493A/495A
MICROWAVE AMPLIFIER

SERIAL NUMBERS

This manual applies directly to HP Model 493A/ 495A Microwave Amplifier having serial numbers prefixed: 350-, 330-, 304-, 229-, 151-, 142-.

MANUAL PART NO. 00493-90004
Microfiche Part No. 00493-90025

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HEWLETT PACKARD

SAFETY CONSIDERATIONS

GENERAL

This product and related documentation must be reviewed for familiarization with safety markings and instructions before operation. This product has been designed and tested in accordance with international standards.

SAFETY SYMBOLS

Instruction manual symbol: the product will be marked with this symbol when it is necessary for the user to refer to the instruction manual (refer to Table of Contents).

Indicates hazardous voltages.

Indicates earth (ground) terminal.

WARNING The WARNING sign denotes a hazard. It calls attention to a procedure, practice, or the like, which, if not correctly performed or adhered to, could result in personal injury. Do not proceed beyond a WARNING sign until the indicated conditions are fully understood and met.

CAUTION The CAUTION sign denotes a hazard. It calls attention to an operating procedure, practice, or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product. Do not proceed beyond a CAUTION sign until the indicated conditions are fully understood and met.

SAFETY EARTH GROUND

This is a Safety Class I product (provided with a protective earthing terminal). An uninterruptible safety earth ground must be provided from the main power source to the product input wiring terminals, power cord, or supplied power cord set. Whenever it is likely that the protection has been impaired, the product must be made inoperative and be secured against any unintended operation.

BEFORE APPLYING POWER

Verify that the product is configured to match the available main power source per the input power configuration instructions provided in this manual.

If this product is to be energized via an autotransformer make sure the common terminal is connected to the neutral (grounded side of mains supply).

SERVICING

WARNING

Any servicing, adjustment, maintenance, or repair of this product must be performed only by qualified personnel.

Adjustments described in this manual may be performed with power supplied to the product while protective covers are removed. Energy available at many points may, if contacted, result in personal injury.

Capacitors inside this product may still be charged even when disconnected from its power source.

To avoid a fire hazard, only fuses with the required current rating and of the specified type (normal blow, time delay, etc.) are to be used for replacement.

SECTION I
GENERAL INFORMATION

1-1. INTRODUCTION.

1-2. This manual provides instructions for installation, operation, circuit description, and maintenance of the Models 493A and 495A Microwave Amplifiers. The manual applies directly to instruments which carry the serial number prefix indicated on the title page. The Model 495A Microwave Amplifier is shown in figure 1-1. Specifications for both instruments are given in table 1-1.

1-3. DESCRIPTION.

1-4. The Models 493A and 495A are broadband linear amplifiers that provide signal amplification to at least 30 db. The Model 493A covers the 4.0 to 8.0 gc range; the Model 495A covers the 7.0 to 12.4 gc range. Both instruments produce at least 1 watt at the output with the application of 1 milliwatt or less at the input.

1-5. The Models 493A and 495A output can be amplitude modulated. Externally supplied modulation signals are applied to the MOD INPUT. Since the modulation circuit is dc coupled, an external leveler circuit can be connected at the MOD INPUT to obtain relatively flat power output across the band.

1-6. The Models 493A and 495A require no tuning and are particularly useful for signal amplification over a broad band of frequencies. The GAIN control is the only variable front panel control. It controls rf signal amplification and average rf power output.

1-7. The Models 493A and 495A traveling-wave amplifier tubes (twt's) utilize periodic permanent magnet focusing, thus they are lightweight, compact and consume less power than solenoid focused twt's.

1-8. An instrument in one frequency range can be converted to an instrument in another frequency range, since both the Models 493A and 495A are identical except for traveling-wave amplifier tube.

1-9. Since the Models 493A and 495A are identical except for the twt, the manual will be discussed in terms of the Model 493A. The Model 495A will be mentioned only when its operation differs from that of the Model 493A.

1-10. The Model 493A uses a modular design which includes a kit that allows conversion to either a cabinet or rack mount configuration.

1-11. INSTRUMENT OPTION.

1-12. The option 01 Model 493A microwave amplifier RF INPUT and OUTPUT connectors are located on the rear panel. In all other respects the option 01 microwave amplifier is the same as a regular microwave amplifier.

1-13. INSTRUMENT IDENTIFICATION.

1-14. Hewlett-Packard uses a two-section eight-digit serial number (000-00000). If the first three digits of the serial number on your instrument do not agree with those on the title page of this manual, change sheets supplied with the manual will define differences between your instrument and the Model 493A described in this manual.

