 GHz signal in the forward direction as well as higher frequencies that leak through the isolation amplifier from the output mixer.

The leveling attenuator and normalizing attenuator are identical. The forward gain of the isolation amplifier is 7 dB; the reverse gain is -20 dB or less. This amplifier drives the mixer through a 5 dB attenuator.

The lower conversion frequencies from the mixer pass through a 3 dB attenuator and a low-pass filter to the wideband amplifier. The 3 dB attenuator provides a wideband (to 6.6 GHz) termination for the mixer and the low-pass filter attenuates 2.072 GHz and higher products from mixer. This filter is flat up to 1.8 GHz and cuts off above that with a sharp notch at 2.072 GHz. The wideband amplifier provides 40 dB of gain.

The wideband amplifier sends its output to a second 1.8 GHz low-pass filter. This filter rejects harmonic distortion products of the amplifier. (Amplifier distortion is dependent on signal frequency and level.) The filter output is sent to the power divider and peak detector.

The level detector is a directional peak detector that senses forward power but not reflected or reverse power. The forward power is load-independent. The power loss through the divider is 6 dB for the RF OUT connector and 9.5 dB for the AUX RF OUT connector. The output attenuator provides calibrated 1 dB and 10 dB steps of attenuation for the RF OUT connector.

### Bias and Leveling Loop Circuitry

Bias for the microwave and isolation amplifiers is supplied by five bias supplies (U150, U160, U170, U180, and U240) on the Bias circuit board. The bias circuits and rf amplifiers are connected by a feedback loop with the collector load current of the rf amplifier sensed by the input resistor (R) of the operational amplifier. The voltage

## Theory of Operation—TR 503

across this resistor is compared to a +10 V reference. The op amp output drives the base of the rf amplifier, setting the bias and holding the collector resistor voltage at +10 V.

The load resistors for the output amplifiers are R140, R162, R174, and the resistor in the microwave assembly for the final amplifier stage. These resistors set the collector currents of the first two amplifiers at 10 mA, the third amplifier at 20 mA, and the final at 30 mA. The load resistor (R242) for the isolation amplifier sets the collector current at 15 mA.

The +10 V reference for the bias circuits is generated by a voltage regulator circuit using op-amp U250. The reference for the regulator is a 6.2 V Zener diode (VR258) which sets the voltage level at the inverting input of the op amp. This is amplified to +10 V. The bias current for the 6.2 V Zener is provided by the +10 V reference. A 7.5 V Zener (VR250) is connected from the output to the +15 V supply; the Zener is used to start the +10 V reference. As soon as the output of the regulator exceeds +7.5 V the Zener ceases to draw current and is isolated from regulator operation.

Diode CR250, connected between ground and the +15 V line, protects the microwave circuitry from accidental application of negative voltage.

The leveling loop consists of a level detector and a temperature-compensating diode driving a differential amplifier. The output of this amplifier drives a second amplifier which sets the leveling attenuator. With no power into the detector, the output of the diodes is close to 0.4 V. The diode outputs drive the inputs of differential amplifier U200. The output of the compensation diode is summed with a voltage set by the leveling control circuit. The temperature compensating diode corrects for detector output variations induced by temperature shifts. As power into the detector increases, positive signal excursions are clamped to +0.4 V.

U200 is an op-amp configured as an integrator. Its output is a correction signal depending on the difference between the reference and level detector. The reference voltage is set by a voltage divider network composed by R225, R220, R222, and the front panel VAR dB control. Min Output Level adjustment R225 sets the minimum level (or offset constant). Max Output Level adjustment R220 sets the range of the VAR dB control to cover 2 dB. The VAR dB

## Phase Lock Loop

The 2.072 GHz oscillator is phase locked 110 MHz below the 2.182 GHz 2nd LO signal from the spectrum analyzer. The 110 MHz difference product from the input mixer is sent through five stages of amplification, divided down to 55 MHz, and compared to a 55 MHz signal from the crystal oscillator. A voltage that is proportional to the phase difference between the two 55 MHz signals is fed back to the 2.072 GHz oscillator, forcing its output to be exactly 110 MHz below the 2.182 GHz 2nd LO signal.

The 110 MHz signal is sent through three stages of common-emitter amplification, transistors Q550, Q505, and Q510. The collector of Q510 is coupled to transformer T520, which provides a differential signal for the next two stages. Differential amplifiers U540B and U540A successively amplify the 110 MHz signal and send it to a divide-by-two counter, U550. The total gain is about 60 dB for an input below -45 dBm; from -45 dBm to +10 dBm the output remains relatively constant. U550 provides a 55 MHz output which is sent to the phase/frequency detector U545. This device compares the signal from U550 to the signal from the 55 MHz crystal-controlled oscillator.

The reference 55 MHz signal from the crystal-controlled oscillator U520A is sent through buffer U520B which is connected to the phase/frequency detector U545. The crystal operates on the third overtone which is selected by the low Q resonant circuit tuned by C524. The frequency can be tuned through 55 MHz by varying the voltage bias on the variable capacitance diode CR526. This bias is set by the front panel TRACKING ADJUST control R10. (Voltages for the adjustment are supplied by U365B). This control allows the operator to set the TR 503 to the spectrum analyzer input frequency or offset the frequency by a slight amount.

The output of the phase/frequency detector is sent to a compensating amplifier U365A and Q420. The compensating amplifier has a buffered output that drives the collector of the 2.072 GHz oscillator. Q440 limits the current if the output is inadvertently shorted.

Transistors Q445 and Q430 are the active components of an anti-latch circuit. When this circuit is activated, it drives the 2.072 GHz oscillator through a frequency band until it locks to the 2nd LO of the spectrum analyzer. When the tune voltage is +3 V or less, Q445 is cut off. The collector voltage rises towards Vcc and allows C432 to charge through R438 and R444 until it is 0.7 V above the gate potential of Q430 (this is a programmable unijunction transistor). When this transistor turns on, the charge on the capacitor C432 is transferred to the cathode and sent to the non-inverting input of operational amplifier U365A (C432 also acquires a charge). The output of the compen-

the 2nd LO of the spectrum analyzer, the phase lock regains control. If the oscillator fails to start or lock, the cycle is repeated.

Q410 is the 25 mA current source for the 2.072 GHz oscillator. Q480 is the output of the +20 V supply for the compensation amplifier circuitry.

### Power Supply Regulators

Three power supply regulators (U350, U370, and U390) provide +15 V, +15.1 V, and -15 V respectively. These IC regulators use external pass transistors that are located in the TM 500 mainframe for the positive supplies and on the Mother board of the TR 503 for the negative supply. All

regulators are short-circuit protected with foldback current limiting.

For example: the -15 V supply (U390) current sensing resistor is R394 and the foldback circuit includes R398 and R396. If the current delivered to the load becomes excessive, the voltage drop across R394 will be enough to turn on the current-limiting transistor Q395. This decreases the current through the pass transistor Q390 and limits the current to the load. Foldback current is 50 mA ( $1\text{ V}/20\ \Omega$ ) and power dissipation in the pass transistor is about 1 W ( $50\text{ mA} \times 20\text{ V}$ ). If the -15 V line is shorted to ground, the current will be limited to 35 mA ( $0.7\text{ V}/20\ \Omega$ ) and the power dissipation to 1.2 W ( $35\text{ mA} \times 35\text{ V}$ ).

# CALIBRATION

## Introduction

Calibration consists of a Performance Check and an Adjustment Procedure.\* The Performance Check describes procedures to verify that the instrument is performing properly and meets the specifications listed in Section 1. All tests can be performed without access to the interior of the instrument. The Adjustment part provides instructional steps required to recalibrate the instrument circuits. After adjustment, the performance should be checked by the procedure described under the Performance Check part. We recommend only adjusting those circuits that do not meet performance specifications.

The limits, tolerances, and waveform illustrations are aids to calibrate the instrument and are not intended as performance specifications.

## History Information

The instrument and manual are periodically evaluated and revised. If modifications require changes in the calibration procedure, history applicable to earlier instruments is included as a deviation within a step or as a sub-part to a step.

## Equipment Required

The table below lists the test equipment recommended for the Performance Check and Adjustment Procedure. The characteristics specified are the minimum required for the checks. Equipment that is substituted must meet or exceed these characteristics.

**Table 4-1**  
**EQUIPMENT REQUIRED**

### Performance Check

Equipment	Characteristics	Recommendation and Use
Power Meter	Measurement Range, up to 0 dBm.	General Microwave Model 454A. Hewlett Packard Model 435A with 8484A power sensor.
Test Spectrum Analyzer		Tektronix 492

### Adjustments

All of the items listed above as well as the following are required for the Adjustment Procedure.

## PERFORMANCE CHECK

### Introduction

The Performance Check is used to confirm the specifications of the TR 503. The first procedure requires no test equipment; the remaining procedures require an analog power meter and a second spectrum analyzer. If a specification is not met, turn to the Adjustment Procedure part of this section.

### Preliminary Inspection

Connect the TR 503 to the 492 Spectrum Analyzer and perform the Operators Checkout Procedure described in Section 2, Operating Instructions. Check the flatness, output level, and the tracking adjustment.

### Performance Verification

This procedure does not require test equipment.

#### 1. Check Frequency Range

a. Connect the TR 503 RF OUTPUT to the 492 RF Input. Set the 492 Reference Level to 0 dBm, Vertical Display to 10 dB/div, Frequency to 1 GHz, Span/Div to 200 MHz/Div, and Resolution to Auto.

b. Set the TR 503 OUTPUT LEVEL to 0 dBm with the VAR dB control set to 0 (fully clockwise). Check that the TR 503 RF OUTPUT is connected to the 492 RF Input with a 50  $\Omega$  cable.

c. Check that the 492 display shows a flat response extending from 100 kHz to 1.8 GHz.

d. The remaining procedures require test equipment (shown in the table at the beginning of this section). They check the output level, output flatness, auxiliary output level, and spurious signal levels. Refer to Fig. 4-1 for the connections used in these procedures.

#### 2. Check Output Level (at 100 MHz)

Procedures 2, 3, and 4 require an analog power meter.

a. Set the 492 Frequency to 100 MHz and decrease the Span/Div to 0 Hz.

b. Connect the TR 503 RF OUTPUT to the power meter with a short length of 50  $\Omega$  cable. Set the VAR dB control to 0 dB and the OUTPUT LEVEL control to 0 dBm. The power meter should indicate 0 dBm  $\pm$ 0.5 dB. Note this value and use it as a zero reference for the following steps.

c. Reduce the OUTPUT LEVEL in  $-1$  dB steps and check the power meter. The error between steps should be no greater than  $\pm$ 0.2 dB for every 1 dB step.

d. Reset the OUTPUT LEVEL to 0 dBm. Reduce the OUTPUT LEVEL in 10 dB steps and check the power meter. The error between steps should be no greater than  $\pm$ 2.0 dB for every 10 dB step.

e. Set the OUTPUT LEVEL to  $-59$  dBm. The total error should be no greater than  $\pm$ 2.0 dB. Reset the OUTPUT LEVEL to 0 dBm.

#### 3. Check Flatness

a. Connect the TR 503 AUX RF OUTPUT to the 492 RF Input. Set the 492 Frequency to 100 MHz and reduce the Span/Div to Zero.

b. Adjust the TR 503 OUTPUT LEVEL and VAR dB controls to produce a  $-2$  dBm reading on the power meter.

c. Set the 492 Frequency to 1 GHz, Span/Div to 200 MHz, and press the Single Sweep button. Set the Time/Div to 5 seconds and press Single Sweep again.

d. Check the power meter as the TR 502/492 sweeps the 100 kHz to 1.8 GHz range (ignore the 0 Hz spur). The highest reading should not exceed  $-1.25$  dBm; the lowest reading should not exceed  $-2.75$  dBm. (TR 503 specification is within  $\pm$ 0.75 dB from 100 kHz to 1.8 GHz, referred to 100 MHz.)

e. Press Single Sweep and repeat the measurement, checking the frequencies of the lowest and highest readings.

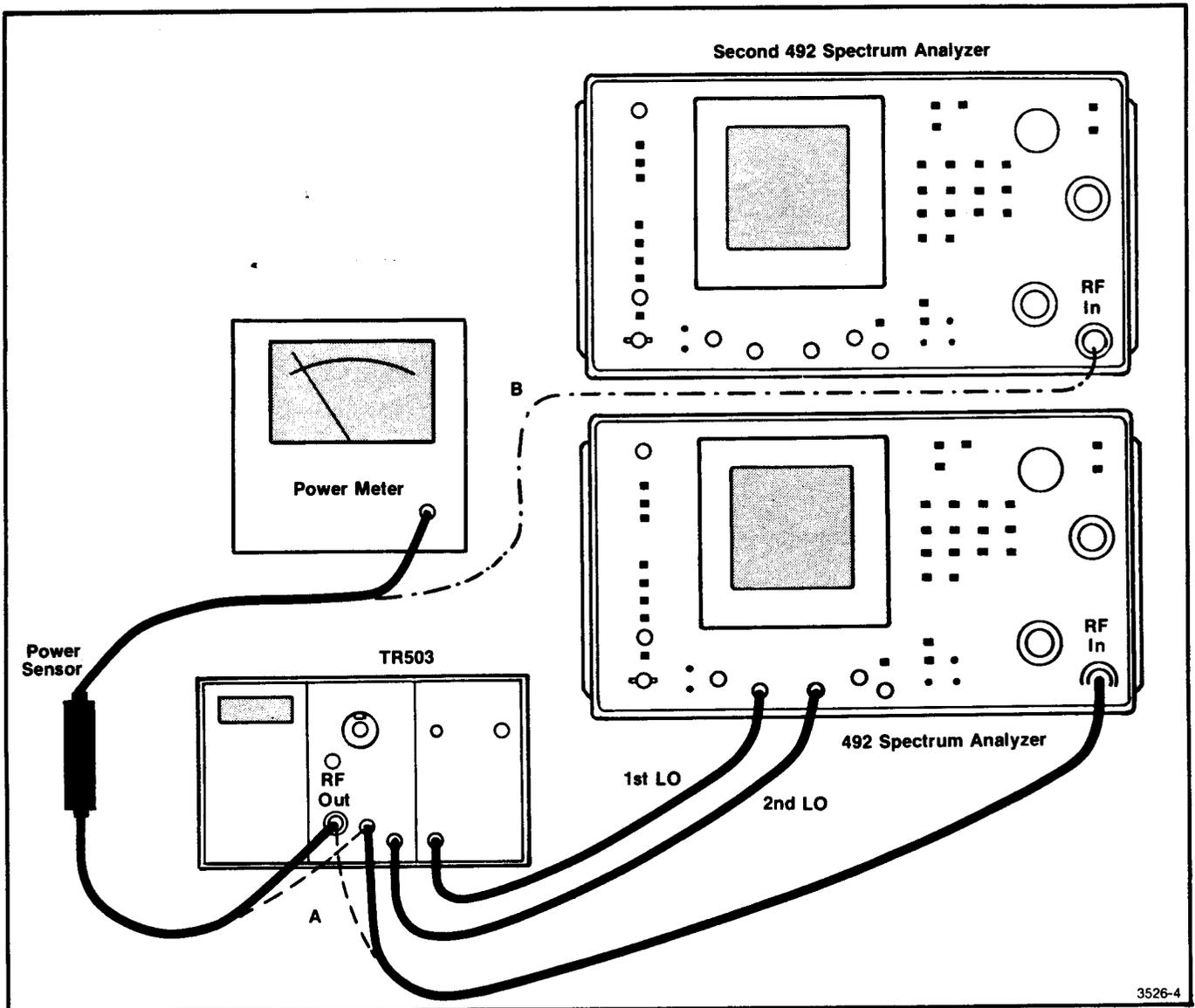


Fig. 4-1. Setup for Performance Check.

#### 4. Check Auxiliary Output Level

Refer to Fig. 4-1 and use connection "A".

a. Connect the power meter to the TR 503 AUX RF OUTput. Connect the 492 RF Input to the TR 503 RF OUTput. (Reverse the outputs of the TR 503.)

b. Set the TR 503 VAR dB control to -2.

c. Press Single Sweep on the 492. Read the power meter and check that the AUX RF OUTput is at least -7 dBm (0.1 V rms into 50 Ω) over the 100 kHz to 1.8 GHz frequency range.

d. Reset the TR 503 VAR dB control to 0. Disconnect the power meter and 492 from the TR 503. Set the 492 Time/Div control to AUTO and press Free Run.

#### 5. Check for Spurious Signals

This procedure requires a second spectrum analyzer. Although the procedure describes a 492, other analyzers such as a 7L12 or 7L13 may be used. Refer to Fig. 4-1 and use connection "B".

a. Tune the Frequency control of the original 492 to 100 MHz and set Span/Div to 0 Hz. Do not make any further adjustments to the controls of this 492.

## Calibration—TR 503 Adjustment Procedure

b. Connect the TR 503 RF OUTPUT to the RF Input of a second 492. Set the Reference Level of this instrument to 0 dBm, Frequency to 200 MHz, Span/Div to 100 MHz, and Vertical Display to 10 dB/Div.

c. Check that the harmonic spurs (at 200 MHz, 300 MHz, 400 MHz, etc.) are at least 20 dB below the level of the 100 MHz fundamental.

d. Tune the second 492 to 1 GHz and set Span/Div to 200 MHz. Check that all non-harmonic spurs are at least 40 dB below the level of the 100 MHz signal. Harmonic spurs will occur at multiples of 100 MHz; non-harmonic spurs will not.

This concludes the Performance Check of the TR 503/492 system.

# ADJUSTMENT PROCEDURE

## Introduction

If the Performance Check reveals that the TR 503 specifications are not being met, the instrument should be calibrated by using the Adjustment Procedure. When the calibration for the TR 503 is completed, repeat the Performance Check and see that the specifications are met.

## Complete or Partial Calibration

Do all of the procedures in sequence if an important component has been replaced or if the TR 503 is known to be completely out of calibration. Otherwise, recalibrate only those circuits that fail to meet specifications.

The adjustments for the 2.182 GHz four-cavity filter and mixer assembly are required only after replacement. The adjustments for this assembly are part of the replacement procedure in the Maintenance Instructions section of this manual.

Before performing a complete calibration, clean and inspect the TR 503, following the procedure described in the Maintenance Instructions sections.

## Test Points

Test points and adjustment locations are shown with the appropriate procedure. The outer covers of the TR 503 must be removed to gain access to these points. Adjustments that interact with other circuits are noted along with the affected circuit.

## Preliminary Preparation

- a. Turn off the power to the TM 500 mainframe.
- b. Remove the TR 503 from the mainframe. Connect the instrument to a flexible plug-in extender and connect the extender to the mainframe connector. Refer to Fig. 4-2.

c. Turn on the power to all instruments. Warm up the instruments in a room temperature environment for a minimum of 2 hours.

## 1. 55 MHz Oscillator Mode Adjust

### NOTE

*This adjustment is required only if the TR 503 is not within specification or if a frequency-setting component (such as the 55 MHz crystal or U520 integrated circuit) is replaced.*

a. Remove the cover on the honeycomb assembly. This assembly is on the right side of the TR 503.

b. Connect a frequency counter through a 1X probe to receptacle K or W520. Connect the oscilloscope through a 10X probe to the same point. Refer to Fig. 4-3.

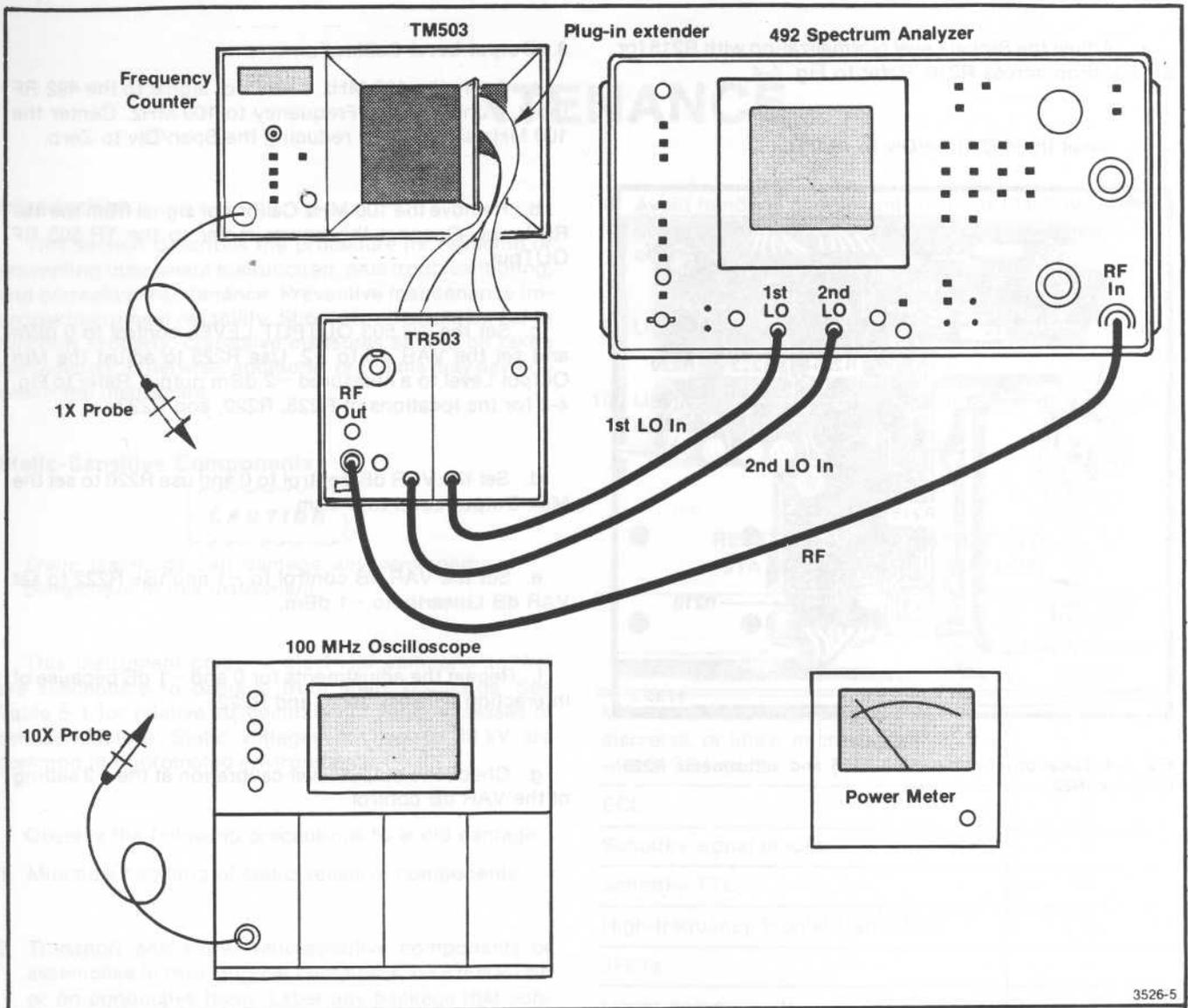
### NOTE

*Use low-capacitance probes to minimize loading. Connect the probe grounds to the TR 503 chassis.*

c. The output of U520B is 800 mV peak-to-peak. Adjust the scope sensitivity to 0.2 V/div.

d. Rotate the Mode Adjust cap C524 (Fig. 4-3) so the 55 MHz oscillator starts at any position of the TRACKING ADJUST control. Check that the oscillator continues to start as the TR 503 power is turned on and off. (Give the mainframe supply voltage time to decay before restoring power.)

e. Check the frequency range of the TRACKING ADJUST control. Readjust C524 so the range of the TRACKING ADJUST is at least  $\pm 1.0$  kHz around 55 MHz.



3526-5

Fig. 4-2. Setup for Adjustment Procedure.

f. Replace the honeycomb cover.

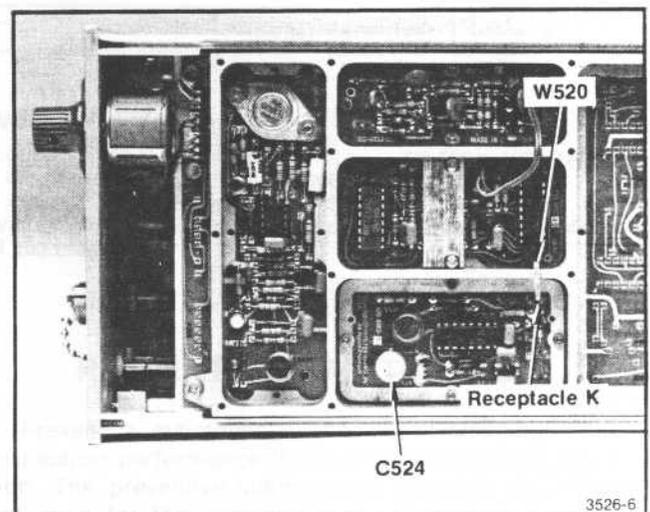
g. Check that the TRACKING ADJUST can be set to track the 492 input frequency. Set the 492 to Zero Span and 100 Hz Resolution Bandwidth and rotate the TRACKING ADJUST control for maximum trace height on the 492 crt.

## 2. Adjust the Normalizing Attenuator

### NOTE

*This adjustment is only required if the TR 503 does not meet the flatness specification or if the 2.072 GHz Oscillator and Amplitude Control Assembly is replaced.*

a. Set the 492 Span/Div to MAX and the Time/Div to 10 ms.



