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1401A SPECTRUM ANALYZER MODULE

INSTRUCTION MANUAL

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070-1197-00
Product Group 26

Serial Number _____

First Printing JUN 1971
Revised DEC 1982

Printed in U.S.A. Specification and price change privileges are reserved.

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Abbreviations and symbols used in this manual are based on or taken directly from IEEE Standard 260 "Standard Symbols for Units", MIL-STD-12B and other standards of the electronics industry. Change information, if any, is located at the rear of this manual.

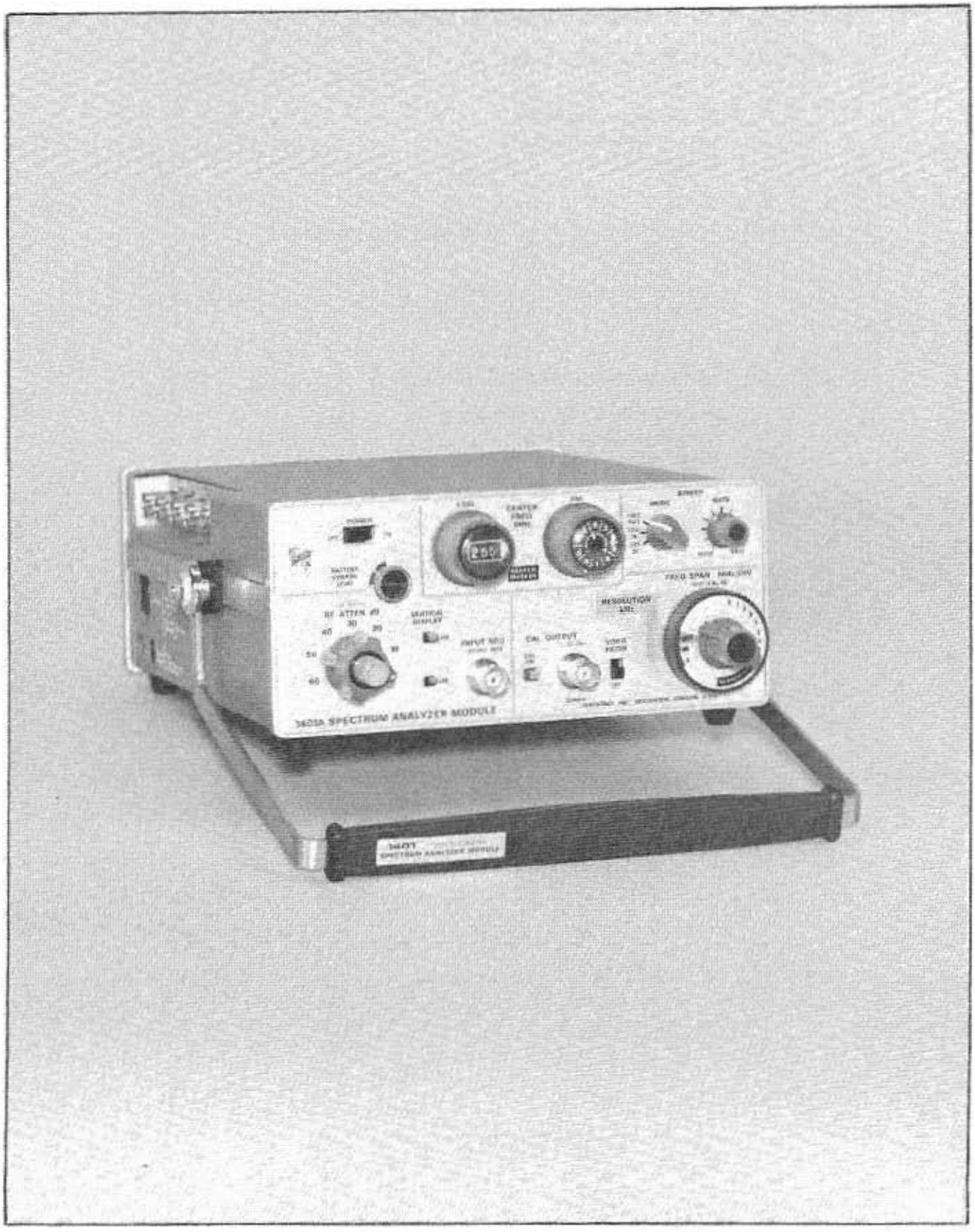


Fig. 1-1. 1401A Spectrum Analyzer Module.