1-15. COOLING SYSTEM.

1-16. The Model 493A uses the forced air method for obtaining the desired temperature within the instrument. Incoming air is filtered through a specially treated filter at the rear of the instrument. The air filter should be checked periodically and if dirty, cleaned. A dirty air filter will affect instrument performance as well as component life. Refer to paragraph 5-1 for air filter maintenance.

1-17. THREE-CONDUCTOR POWER CABLE.

1-18. To protect operating personnel, the National Electrical Manufacturers' Association (NEMA) recommends that the instrument panel and cabinet be grounded. All Hewlett-Packard instruments are equipped with a three-conductor power cable which, when plugged into an appropriate receptacle, grounds the instrument. The offset pin on the power cable's three-prong connector is the green grounding wire.

1-19. To preserve the protection feature when operating the instrument from a two-contact outlet, use a three-prong to two-prong adapter and connect the green pigtail on the adapter to ground.

1-20. INCREASING TUBE LIFE.

1-21. The cathode of the traveling-wave amplifier tube has a shorter cathode life than those used in conventional types of tubes. In addition, the traveling-wave amplifier tube is expensive. TURN THE INSTRUMENT OFF WHEN NOT IN USE.

1-22. TRAVELING-WAVE AMPLIFIER TUBE (TWT).

1-23. The warranty for the twt supplied with this microwave amplifier and replacement twt's purchased from Hewlett-Packard Company is on page 1-2 of this manual. For further information regarding warranty contact your local Hewlett-Packard sales and service office. Addresses are provided at the back of this manual.

CONDITIONS OF WARRANTY
FOR
BACKWARD WAVE OSCILLATOR TUBES
AND
TRAVELING WAVE TUBES

Microwave (BWO, TWT) tubes are warranted to be free from manufacturing defects. The operating tube warranty will be 12 months unconditional from date of shipment from Hewlett-Packard. If a tube carrying this warranty fails and must be replaced, only the applicable remaining warranty of the first tube is transferred to the replacement tube, or 90 days, which ever is greater. The Hewlett-Packard Company will process warranty claims for customers on tubes which were supplied by Hewlett-Packard for use in Hewlett-Packard instruments. The serial number of the tube failing and the serial number of the replacement tube must be noted on the warranty claim form.

"In Warranty" tubes purchased from Hewlett-Packard must be returned immediately (not to exceed 30 days from date of failure) with a complete Warranty Claim Form, to your local Hewlett-Packard Sales and Service Office. Addresses are listed in the instrument Manual. Be sure to pack the tube in accordance with the Packing Instructions listed on the Warranty Claim Form; warranty allowance cannot be made on tubes received broken due to improper packaging or showing evidence of tampering.

Instructions for filing a warranty claim are listed on the "Microwave Tube Warranty Claim" form which is included with the Operating and Service Manual for your instrument. This form is also included with replacement Microwave tubes supplied by Hewlett-Packard. Additional copies may be obtained from your local Hewlett-Packard Sales and Service Office. (Please ref: HP Stock No. 9320-1865.)

Hewlett-Packard specified replacement tubes can be obtained from your local Hewlett-Packard Sales and Service Office.

Figure 1-2. TWT Warranty Claim Sheet

SECTION II
INSTALLATION

2-1. AIR FILTER.

2-2. This instrument is equipped with a renewable type air filter. When first unpacking and placing the instrument into service the filter must be coated with a dirt gathering adhesive to make it effective. While light machine oil is satisfactory, we recommend a water-soluble adhesive such as "Super Filter Coat" manufactured by Research Products Corporation of Madison 1, Wisconsin.

2-3. MECHANICAL INSPECTION.

2-4. Unpack the instrument upon receipt and inspect it for signs of physical damage such as scratched panel surfaces, broken knobs, etc. The Model 493A should be checked electrically. Section V includes a performance check which is an in-cabinet check to verify proper operation and is a good test as part of incoming inspection. If there is any apparent damage, file a claim with the carrier and refer to the warranty page in this manual.

2-5. INSTALLATION.

2-6. The Model 493A is of modular design. It is shipped as a cabinet instrument. A kit is included with the instrument for conversion from cabinet to rack mount configuration (see paragraph 2-7, Conversion to Rack Mount).

Note

The instrument fan is located on the rear panel. Make provisions to insure that the instrument obtains sufficient air. The ambient temperature within the instrument should not be greater than 35°C.