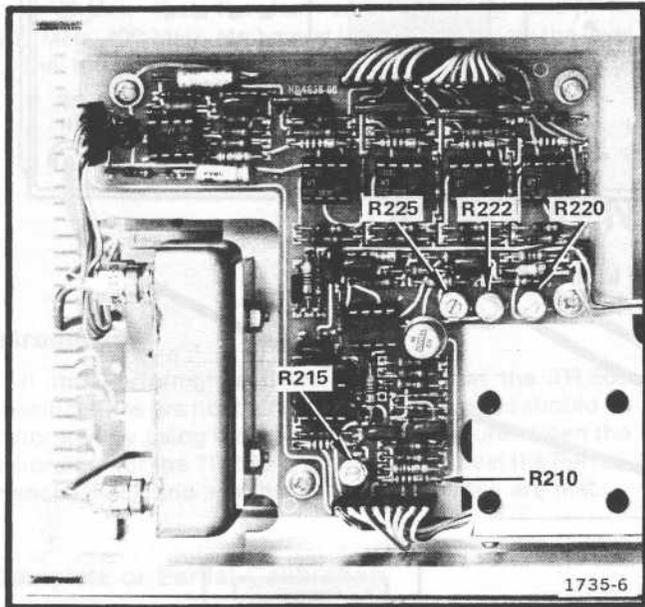
3526-6

Fig. 4-3. Location of Receptacle K, W520, and C524.

**Calibration—TR 503  
Adjustment Procedure**

b. Adjust the Signal Level Normalization with R215 for a 1.5 V drop across R210. Refer to Fig. 4-4.

c. Reset the 492 Time/Div to AUTO.



**Fig. 4-4. Location of adjustment R215 and adjustments R225, R220 and R222.**

**3. Output Level Calibration**

a. Apply the 100 MHz Calibrator signal to the 492 RF Input. Tune the 492 Frequency to 100 MHz. Center the 100 MHz signal while reducing the Span/Div to Zero.

b. Remove the 100 MHz Calibrator signal from the 492 RF Input. Connect the power meter to the TR 503 RF OUTPUT.

c. Set the TR 503 OUTPUT LEVEL control to 0 dBm and set the VAR dB to -2. Use R225 to adjust the Min Output Level to a measured -2 dBm output. Refer to Fig. 4-4 for the locations of R225, R220, and R222.

d. Set the VAR dB control to 0 and use R220 to set the Max Output Level to 0 dBm.

e. Set the VAR dB control to -1 and use R222 to set VAR dB Linearity to -1 dBm.

f. Repeat the adjustments for 0 and -1 dB because of interaction between R220 and R222.

g. Check the output level calibration at the -2 setting of the VAR dB control.

# MAINTENANCE

## Introduction

This section describes the procedure for reducing or preventing instrument malfunction, plus troubleshooting, and corrective maintenance. Preventive maintenance improves instrument reliability. Should the instrument fail to function properly, corrective measures should be taken immediately; otherwise, additional problems may develop within the instrument.

## Static-Sensitive Components

### CAUTION

*Static discharge can damage any semiconductor component in this instrument.*

This instrument contains electrical components that are susceptible to damage from static discharge. See Table 5-1 for relative susceptibility of various classes of semiconductors. Static voltages of 1 kV to 30 kV are common in unprotected environments.

Observe the following precautions to avoid damage:

1. Minimize handling of static-sensitive components.
2. Transport and store static-sensitive components or assemblies in their original containers, on a metal rail, or on conductive foam. Label any package that contains static-sensitive assemblies or components.
3. Discharge the static voltage from your body by wearing a wrist strap while handling these components. Servicing static-sensitive assemblies or components should be performed only at a static-free work station by qualified service personnel.
4. Nothing capable of generating or holding a static charge should be allowed on the work station surface.
5. Keep the component leads shorted together whenever possible.
6. Pick up components by the body, never by the leads.
7. Do not slide the components over any surface.
8. Avoid handling components in areas that have a floor or work-surface covering capable of generating a static charge.
9. Use a soldering iron that is connected to earth ground.
10. Use only special antistatic suction type or wick type desoldering tools.

Table 5-1

RELATIVE SUSCEPTIBILITY TO  
STATIC DISCHARGE DAMAGE

Semiconductor Classes	Relative Susceptibility Levels <sup>a</sup>
MOS or CMOS microcircuits or discretes, or linear microcircuits with MOS inputs. (Most Sensitive)	1
ECL	2
Schottky signal diodes	3
Schottky TTL	4
High-frequency bipolar transistors	5
JFETs	6
Linear microcircuits	7
Low-power Schottky TTL	8
TTL (Least Sensitive)	9

<sup>a</sup> Voltage equivalent for levels:

1 = 100 to 500 V    4 = 500 V    7 = 400 to 1000 V (est.)  
 2 = 200 to 500 V    5 = 400 to 600 V    8 = 900 V  
 3 = 250 V    6 = 600 to 800 V    9 = 1200 V  
 (Voltage discharged from a 100 pF capacitor through a resistance of 100 ohms.)

## PREVENTIVE MAINTENANCE

Preventive maintenance consists of cleaning, visual inspection, performance check, and if needed, a recalibration. The preventive maintenance schedule that is established for the instrument should be based on the environment should be based on the environment in which

the instrument is operated and the amount of use. Under average conditions (laboratory situation) a preventive maintenance check should be performed every 1000 hours of instrument operation.

### **Cleaning**

Clean the instrument often enough to prevent dust or dirt from accumulating in or on it. Dirt acts as a thermal insulating blanket and prevents efficient heat dissipation. It also provides high resistance electrical leakage paths between conductors or components in a humid environment.

**Exterior.** Clean the dust from the outside of the instrument by wiping or brushing the surface with a soft cloth or small brush. The brush will remove dust from around the front panel selector buttons. Hardened dirt may be removed with a cloth dampened in water that contains a mild detergent. Abrasive cleaners should not be used.

**Interior.** Clean the interior by loosening accumulated dust with a dry soft brush, then remove the loosened dirt with low pressure air to blow the dust clear. (High velocity air can damage some components.) Hardened dirt or grease may be removed with a cotton tipped applicator dampened with a solution of mild detergent in water. Do not leave detergent on critical memory components. Abrasive cleaners should not be used. If the circuit board assemblies need cleaning, remove the circuit board by referring to the instructions under Corrective Maintenance in this section.

After cleaning, allow the interior to thoroughly dry before applying power to the instrument.



*Do not allow water to get inside any enclosed assembly or components such as the hybrid assemblies, RF Attenuator assembly, potentiometers, etc. Instructions for removing these assemblies are provided in the Corrective Maintenance section. Do not clean any plastic materials with organic cleaning solvents such as benzene, toluene, xylene, acetone, or similar compounds because they may damage the plastic.*

### **Lubrication**

Components in this instrument do not required lubrication.

### **Visual Inspection**

After cleaning, carefully check the instrument for such defects as defective connections, damaged parts, and improperly seated transistors and integrated circuits. The remedy for most visible defects is obvious; however, if heat-damaged parts are discovered, try to determine the cause of overheating before the damaged part is replaced; otherwise, the damage may be repeated.

### **Transistor and Integrated Circuit Checks**

Periodic checks of the transistors and integrated circuits are not recommended. The best measure of performance is the actual operation of the component in the circuit. Performance of these components is thoroughly checked during the performance check or recalibration; any sub-standard transistors or integrated circuits will usually be detected at that time.

When handling MOS FET's, keep the shorting strap in place until the device is in its socket.

### **Performance Checks and Recalibration**

The instrument performance should be checked after each 1000 hours of operation or every six months if the instrument is used intermittently to ensure maximum performance and assist in locating defects that may not be apparent during regular operation. Instructions for conducting a performance check are provided in the Performance Check part of the Calibration section.

## **TROUBLESHOOTING**

The following are a few aids and suggestions that may assist in locating a problem. After the defective assembly or component has been located, refer to the Corrective Maintenance part of this section for removal and replacement instructions.

### **Troubleshooting Aids**

**Diagrams.** Block and circuit diagrams, on foldout pages in the Diagrams section, contain any significant waveform, voltage, and logic data information. Any necessary information as to how the data was acquired, such as operational state of the instrument, is provided on the diagram or adjacent to it. Refer to the Replaceable Electrical Parts list section for a description of all assemblies and components.

### **NOTE**

*Corrections and modifications to the manual and instrument are described on inserts bound into the rear of the manual. Check this section for changes and corrections to the manual or the instrument.*

**Circuit Board Illustrations.** Electrical components, connectors, and test points are identified on circuit board illustrations located on the inside fold of the corresponding circuit diagram or the back of the preceding diagram. A grid on the circuit board illustrations and the circuit schematic, plus a look-up table, provide the means to quickly locate components on diagrams.

**Wiring Color Code.** Color coded wires are used to aid circuit tracing. Power supply dc voltage leads have either a red background for positive voltage or a violet background for negative voltage. Signal wires and coaxial cables use an identifying one-band or two-band color code.

**Multiple Terminal (Harmonica) Connectors.** Some inter-circuit connections are made through pin connectors that may be mounted in a harmonica type holder. The terminals in the holder are identified by numbers that appear on the holder and the circuit diagrams. Connector orientation to the circuit board is keyed by triangles on the holder and the circuit board (see Fig. 5-1). In some cases, the triangle or arrow is screened on the chassis adjacent to the connector. Some connectors contain more than one section. Connectors are identified on the schematic and board with a "P" or "J".

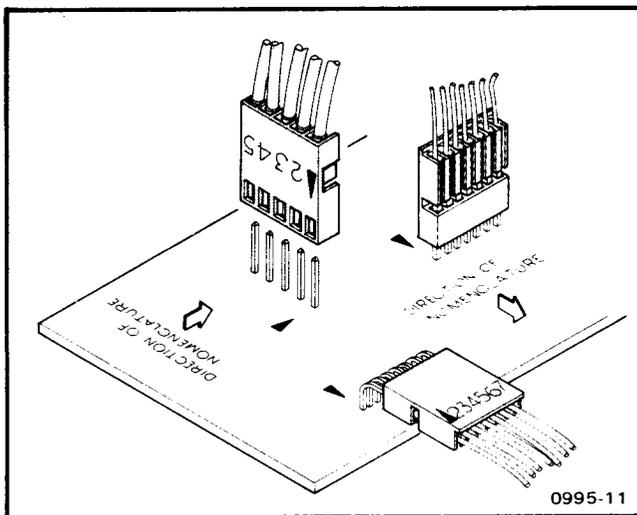


Fig. 5-1. Multipin (harmonica) connector configuration.

**Resistor Values.** Many types of resistors (such as composition, metal film, tapped, thick film resistor network package, plate, etc.) are used in the TR 503. The value is either color coded in accordance with the EIA color code, or printed on the body of the component.

**Capacitor Marking.** The capacitance value of ceramic disc, plate, slug, or electrolytic capacitors are marked in microfarads on the side of the component body. The ceramic tubular capacitors and feedthrough capacitors are color coded in picofarads. Tantalum capacitors are color coded as shown in Fig. 5-2.

**DIPPED TANTALUM CAPACITOR MARKING**

A AND B CASE

CAPACITANCE AND VOLTAGE COLOR CODE

Rated Voltage VDC 25°C	Color	CODE FOR CAPACITANCE IN PICO FARADS		
		1st Figure	2nd Figure	Multiplier
3-4	Black	0	0	None
3-6	Brown	1	1	X10
3-10	Red	2	2	X10 <sup>2</sup>
3-15	Orange	3	3	X10 <sup>3</sup>
3-20	Yellow	4	4	X10 <sup>4</sup>
3-25	Green	5	5	X10 <sup>5</sup>
3-35	Blue	6	6	X10 <sup>6</sup>
3-50	Violet	7	7	X10 <sup>7</sup>
	Gray	8	8	
3	White	9	9	

(1733) 1735-9

Fig. 5-2. Color code for tantalum capacitors.

**Diode Color Code.** The cathode of each glass encased diode is indicated by a stripe, a series of stripes, or a dot. Some diodes have a diode symbol printed on one side. Figure 5-3 illustrates diode types and polarity markings that are used in this instrument.

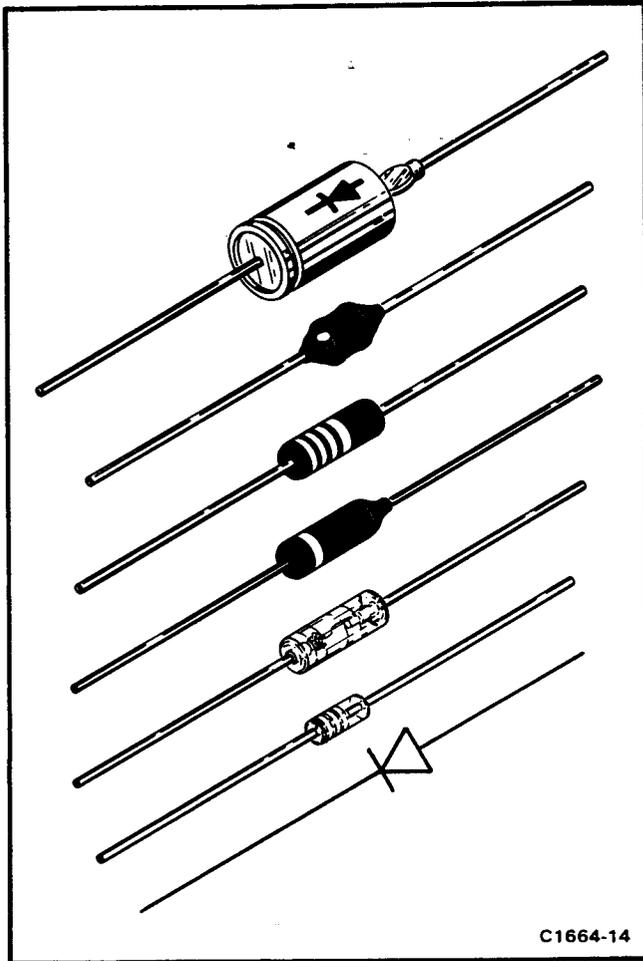


Fig. 5-3. Diode polarity markings.

**Transistor and Integrated Circuit Pin Configuration.** Lead identification for the transistors and MOS FET's is shown in Fig. 5-4. IC pin outs are shown either by table or box on the schematic diagram.

Semiconductor failures account for the majority of electronic equipment failures. Most semiconductors are soldered to the boards. The following guidelines should be observed when substituting these components.

**NOTE**

*Before using any test equipment to make measurements on static-sensitive components or assemblies, be certain that any voltage or current supplied by the test equipment does not exceed the limits of the component to be tested.*

a. Try to isolate the problem to a component through signal analysis. Determine that circuit voltages will not damage the replacement.

b. Turn power off before removing a component.

c. Use a de-soldering tool and 25 watt or less soldering iron to remove the component.

d. Use only good components for substitution and be sure the new component is inserted into the socket properly before soldering. Refer to the manufacturers data sheet or Fig. 5-4 for lead configuration.

e. Turn power on and check performance.

**NOTE**

If a substitute is not available, check the transistor or MOS FET with a dynamic tester such as the TEKTRONIX Type 576 Curve Tracer. Static type testers, such as an ohmmeter, can be used to check the resistance ratio across some semiconductor junctions if no other method is available. (Do not measure resistance across MOS FET's because they are very susceptible to static charges). Use the high resistance ranges (R X 1 k or higher) so the external test current is limited to less than 6 mA. If uncertain, measure the external test current with an ammeter. Resistance ratios across base-to-emitter or base-to-collector junctions usually run 100:1 or higher. The ratio is measured by connecting the meter leads across the terminals, noting the reading, then reversing the leads and noting the second reading.

**Diode Checks.** Most diodes can be checked in the circuit by taking measurements across the diode and comparing these with voltages listed on the diagram. Forward-to-back resistance ratios can usually be taken by referring to the schematic and pulling appropriate transistors and pin connectors to remove low resistance loops around the diode.

**CAUTION**

*Do not use an ohmmeter scale with a high external current to check the diode junction. Do not check the forward-to-back resistance ratios of mixer diodes. See Replacing the Dual Diode Assembly instructions under Replacing Assemblies.*

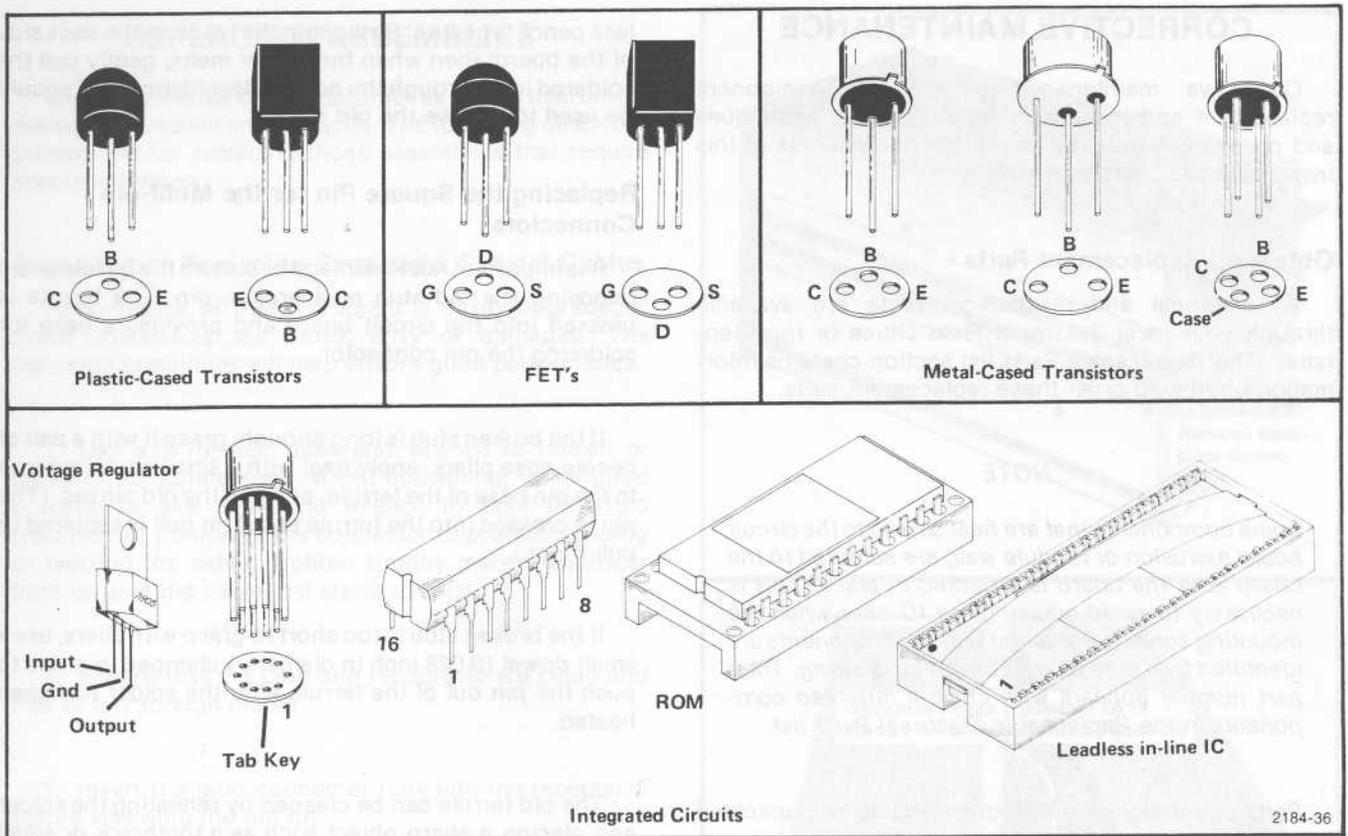


Fig. 5-4. Pin configuration for semiconductor components.

### General Troubleshooting Techniques

The following procedure is recommended to isolate a problem and expedite repairs.

1. Ensure that the malfunction exists in the instrument. Check the operation of associated equipment and the operating procedure of the TR 503 (see Operating Instructions).

2. Determine and evaluate all trouble symptoms. Try to isolate the problem to a circuit or assembly. The block diagrams in the Diagrams section can aid in signal tracing and circuit isolation. It also shows the required signal level at different points to produce full screen deflection.

#### CAUTION

When measuring voltages and waveforms, use extreme care in placing meter leads or probes. Because of high component density and limited access within the instrument, an inadvertent movement of the leads or probe could cause a short circuit. This may produce transient voltages which can destroy many components.

3. Make an educated guess as to the nature of the problem such as component failure or calibration, and the functional area most likely at fault.

4. Visually inspect the area or the assembly for such defects as broken or loose connections, improperly seated components, overheated or burned components, chafed insulation, etc. Repair or replace all obvious defects. In the case of overheated components, try to determine the cause of the overheated condition and correct before applying power.

5. By successive electrical checks, locate the problem. At this time an oscilloscope or spectrum analyzer is a valuable test item for evaluating circuit performance. If applicable, check the calibration adjustments. Before changing an adjustment, note its position so it can be returned to its original setting. This will facilitate recalibration after the trouble has been located and repaired.

6. Determine the extent of the repair needed; if complex, we recommend contacting your local Tektronix Field Office or representative. If minor, such as a component replacement, see the Replaceable Parts list for replacement information. Removal and replacement procedure of the assemblies and sub-assemblies is described under Corrective Maintenance.

## CORRECTIVE MAINTENANCE

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

### Obtaining Replacement Parts

All electrical and mechanical parts are available through your local Tektronix Field Office or representative. The Replaceable Parts list section contains information on how to order these replacement parts.

#### NOTE

*Some components that are heat sunk to the circuit board extrusion or module wall, are soldered to the board after the board is mounted in place. This is necessary to avoid cracking the IC case when the mounting screw is tightened. These components are identified by a note on the schematic drawing. Their part number appears with chassis mounted components in the Replaceable Electrical Parts list.*

Parts orientation and lead dress should be duplicated because some components are oriented to reduce interaction or control circuit characteristics.

If a part you have ordered has been replaced with a new or improved part, your local Field Office or representative will contact you concerning any change in the part number. After repair, the circuits may need recalibration.

### Parts Repair and Replacement Program

Tektronix repair centers provide replacement or repair service on major assemblies as well as the unit. Return the instrument or assembly to your local Field Office for this service.

### Soldering Technique

#### CAUTION

*Disconnect the instrument from its power source before replacing or soldering components.*

Some of the circuit boards in this instrument are multilayer; therefore, extreme caution must be used when a soldered component is removed or replaced. Excess heat from the soldering iron and bent component leads may pull the plating out of the hole. We suggest clipping the old component free. Leave enough lead length so the new component leads can be soldered in place. If you desire to remove the component leads, use a 15 watt or

less pencil type iron. Straighten the leads on the back side of the board; then when the solder melts, gently pull the soldered lead through the hole. A desoldering tool should be used to remove the old solder.

### Replacing the Square Pin for the Multi-pin Connectors

It is important not to damage or disturb the ferrule when removing the old stub of a broken pin. The ferrule is pressed into the circuit board and provides a base for soldering the pin connector.

If the broken stub is long enough, grasp it with a pair of needle nose pliers, apply heat with a small soldering iron to the pin base of the ferrule, and pull the old pin out. (The pin is pressed into the ferrule so a firm pull is required to pull it out.)

If the broken stub is too short to grasp with pliers, use a small dowel (0.028 inch in diameter) clamped in a vise to push the pin out of the ferrule after the solder has been heated.

The old ferrule can be cleaned by reheating the solder and placing a sharp object such as a toothpick or small dowel into the hole. A 0.031 inch drill mounted in a pin vise may also be used to ream the solder out of the old ferrule.

Use a pair of diagonal cutters to remove the ferrule from the new pin; then insert the pin into the old ferrule and solder the pin to both sides of the ferrule.

If it is necessary to bend the new pin, grasp the base of the pin with needle nose pliers and bend against the pressure of the pliers to avoid breaking the board around the ferrule.

### Selected Components

Some components, such as microcircuits, are selected to meet Tektronix specifications. These components carry only Tektronix part numbers under the Mfr Part number column, in the Replaceable Parts list.

Some circuits require a selected component value to compensate for parameter differences between active components. These are identified on the circuit diagram and the Replaceable Parts list. The Replaceable Parts list description for the component gives either a nominal value or range of value. If the procedure for selection is not obvious or complex, such as setting the gain or response of a stage, the criteria for selection is explained in the Calibration or Maintenance section of the manual. Where the selection procedure is obvious, such as establishing the frequency of an oscillator, no procedure is given.

## REPLACING ASSEMBLIES

Most assemblies or sub-assemblies in this instrument are easily removed and replaced. The following describes procedures for replacing those assemblies that require special attention.

### Removing or Replacing Semi-rigid Coaxial Cables

Performance of the instrument is easily degraded if these connectors are loose, dirty or damaged. The following procedure will help ensure good performance.

1. Use a 5/16 inch open-end wrench to loosen or tighten the connectors. When loosening, it is good practice to use a second wrench to hold the rigid (receptacle) portion of the connector to prevent bending or twisting the cable. Tighten slightly more than finger tight or until the cable just starts to twist.

2. Ensure that the plug and receptacle are clean and free of any foreign matter.

3. Insert the plug connector fully into the receptacle before screwing the nut on.

### Replacement of Microwave Assemblies

**Tools Required.** Open-end offset wrenches, such as those recommended for the 492 rf connectors, are required to loosen or tighten the nuts of the semi-rigid coaxial connectors.