2-7. CONVERSION TO RACK MOUNT.

2-8. To convert the Model 493A to a rack-mounted instrument. proceed as follows (see Figure 2-1):

a. Remove adhesive-backed trim strip from sides of instrument.

b. Remove tilt stand by pressing the two sides of the stand toward center of instrument.

c. Remove plastic feet by pressing button in center of each foot and sliding the foot toward center of instrument.

d. Attach filler strip to bottom of instrument.

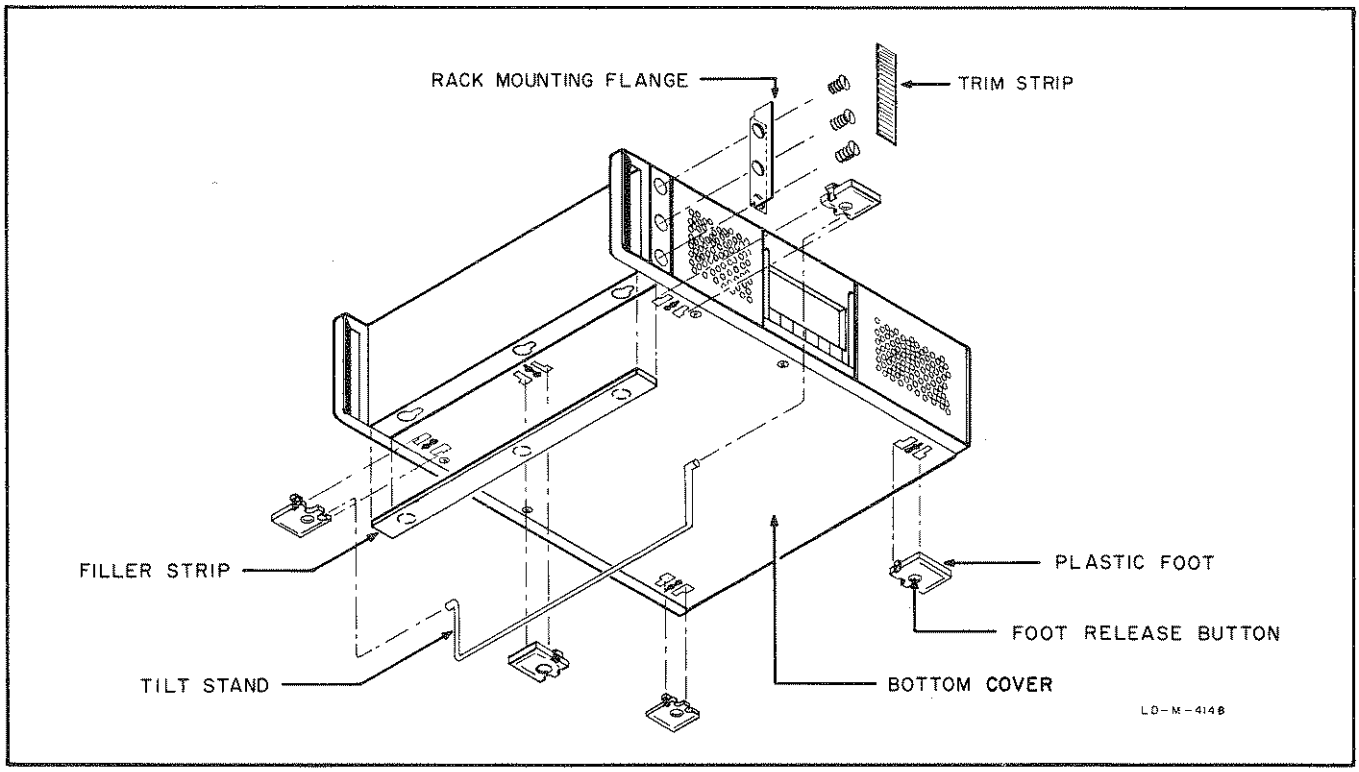


Figure 2-1. Cabinet to Rack Mount Conversion

e. Add filler strip to bottom of instrument.

2-9. POWER REQUIREMENTS.

2-10. The Model 493A is usually shipped connected for 115-volt, 50 to 60 cps operation. To convert tc 230-volt, 50 to 60 cps operation:

a. Move slide switch in the rear of the instrument to the 230-volt position (when properly positioned switch will read 230 volts). See figure 2-2.