#### 1. Separating the TR 503

- a. Place the TR 503 so that the rear side is facing you. Turn it on its right side (honeycomb assembly facing up).

- b. Remove the four screws holding the top section to the U-shaped coupling blocks. Refer to the arrows marked "A" in Fig. 5-5. Loosen the four screws holding the bottom section to the U-shaped coupling blocks (marked "B").

- c. Turn the TR 503 right-side up. Remove the screws from the backplate. Separate the two sections slightly.

- d. Remove the semi-rigid coaxial connector from the LO port of the Output Mixer. Remove the harmonica connector from P370.

- e. Move the two sections further apart and remove the coaxial connector from the IF Output of the Oscillator and Amplitude Control Assembly. The two sections are now completely disconnected.

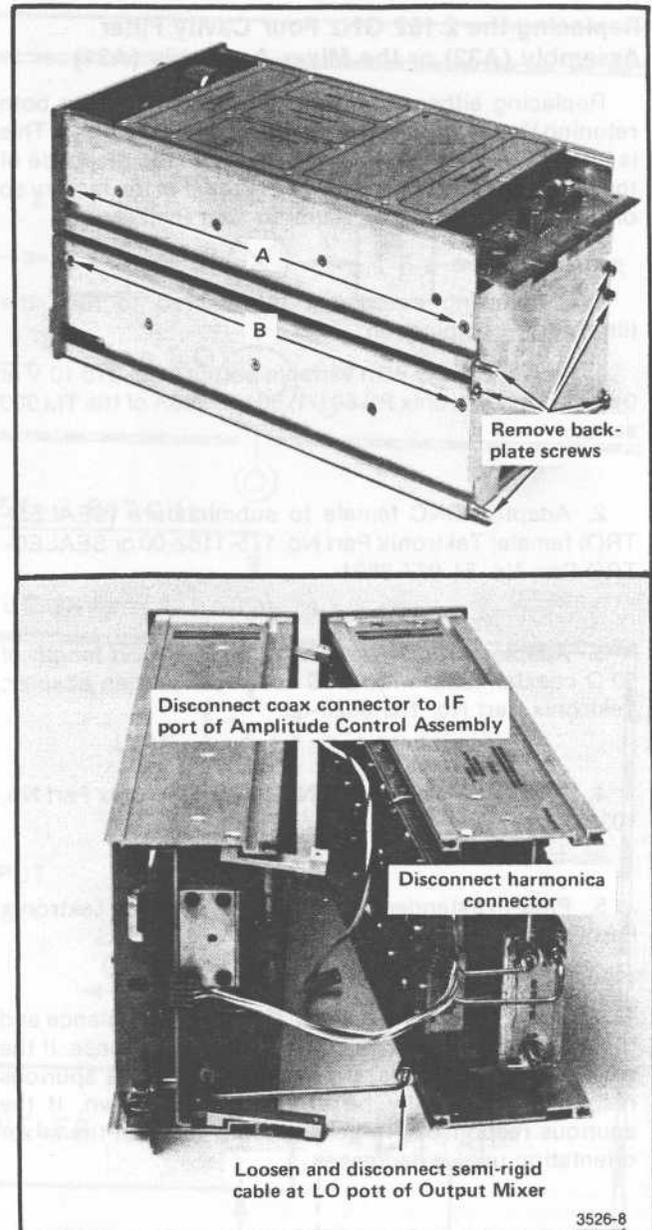


Fig. 5-5. Procedure for separating the two sections of the TR 503.

#### 2. Removing the Assembly

- a. Loosen and remove the semi-rigid coaxial connectors from the applicable assembly. Remove any harmonica connectors.

- b. Loosen and remove the mounting screws of the assembly. Lift the assembly out of the TR 503.

Reverse the above steps to replace an assembly and reassemble the TR 503.

### Replacing the 2.182 GHz Four Cavity Filter Assembly (A32) or the Mixer Assembly (A31)

Replacing either the filter or the mixer requires both retuning the filter and readjusting the mixer coupling. This is due to the effect that the mixer has on the response of the filter. The filter assembly is pretuned at the factory so only slight adjustment is required after installation.

The following equipment is required to tune the filter/mixer combination:

1. Power Supply with variable output from 0 to 10 V at 0 to 40 mA; Tektronix PS 501-1, 501-2, 503A of the TM 500 series.
2. Adapter: BNC female to subminiature (SEALEC-TRO) female; Tektronix Part No. 175-1162-00 or SEALEC-TRO Part No. 51-077-6801.
3. Adapter: BNC male to BNC male—short length of 50  $\Omega$  coaxial cable with BNC connectors or an adapter; Tektronix Part No. 103-0028-00.
4. Adapter: N female to BNC male; Tektronix Part No. 103-0058-00.
5. Plug-In extender for TM 500 instruments; Tektronix Part No. 067-0645-01.

The orientation of the mixer affects mixer balance and the suppression of a 2.182 GHz spurious response. If the mixer is positioned as shown in Fig. 5-6, the spurious response will usually be at least 70 dB down. If the spurious response is larger than this, readjust the mixer orientation until it decreases.

#### 1. Remove and Replace the Filter Assembly

- a. Disconnect the two semi-rigid cables and remove the mounting screws.
- b. Remove the filter mixer assembly.
- c. Remove the mixer assembly and install it in the replacement filter assembly. Position the mixer assembly as illustrated in Fig. 5-6.

#### CAUTION

Do not push the mixer assembly all the way into the filter cavity; this will damage the mixer diodes.

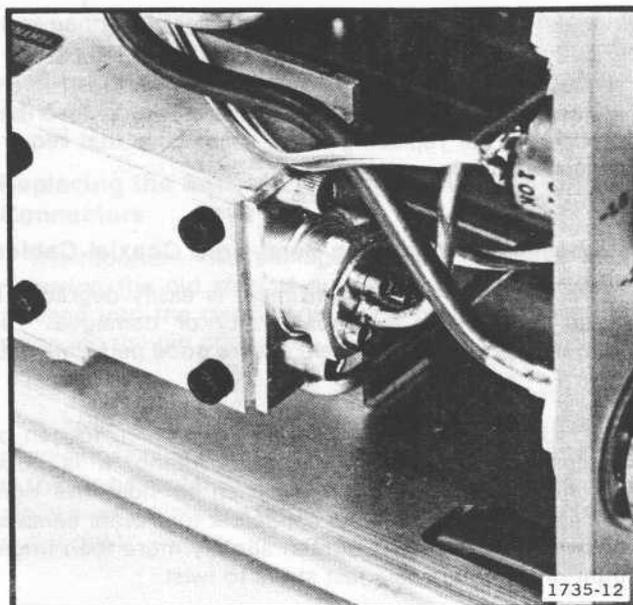


Fig. 5-6. Typical position for the mixer in the 2.182 GHz filter assembly.

- d. Install the mixer assembly by reversing the removal procedure. Reconnect the semi-rigid cables.

#### 2. Filter Alignment Procedure

This procedure obtains the response of the 2.182 GHz filter by feeding it a 2.157 to 2.207 GHz sweep from the 1st LO of the 492 spectrum analyzer. The output of the filter is mixed with a fixed 2.072 GHz signal, resulting in a 85 to 135 MHz representation of the filter response. This sweep is fed to the 492 RF Input and viewed on the 492 crt.

Figure 5-7 is an expanded view of Fig. 3-1. This figure shows the TR 503/492 system with more detail for the TR 503 phase-lock assembly and four-cavity filter/mixer. Dashed lines show the four connections made in the following procedure together with the two breaks made in the signal path.

#### CAUTION

The response of the filter is a function of all adjustments. All must be very close to optimum. If the adjustments are moved to where the signal is no longer seen, there is almost no way to tune the filter without special equipment.

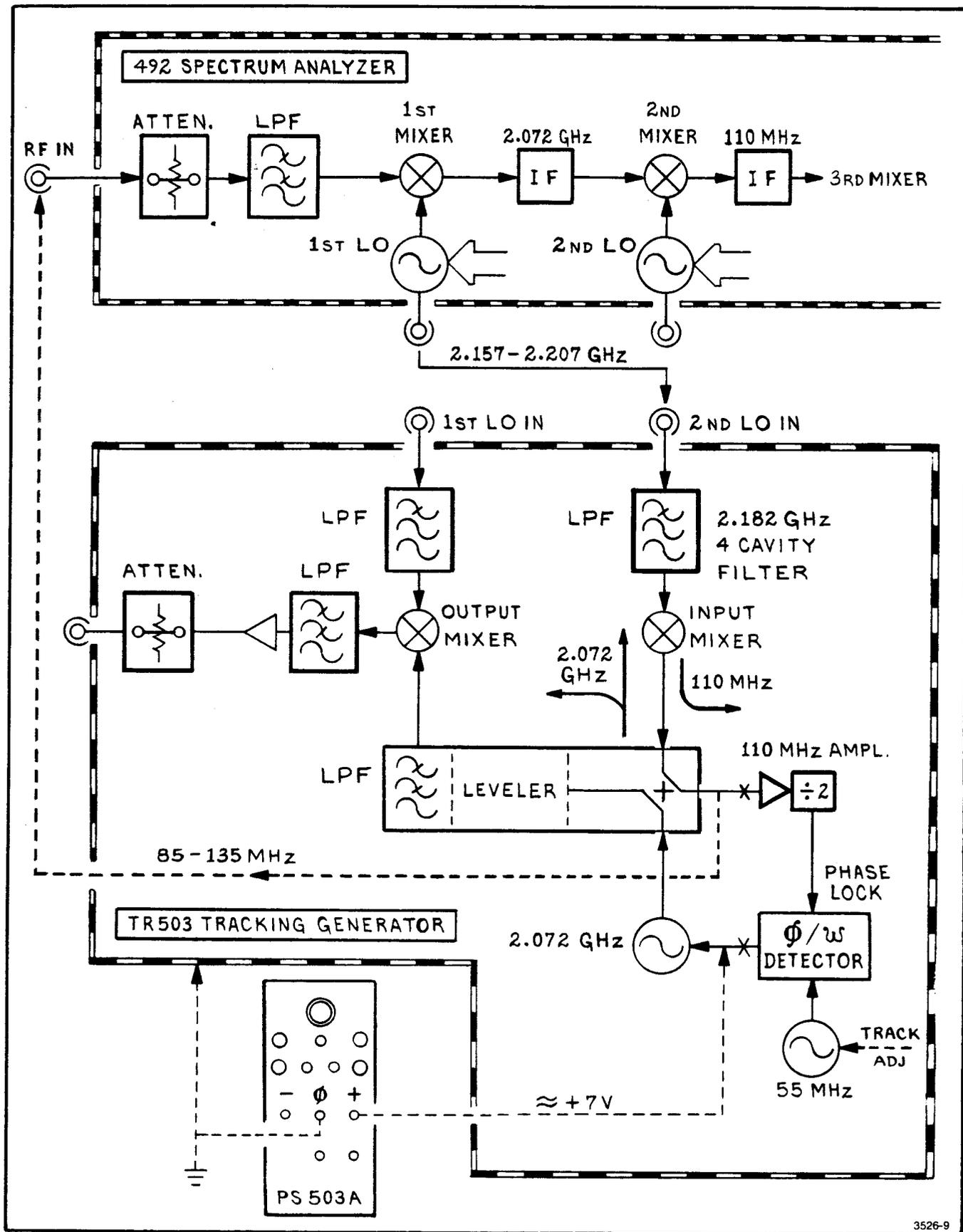


Fig. 5-7. TR 503/492 System Diagram showing Phase-Lock Assembly.

3526-9

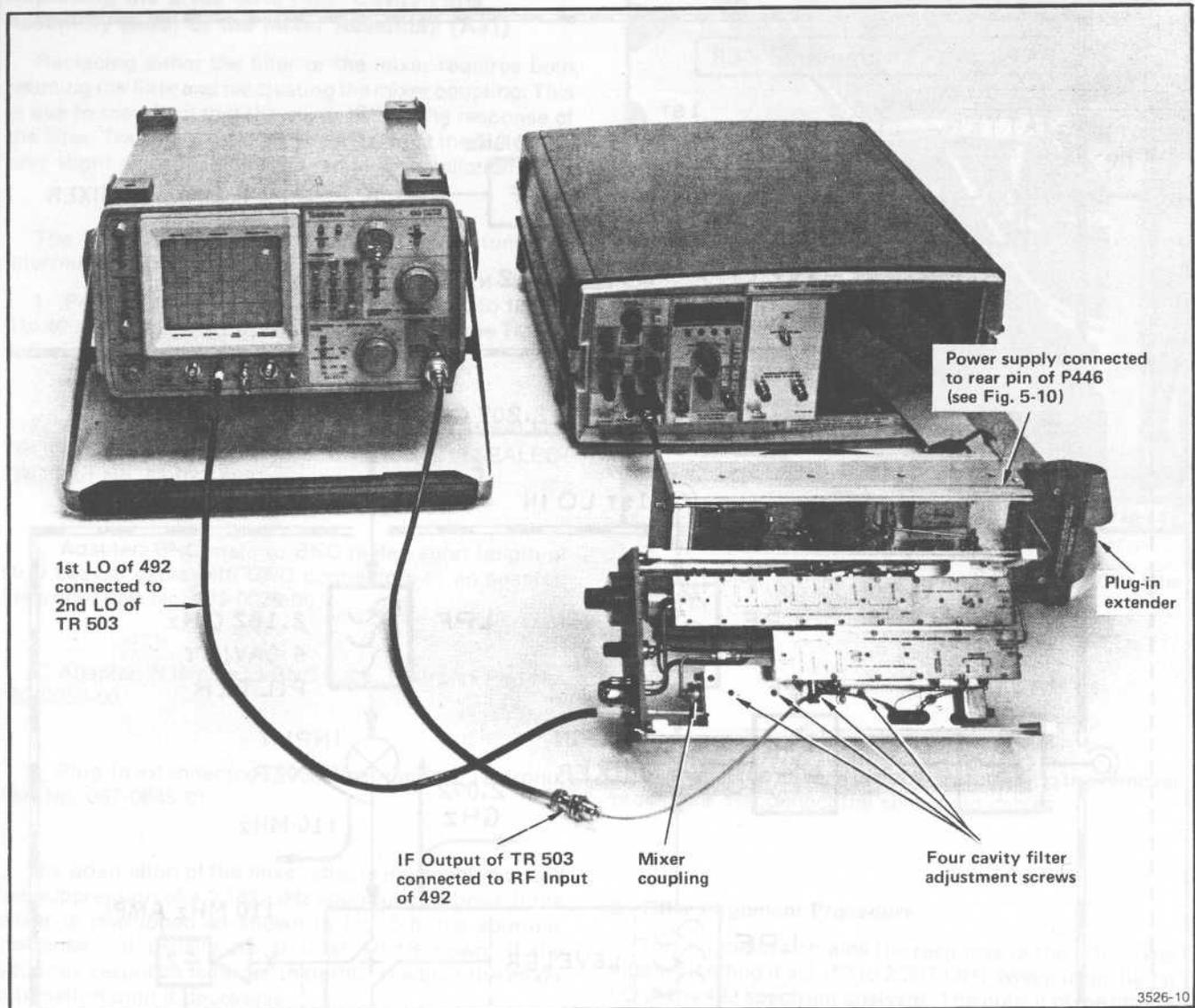


Fig. 5-8. Positioning the TR 503 to adjust the 2.182 GHz filter/mixer assembly.

a. Refer to the steps described above in "Separating the TR 503". Position the two sections as shown in Fig. 5-8, with the control section of the TR 503 horizontal and the other section upside down. Connect the plug-in extender between the TR 503 and the TM 500 mainframe (because the TR 503 card edge is upside-down, give the extender cable a half-twist before plugging it into the TM 500 mainframe).

b. Remove the P446 link (Tune Voltage Line, Fig. 5-9). Reconnect P370 and P210 to the mother board and the Leveling Loop and Bias board. Connect the + terminal of the power supply to the rear Tune Voltage pin of P446. Connect the "minus" or "common" of the power supply to the TR 503 chassis.

c. Switch on the TM 500 mainframe. Adjust the power supply output for +7 V.

d. Connect the 2nd LO Output of the 492 to the 2nd LO INPUT of the TR 503.

e. Apply the 100 MHz Calibrator signal to the RF Input of the 492. Set the Span/Div to 5 MHz. Using the 100 MHz signal as a reference, tune the Frequency to 110 MHz by tuning the 100 MHz signal two divisions to the left of center. After the 492 Frequency has been set to 110 MHz, disconnect the 100 MHz Calibrator signal from the RF Input.

f. Use a short 50  $\Omega$  cable to connect the IF Output of the TR 503 2.072 GHz Oscillator to the RF Input of the 492.

g. Adjust the voltage of the power supply to tune the 2.072 GHz Oscillator so the 110 MHz IF signal is centered on the screen.

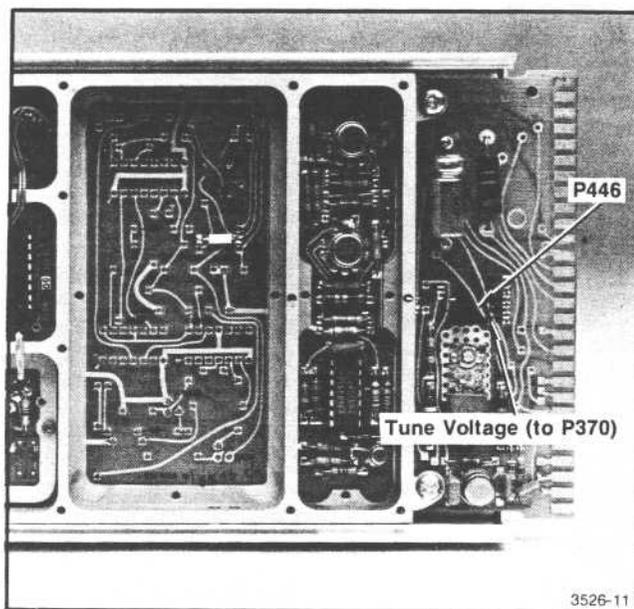


Fig. 5-9. Location of P446 on the mother board.

h. Move the cable from the 492 2nd LO Out to the 1st LO Out. The 1st LO Out is now connected to the TR 503 2nd LO INput.

i. Set the Vertical Display of the 492 to 2 dB/Div. Set the 492 Reference Level to  $-15$  dBm. Maximize the filter response amplitude by carefully adjusting the power supply voltage (use the vernier adjustment on the voltage control). Do not exceed 20 V.

j. Loosen the mixer clamp so the coupling and orientation can be adjusted. Orient the mixer as shown in Fig. 5-6.

k. Adjust the four cavities and the mixer coupling for the flattest bandpass response. Keep the response centered at the reference frequency as you adjust. Be very careful not to lose the signal. Typical response curves are shown in Fig. 5-10.

l. After adjustment, remove the power supply connection from the Tune Voltage of P446. Restore the original connections to P446, P370, P210, and the IF output of 2.072 GHz Oscillator.

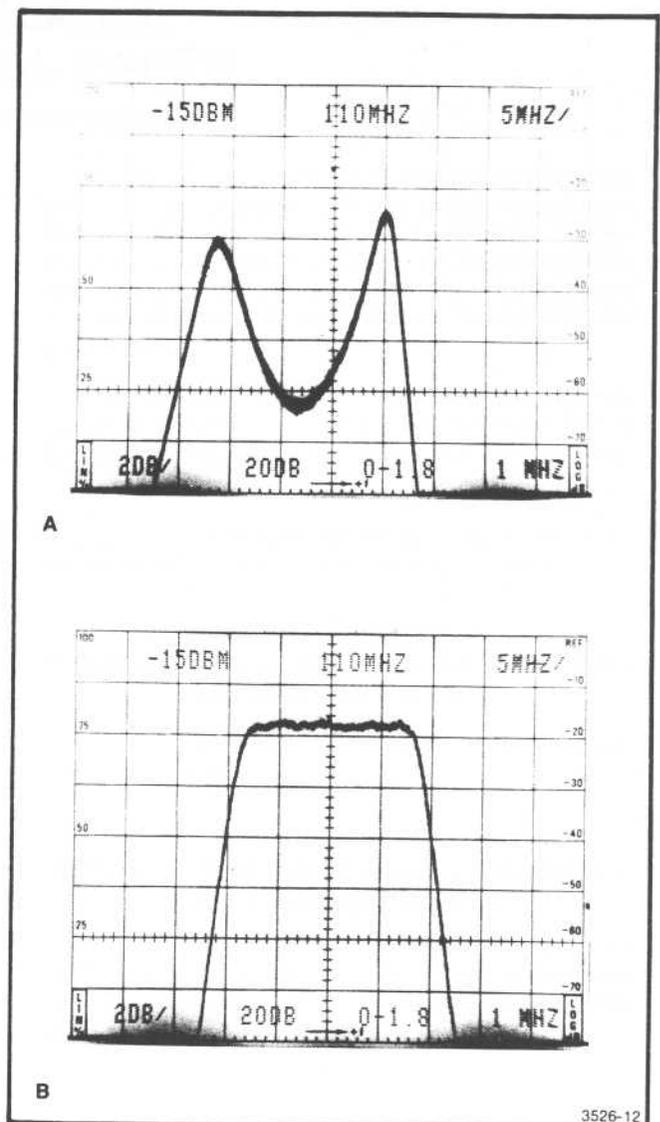


Fig. 5-10. Typical responses of the filter/mixer assemblies. (A) Detuned filter/mixer response. (B) Correct filter/mixer response.

m. Reassemble the TR 503.

This completes the calibration of the TR 503 Filter/Mixer Assembly. Do the Performance Check (Section 4) to verify that the TR 503 meets specifications.

# REPLACEABLE ELECTRICAL PARTS

## PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

Change information, if any, is located at the rear of this manual.

### LIST OF ASSEMBLIES

A list of assemblies can be found at the beginning of the Electrical Parts List. The assemblies are listed in numerical order. When the complete component number of a part is known, this list will identify the assembly in which the part is located.

### CROSS INDEX-MFR. CODE NUMBER TO MANUFACTURER

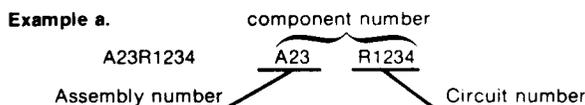
The Mfr. Code Number to Manufacturer index for the Electrical Parts List is located immediately after this page. The Cross Index provides codes, names and addresses of manufacturers of components listed in the Electrical Parts List.

### ABBREVIATIONS

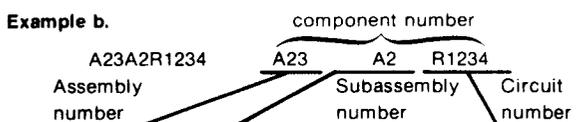
Abbreviations conform to American National Standard Y1.1.

### COMPONENT NUMBER (column one of the Electrical Parts List)

A numbering method has been used to identify assemblies, subassemblies and parts. Examples of this numbering method and typical expansions are illustrated by the following:



**Read: Resistor 1234 of Assembly 23**



**Read: Resistor 1234 of Subassembly 2 of Assembly 23**

Only the circuit number will appear on the diagrams and circuit board illustrations. Each diagram and circuit board illustration is clearly marked with the assembly number. Assembly numbers are also marked on the mechanical exploded views located in the Mechanical Parts List. The component number is obtained by adding the assembly number prefix to the circuit number.

The Electrical Parts List is divided and arranged by assemblies in numerical sequence (e.g., assembly A1 with its subassemblies and parts, precedes assembly A2 with its subassemblies and parts).

Chassis-mounted parts have no assembly number prefix and are located at the end of the Electrical Parts List.

### TEKTRONIX PART NO. (column two of the Electrical Parts List)

Indicates part number to be used when ordering replacement part from Tektronix.

### SERIAL/MODEL NO. (columns three and four of the Electrical Parts List)

Column three (3) indicates the serial number at which the part was first used. Column four (4) indicates the serial number at which the part was removed. No serial number entered indicates part is good for all serial numbers.

### NAME & DESCRIPTION (column five of the Electrical Parts List)

In the Parts List, an Item Name is separated from the description by a colon (:). Because of space limitations, an Item Name may sometimes appear as incomplete. For further Item Name identification, the U.S. Federal Cataloging Handbook H6-1 can be utilized where possible.

### MFR. CODE (column six of the Electrical Parts List)

Indicates the code number of the actual manufacturer of the part. (Code to name and address cross reference can be found immediately after this page.)

### MFR. PART NUMBER (column seven of the Electrical Parts List)

Indicates actual manufacturers part number.