CAUTION

NEVER SWITCH THE 115-230 VOLT SWITCH S2 FROM ONE POSITION TO THE OTHER WHEN THE INSTRUMENT IS IN OPERATION.

b. Replace the 3-ampere standard fuse with a 1-1/2 ampere standard fuse.

2-11. REPACKAGING FOR SHIPMENT.

2-12. The following list is a general guide for repackaging an instrument for shipment. However, if you have any questions, contact your Hewlett-Packard Engineering Representative.

a. If possible, use the original container designed for the instrument.

b. Wrap the instrument in heavy paper or plastic before placing it in the shipping container.

c. Use plenty of packing material around all sides of the instrument and protect panel faces with cardboard strips.

d. Use a heavy cardboard carton or wooden box tc house the instrument and use heavy tape or metal bands to seal the container.

e. Mark the packing box with "Fragile", "Delicate Instrument", etc.

SECTION III
OPERATION

3-1. INTRODUCTION.

3-2. The Model 493A Microwave Amplifier has only one control, the GAIN control; thus it is easy to operate. The GAIN control and input and output connectors are explained under paragraph 3-3.

CAUTION

The instrument should not be allowed to remain in operation for long periods of time without fan duct and panels. Ambient temperature within instrument will increase causing excessive helix current to flow.

3-3. FRONT PANEL CONTROLS.

3-4. GAIN CONTROL. The GAIN control sets the gain of the amplifier. Maximum input-vs-output gain of the instrument is at least 30 db for outputs up to 1 watt. With a signal applied at the microwave amplifier input the only way to insure zero output is to place the instrument on STANDBY.

3-5. CURRENT METER. The current meter monitors cathode current. The instrument has a gain of at least 30 db for outputs up to 1 watt when the GAIN control is adjusted to within the RATED POWER limits indicated on the meter.

3-6. RF INPUT AND OUTPUT. An rf signal, up to 100 milliwatts, in the 4.0 to 8.0 gc range (7.0 to 12.4 gc for the Model 495A) is applied to the RF INPUT. Input and output impedance is 50 ohms at rf frequencies; infinity at dc. SWR is less than 3:1.

CAUTION

DO NOT APPLY AN INPUT SIGNAL BEFORE APPLYING AN EXTERNAL LOAD AT THE RF OUTPUT. THE TWT CAN BE DAMAGED.

3-7. MODULATION INPUT. The MOD INPUT accepts externally applied dc to 500 kc signals up to 10 volts in amplitude, or dc to 100 kc signals up to -20 volts in amplitude. Modulation signal amplitudes of -20 volts will produce a modulation on-off ratio of at least 20 db. Since the modulator is dc coupled, an rf power leveler circuit can be applied between the RF POWER OUTPUT and MOD INPUT (see paragraph 3-16). Under no circumstances should the modulation voltage be allowed to go positive unless GAIN is reduced accordingly. In other words, peak cathode current must not exceed RATED POWER level.

3-8. OPERATING INSTRUCTIONS.

3-9. Turn-on and amplitude modulation procedures are given in figures 3-1 and 3-2.

3-10. MICROWAVE AMPLIFIER APPLICATIONS.

3-11. The Model 493A is used for broadband or narrow-band power amplification and amplitude modulation. An external rf leveler circuit can be employed where relatively constant output power is required.

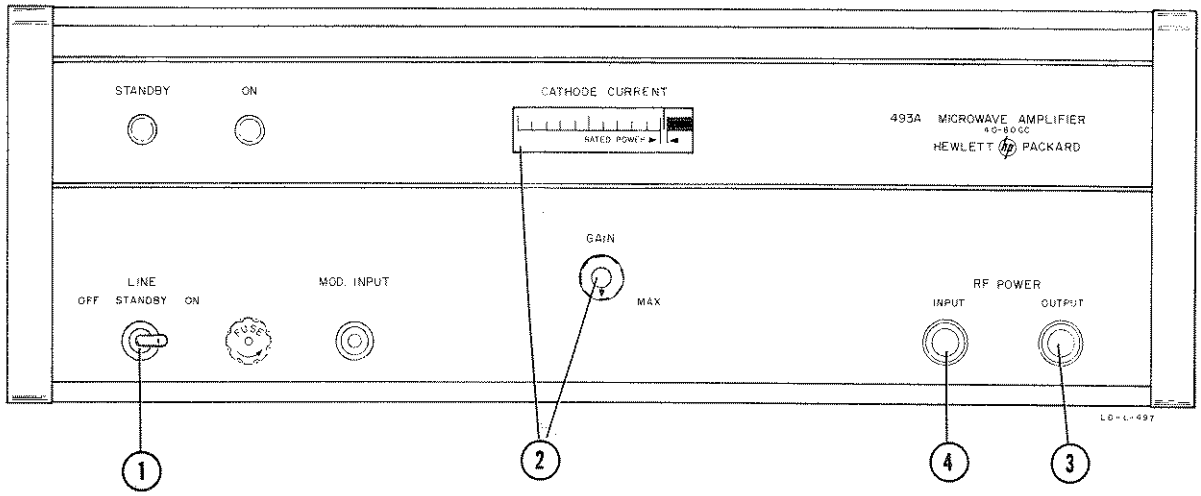
3-12. BROADBAND AMPLIFICATION. The Model 493A will faithfully amplify many broadband signals such as those employed in radar, television relays and microwave carrier systems. In addition to this broadband feature, it has a linear amplification characteristic over the frequency range.

3-13. Of the many broadband applications of the Model 493A, some of the most useful are: 1) investigation of information handling capacity in broadband microwave communications systems, 2) amplification of low-frequency harmonics to produce frequency markers used in microwave-frequency measurements.

3-14. NARROWBAND AMPLIFICATION. The Models 493A and 495A can be used for narrowband amplification at any one point across the 4.0 to 12.4 gc range. Noise can be greatly reduced by employing a narrow bandpass filter in conjunction with the Models 493A and 495A Microwave Amplifiers.

3-15. POWER AMPLIFICATION. The Model 493A can be used as a moderate power, broadband signal source by amplifying the low power output of klystron signal generators in the 4.0 to 12.4 gc range. Thus a microwave source-amplifier combination can be used in many applications where a generous amount of microwave power is required. Typical applications are 1) wide-range antenna measurements to plot patterns to determine efficiency, directivity, etc., 2) portable low-cost means of providing moderate power microwave-signal sources for field-testing a microwave installation.

3-16. CONSTANT OUTPUT AMPLIFICATION. Many amplifier applications require a constant output level characteristic. Although the Model 493A traveling-wave amplifier tube's saturated output characteristic can be used to provide nearly constant power output, the use of feedback circuitry provides a more versatile and effective means of control. One such arrangement for obtaining relatively constant rf output power is shown in figure 3-3. In this circuit a portion of the rf signal is coupled from the traveling-wave amplifier tube output, through a directional coupler to a detector such as a crystal rectifier. The detected rf output is then amplified and applied to the MOD INPUT. With this arrangement any tendency for the output-power level to increase is immediately detected, amplified, and fed back to reduce the gain of the amplifier. Conversely, any reduction in output level increases the



CAUTION

NEVER APPLY POWER TO THE MODEL 493A/495A INPUT UNLESS ITS OUTPUT IS TERMINATED INTO A 50-OHM LOAD. THE TWT CAN BE DAMAGED.

1. Set LINE switch to ON. The STANDBY lamp glows. Approximately 90 seconds later the ON lamp will glow and the instrument is ready for normal operation. If the Model 493A/495A is placed in the STANDBY position, the STANDBY lamp will glow. Approximately 90 seconds later high voltage will be applied to the instrument only when the primary power switch is set from STANDBY to ON. The purpose of the STANDBY position is to instantly turn rf power output "on" or "off" after initial turn-on without waiting for the initial 90-second time delay.

   Note

   The instrument should be turned to ON and allowed to warm up for 30 minutes before proceeding to step 2.

2. Rotate GAIN control clockwise to within RATED POWER indicated on meter (full clockwise). With the CURRENT meter pointer set within normal meter limits, a maximum of 1 mw at the input produces a minimum of 1 watt at the output across the frequency range. Small signal gain is at least 30 db. A constant 1-mw signal at the input of the Model 493A/495A across the band produces an amplified power output variation across the band of 6 db or less.