CROSS INDEX—MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip
S0557	TOKYO SHIBAURA ELECTRIC CO., LTD.		TOKYO, JAPAN
00779	AMP, INC.	P O BOX 3608	HARRISBURG, PA 17105
01121	ALLEN-BRADLEY COMPANY	1201 2ND STREET SOUTH	MILWAUKEE, WI 53204
01295	TEXAS INSTRUMENTS, INC., SEMICONDUCTOR GROUP	P O BOX 5012, 13500 N CENTRAL EXPRESSWAY	DALLAS, TX 75222
02735	RCA CORPORATION, SOLID STATE DIVISION	ROUTE 202	SOMERVILLE, NY 08876
03508	GENERAL ELECTRIC COMPANY, SEMI-CONDUCTOR PRODUCTS DEPARTMENT	ELECTRONICS PARK	SYRACUSE, NY 13201
04423	TELONIC INDUSTRIES, INC.	21282 LAGUNA CANYON ROAD	LAGUNA BEACH, CA 92652
04713	MOTOROLA, INC., SEMICONDUCTOR PROD. DIV.	5005 E MCDOWELL RD, PO BOX 20923	PHOENIX, AZ 85036
07263	FAIRCHILD SEMICONDUCTOR, A DIV. OF FAIRCHILD CAMERA AND INSTRUMENT CORP.	464 ELLIS STREET	MOUNTAIN VIEW, CA 94042
08806	GENERAL ELECTRIC CO., MINIATURE LAMP PRODUCTS DEPARTMENT	NELA PARK	CLEVELAND, OH 44112
14433	ITT SEMICONDUCTORS	3301 ELECTRONICS WAY	WEST PALM BEACH, FL 33402
18324	SIGNETICS CORP.	P O BOX 3049	SUNNYVALE, CA 94086
21847	AERTECH INDUSTRIES	811 E. ARQUES	SUNNYVALE, CA 94086
32997	BOURNS, INC., TRIMPOT PRODUCTS DIV.	825 STEWART DR.	RIVERSIDE, CA 92507
33096	COLORADO CRYSTAL CORPORATION	1200 COLUMBIA AVE.	LOVELAND, CO 80537
55210	GETTIG ENG. AND MFG. COMPANY	2303 W 8TH STREET	SPRING MILLS, PA 16875
56289	SPRAGUE ELECTRIC CO.	PO BOX 85, OFF ROUTE 45	NORTH ADAMS, MA 01247
72982	ERIE TECHNOLOGICAL PRODUCTS, INC.	644 W. 12TH ST.	ERIE, PA 16512
75042	TRW ELECTRONIC COMPONENTS, IRC FIXED RESISTORS, PHILADELPHIA DIVISION	401 N. BROAD ST.	PHILADELPHIA, PA 19108
80009	TEKTRONIX, INC.	P O BOX 500	BEAVERTON, OR 97077
91637	DALE ELECTRONICS, INC.	P. O. BOX 609	COLUMBUS, NE 68601

Component No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
A6	119-0738-00		AMPLIFIER: 2 TO 4 GHZ	80009	119-0738-00
A7	119-0633-0C		ISOLATOR, RF REF: 1.2-4GHZ, 20DBMIN	21847	ASI2040
A8	015-1027-00		FILTER, LOW PASS: 4.5 GHZ	80009	015-1027-00
A9	119-0751-00		FILTER, BANDPASS: INTERDIGITAL	80009	119-0751-00
A10	119-0633-00		ISOLATOR, RF REF: 1.2-4GHZ, 20DBMIN	21847	ASI2040
A11	119-0732-00		MIXER ASSEMBLY: OUT PUT	80009	119-0732-00
A12	119-0736-00		AMPL/DET ASSY: 0.1-1800MHZ	80009	119-0736-00
A13	119-0740-00		ATTENUATOR ASSY: 2-50 OHM, STEP ATTENUATOR	04423	0BD
A14	119-0737-02		AMPTD CONT ASSY: 2.072 GHZ	80009	119-0737-02
A15	670-4145-00		CKT BOARD ASSY: LEVELING LOOP & BIAS	80009	670-4145-00
A31	119-0306-03		MIXER UNIT, BAL:	80009	119-0306-03
A32	119-0735-01		FILTER, RFI: LOW PASS FILTER	80009	119-0735-01
A35A1	670-4304-00		CKT BOARD ASSY: MOTHER	80009	670-4304-00
A35A2	670-4141-01		CKT BOARD ASSY: 105MHZ AMPLIFIER	80009	670-4141-01
A35A3	670-7055-00		CKT BOARD ASSY: 55.0MHZ OSC.	80009	670-7055-00
A35A4	670-4142-00		CKT BOARD ASSY: FREQUENCY DETECTOR	80009	670-4142-00
A15	-----		CKT BOARD ASSY: LEVELING LOOP & BIAS		
A15C150	283-0129-00		CAP., FXD, CER DI: 0.56UF, 20%, 100V	56289	725C7
A15C162	283-0129-00		CAP., FXD, CER DI: 0.56UF, 20%, 100V	56289	725C7
A15C174	283-0129-00		CAP., FXD, CER DI: 0.56UF, 20%, 100V	56289	725C7
A15C186	283-0129-00		CAP., FXD, CER DI: 0.56UF, 20%, 100V	56289	725C7
A15C202	283-0346-00		CAP., FXD, CER DI: 0.47UF, +80-20%, 100V	72982	8131-M100F474Z
A15C210	283-0341-00		CAP., FXD, CER DI: 0.047UF, 10%, 100V	72982	8121N153X7R0473K
A15C212	283-0346-00		CAP., FXD, CER DI: 0.47UF, +80-20%, 100V	72982	8131-M100F474Z
A15C218	283-0346-00		CAP., FXD, CER DI: 0.47UF, +80-20%, 100V	72982	8131-M100F474Z
A15C226	283-0346-00		CAP., FXD, CER DI: 0.47UF, +80-20%, 100V	72982	8131-M100F474Z
A15C232	283-0129-00		CAP., FXD, CER DI: 0.56UF, 20%, 100V	56289	725C7
A15C250	290-0340-00		CAP., FXD, ELCTLT: 10UF, 10%, 50V	56289	109D106X9050C2
A15C254	283-0346-00		CAP., FXD, CER DI: 0.47UF, +80-20%, 100V	72982	8131-M100F474Z
A15C260	290-0340-00		CAP., FXD, ELCTLT: 10UF, 10%, 50V	56289	109D106X9050C2
A15C262	283-0346-00		CAP., FXD, CER DI: 0.47UF, +80-20%, 100V	72982	8131-M100F474Z
A15CR212	152-0141-02		SEMICONV DEVICE: SILICON, 30V, 50NA	01295	1N4152R
A15CR214	152-0141-02		SEMICONV DEVICE: SILICON, 30V, 50NA	01295	1N4152R
A15CR216	152-0141-02		SEMICONV DEVICE: SILICON, 30V, 50NA	01295	1N4152R
A15CR250	152-0040-00		SEMICONV DEVICE: SILICON, 600V, 1A	80009	152-0040-00
A15L250	108-0395-00		COIL, RF: 64UH	80009	108-0395-00
A15Q210	151-0103-00		TRANSISTOR: SILICON, NPN	80009	151-0103-00
A15R150	321-0167-00		RES., FXD, FILM: 536 OHM, 1%, 0.125W	91637	MFF1816G536R0F
A15R152	315-0184-00		RES., FXD, CMPSN: 180K OHM, 5%, 0.25W	01121	CB1845
A15R154	315-0103-00		RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
A15R156	315-0104-00		RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
A15R158	315-0272-00		RES., FXD, CMPSN: 2.7K OHM, 5%, 0.25W	01121	CB2725
A15R160	321-0193-00		RES., FXD, FILM: 1K OHM, 1%, 0.125W	91637	MFF1816G10000F
A15R162	321-0167-00		RES., FXD, FILM: 536 OHM, 1%, 0.125W	91637	MFF1816G536R0F
A15R164	315-0184-00		RES., FXD, CMPSN: 180K OHM, 5%, 0.25W	01121	CB1845
A15R166	315-0103-00		RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
A15R168	315-0104-00		RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
A15R170	315-0272-00		RES., FXD, CMPSN: 2.7K OHM, 5%, 0.25W	01121	CB2725
A15R172	321-0193-00		RES., FXD, FILM: 1K OHM, 1%, 0.125W	91637	MFF1816G10000F
A15R174	321-0150-00		RES., FXD, FILM: 357 OHM, 1%, 0.125W	91637	MFF1816G357R0F
A15R176	315-0184-00		RES., FXD, CMPSN: 180K OHM, 5%, 0.25W	01121	CB1845
A15R178	315-0103-00		RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
A15R180	315-0104-00		RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
A15R182	315-0272-00		RES., FXD, CMPSN: 2.7K OHM, 5%, 0.25W	01121	CB2725

Replaceable Electrical Parts—TR 503

Component No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
A15R184	321-0193-00		RES., FXD, FILM: 1K OHM, 1%, 0.125W	91637	MFF1816G10000F
A15R188	315-0184-00		RES., FXD, CMPSN: 180K OHM, 5%, 0.25W	01121	CB1845
A15R190	315-0103-00		RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
A15R192	315-0104-00		RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
A15R194	315-0272-00		RES., FXD, CMPSN: 2.7K OHM, 5%, 0.25W	01121	CB2725
A15R196	321-0193-00		RES., FXD, FILM: 1K OHM, 1%, 0.125W	91637	MFF1816G10000F
A15R200	315-0101-00		RES., FXD, CMPSN: 100 OHM, 5%, 0.25W	01121	CB1015
A15R202	321-0422-00		RES., FXD, FILM: 243K OHM, 1%, 0.125W	91637	MFF1816G24302F
A15R204	315-0243-00		RES., FXD, CMPSN: 24K OHM, 5%, 0.25W	01121	CB2435
A15R206	315-0912-00		RES., FXD, CMPSN: 9.1K OHM, 5%, 0.25W	01121	CB9125
A15R207	315-0472-00		RES., FXD, CMPSN: 4.7K OHM, 5%, 0.25W	01121	CB4725
A15R208	321-0251-00		RES., FXD, FILM: 4.02K OHM, 1%, 0.125W	91637	MFF1816G40200F
A15R209	315-0821-00		RES., FXD, CMPSN: 820 OHM, 5%, 0.25W	01121	CB8215
A15R210	321-0222-00		RES., FXD, FILM: 2K OHM, 1%, 0.125W	91637	MFF1816G20000F
A15R211	315-0472-00		RES., FXD, CMPSN: 4.7K OHM, 5%, 0.25W	01121	CB4725
A15R212	315-0683-00		RES., FXD, CMPSN: 68K OHM, 5%, 0.25W	01121	CB6835
A15R214	321-0228-00		RES., FXD, FILM: 2.32K OHM, 1%, 0.125W	91637	MFF1816G23200F
A15R215	311-1268-00		RES., VAR, NONWIR: 10K OHM, 10%, 0.50W	32997	3329P-L58-103
A15R218	315-0100-00		RES., FXD, CMPSN: 10 OHM, 5%, 0.25W	01121	CB1005
A15R220	311-1271-00		RES., VAR, NONWIR: 50K OHM, 10%, 0.50W	32997	3329P-L58-503
A15R221	321-0356-00		RES., FXD, FILM: 49.9K OHM, 1%, 0.125W	91637	MFF1816G49901F
A15R222	311-1271-00		RES., VAR, NONWIR: 50K OHM, 10%, 0.50W	32997	3329P-L58-503
A15R225	311-1270-00		RES., VAR, NONWIR: 12K OHM, 10%, 0.5W	32997	3329P-L58-253
A15R226	315-0154-00		RES., FXD, CMPSN: 150K OHM, 5%, 0.25W	01121	CB1545
A15R228	321-0347-00		RES., FXD, FILM: 40.2K OHM, 1%, 0.125W	91637	MFF1816G40201F
A15R232	315-0184-00		RES., FXD, CMPSN: 180K OHM, 5%, 0.25W	01121	CB1845
A15R234	315-0103-00		RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
A15R236	315-0104-00		RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
A15R238	315-0272-00		RES., FXD, CMPSN: 2.7K OHM, 5%, 0.25W	01121	CB2725
A15R240	321-0193-00		RES., FXD, FILM: 1K OHM, 1%, 0.125W	91637	MFF1816G10000F
A15R242	321-0147-00		RES., FXD, FILM: 332 OHM, 1%, 0.125W	91637	MFF1816G332R0F
A15R250	321-0345-00		RES., FXD, FILM: 38.3K OHM, 1%, 0.125W	91637	MFF1816G38301F
A15R252	321-0364-00		RES., FXD, FILM: 60.4K OHM, 1%, 0.125W	91637	MFF1816G60401F
A15R254	315-0362-00		RES., FXD, CMPSN: 3.6K OHM, 5%, 0.25W	01121	CB3625
A15R256	315-0203-00		RES., FXD, CMPSN: 20K OHM, 5%, 0.25W	01121	CB2035
A15R258	315-0182-00		RES., FXD, CMPSN: 1.8K OHM, 5%, 0.25W	01121	CB1825
A15R260	315-0100-00		RES., FXD, CMPSN: 10 OHM, 5%, 0.25W	01121	CB1005
A15R261	321-0239-00		RES., FXD, FILM: 3.01K OHM, 1%, 0.125W	91637	MFF1816G30100F
A15R262	315-0101-00		RES., FXD, CMPSN: 100 OHM, 5%, 0.25W	01121	CB1015
A15U150	156-0067-00		MICROCIRCUIT, LI: OPERATIONAL AMPLIFIER	02735	85145
A15U160	156-0067-00		MICROCIRCUIT, LI: OPERATIONAL AMPLIFIER	02735	85145
A15U170	156-0067-00		MICROCIRCUIT, LI: OPERATIONAL AMPLIFIER	02735	85145
A15U180	156-0067-00		MICROCIRCUIT, LI: OPERATIONAL AMPLIFIER	02735	85145
A15U200	156-0067-00		MICROCIRCUIT, LI: OPERATIONAL AMPLIFIER	02735	85145
A15U240	156-0067-00		MICROCIRCUIT, LI: OPERATIONAL AMPLIFIER	02735	85145
A15U250	156-0067-00		MICROCIRCUIT, LI: OPERATIONAL AMPLIFIER	02735	85145
A15VR250	152-0461-00		SEMICONV DEVICE: ZENER, 0.4W, 6.2V, 5%	04713	1N821
A15VR258	152-0127-00		SEMICONV DEVICE: ZENER, 0.4W, 7.5V, 5%	04713	SZG35009K2
A15VR262	152-0461-00		SEMICONV DEVICE: ZENER, 0.4W, 6.2V, 5%	04713	1N821

Component No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
A35A1	-----		CKT BOARD ASSY:MOTHER		
A35A1C360	283-0197-00		CAP., FXD, CER DI:470PF, 5%, 100V	72982	8121N075C0G0471J
A35A1C362	283-0346-00		CAP., FXD, CER DI:0.47UF, +80-20%, 100V	72982	8131-M100F474Z
A35A1C364	281-0752-00		CAP., FXD, CER DI:0.00175UF, 10A	72982	1214-007
A35A1C366	281-0752-00		CAP., FXD, CER DI:0.00175UF, 10A	72982	1214-007
A35A1C374	283-0114-00		CAP., FXD, CER DI:0.0015UF, 5%, 200V	72982	805-509B152J
A35A1C384	290-0513-00		CAP., FXD, ELCTLT:510UF, +75-10%, 25V	56289	109D575
A35A1C386	281-0752-00		CAP., FXD, CER DI:0.00175UF, 10A	72982	1214-007
A35A1C388	281-0752-00		CAP., FXD, CER DI:0.00175UF, 10A	72982	1214-007
A35A1C390	281-0752-00		CAP., FXD, CER DI:0.00175UF, 10A	72982	1214-007
A35A1C404	283-0060-00		CAP., FXD, CER DI:100PF, 5%, 200V	72982	855-535U2J101J
A35A1C408	283-0346-00		CAP., FXD, CER DI:0.47UF, +80-20%, 100V	72982	8131-M100F474Z
A35A1C410	283-0167-00		CAP., FXD, CER DI:0.1UF, 10%, 100V	72982	8131N145X5R0104K
A35A1C412	283-0346-00		CAP., FXD, CER DI:0.47UF, +80-20%, 100V	72982	8131-M100F474Z
A35A1C420	281-0752-00		CAP., FXD, CER DI:0.00175UF, 10A	72982	1214-007
A35A1C422	281-0752-00		CAP., FXD, CER DI:0.00175UF, 10A	72982	1214-007
A35A1C424	285-0882-00		CAP., FXD, PLSTC:0.047UF, 10%, 100V	56289	LP66A1B473K001
A35A1C428	285-0882-00		CAP., FXD, PLSTC:0.047UF, 10%, 100V	56289	LP66A1B473K001
A35A1C432	283-0346-00		CAP., FXD, CER DI:0.47UF, +80-20%, 100V	72982	8131-M100F474Z
A35A1C480	283-0346-00		CAP., FXD, CER DI:0.47UF, +80-20%, 100V	72982	8131-M100F474Z
A35A1CR370	152-0242-00		SEMICONV DEVICE:SILICON, 225V, 200MA	07263	FDH5004
A35A1CR372	152-0242-00		SEMICONV DEVICE:SILICON, 225V, 200MA	07263	FDH5004
A35A1CR395	152-0333-00		SEMICONV DEVICE:SILICON, 55V, 200MA	07263	FDH-6012
A35A1CR428	152-0574-00		SEMICONV DEVICE:SILICON, 120V, 0.15A	80009	152-0574-00
A35A1CR480	152-0061-00		SEMICONV DEVICE:SILICON, 175V, 100MA	07263	FDH2161
A35A1P384	131-0993-00		BUS, CONDUCTOR:2 WIRE BLACK	00779	530153-2
A35A1Q390	151-0364-00		TRANSISTOR:SILICON, PNP	80009	151-0364-00
A35A1Q395	151-0301-00		TRANSISTOR:SILICON, PNP	04713	2N2907A
A35A1Q410	151-0134-00		TRANSISTOR:SILICON, PNP	80009	151-0134-00
A35A1Q420	151-0286-00		TRANSISTOR:SILICON, NPN	S0557	28C515A
A35A1Q430	151-0508-00		TRANSISTOR:SILICON, NPN, PROGRAMMABLE	03508	2N6027
A35A1Q440	151-0302-00		TRANSISTOR:SILICON, NPN	07263	S038487
A35A1Q445	151-0302-00		TRANSISTOR:SILICON, NPN	07263	S038487
A35A1Q480	151-0136-00		TRANSISTOR:SILICON, NPN	02735	35495
A35A1R350	315-0271-00		RES., FXD, CMPSN:270 OHM, 5%, 0.25W	01121	CB2715
A35A1R352	315-0301-00		RES., FXD, CMPSN:300 OHM, 5%, 0.25W	01121	CB3015
A35A1R354	315-0153-00		RES., FXD, CMPSN:15K OHM, 5%, 0.25W	01121	CB1535
A35A1R356	307-0052-00		RES., FXD, CMPSN:3 OHM, 5%, 0.50W	01121	EB30G5
A35A1R358	321-0279-00		RES., FXD, FILM:7.87K OHM, 1%, 0.125W	91637	MFF1816G78700F
A35A1R360	321-0275-00		RES., FXD, FILM:7.15K OHM, 1%, 0.125W	91637	MFF1816G71500F
A35A1R362	321-0164-00		RES., FXD, FILM:499 OHM, 1%, 0.125W	91637	MFF1816G4990F
A35A1R364	321-0270-00		RES., FXD, FILM:6.34K OHM, 1%, 0.125W	91637	MFF1816G63400F
A35A1R370	315-0620-00		RES., FXD, CMPSN:62 OHM, 5%, 0.25W	01121	CB6205
A35A1R372	315-0271-00		RES., FXD, CMPSN:270 OHM, 5%, 0.25W	01121	CB2715
A35A1R374	321-0222-00		RES., FXD, FILM:2K OHM, 1%, 0.125W	91637	MFF1816G20000F
A35A1R376	321-0260-00		RES., FXD, FILM:4.99K OHM, 1%, 0.125W	91637	MFF1816G49900F
A35A1R378	315-0431-00		RES., FXD, CMPSN:430 OHM, 5%, 0.25W	01121	CB4315
A35A1R380	308-0677-00		RES., FXD, WW:1 OHM, 5%, 2W	75042	BWH-1R000J
A35A1R382	315-0562-00		RES., FXD, CMPSN:5.6K OHM, 5%, 0.25W	01121	CB5625
A35A1R390	301-0392-00		RES., FXD, CMPSN:3.9K OHM, 5%, 0.50W	01121	EB3925
A35A1R392	301-0121-00		RES., FXD, CMPSN:120 OHM, 5%, 0.50W	01121	EB1215
A35A1R394	315-0200-00		RES., FXD, CMPSN:20 OHM, 5%, 0.25W	01121	CB2005
A35A1R396	315-0153-00		RES., FXD, CMPSN:15K OHM, 5%, 0.25W	01121	CB1535
A35A1R398	315-0471-00		RES., FXD, CMPSN:470 OHM, 5%, 0.25W	01121	CB4715
A35A1R400	321-0295-00		RES., FXD, FILM:11.5K OHM, 1%, 0.125W	91637	MFF1816G11501F
A35A1R402	321-0239-00		RES., FXD, FILM:3.01K OHM, 1%, 0.125W	91637	MFF1816G30100F
A35A1R404	321-0247-00		RES., FXD, FILM:3.65K OHM, 1%, 0.125W	91637	MFF1816G36500F

Replaceable Electrical Parts—TR 503

Component No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
A35A1R406	321-0239-00		RES., FXD, FILM: 3.01K OHM, 1%, 0.125W	91637	MFF1816G30100F
A35A1R408	321-0193-00		RES., FXD, FILM: 1K OHM, 1%, 0.125W	91637	MFF1816G10000F
A35A1R410	315-0301-00		RES., FXD, CMPSN: 300 OHM, 5%, 0.25W	01121	CB3015
A35A1R412	315-0271-00		RES., FXD, CMPSN: 270 OHM, 5%, 0.25W	01121	CB2715
A35A1R414	315-0201-00		RES., FXD, CMPSN: 200 OHM, 5%, 0.25W	01121	CB2015
A35A1R420	321-0282-0Q		RES., FXD, FILM: 8.45K OHM, 1%, 0.125W	91637	MFF1816G84500F
A35A1R422	321-0282-00		RES., FXD, FILM: 8.45K OHM, 1%, 0.125W	91637	MFF1816G84500F
A35A1R424	321-0222-00		RES., FXD, FILM: 2K OHM, 1%, 0.125W	91637	MFF1816G20000F
A35A1R426	315-0181-00		RES., FXD, CMPSN: 180 OHM, 5%, 0.25W	01121	CB1815
A35A1R428	321-0222-00		RES., FXD, FILM: 2K OHM, 1%, 0.125W	91637	MFF1816G20000F
A35A1R430	315-0102-00		RES., FXD, CMPSN: 1K OHM, 5%, 0.25W	01121	CB1025
A35A1R432	315-0104-00		RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
A35A1R434	315-0623-00		RES., FXD, CMPSN: 62K OHM, 5%, 0.25W	01121	CB6235
A35A1R436	315-0243-00		RES., FXD, CMPSN: 24K OHM, 5%, 0.25W	01121	CB2435
A35A1R438	315-0434-00		RES., FXD, CMPSN: 430K OHM, 5%, 0.25W	01121	CB4345
A35A1R440	315-0471-00		RES., FXD, CMPSN: 470 OHM, 5%, 0.25W	01121	CB4715
A35A1R442	315-0150-00		RES., FXD, CMPSN: 15 OHM, 5%, 0.25W	01121	CB1505
A35A1R444	315-0104-00		RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
A35A1R446	315-0203-00		RES., FXD, CMPSN: 20K OHM, 5%, 0.25W	01121	CB2035
A35A1R448	315-0682-00		RES., FXD, CMPSN: 6.8K OHM, 5%, 0.25W	01121	CB6825
A35A1R451	315-0470-00		RES., FXD, CMPSN: 47 OHM, 5%, 0.25W	01121	CB4705
A35A1R480	315-0150-00		RES., FXD, CMPSN: 15 OHM, 5%, 0.25W	01121	CB1505
A35A1R482	315-0392-00		RES., FXD, CMPSN: 3.9K OHM, 5%, 0.25W	01121	CB3925
A35A1R484	315-0271-00		RES., FXD, CMPSN: 270 OHM, 5%, 0.25W	01121	CB2715
A35A1U350	156-0053-00		MICROCIRCUIT, LI: VOLTAGE REGULATOR	07263	SL21721
A35A1U365	156-0158-00		MICROCIRCUIT, LI: DUAL OPERATIONAL AMPLIFIER	18324	MC1458V
A35A1U370	156-0053-00		MICROCIRCUIT, LI: VOLTAGE REGULATOR	07263	SL21721
A35A1U390	156-0071-00		MICROCIRCUIT, LI: VOLTAGE REGULATOR	04713	MC1723CL
A35A1VR362	152-0461-00		SEMICONV DEVICE: ZENER, 0.4W, 6.2V, 5%	04713	1N821
A35A1VR364	152-0461-00		SEMICONV DEVICE: ZENER, 0.4W, 6.2V, 5%	04713	1N821
A35A1VR480	152-0304-00		SEMICONV DEVICE: ZENER, 0.4W, 20V, 5%	14433	1N968B
A35A1W494	131-0566-00		BUS CONDUCTOR: DUMMY RES, 2.375, 22 AWG	55210	L-2007-1



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Component No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
A35A2	-----		CKT BOARD ASSY:105MHZ AMPLIFIER		
A35A2C500	283-0107-00		CAP., FXD, CER DI:51PF, 5%, 200V	72982	8121B232COG0510J
A35A2C502	283-0204-00		CAP., FXD, CER DI:0.01UF, 20%, 50V	72982	8121N06125U0103M
A35A2C510	283-0067-00		CAP., FXD, CER DI:0.001UF, 10%, 200V	72982	835-515B102K
A35A2C512	283-0168-00		CAP., FXD, CER DI:12PF, 5%, 100V	72982	8101B121COG0120J
A35A2C514	283-0204-00		CAP., FXD, CER DI:0.01UF, 20%, 50V	72982	8121N06125U0103M
A35A2C520	283-0067-00		CAP., FXD, CER DI:0.001UF, 10%, 200V	72982	835-515B102K
A35A2C523	283-0067-00		CAP., FXD, CER DI:0.001UF, 10%, 200V	72982	835-515B102K
A35A2L506	108-0733-00		COIL, RF:113NH	80009	108-0733-00
A35A2L520	108-0733-00		COIL, RF:113NH	80009	108-0733-00
A35A2Q500	151-0367-00		TRANSISTOR:SILICON, NPN, SEL FROM 3571TP	01295	SKA6516
A35A2Q505	151-0367-00		TRANSISTOR:SILICON, NPN, SEL FROM 3571TP	01295	SKA6516
A35A2Q510	151-0367-00		TRANSISTOR:SILICON, NPN, SEL FROM 3571TP	01295	SKA6516
A35A2R500	315-0101-00		RES., FXD, CMPSN:100 OHM, 5%, 0.25W	01121	CB1015
A35A2R502	315-0200-00		RES., FXD, CMPSN:20 OHM, 5%, 0.25W	01121	CB2005
A35A2R504	315-0432-00		RES., FXD, CMPSN:4.3K OHM, 5%, 0.25W	01121	CB4325
A35A2R506	315-0301-00		RES., FXD, CMPSN:300 OHM, 5%, 0.25W	01121	CB3015
A35A2R508	315-0302-00		RES., FXD, CMPSN:3K OHM, 5%, 0.25W	01121	CB3025
A35A2R510	315-0301-00		RES., FXD, CMPSN:300 OHM, 5%, 0.25W	01121	CB3015
A35A2R512	315-0432-00		RES., FXD, CMPSN:4.3K OHM, 5%, 0.25W	01121	CB4325
A35A2R514	315-0200-00		RES., FXD, CMPSN:20 OHM, 5%, 0.25W	01121	CB2005
A35A2R516	315-0301-00		RES., FXD, CMPSN:300 OHM, 5%, 0.25W	01121	CB3015
A35A2R518	315-0302-00		RES., FXD, CMPSN:3K OHM, 5%, 0.25W	01121	CB3025
A35A2R520	315-0301-00		RES., FXD, CMPSN:300 OHM, 5%, 0.25W	01121	CB3015
A35A2R521	315-0201-00		RES., FXD, CMPSN:200 OHM, 5%, 0.25W	01121	CB2015
A35A2R523	315-0621-00		RES., FXD, CMPSN:620 OHM, 5%, 0.25W	01121	CB6215
A35A2T520	120-0487-00		XFMR, TOROID:5 TURNS BIFILAR	80009	120-0487-00

Replaceable Electrical Parts—TR 503

Component No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
A35A3	-----		CKT BOARD ASSY:55.0MHZ OSC.		
A35A3C522	283-0346-00		CAP.,FXD,CER DI:0.47UF,+80-20%,100V	72982	8131-M100F474Z
A35A3C524	281-0167-00		CAP.,VAR,CER DI:9-45PF,200V	72982	538-011-D 9-45
A35A3C526	281-0508-00		CAP.,FXD,CER DI:12PF,+/-0.6PF,500V	72982	301-000C0G0120J
A35A3C528	283-0346-00		CAP.,FXD,CER DI:0.47UF,+80-20%,100V	72982	8131-M100F474Z
A35A3C532	283-0346-00		CAP.,FXD,CER DI:0.47UF,+80-20%,100V	72982	8131-M100F474Z
A35A3CR526	152-0595-00		SEMICONV DEVICE:VVC,SI,12V,120PF	04713	MV 1404
A35A3L526	108-0707-00		COIL,RF:150NH	80009	108-0707-00
A35A3R520	315-0102-00		RES.,FXD,CMPNSN:1K OHM,5%,0.25W	01121	CB1025
A35A3R522	315-0102-00		RES.,FXD,CMPNSN:1K OHM,5%,0.25W	01121	CB1025
A35A3R526	315-0200-00		RES.,FXD,CMPNSN:20 OHM,5%,0.25W	01121	CB2005
A35A3R532	315-0100-00		RES.,FXD,CMPNSN:10 OHM,5%,0.25W	01121	CB1005
A35A3R536	315-0471-00		RES.,FXD,CMPNSN:470 OHM,5%,0.25W	01121	CB4715
A35A3R538	315-0471-00		RES.,FXD,CMPNSN:470 OHM,5%,0.25W	01121	CB4715
A35A3R539	315-0510-00		RES.,FXD,CMPNSN:51 OHM,5%,0.25W	01121	CB5105
A35A3U520	156-0308-00		MICROCIRCUIT,DI:QUAD DIFF LINE RECEIVER	04713	SC22689P115
A35A3Y526	158-0237-00		XTAL UNIT,QTZ:55.0MHZ,0.0005%	33096	TO-5

Component No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
A35A4	-----		CKT BOARD ASSY:FREQUENCY DETECTOR		
A35A4C542	283-0239-00		CAP., FXD, CER DI:0.022UF, 10%, 50V	72982	8121N083X7R0223K
A35A4C544	283-0346-00		CAP., FXD, CER DI:0.47UF, +80-20%, 100V	72982	8131-M100F474Z
A35A4C550	283-0346-00		CAP., FXD, CER DI:0.47UF, +80-20%, 100V	72982	8131-M100F474Z
A35A4L540	108-0724-00		COIL, RF: 12.5NH	80009	108-0724-00
A35A4R542	315-0100-00		RES., FXD, CMPSN: 10 OHM, 5%, 0.25W	01121	CB1005
A35A4R544	315-0511-00		RES., FXD, CMPSN: 510 OHM, 5%, 0.25W	01121	CB5115
A35A4R546	321-0097-00		RES., FXD, FILM: 100 OHM, 1%, 0.125W	91637	MFF1816G100ROF
A35A4R548	321-0097-00		RES., FXD, FILM: 100 OHM, 1%, 0.125W	91637	MFF1816G100ROF
A35A4R549	315-0511-00		RES., FXD, CMPSN: 510 OHM, 5%, 0.25W	01121	CB5115
A35A4R550	315-0271-00		RES., FXD, CMPSN: 270 OHM, 5%, 0.25W	01121	CB2715
A35A4R552	315-0471-00		RES., FXD, CMPSN: 470 OHM, 5%, 0.25W	01121	CB4715
A35A4R554	315-0471-00		RES., FXD, CMPSN: 470 OHM, 5%, 0.25W	01121	CB4715
A35A4R556	315-0471-00		RES., FXD, CMPSN: 470 OHM, 5%, 0.25W	01121	CB4715
A35A4R558	315-0471-00		RES., FXD, CMPSN: 470 OHM, 5%, 0.25W	01121	CB4715
A35A4R559	315-0471-00		RES., FXD, CMPSN: 470 OHM, 5%, 0.25W	01121	CB4715
A35A4U540	156-0369-00		MICROCIRCUIT, DI: TRIPLE LINE RECEIVER	80009	156-0369-00
A35A4U545	156-0518-00		MICROCIRCUIT, DI: PHASE-FREQ DETECTOR	04713	MC12040L
A35A4U550	156-0230-00		MICROCIRCUIT, DI: DUAL D MA-SLAVE FLIP-FLOP	80009	156-0230-00

Replaceable Electrical Parts—TR 503

Component No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
CHASSIS PARTS					
DS10	150-0048-01		LAMP, INCAND:5V,0.06A,SEL	08806	683AS15
R5	311-0645-00		RES.,VAR, NONWIR:50K OHM,20%,0.50W	01121	GS1N048S503MA
R10	311-1341-00		RES.,VAR,WW:10K OHM,5%,0.25%	01121	534-9608103J
R20	311-1298-00		RES.,VAR, NONWIR:10K OHM,20%,0.50W	01121	W-7909
W10	175-1746-00		CA ASSY,SP,ELEC:IF OUT	80009	175-1746-00
W75	175-1720-00		CA ASSY,SP,ELEC:LOWPASS TO ISOLATOR	80009	175-1720-00
W85	175-1713-00		CA ASSY,SP,ELEC:INTERDIGITAL TO 4.5 GHZ	80009	175-1713-00
W95	175-1716-00		CA ASSY,SP,ELEC:2.1-3.9 TO ISOLATOR	80009	175-1716-00
W105	175-1721-00		CA ASSY,SP,ELEC:MIXER TO ISOLATOR	80009	175-1721-00
W130	175-1710-00		CA ASSY,SP,ELEC:ATTENUATOR TORF OUT	80009	175-1710-00
W135	175-1715-00		CA ASSY,SP,ELEC:1 DB TO 10 DB	80009	175-1715-00

# DIAGRAMS AND CIRCUIT BOARD ILLUSTRATIONS

## Symbols

Graphic symbols and class designation letters are based on ANSI Standard Y32.2-1975.

Logic symbology is based on ANSI Y32.14-1973 in terms of positive logic. Logic symbols depict the logic function performed and may differ from the manufacturer's data.

The overline on a signal name indicates that the signal performs its intended function when it is in the low state.

Abbreviations are based on ANSI Y1.1-1972.

Other ANSI standards that are used in the preparation of diagrams by Tektronix, Inc. are:

- Y14.15, 1966 Drafting Practices.
- Y14.2, 1973 Line Conventions and Lettering.
- Y10.5, 1968 Letter Symbols for Quantities Used in Electrical Science and Electrical Engineering.

American National Standard Institute  
1430 Broadway  
New York, New York 10018

## Component Values

Electrical components shown on the diagrams are in the following units unless noted otherwise:

Capacitors = Values one or greater are in picofarads (pF).  
Values less than one are in microfarads ( $\mu$ F).

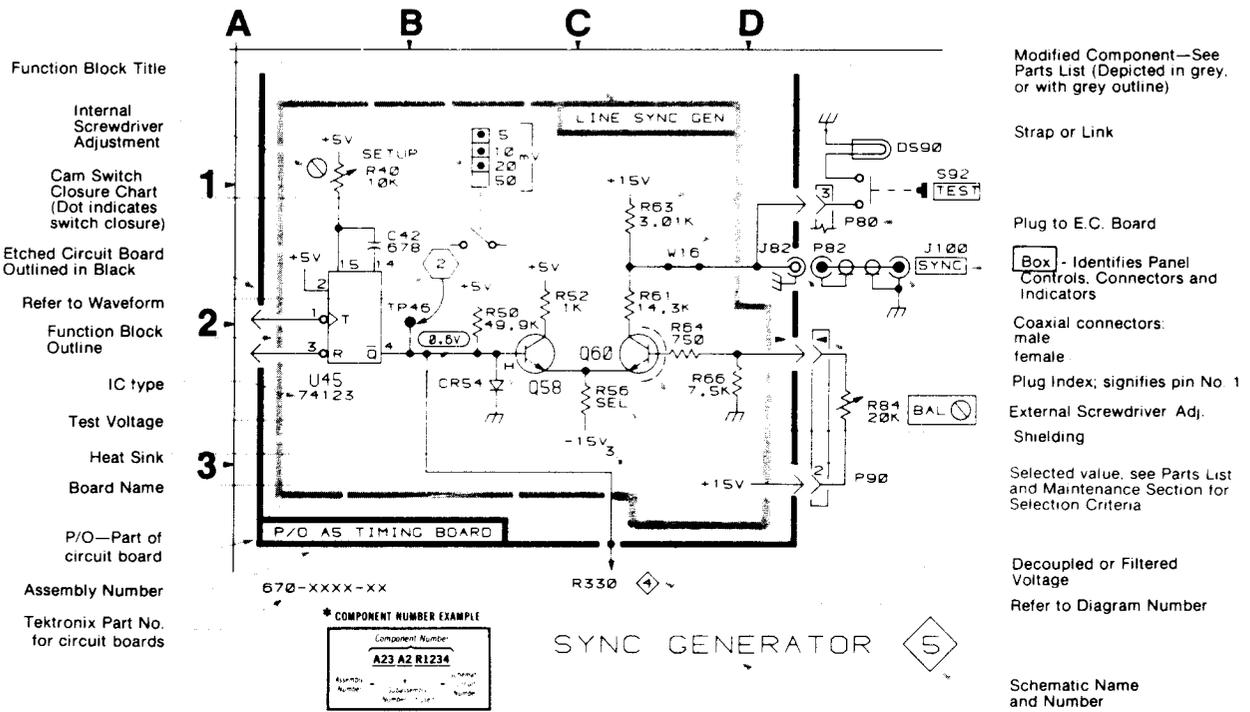
Resistors = Ohms ( $\Omega$ ).

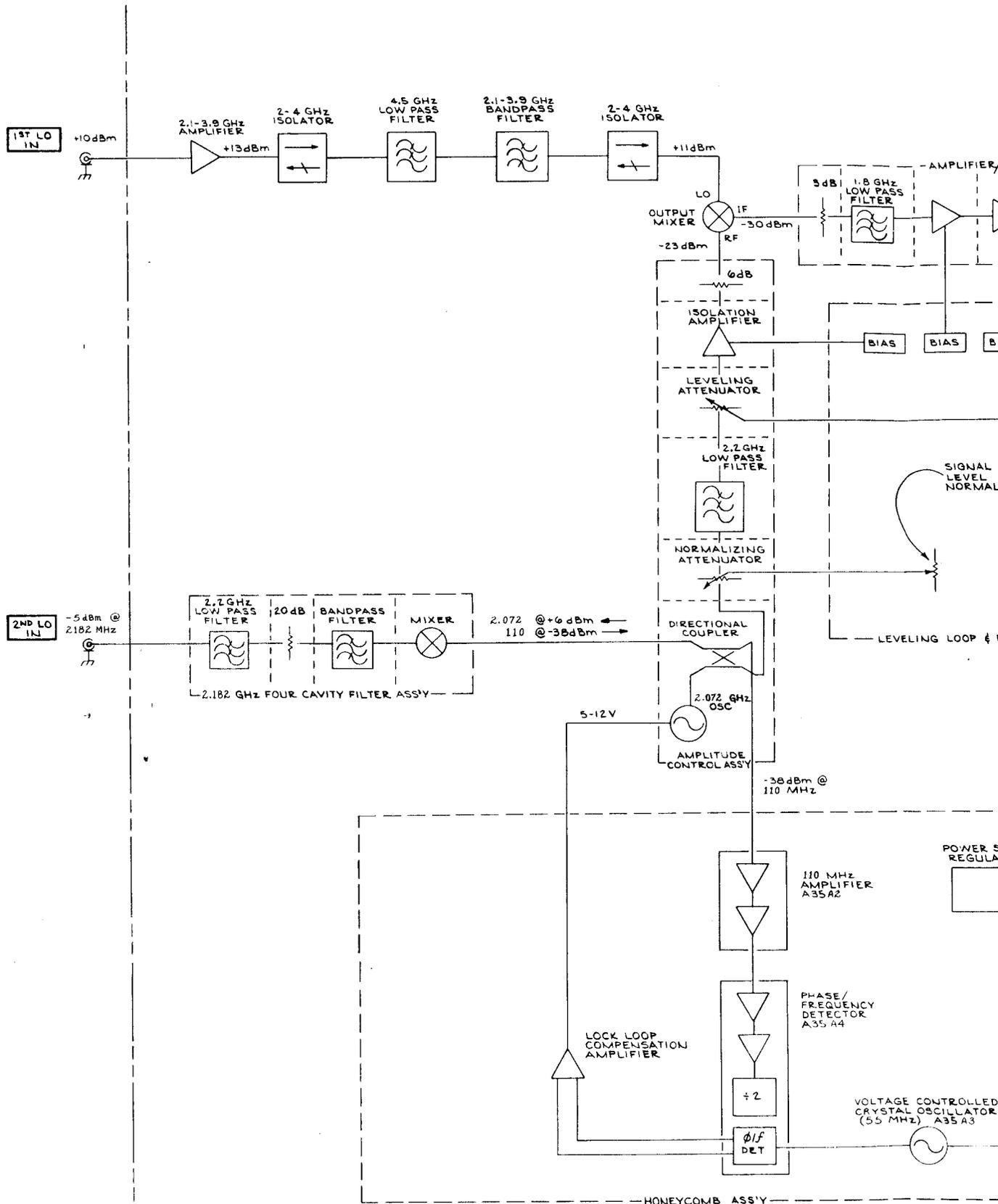
———— The information and special symbols below may appear in this manual. ————

## Assembly Numbers and Grid Coordinates

Each assembly in the instrument is assigned an assembly number (e.g., A20). The assembly number appears on the circuit board outline on the diagram, in the title for the circuit board component location illustration, and in the lookup table for the schematic diagram and corresponding component locator illustration. The Replaceable Electrical Parts list is arranged by assemblies in numerical sequence; the components are listed by component number \*(see following illustration for constructing a component number).

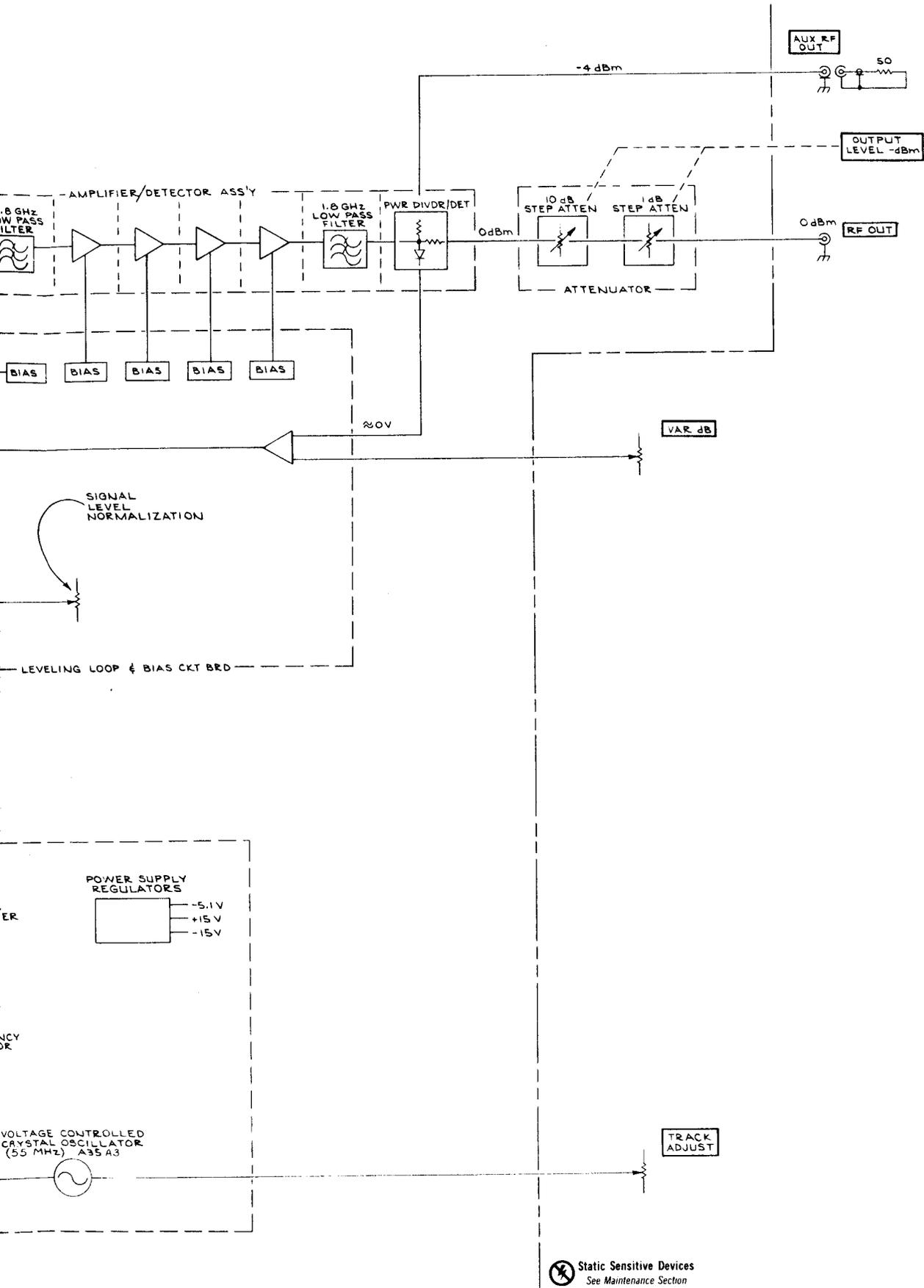
The schematic diagram and circuit board component location illustration have grids. A lookup table with the grid coordinates is provided for ease of locating the component. Only the components illustrated on the facing diagram are listed in the lookup table. When more than one schematic diagram is used to illustrate the circuitry on a circuit board, the circuit board illustration may only appear opposite the first diagram on which it was illustrated; the lookup table will list the diagram number of other diagrams that the circuitry of the circuit board appears on.





TR503

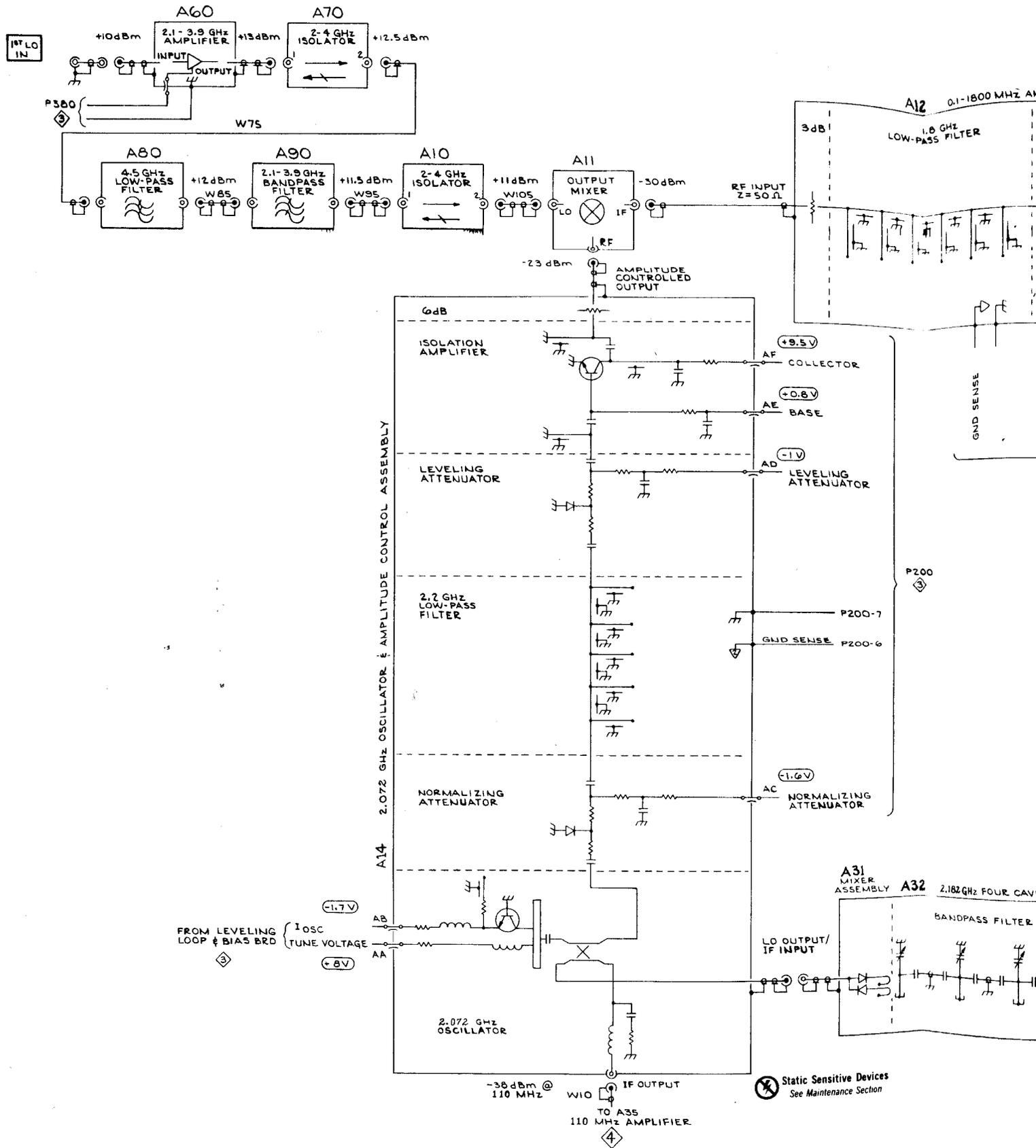
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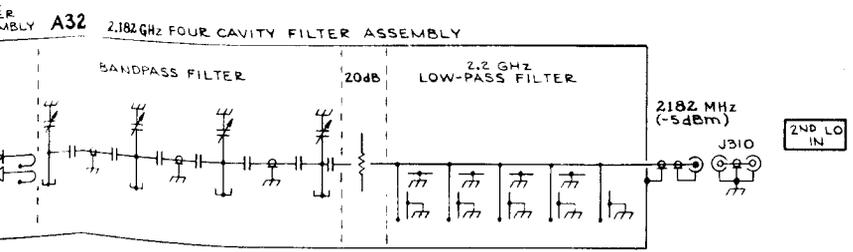
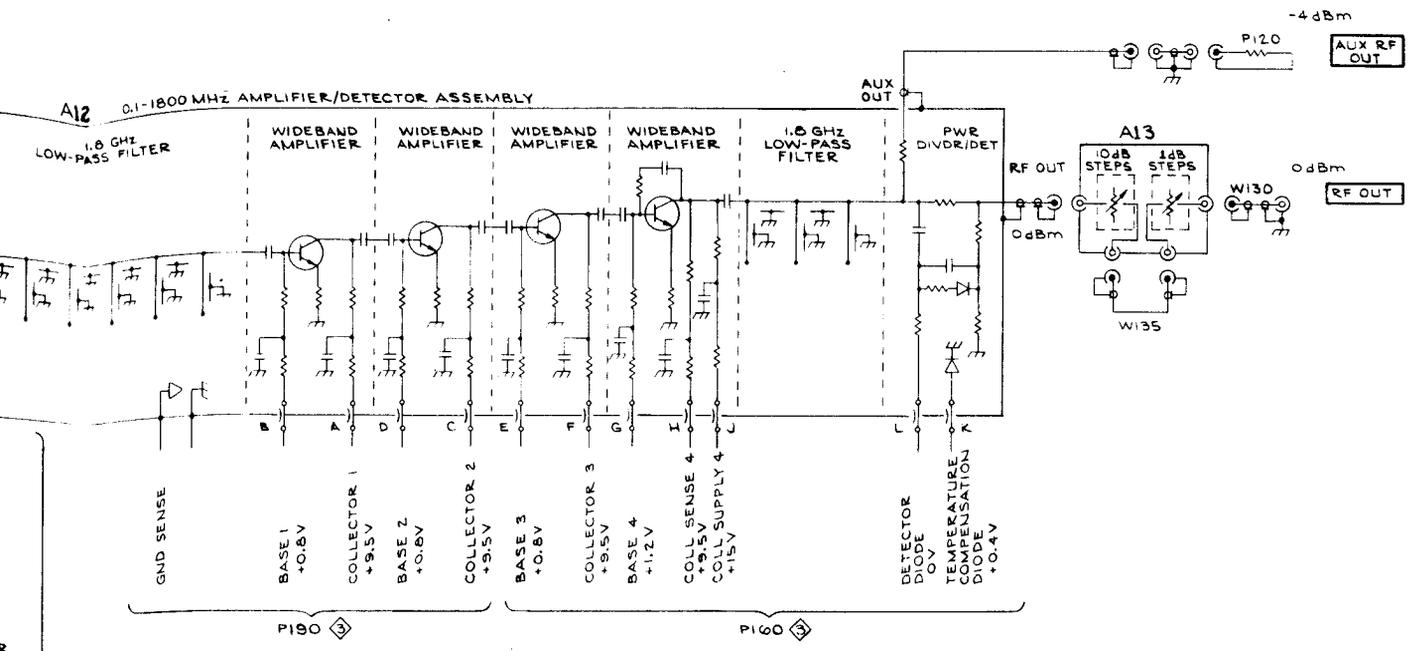