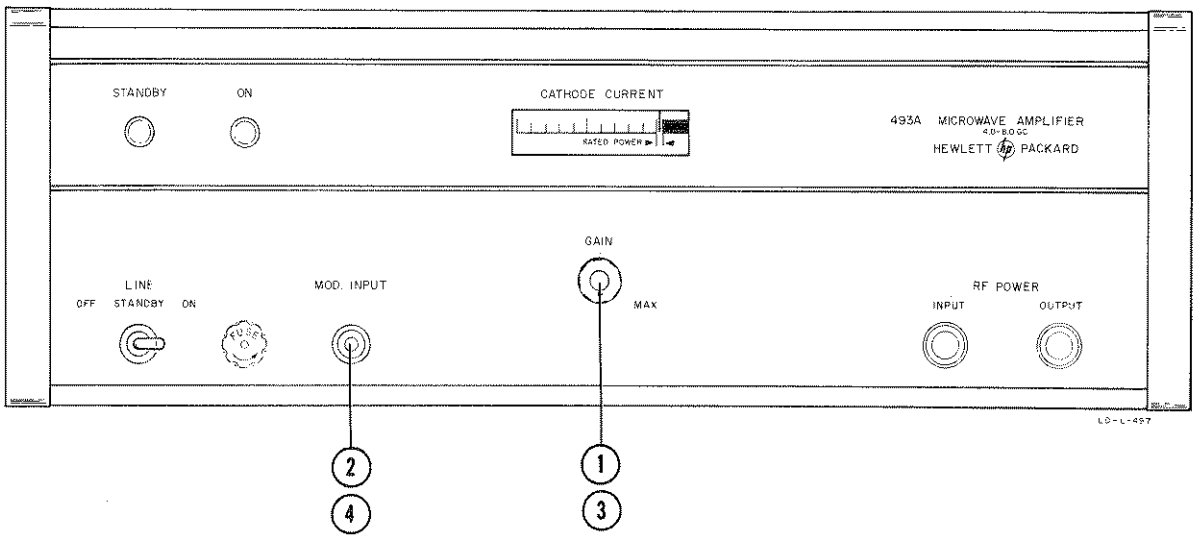
   Note

   If excessive helix current is drawn by the twt, the overload relay K3 will energize, removing high voltage from the circuit. Also if the filament voltage is not correct, the fail-safe relay K304 will energize, removing high voltage and filament voltage from the circuit. In such cases, the primary power switch must be switched off, then on again. If condition persists remove the power from the instrument and troubleshoot.

3. Connect Model 493A/495A OUTPUT to the instrument into which the amplified signal is to be applied.

4. Apply rf power to the Model 493A/495A INPUT. The maximum allowable power than can be applied to the Model 493A/495A INPUT is 100 mw.

Figure 3-1. Turn-On Procedure



1. Rotate the GAIN control full clockwise.

2. Apply a negative-going signal to the MOD INPUT. Specifications: bandpass for small signal inputs dc to 500 kc; bandpass for large signal inputs dc to 100 kc. Small signal inputs are from 0 to -10 volts; large signal inputs -10 to -20 volts. Bandwidths are measured at the grid of the twt.

Note

Peak cathode current must not be allowed to exceed RATED POWER level. If the MOD INPUT voltage is positive during any part of the modulation cycle, GAIN must be reduced accordingly.

Figure 3-2. Amplitude Modulation

gain of the amplifier to hold the output level constant. In practice, output levels can be held within 1 db during input signal variations as great as 20 db.

Note

The limitations to the degree of leveling obtainable is determined by errors introduced by crystal detector and directional coupler.

3-17. BUFFER OR ISOLATION. The Model 493A Microwave Amplifier can also be used as a buffer between a microwave-signal source and an external load. As a buffer it isolates load reflections from the signal source and eliminates the problems which occur when the source is modulated directly.

3-18. AMPLITUDE MODULATION. The Model 493A is particularly suitable for use in power amplifier systems. This feature opens new fields of application since it is not possible to amplitude modulate a reflex klystron directly. Furthermore, the traveling wave amplifier tube's use as a power amplifier means that rf output from a microwave oscillator can be sine wave, pulse, or pulse-train modulated without starting delays and jitter generally present when the oscillator itself is modulated. Thus, in addition to amplification the traveling-wave amplifier tube provides a simple system of amplitude modulation.

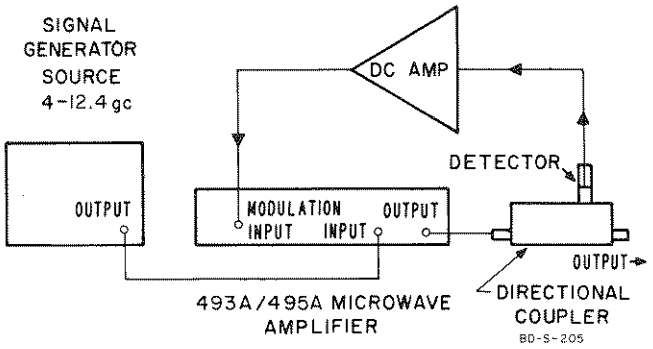


Figure 3-3. RF Leveler Setup