BLOCK DIAGRAM

1

BLOCK DIAGRAM 1



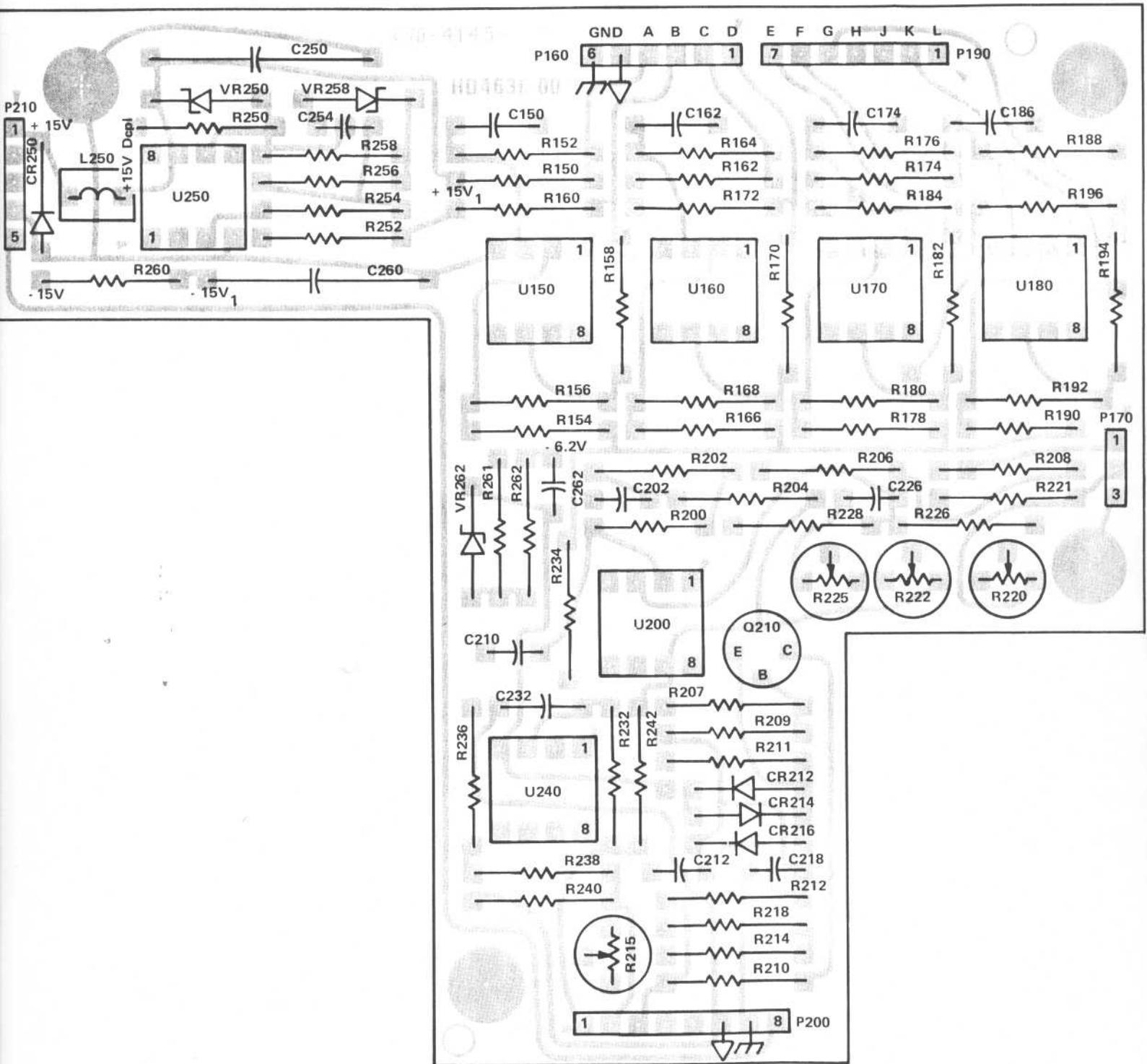


A

B

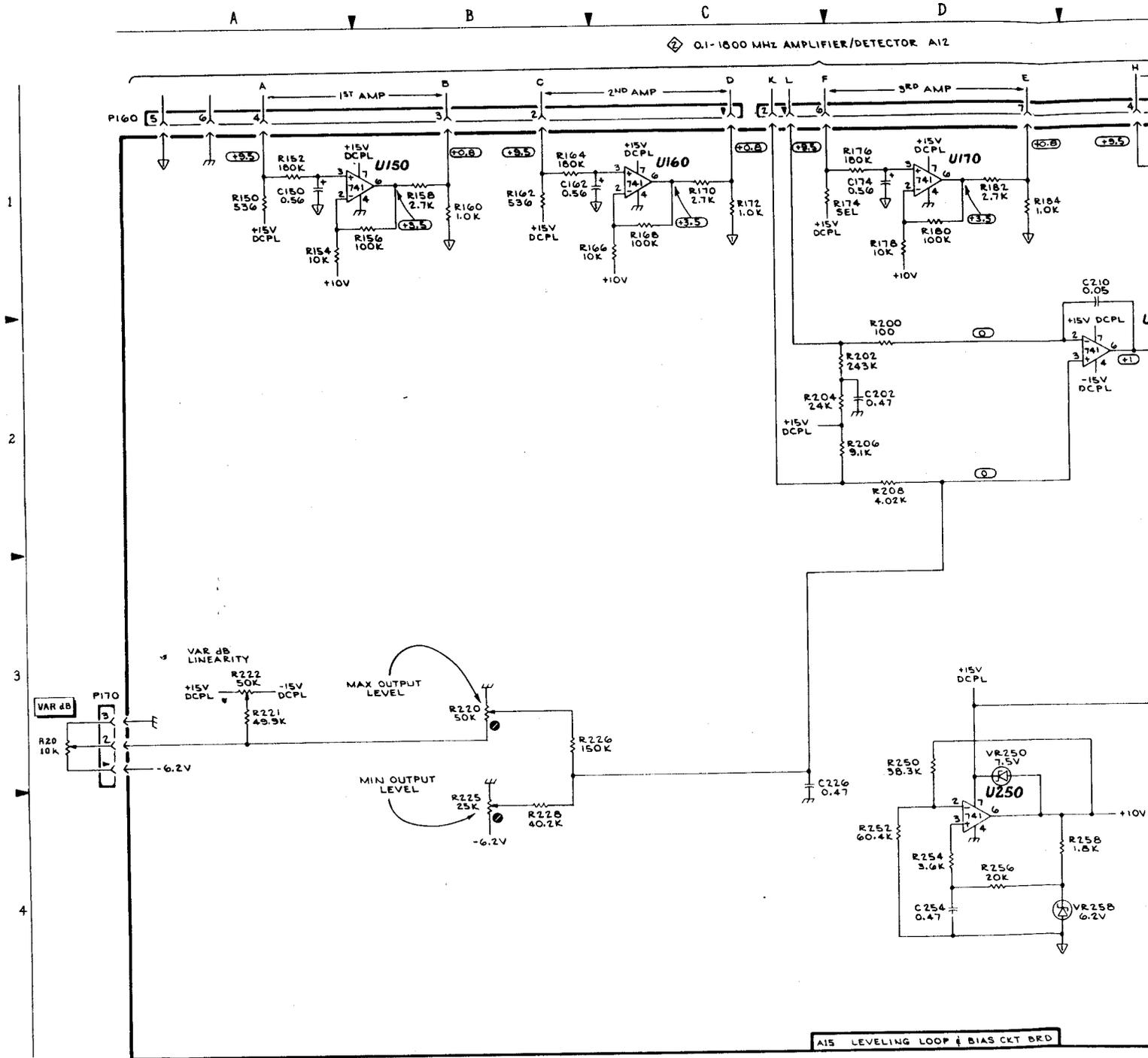
C

D





0.1-1000 MHz AMPLIFIER/DETECTOR A12

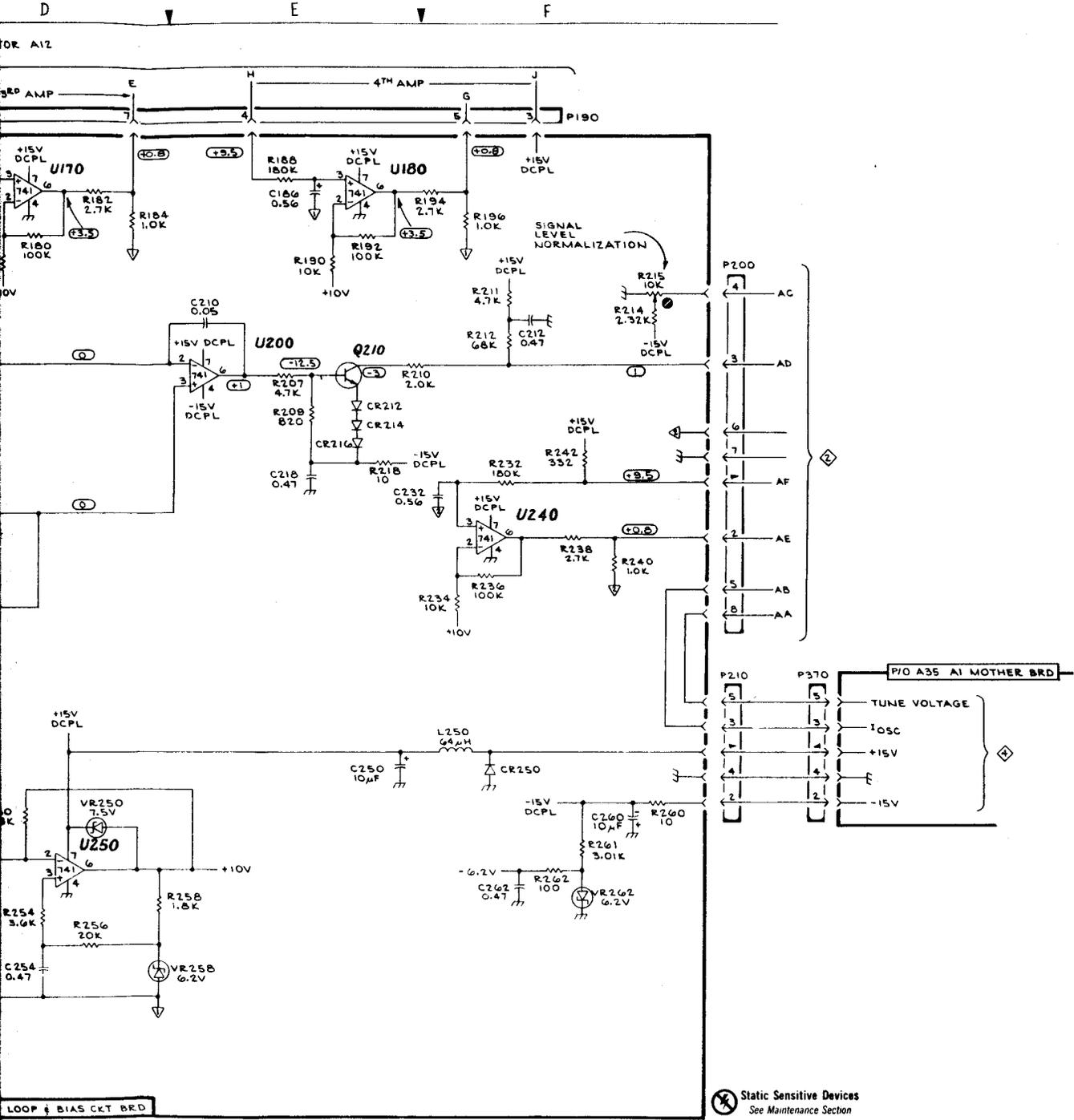


AIS LEVELING LOOP & BIAS CKT BRD

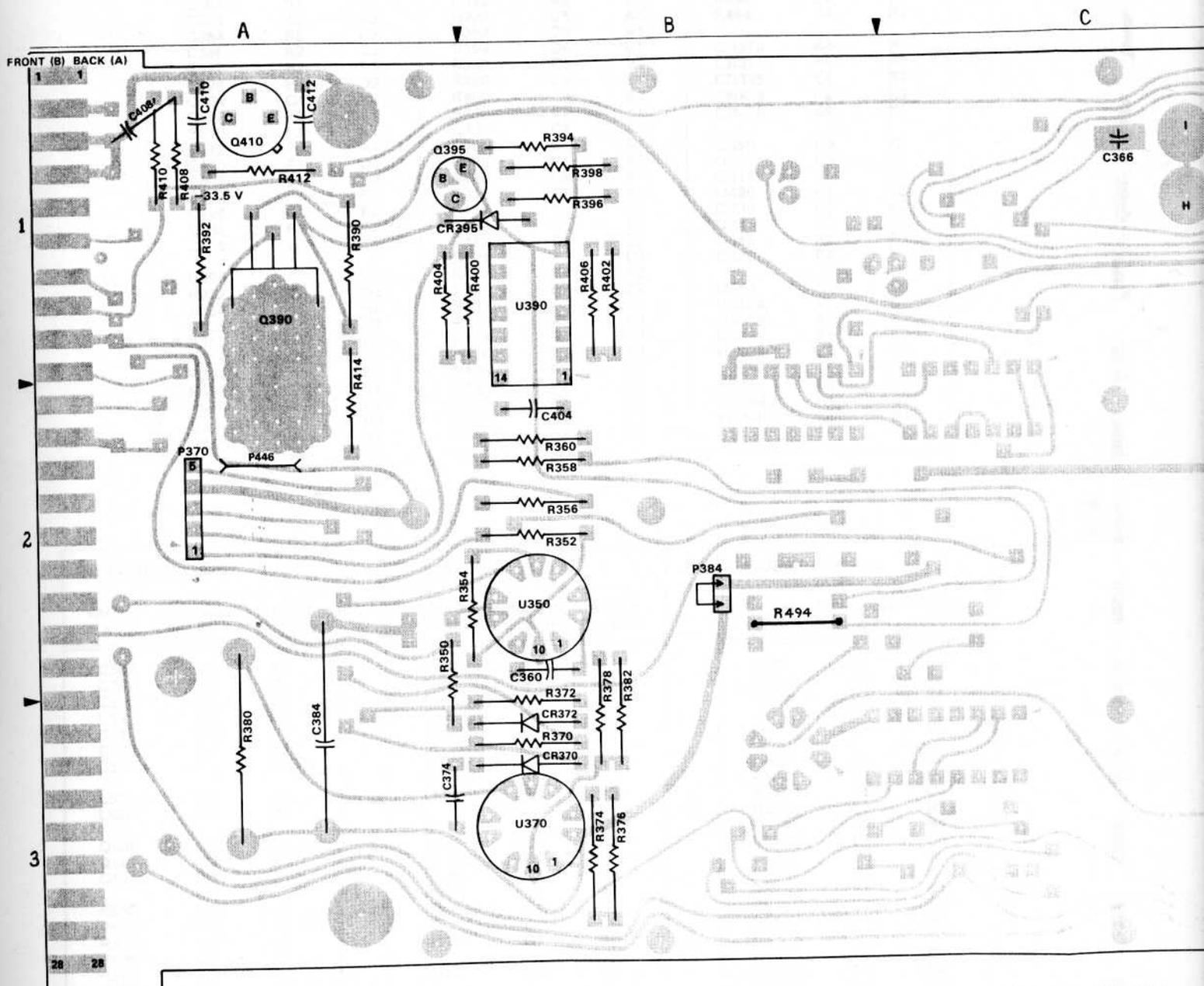
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TR503

LEVELING LOOP

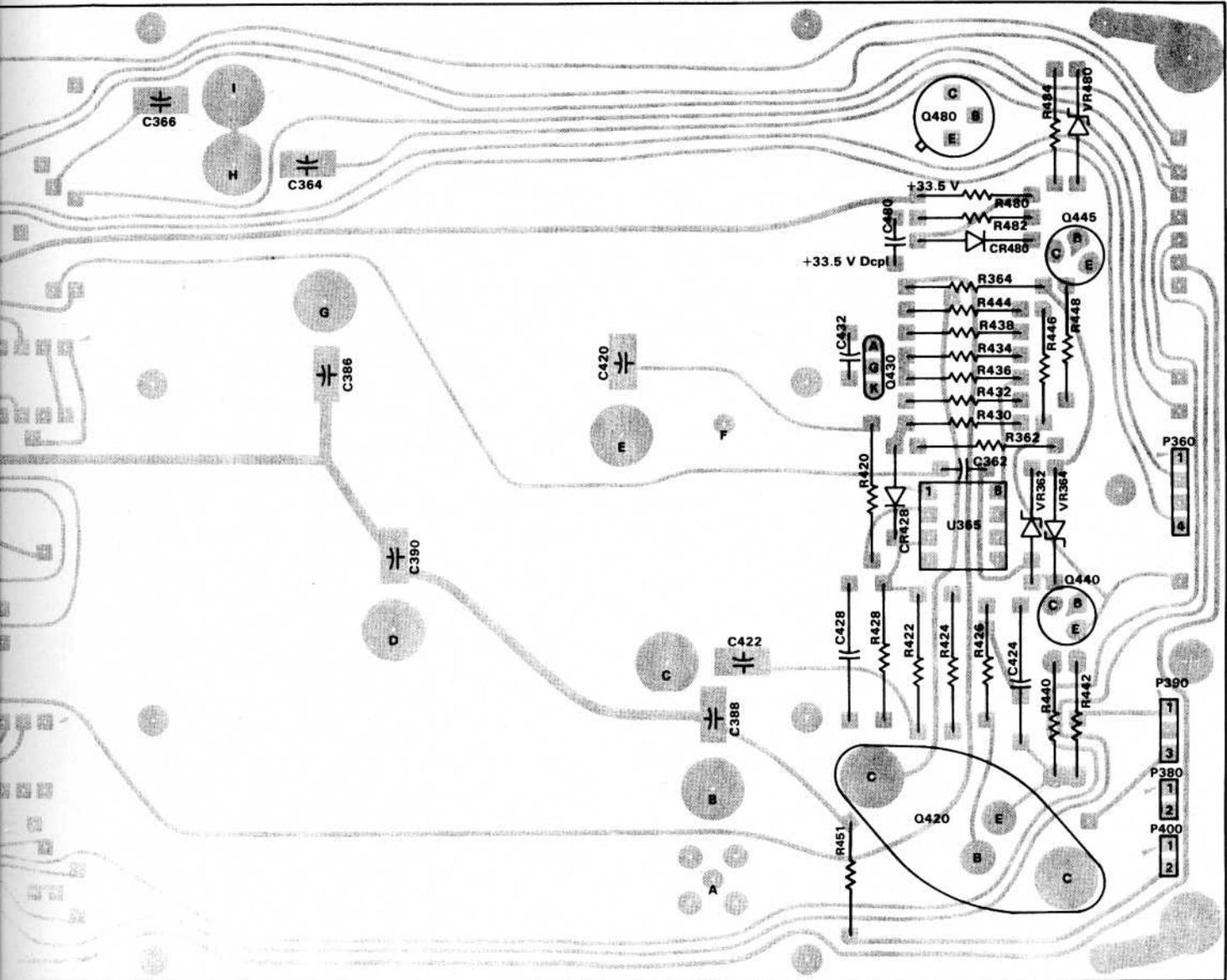


LEVELING LOOP & AMPLIFIER BIAS CIRCUITRY ③



A35 A1 Mother Board

C V D V E



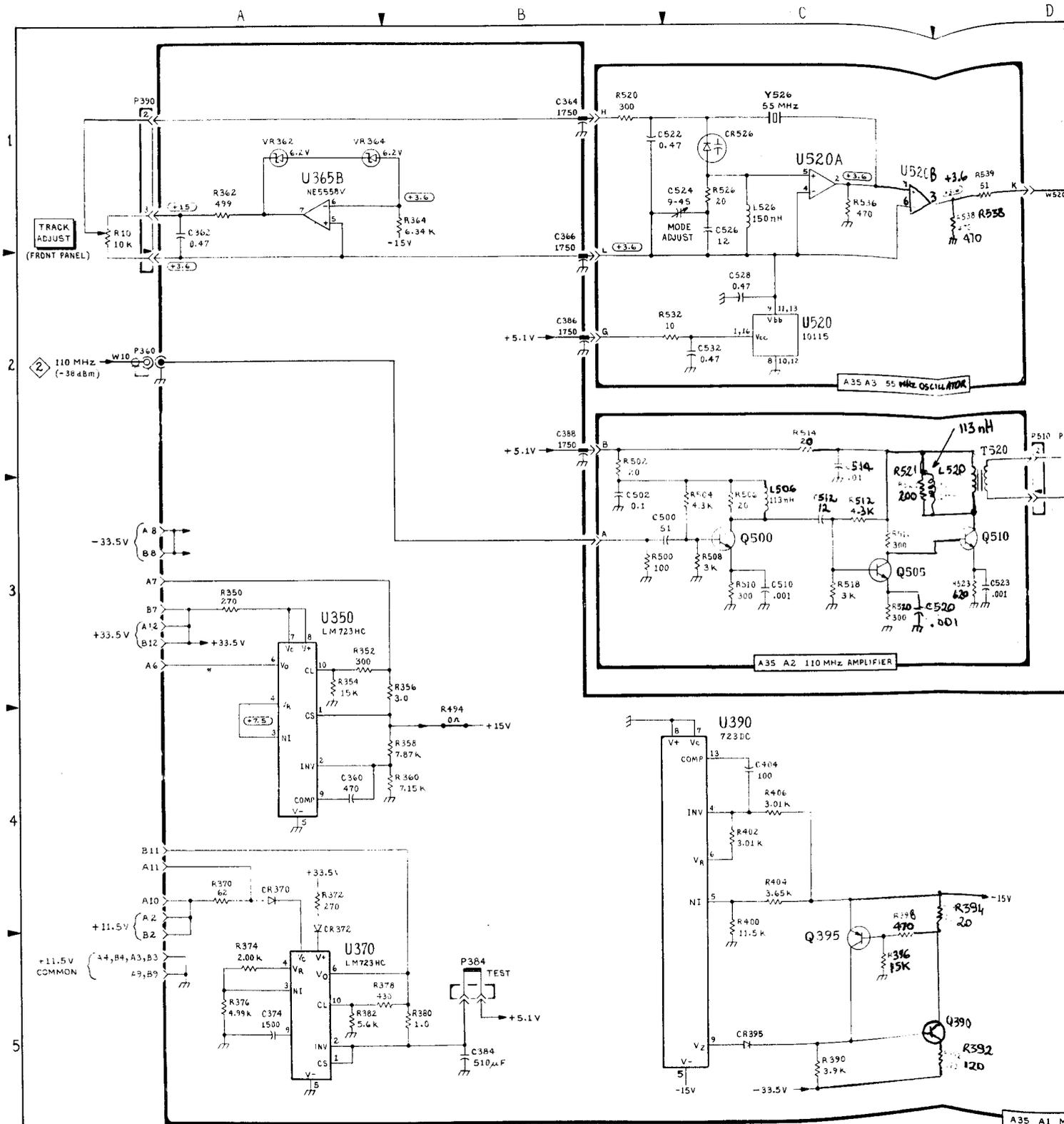
A35 A1 Mother Board

ASSEMBLY A35								
Circuit Number	Schematic Location	Board Location	Circuit Number	Schematic Location	Board Location	Circuit Number	Schematic Location	Board Location
C360	A4	B2	R376	A5	B3	R448	F3	E1
C362	A1	E2	R378	A5	B3	R480	E4	E1
C364	B1	C1	R380	B5	A3	R482	E4	E1
C366	B1	C1	R382	A5	B3	R484	E4	E1
C374	A5	A3	R390	C5	A1	R494	B4	B2
C384	B5	A3	R392	C5	A1			
C386	B2	C2	R394	D4	B1	CR370	A4	B3
C388	B2	D3	R396	C5	B1	CR372	A4	B3
C390	E4	D2	R398	C5	B1	CR395	C5	B1
C404	C4	B2	R400	C4	B1	CR428	F2	E2
C408	F3	A1	R402	C4	B1	CR480	E4	E1
C410	F3	A1	R404	C4	A1			
C412	F4	A1	R406	C4	B1	Q390	C5	A1
C420	E1	D2	R408	F3	A1	Q395	C5	A1
C422	E1	D2	R410	F3	A1	Q410	F3	A1
C424	F1	E2	R412	F3	A1	Q420	F1	E3
C428	E2	E2	R414	F4	A2	Q430	F2	E2
C432	F3	E2	R420	E1	E2	Q440	F2	E2
C480	E4	E1	R422	E1	E2	Q445	F3	E1
			R424	F1	E2	Q480	E4	E1
R350	A3	A2	R426	F1	E2			
R352	A3	B2	R428	E2	E2	U350	A3	B2
R354	A3	B2	R430	F2	E2	U365A	F1	E2
R356	B3	B2	R432	F3	E2	U365B	A1	E2
R358	B4	B2	R434	F2	E2	U370	A5	B3
R360	B4	B2	R436	F2	E2	U390	C4	A2
R362	A1	E2	R438	F2	E1			
R364	B1	E1	R440	F2	E3	VR362	A1	E2
R370	A4	B3	R442	F2	E3	VR364	A1	E2
R372	A4	B3	R444	F2	E1	VR480	E4	E1
R374	A5	B3	R446	F3	E2			

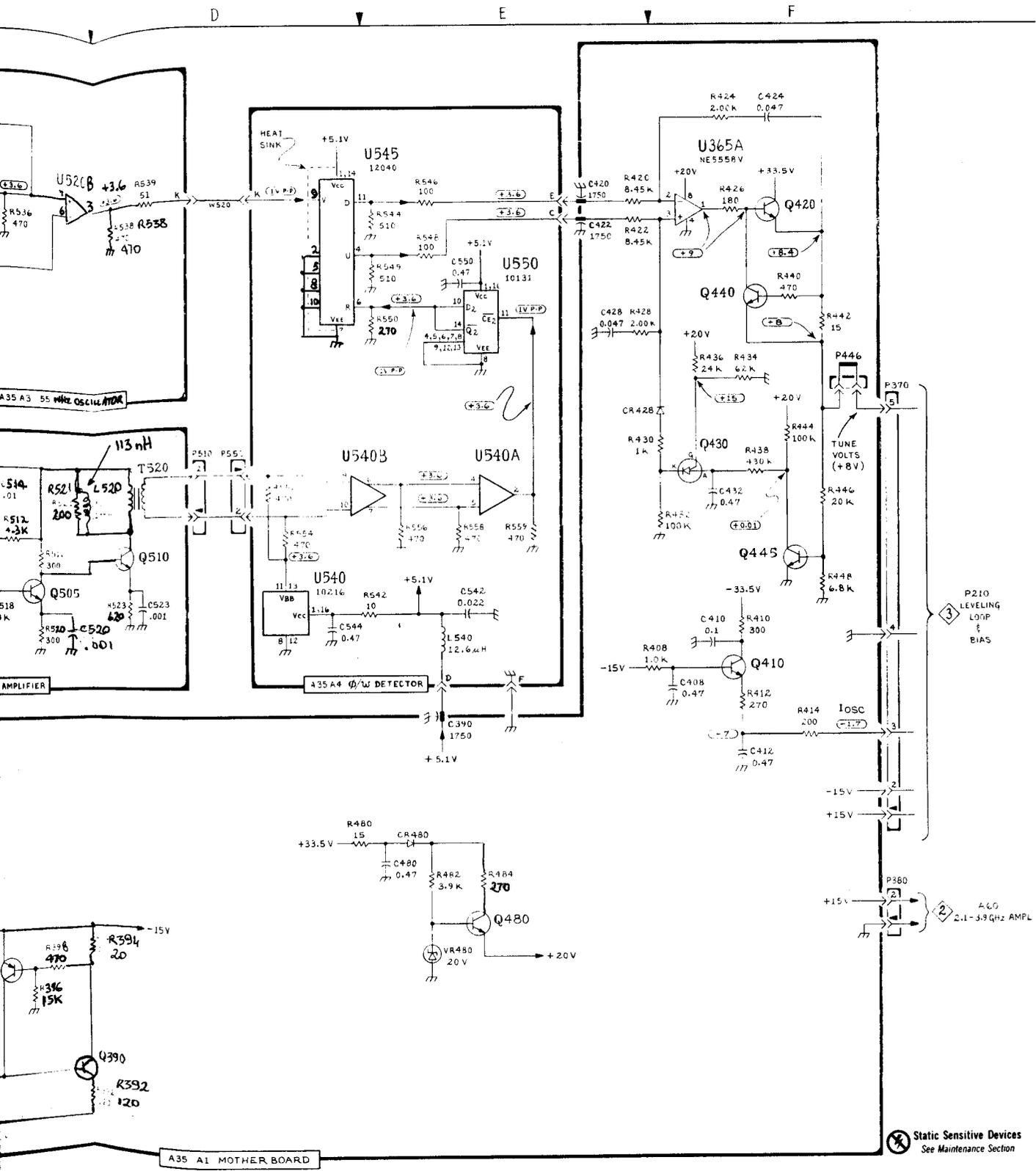
ASSEMBLY A35A2		
Circuit Number	Schematic Location	Board Location
C500	B3	A1
C502	B3	B1
C510	C3	B1
C512	C3	A1
C514	C2	C1
C520	C3	B1
C523	D3	C1
L506	C3	A1
L520	C3	B1
Q500	C3	A1
Q505	C3	B1
Q510	D3	C1
R500	B3	A1
R502	B2	A1
R504	C3	A1
R506	C3	A1
R508	C3	A1
R510	C3	B1
R512	C3	B1
R514	C2	B1
R516	C3	B1
R518	C3	B1
R520	C3	B1
R521	C3	B1
R523	D3	C1
T520	D3	C1

ASSEMBLY A35A3		
Circuit Number	Schematic Location	Board Location
C522	B1	A3
C524	C1	C2
C526	C1	B2
C528	C2	A2
C532	C2	A2
CR526	C1	B3
L526	C1	B2
R520	B1	A3
R526	C1	B2
R532	C2	A3
R536	C1	C3
R538	D1	A3
R539	D1	A3
U520	C1	B3
Y526	C1	B3

ASSEMBLY A35A4		
Circuit Number	Schematic Location	Board Location
C542	E3	B5
C544	D3	A4
C550	E2	B4
L540	E3	B5
R542	E3	A4
R544	E1	B4
R546	E1	C4
R548	E1	B5
R549	E2	B5
R550	E2	C5
R552	D3	A5
R554	D3	A5
R556	E3	B4
R558	E3	B4
R559	E3	B4
U540	D3	A4
U545	D1	B4
U550	E2	C4



TR 503



A35 A1 MOTHER BOARD

© 3526-54

VOLTAGE REGULATORS & PHASE LOCK CIRCUITRY

Static Sensitive Devices See Maintenance Section

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# REPLACEABLE MECHANICAL PARTS

## PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

Change information, if any, is located at the rear of this manual.

## SPECIAL NOTES AND SYMBOLS

X000 Part first added at this serial number  
00X Part removed after this serial number

## FIGURE AND INDEX NUMBERS

Items in this section are referenced by figure and index numbers to the illustrations.

## INDENTATION SYSTEM

This mechanical parts list is indented to indicate item relationships. Following is an example of the indentation system used in the description column.

```

1 2 3 4 5      Name & Description
Assembly and/or Component
Attaching parts for Assembly and/or Component
-----
Detail Part of Assembly and/or Component
Attaching parts for Detail Part
-----
Parts of Detail Part
Attaching parts for Parts of Detail Part
-----

```

Attaching Parts always appear in the same indentation as the item it mounts, while the detail parts are indented to the right. Indented items are part of, and included with, the next higher indentation. The separation symbol ----- indicates the end of attaching parts.

Attaching parts must be purchased separately, unless otherwise specified.

## ITEM NAME

In the Parts List, an Item Name is separated from the description by a colon (:). Because of space limitations, an Item Name may sometimes appear as incomplete. For further Item Name identification, the U.S. Federal Cataloging Handbook H6-1 can be utilized where possible.

## ABBREVIATIONS

#	INCH	ELCTRN	ELECTRON	IN	INCH	SE	SINGLE END
ACTR	NUMBER SIZE	ELEC	ELECTRICAL	INCAND	INCANDESCENT	SECT	SECTION
ADPTR	ACTUATOR	ELCTLT	ELECTROLYTIC	INSUL	INSULATOR	SEMICOND	SEMICONDUCTOR
ALIGN	ADAPTER	ELEM	ELEMENT	INTL	INTERNAL	SHLD	SHIELD
AL	ALIGNMENT	EPL	ELECTRICAL PARTS LIST	LPHLDR	LAMPHOLDER	SHLDR	SHOULDERED
ALUM	ALUMINUM	EQPT	EQUIPMENT	MACH	MACHINE	SKT	SOCKET
ASSEM	ASSEMBLED	EXT	EXTERNAL	MECH	MECHANICAL	SL	SLIDE
ASSY	ASSEMBLY	FIL	FILLISTER HEAD	MTG	MOUNTING	SLFLKG	SELF-LOCKING
ATTEN	ATTENUATOR	FLEX	FLEXIBLE	NIP	NIPPLE	SLVKG	SLEEVING
AWG	AMERICAN WIRE GAGE	FLH	FLAT HEAD	NON WIRE	NOT WIRE WOUND	SPR	SPRING
BD	BOARD	FLTR	FILTER	OBD	ORDER BY DESCRIPTION	SQ	SQUARE
BRKT	BRACKET	FR	FRAME or FRONT	OD	OUTSIDE DIAMETER	SST	STAINLESS STEEL
BRS	BRASS	FSTNR	FASTENER	OVH	OVAL HEAD	STL	STEEL
BRZ	BRONZE	FT	FOOT	PH BRZ	PHOSPHOR BRONZE	SW	SWITCH
BSHG	BUSHING	FXD	FIXED	PL	PLAIN or PLATE	T	TUBE
CAB	CABINET	GSKT	GASKET	PLSTC	PLASTIC	TERM	TERMINAL
CAP	CAPACITOR	HDL	HANDLE	PN	PART NUMBER	THD	THREAD
CER	CERAMIC	HEX	HEXAGON	PNH	PAN HEAD	THK	THICK
CHAS	CHASSIS	HGX HD	HEXAGONAL HEAD	PWR	POWER	TNSN	TENSION
CKT	CIRCUIT	HEX SOC	HEXAGONAL SOCKET	RCPT	RECEPTACLE	TPG	TAPPING
COMP	COMPOSITION	HLCPS	HELICAL COMPRESSION	RES	RESISTOR	TRH	TRUSS HEAD
CONN	CONNECTOR	HLEXT	HELICAL EXTENSION	RGD	RIGID	V	VOLTAGE
COV	COVER	HV	HIGH VOLTAGE	RLF	RELIEF	VAR	VARIABLE
CPLG	COUPLING	IC	INTEGRATED CIRCUIT	RTNR	RETAINER	W/	WITH
CRT	CATHODE RAY TUBE	ID	INSIDE DIAMETER	SCH	SOCKET HEAD	WSHR	WASHER
DEG	DEGREE	IDNT	IDENTIFICATION	SCOPE	OSCILLOSCOPE	XFMR	TRANSFORMER
DWR	DRAWER	IMPLR	IMPELLER	SCR	SCREW	XSTR	TRANSISTOR

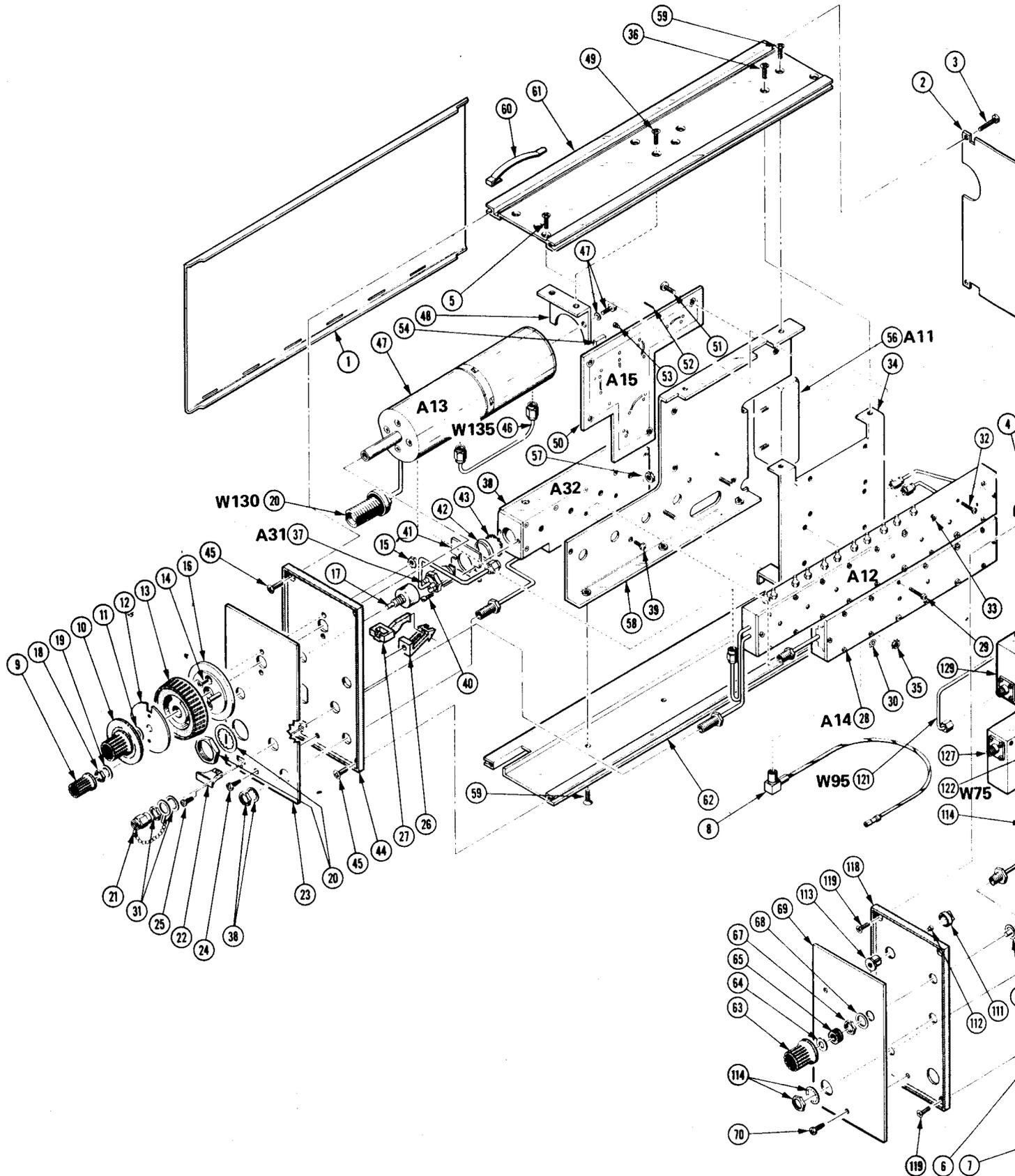
CROSS INDEX—MFR. CODE NUMBER TO MANUFACTURER

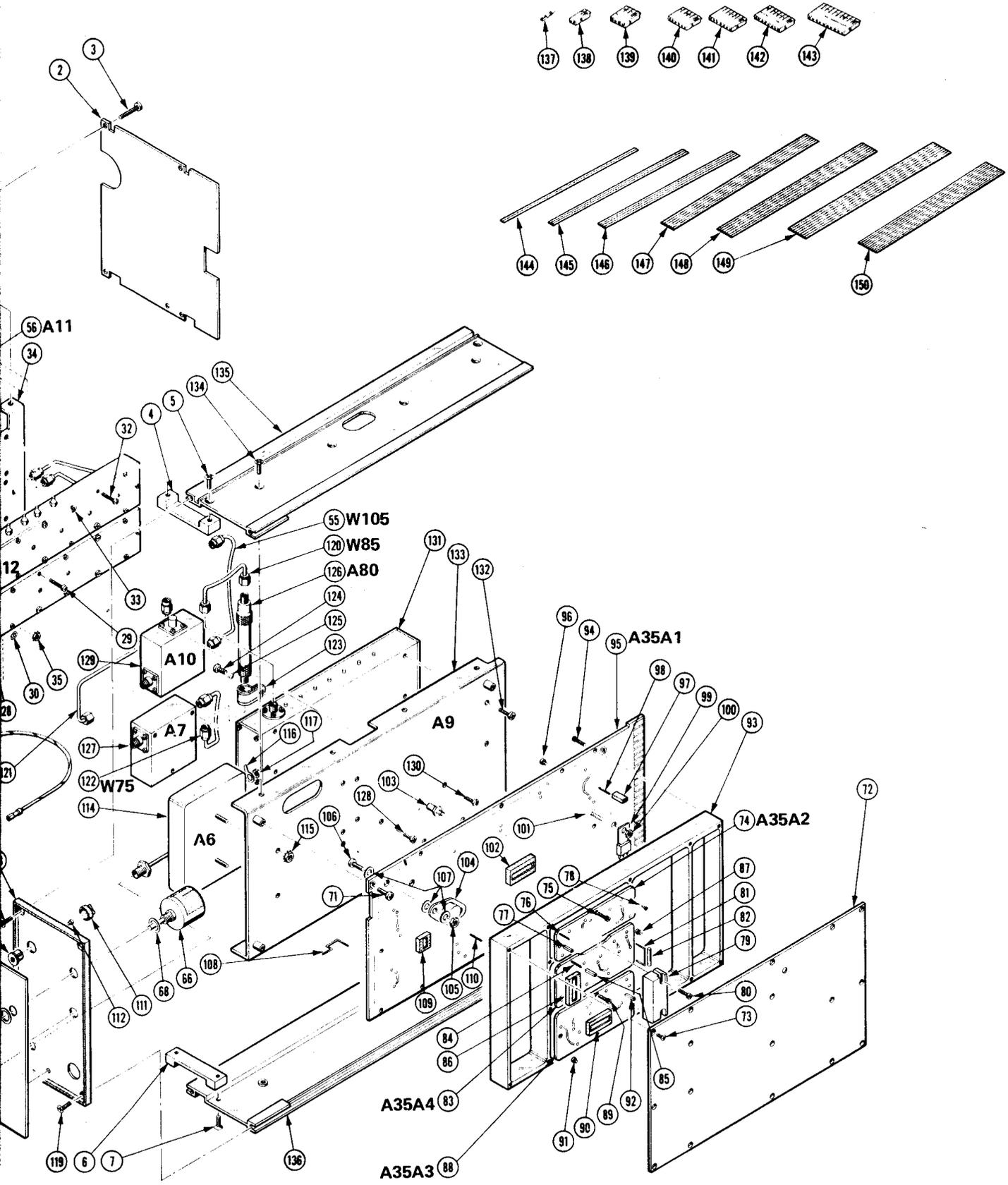
Mfr. Code	Manufacturer	Address	City, State, Zip
000AH	STANDARD PRESSED STEEL CO., UNBRAKO DIV.	8535 DICE ROAD	SANTA FE SPRINGS, CA 90670
000CY	NORTHWEST FASTENER SALES, INC.	7923 SW CIRRUS DRIVE	BEAVERTON, OREGON 97005
000ES	SLOSS FASTENERS	P O DRAWER 24155	OAKLAND, CA 94623
000HG	RAY OVER SALES TECKNIC	320 NORTH NOPAL ST.	SANTA BARBARA, CA 93103
00779	AMP, INC.	P O BOX 3608	HARRISBURG, PA 17105
08261	SPECTRA-STRIP CORP.	7100 LAMPSON AVE.	GARDEN GROVE, CA 92642
12327	FREEWAY CORPORATION	9301 ALLEN DRIVE	CLEVELAND, OH 44125
18203	ENGELMANN MICROWAVE CO.	SKYLINE DR.	MONTVILLE, NJ 07045
22526	BERG ELECTRONICS, INC.	YOUK EXPRESSWAY	NEW CUMBERLAND, PA 17070
70485	ATLANTIC INDIA RUBBER WORKS, INC.	571 W. POLK ST.	CHICAGO, IL 60607
71785	TRW, CINCH CONNECTORS	1501 MORSE AVENUE	ELK GROVE VILLAGE, IL 60007
73743	FISCHER SPECIAL MFG. CO.	446 MORGAN ST.	CINCINNATI, OH 45206
73803	TEXAS INSTRUMENTS, INC., METALLURGICAL MATERIALS DIV.	34 FOREST STREET	ATTLEBORO, MA 02703
75497	LAMSON AND SESSIONS CO.	5000 TIEDEMAN ROAD	CLEVELAND, OH 44144
78189	ILLINOIS TOOL WORKS, INC. SHAKEPROOF DIVISION	ST. CHARLES ROAD	ELGIN, IL 60120
79807	WROUGHT WASHER MFG. CO.	2100 S. O BAY ST.	MILWAUKEE, WI 53207
80009	TEKTRONIX, INC.	P O BOX 500	BEAVERTON, OR 97077
83309	ELECTRICAL SPECIALITY CO., SUBSIDIARY OF BELDEN CORP.	213 E. HARRIS AVE. SOUTH	SAN FRANCISCO, CA 94080
83385	CENTRAL SCREW CO.	2530 CRESCENT DR.	BROADVIEW, IL 60153
87308	N. L. INDUSTRIES, INC., SOUTHERN SCREW DIV.	P. O. BOX 1360	STATESVILLE, NC 28677
91836	KINGS ELECTRONICS CO., INC.	40 MARBLEDALE ROAD	TUCKAHOE, NY 10707
93907	CAMCAR SCREW AND MFG. CO.	600 18TH AVE.	ROCKFORD, IL 61101
95987	WECKESSER CO., INC.	4444 WEST IRVING PARK RD.	CHICAGO, IL 60641
98291	SEAELECTRO CORP.	225 HOYT	MAMARONECK, NY 10544

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Qty	1	2	3	4	5	Name & Description	Mfr Code	Mfr Part Number
1-1	337-1399-00		1						SHLD, ELECTRICAL: SIDE	80009	337-1399-00
-2	386-3417-00		1						PLATE, REAR: (ATTACHING PARTS)	80009	386-3417-00
-3	213-0192-00		4						SCR, TPG, THD FOR: 6-32 X 0.50 INCH, PNH STL	87308	OBD
-4	343-0590-00		2						RETAINER, BLOCK: UPPER (ATTACHING PARTS)	80009	343-0590-00
-5	211-0101-00		4						SCREW, MACHINE: 4-40 X 0.25" 100 DEG, FLH STL	83385	OBD
-6	343-0589-00		2						RETAINER, BLOCK: LOWER (ATTACHING PARTS)	80009	343-0589-00
-7	211-0101-00		4						SCREW, MACHINE: 4-40 X 0.25" 100 DEG, FLH STL	83385	OBD
-8	-----		1						CABLE ASSY, RF: 50 OHM COAX (SEE W10 EPL)		
-9	366-0494-00		1						KNOB: GRAY WITH SETSCREW	80009	366-0494-00
	213-0153-00		1						. SETSCREW: 5-40 X 0.125, STL BK OXD, HEX	000CY	OBD
-10	366-1645-00		1						KNOB: GRAY, FUNCTION ATTENUATOR	80009	366-1645-00
	213-0153-00		2						. SETSCREW: 5-40 X 0.125, STL BK OXD, HEX	000CY	OBD
-11	210-1011-00		1						WASHER, NONMETAL: 0.13 ID X 0.375 " OD, PLSTC	83309	OBD
-12	331-0402-01		1						MASK, DIAL:	80009	331-0402-01
-13	366-1639-00		1						KNOB: GRAY	80009	366-1639-00
	213-0153-00		2						. SETSCREW: 5-40 X 0.125, STL BK OXD, HEX	000CY	OBD
-14	432-0107-01		1						BASE, KNOB: W/PINS (ATTACHING PARTS)	80009	432-0107-01
-15	210-0586-00		2						NUT, PL, ASSEM WA: 4-40 X 0.25, STL CD PL	83385	211-041800-00
-16	211-0025-00		2						SCREW, MACHINE: 4-40 X 0.375 100 DEG, FLH STL	83385	OBD
-17	-----		1						RESISTOR, VAR: (SEE R20 EPL) (ATTACHING PARTS)		
-18	210-0583-00		1						NUT, PLAIN, HEX.: 0.25-32 X 0.312 INCH, BRS	73743	2X20317-402
-19	210-0940-00		1						WASHER, FLAT: 0.25 ID X 0.375 INCH OD, STL	79807	OBD
-20	-----		1						CABLE ASSY, RF: ATTN TO RF OUT (SEE W130 EPL)		
-21	015-1025-01		1						TERM., COAX: 3MM MALE, 50 OHM, W/CH	18203	T186C5
-22	366-1690-00		1						KNOB, LATCH: SIL GY, 0.53 X 0.23 X 1.059	80009	366-1690-00
-23	333-2703-00		1						PANEL, FRONT: LEFT SIDE (ATTACHING PARTS)	80009	333-2703-00
-24	213-0120-00		1						SCR, TPG, THD FOR: 2-32 X 0.250 INCH, PNH STL	83385	OBD
-25	213-0113-00		1						SCR, TPG, THD FOR: 2-32 X 0.312 INCH, PNH STL	93907	OBD
-26	105-0719-00		1						LATCH, RETAINING: PLUG-IN	80009	105-0719-00
-27	105-0718-01		1						BAR, LATCH RLSE:	80009	105-0718-01
-28	-----		1						AMPTD CONT ASSY: 2.095 OSC AMP (SEE A14 EPL) (ATTACHING PARTS)		
-29	211-0100-00		4						SCREW, MACHINE: 2-56 X 0.750 INCH, PNH, STL	83385	OBD
-30	210-0259-00		1						TERMINAL, LUG: 0.099" ID INT TOOTH, SE	80009	210-0259-00
-31	-----		1						AMPL/DET ASSY: 0.1-18.0 GHZ AMPL (SEE A12 EPL) (ATTACHING PARTS)		
-32	211-0100-00		4						SCREW, MACHINE: 2-56 X 0.750 INCH, PNH, STL	83385	OBD
-33	210-0259-00		1						TERMINAL, LUG: 0.099" ID INT TOOTH, SE	80009	210-0259-00
-34	407-1726-00		1						BRACKET, HOUSING: ALUMINUM (ATTACHING PARTS)	80009	407-1726-00
-35	210-0586-00		2						NUT, PL, ASSEM WA: 4-40 X 0.25, STL CD PL	83385	211-041800-00
-36	211-0101-00		2						SCREW, MACHINE: 4-40 X 0.25" 100 DEG, FLH STL	83385	OBD
-37	-----		1						MIXER UNIT: BALANCE (SEE A31 EPL)		
-38	-----		1						FILTER, ASSY: 2.2 GHZ, 4 CAV FILTER (SEE A32 EPL) (ATTACHING PARTS)		
-39	211-0008-00		3						SCREW, MACHINE: 4-40 X 0.25 INCH, PNH STL	83385	OBD
-40	211-0200-00		2						. FILTER ASSY INCLUDES: . SCREW, CAP: 4-40 X 0.25 INCH, SST HEX	000ES	OBD
-41	343-0369-00		1						. RETAINER COLLET: TUNED CAVITY, BRS	80009	343-0369-00
-42	214-1735-00		1						. COLLET, TUNED CA: TRIPLE	80009	214-1735-00
-43	348-0323-00		1						. SHLD GSKT, ELEK: RING SHAPED MESH, 0.562 OD	000HG	30-90095

Replaceable Mechanical Parts—TR 503

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Qty	1	2	3	4	5	Name & Description	Mfr Code	Mfr Part Number
1-44	386-4505-00		1						SUBPANEL, FRONT:LEFT SIDE (ATTACHING PARTS)	80009	386-4505-00
-45	213-0229-00		4						SCR, TPG, THD FOR:6-20 X0.375"100 DEG, FLH STL - - - * - - -	93907	OBD
-46	-----		1						CABLE ASSY, RF:1 DB TO 10 DB(SEE W135 EPL)		
-47	-----		1						ATTENUATOR ASSY:0.59 DB, 50 OHM(SEE A13 EPL)		
-48	407-1724-00		1						BRACKET, ELEC SW:ALUMINUM (ATTACHING PARTS)	80009	407-1724-00
-49	211-0101-00		2						SCREW, MACHINE:4-40 X 0.25" 100 DEG, FLH STL - - - * - - -	83385	OBD
-50	-----		1						CKT BOARD ASSY: LVL LOOP AND BIAS(SEE A150 EPL) (ATTACHING PARTS)		
-51	211-0008-00		4						SCREW, MACHINE:4-40 X 0.25 INCH, PNH STL - - - * - - -	83385	OBD
-52	-----		-						CKT BOARD ASSY INCLUDES:		
-52	131-0608-00		29						TERMINAL, PIN:0.365 L X 0.025 PH BRZ GOLD	22526	47357
-53	136-0252-07		3						SOCKET, PIN CONN:W/O DIMPLE	22526	75060-012
-54	136-0514-00		7						SKT, PL-IN ELEC:MICROCIRCUIT, 8 DIP	73803	CS9002-8
-55	-----		1						CABLE ASSY, RF:MIXER TO ISOL(SEE W105 EPL)		
-56	-----		1						MIXER ASSEMBLY:OUTPUT(SEE A11 EPL) (ATTACHING PARTS)		
-57	210-0586-00		2						NUT, PL, ASSEM WA:4-40 X 0.25, STL CD PL - - - * - - -	83385	211-041800-00
-58	441-1297-00		1						CHASSIS, GEN:MAIN LEFT (ATTACHING PARTS)	80009	441-1297-00
-59	211-0101-00		5						SCREW, MACHINE:4-40 X 0.25" 100 DEG, FLH STL - - - * - - -	83385	OBD
-60	214-1061-00		1						SPRING, GROUND:FLAT	80009	214-1061-00
-61	426-1267-00		1						FRAME SECT, CAB.:TOP, LEFT	80009	426-1267-00
-62	426-1270-00		1						FRAME SECT, CAB.:BOTTOM, LEFT	80009	426-1270-00
-63	366-0497-01		1						KNOB:GRAY	80009	366-0497-01
-63	213-0153-00		1						SETScrew:5-40 X 0.125, STL BK OXD, HEX	000CY	OBD
-64	210-0804-00		1						WASHER, FLAT:0.17 ID X 0.375 INCH OD, STL	12327	OBD
-65	348-0093-00		1						GROMMET, RUBBER:0.375 INCH	70485	MOLDCM6368
-66	-----		1						RESISTOR, VAR:(SEE R10 EPL) (ATTACHING PARTS)		
-67	210-0583-00		1						NUT, PLAIN, HEX.:0.25-32 X 0.312 INCH, BRZ	73743	2X20317-402
-68	210-0940-00		2						WASHER, FLAT:0.25 ID X 0.375 INCH OD, STL - - - * - - -	79807	OBD
-69	333-2702-00		1						PANEL, FRONT:RIGHT SIDE (ATTACHING PARTS)	80009	333-2702-00
-70	213-0120-00		1						SCR, TPG, THD FOR:2-32 X 0.250 INCH, PNH STL - - - * - - -	83385	OBD
	644-0203-00		1						CONTROL ASSY: (ATTACHING PARTS)	80009	644-0203-00
-71	211-0510-00		4						SCREW, MACHINE:6-32 X 0.375 INCH, PNH STL - - - * - - -	83385	OBD
-72	-----		-						HONEYCOMB ASSY INCLUDES:		
-72	337-2250-00		1						SHIELD, ELEC: (ATTACHING PARTS)	80009	337-2250-00
-73	211-0087-01		17						SCREW, MACHINE:2-56 X 0.188" 82 DEG, FLH, STL - - - * - - -	83385	OBD
-74	-----		1						CKT BOARD ASSY:105 MHZ AMPL(SEE A35A2 EPL) (ATTACHING PARTS)		
-75	211-0162-00		4						SCREW, MACHINE:2-56 X 0.188 INCH, SCH, SST - - - * - - -	000AH	OBD
-76	-----		-						CKT BOARD ASSY INCLUDES:		
-76	131-0608-00		2						TERMINAL, PIN:0.365 L X 0.025 PH BRZ GOLD	22526	47357
-77	136-0263-04		2						SOCKET, PIN TERM:FOR 0.025 INCH SQUARE PIN	22526	75377-001
-78	136-0252-07		9						SOCKET, PIN CONN:W/O DIMPLE	22526	75060-012
-79	214-2342-00		1						HEAT SINK:MICROCIRCUIT (ATTACHING PARTS)	80009	214-2342-00
-80	211-0159-00		2						SCREW, MACHINE:2-56 X 0.375 INCH, PNH STL - - - * - - -	87308	OBD
-81	131-0594-00		1						POST, BDG, ELEC:BLACK	22526	47356
-82	162-0026-00		FT						INS SLV, ELEC:BULK, 0.58 INCH OD	83309	OBD





Part

0649  
 -35  
 0604  
 3526

TR 503 TRACKING GENERATOR

NER

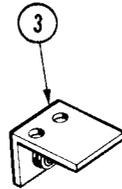
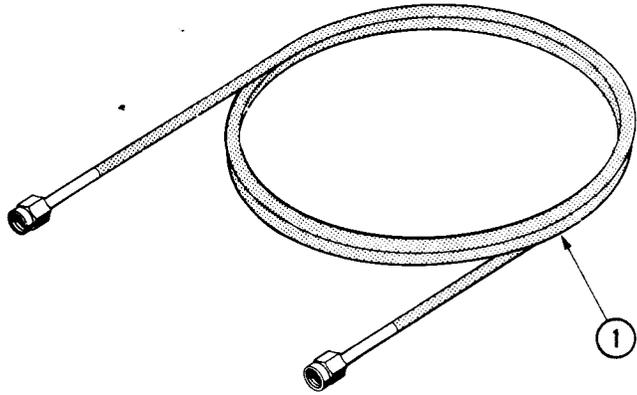


Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1	2	3	4	5	Name & Description	Mfr Code	Mfr Part Number
STANDARD ACCESSORIES												
-1	012-0649-00			2						CABLE ASSY, RF: 50 OHM COAX, 28.5 INCH LONG	80009	012-0649-00
-2	103-0045-00			1						ADAPTER, CONN: BNC FEMALE TO N MALE	91836	KN99-35
-3	343-0604-00			1						RETAINER, PL-IN:	80009	343-0604-00
	070-3526-00			1						MANUAL, TECH: INSTRUCTION	80009	070-3526-00

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1	2	3	4	5	Name & Description	Mfr Code	Mfr Part Number
1-83	-----	-----		1	.	.	.	.	.	CKT BOARD ASSY:0 FREQ DET(SEE A35A4 EPL)		
-84	131-0608-00			2	.	.	.	.	.	TERMINAL,PIN:0.365 L X 0.025 PH BRZ GOLD	22526	47357
-85	136-0263-04			5	.	.	.	.	.	SOCKET,PIN TERM:FOR 0.025 INCH SQUARE PIN	22526	75377-001
-86	136-0260-02			2	.	.	.	.	.	SKT,PL-IN ELEK:MICROCIRCUIT,16 DIP,LOW CLE	71785	133-51-92-008
-87	136-0252-07			14	.	.	.	.	.	SOCKET,PIN CONN:W/O DIMPLE	22526	75060-012
-88	-----			1	.	.	.	.	.	CKT BOARD ASSY:52.5 MHZ OSC(SEE A35A3 EPL) (ATTACHING PARTS)		
-89	211-0162-00			4	.	.	.	.	.	SCREW,MACHINE:2-56 X 0.188 INCH,SCH,SST	000AH	OBD
					-	.	.	.	.	CKT BOARD ASSY INCLUDES:		
-90	136-0260-02			1	.	.	.	.	.	SKT,PL-IN ELEK:MICROCIRCUIT,16 DIP,LOW CLE	71785	133-51-92-008
-91	136-0252-07			3	.	.	.	.	.	SOCKET,PIN CONN:W/O DIMPLE	22526	75060-012
-92	136-0263-04			4	.	.	.	.	.	SOCKET,PIN TERM:FOR 0.025 INCH SQUARE PIN	22526	75377-001
-93	337-1912-00			1	.	.	.	.	.	SHIELD,ELEC:HONEYCOMB	80009	337-1912-00
					-	.	.	.	.	(ATTACHING PARTS)		
-94	211-0162-00			17	.	.	.	.	.	SCREW,MACHINE:2-56 X 0.188 INCH,SCH,SST	000AH	OBD
					-	.	.	.	.	CKT BOARD ASSY:MOTHER(SEE A35A1 EPL)		
-95	-----			1	.	.	.	.	.	CKT BOARD ASSY:MOTHER(SEE A35A1 EPL)		
-96	136-0252-07			38	.	.	.	.	.	SOCKET,PIN CONN:W/O DIMPLE	22526	75060-012
-97	131-0993-00			2	.	.	.	.	.	BUS,CONDUCTOR:2 WIRE BLACK	00779	530153-2
-98	131-0608-00			26	.	.	.	.	.	TERMINAL,PIN:0.365 L X 0.025 PH BRZ GOLD	22526	47357
-99	-----			1	.	.	.	.	.	TRANSISTOR:(SEE Q390 EPL) (ATTACHING PARTS)		
-100	210-0406-00			1	.	.	.	.	.	NUT,PLAIN,HEX.:4-40 X 0.188 INCH,BRS	73743	2X12161-402
-101	211-0007-00			1	.	.	.	.	.	SCREW,MACHINE:4-40 X 0.188 INCH,PNH STL	83385	OBD
					-	.	.	.	.	AMPLIFIER ASSY INCLUDES:		
-102	136-0269-02			1	.	.	.	.	.	SKT,PL-IN ELEK:MICROCIRCUIT,14 DIP,LOW CLE	73803	CS9002-14
-103	131-1729-00			1	.	.	.	.	.	CONNECTOR,RCPT,:SMB SNAP-ON	98291	051-051-0219-1
-104	-----			1	.	.	.	.	.	TRANSISTOR:(SEE Q420 EPL) (ATTACHING PARTS)		
-105	210-0407-00			2	.	.	.	.	.	NUT,PLAIN,HEX.:6-32 X 0.25 INCH,BRS	73743	3038-0228-402
-106	211-0507-00			2	.	.	.	.	.	SCREW,MACHINE:6-32 X 0.312 INCH,PNH STL	83385	OBD
-107	210-0801-00			6	.	.	.	.	.	WASHER,FLAT:0.14 ID X 0.281 OD NP STL	12327	OBD
					-	.	.	.	.	AMPLIFIER ASSY INCLUDES:		
-108	131-0593-00			7	.	.	.	.	.	CONTACT,ELEC:1.15 INCH LONG	22526	47354
-109	136-0514-00			1	.	.	.	.	.	SKT,PL-IN ELEK:MICROCIRCUIT,8 DIP	73803	CS9002-8
-110	131-0787-00			1	.	.	.	.	.	CONTACT,ELEC:0.64 INCH LONG	22526	47359
-111	200-0935-00			1	.	.	.	.	.	BASE,LAMPHOLDER:0.29 OD X 0.19 CASE	80009	200-0935-00
-112	378-0602-00			1	.	.	.	.	.	LENS,LIGHT:GREEN	80009	378-0602-00
-113	352-0157-00			1	.	.	.	.	.	LAMPHOLDER:WHITE PLASTIC	80009	352-0157-00
-114	-----			1	.	.	.	.	.	AMPLIFIER ASSY:2.1-3.9 GHZ(SEE A6 EPL) (ATTACHING PARTS)		
-115	210-0586-00			2	.	.	.	.	.	NUT,PL,ASSEM WA:4-40 X 0.25,STL CD PL	83385	211-041800-00
					-	.	.	.	.	AMPLIFIER ASSY INCLUDES:		
-116	210-0202-00			1	.	.	.	.	.	TERMINAL,LUG:0.146 ID,LOCKING,BRZ TINNED (ATTACHING PARTS)	78189	2104-06-00-2520N
-117	210-0586-00			1	.	.	.	.	.	NUT,PL,ASSEM WA:4-40 X 0.25,STL CD PL	83385	211-041800-00
-118	386-4506-00			1	.	.	.	.	.	SUBPANEL,FRONT:RIGHT SIDE (ATTACHING PARTS)	80009	386-4506-00
-119	213-0229-00			4	.	.	.	.	.	SCR,TPG,THD FOR:6-20 X0.375"100 DEG,FLH STL	93907	OBD
					-	.	.	.	.	CABLE ASSY,RF:BANDPASS TO LP(SEE W85 EPL)		
-120	-----			1	.	.	.	.	.	CABLE ASSY,RF:BANDPASS TO LP(SEE W85 EPL)		
-121	-----			1	.	.	.	.	.	CABLE ASSY,RF:BANDPASS TO ISOL(SEE W95 EPL)		
-122	-----			1	.	.	.	.	.	CABLE ASSY,RF:LOWPASS TO ISOL(SEE W75 EPL)		
-123	343-0013-00			1	.	.	.	.	.	CLAMP,LOOP:0.375 INCH DIA (ATTACHING PARTS)	95987	3-8-6B
-124	211-0012-00			1	.	.	.	.	.	SCREW,MACHINE:4-40 X 0.375,PNH STL CD PL	83385	OBD
-125	210-0938-00			1	.	.	.	.	.	WASHER,FLAT:0.109 ID X 0.25 INCH OD,STL	75497	AN960-3
					-	.	.	.	.	FILTER,LOW PASS:4.5 GHZ(SEE A8 EPL)		
-126	-----			1	.	.	.	.	.	FILTER,LOW PASS:4.5 GHZ(SEE A8 EPL)		
-127	-----			1	.	.	.	.	.	ISOLATOR,RF REF:1.2-4 GHZ(SEE A7 EPL) (ATTACHING PARTS)		
-128	211-0008-00			3	.	.	.	.	.	SCREW,MACHINE:4-40 X 0.25 INCH,PNH STL	83385	OBD

Replaceable Mechanical Parts—TR 503

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
1-129	-----			1		ISOLATOR, RF REF: 1.2-4 GHZ (SEE A10 EPL) (ATTACHING PARTS)		
-130	211-0008-00			3		SCREW, MACHINE: 4-40 X 0.25 INCH, PNH STL -----*-----	83385	OBD
-131	-----			1		BANDPASS FILTER: INTERDIGITAL (SEE A9 EPL) (ATTACHING PARTS)		
-132	211-0008-00			4		SCREW, MACHINE: 4-40 X 0.25 INCH, PNH STL -----*-----	83385	OBD
-133	441-1296-00			1		CHASSIS GEN: MAIN, RIGHT (ATTACHING PARTS)	80009	441-1269-00
-134	211-0101-00			8		SCREW, MACHINE: 4-40 X 0.25" 100 DEG, FLH STL -----*-----	83385	OBD
-135	426-1268-00			1		FRAME SECT, CAB.: TOP, RIGHT	80009	426-1268-00
-136	426-1269-00			1		FRAME SECT, CAB.: BOTTOM, RIGHT	80009	426-1269-00
	198-3098-00			1		WIRE SET, ELEC:	80009	198-3098-00
-137	131-0707-00			112		. CONNECTOR, TERM.: 22-26 AWG, BRS& CU BE GOLD	22526	47439
-138	352-0169-01			2		. HLDR TERM CONN: 2 WIRE, BROWN	80009	352-0169-01
	352-0169-04			2		. CONN BODY, PL, EL: 2 WIRE YELLOW	80009	352-0169-04
-139	352-0162-01			4		. CONN BODY, PL, EL: 4 WIRE BROWN	80009	352-0162-01
-140	352-0164-00			2		. CONN BODY, PL, EL: 6 WIRE BLACK	80009	352-0164-00
	352-0164-01			2		. CONN BODY, PL, EL: 6 WIRE BROWN	80009	352-0164-01
-141	352-0165-00			2		. CONN BODY, PL, EL: 7 WIRE BLACK	80009	352-0165-00
	352-0165-01			2		. CONN BODY, PL, EL: 7 WIRE BROWN	80009	352-0165-01
-142	352-0166-00			2		. CONN BODY, PL, EL: 8 WIRE BLACK	80009	352-0166-00
-143	352-0168-00			2		. CONN BODY, PL, EL: 10 WIRE BLACK	80009	352-0168-00
-144	175-0825-00			FT		. WIRE, ELECTRICAL: 2 WIRE RIBBON	80009	175-0825-00
-145	175-0826-00			FT		. WIRE, ELECTRICAL: 3 WIRE RIBBON	80009	175-0826-00
-146	175-0827-00			FT		. CABLE, SP, ELEC: 4, 26 AWG, STRD, PVC JKT, RBN	08261	SS04267(1061)0C
-147	175-0829-00			FT		. WIRE, ELECTRICAL: 6 WIRE RIBBON	08261	SS-0626-710610C
-148	175-0830-00			FT		. WIRE, ELECTRICAL: 7 WIRE RIBBON	08261	SS-0726-710610C
-149	175-0855-00			FT		. WIRE, ELECTRICAL: 10 WIRE RIBBON	08261	SS-1022(1061)0C
-150	175-0857-00			FT		. WIRE, ELECTRICAL: 8 WIRE RIBBON	08261	SS-0822-1910610C
	198-2582-00			1		WIRE SET, ELEC:	80009	198-2582-00
	131-0707-00			4		. CONNECTOR, TERM.: 22-26 AWG, BRS& CU BE GOLD	22526	47439
	352-0169-00			2		. HLDR, TERM CONN: 2 WIRE BLACK	80009	352-0169-00
	175-0825-00			FT		. WIRE, ELECTRICAL: 2 WIRE RIBBON	80009	175-0825-00

## **MANUAL CHANGE INFORMATION**

At Tektronix, we continually strive to keep up with latest electronic developments by adding circuit and component improvements to our instruments as soon as they are developed and tested.

Sometimes, due to printing and shipping requirements, we can't get these changes immediately into printed manuals. Hence, your manual may contain new change information on following pages.

A single change may affect several sections. Since the change information sheets are carried in the manual until all changes are permanently entered, some duplication may occur. If no such change pages appear following this page, your manual is correct as printed.

## **SERVICE NOTE**

Because of the universal parts procurement problem, some electrical parts in your instrument may be different from those described in the Replaceable Electrical Parts List. The parts used will in no way alter or compromise the performance or reliability of this instrument. They are installed when necessary to ensure prompt delivery to the customer. Order replacement parts from the Replaceable Electrical Parts List.

# CALIBRATION TEST EQUIPMENT REPLACEMENT

## Calibration Test Equipment Chart

This chart compares TM 500 product performance to that of older Tektronix equipment. Only those characteristics where significant specification differences occur, are listed. In some cases the new instrument may not be a total functional replacement. Additional support instrumentation may be needed or a change in calibration procedure may be necessary.

Comparison of Main Characteristics

DM 501 replaces 7D13		
PG 501 replaces 107 108	PG 501 - Risetime less than 3.5 ns into 50 Ω. PG 501 - 5 V output pulse; 3.5 ns Risetime	107 - Risetime less than 3.0 ns into 50 Ω. 108 - 10 V output pulse 1 ns Risetime
PG 502 replaces 107 108 111	PG 502 - 5 V output PG 502 - Risetime less than 1 ns; 10 ns Pretrigger pulse delay	108 - 10 V output 111 - Risetime 0.5 ns; 30 to 250 ns Pretrigger pulse delay
PG 508 replaces 114 115 2101	Performance of replacement equipment is the same or better than equipment being replaced.	
PG 506 replaces 106 067-0502-01	PG 506 - Positive-going trigger output signal at least 1 V; High Amplitude output, 60 V. PG 506 - Does not have chopped feature.	106 - Positive and Negative-going trigger output signal, 50 ns and 1 V; High Amplitude output, 100 V. 0502-01 - Comparator output can be alternately chopped to a reference voltage.
SG 503 replaces 190, 190A, 190B 191 067-0532-01	SG 503 - Amplitude range 5 mV to 5.5 V p-p. SG 503 - Frequency range 250 kHz to 250 MHz.	190B - Amplitude range 40 mV to 10 V p-p. 0532-01 - Frequency range 65 MHz to 500 MHz.
SG 504 replaces 067-0532-01 067-0650-00	SG 504 - Frequency range 245 MHz to 1050 MHz.	0532-01 - Frequency range 65 MHz to 500 MHz.
TG 501 replaces 180, 180A 181 184 2901	TG 501 - Trigger output-slaved to marker output from 5 sec through 100 ns. One time-mark can be generated at a time. TG 501 - Trigger output-slaved to market output from 5 sec through 100 ns. One time-mark can be generated at a time. TG 501 - Trigger output-slaved to marker output from 5 sec through 100 ns. One time-mark can be generated at a time.	180A - Trigger pulses 1, 10, 100 Hz; 1, 10, and 100 kHz. Multiple time-marks can be generated simultaneously. 181 - Multiple time-marks 184 - Separate trigger pulses of 1 and 0.1 sec; 10, 1, and 0.1 ms; 10 and 1 μs. 2901 - Separate trigger pulses, from 5 sec to 0.1 μs. Multiple time-marks can be generated simultaneously.

NOTE: All TM 500 generator outputs are short-proof. All TM 500 plug-in instruments require TM 500-Series Power Module.