SECTION 1
SPECIFICATION

Change information, if any, affecting this section will be found at the rear of the manual.

Introduction

The 1401A Spectrum Analyzer Module is a compact portable instrument designed to operate with a Tektronix Type 323 or 324 portable oscilloscope so that the two instruments comprise a portable spectrum analyzer system that can be used for on-site spectrum surveillance, RFI testing, etc.

The 1401A is a swept front-end spectrum analyzer covering the frequency range from 1 MHz to 500 MHz. It features center frequency positioning in Search mode. At 50 MHz/div frequency span, the center frequency becomes 250 MHz. In the Search mode, the Center Frequency control positions a marker on the display to indicate which part of the spectrum will appear at center screen when the frequency span is reduced from SEARCH position.

The 1401A will operate from any one of three power sources; internal rechargeable batteries, external (+6 V to 16 V) DC, and AC line. Power comsumption is about 4.5 watts DC, and up to 14 watts when powered from an AC source.

WARNING

When the 1401A is used as a portable instrument, a common ground return to the signal source must be provided. This insures that measurements are reliable, and eliminates any possibility of the instrument case becoming elevated to signal source potentials.

The instrument power pack is provided with a three-terminal polarized power receptacle and a three wire line cord for applying AC to the power pack. The third wire is directly connected to the power pack chassis, which is connected by interconnecting wires to the 1401A chassis. This grounds the instrument when operating from an AC source to protect operating personnel as recommended by national and international safety codes.

Performance Conditions

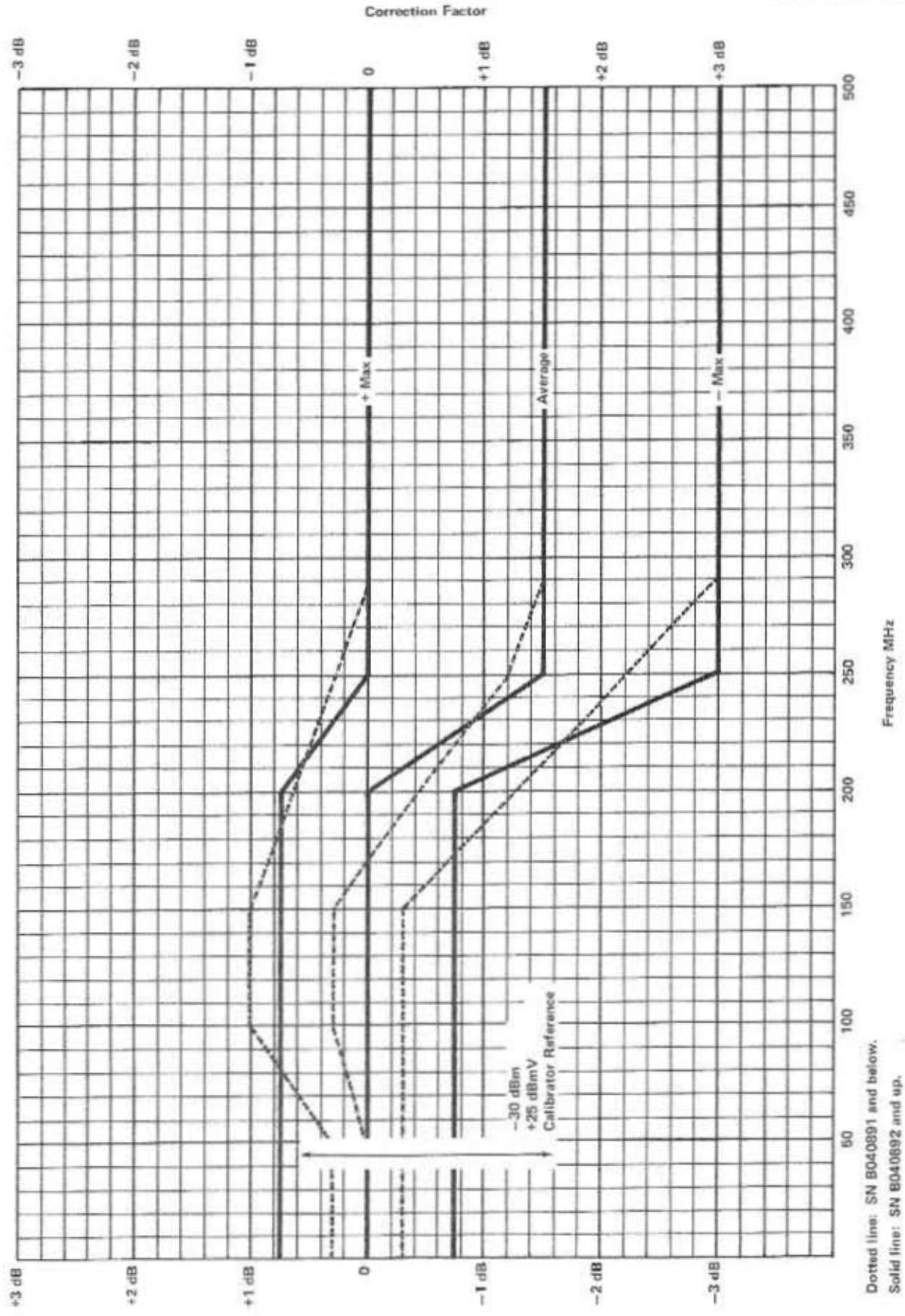
The performance limits in this section are valid with the following conditions:

Power the instrument from the battery or an external DC source. The instrument must have been calibrated within an ambient temperature of 20°C to 30°C (Section 5 provides a description of the procedure for checking the 1401A.) The instrument must be operated within an ambient temperature of −15°C to +55°C, and must be allowed to warm up for at least 25 minutes after switching the POWER to ON position.

ELECTRICAL CHARACTERISTICS

Characteristic	Performance Requirement	Supplemental Information
Center Frequency		
Range	1 MHz to 500 MHz, continuously variable	
Accuracy	Within (5 MHz + 5% of the 1-500 dial readout), FINE control at 0	Increased accuracy can be obtained by using the 50 MHz Calibrator markers as a reference. See Operating instructions.
FINE Control Range	1 MHz, within 10% either side of Center Frequency	

Characteristic	Performance Requirement	Supplemental Information
Sensitivity (Resolution		
3 kHz		At least –100 dBm
B051021 · up 10 kHz		At least –92 dBm
100 kHz	At least –82 dBm	
1000 kHz	At least –75 dBm	
Frequency Span	0 Hz to 500 MHz	
Calibrated MHz/Div Range	.1 MHz/Div to 50 MHz/Div in 1, 2, 5 sequence, plus 0 position	
Accuracy	Within 10% of FREQ SPAN MHz/DIV selector setting, VARiable control in CAL position	
Linearity	Within 15%, 10 division display	
Frequency Stability	Within 100 kHz, +20°C to +30°C, over any 5 minute interval after 25 minute warm up. Temperature coefficient less than 0.5 MHz/°C or less.	
Intermodulation Distortion	At least 55 dB down for two –30 dBm (+25 dBmV 1401A-1) signals at 1 MHz separation. At least 60 dB down for two –40 dBm (+15 dBmV 1401A-1) signals at 1 MHz separation.	
Incidental FM'ing	No more than 20 kHz	
Resolution Bandwidth	1000 kHz, 100 kHz, and 3 kHz; within 10%	
Display Flatness	SN B040891 and below: Within 1.5 dB to 200 MHz and 3.0 dB to 500 MHz. SN B040892 - B071440: Measured with respect to the level at 50 MHz. Within ±0.75 dB from 1 MHz to 200 MHz and within +0 dB to –3.0 dB from 200 MHz to 500 MHz. SN B071441 and up: Measured with respect to the level at 50 MHz, within +1.5 to –2.5 dB from 1 MHz to 200 MHz and +1.5 to –3.5 dB from 200 MHz to 500 MHz.	
Calibrator		
Frequency	50 MHz ±.01%	
Amplitude of the fundamental	–30 dBm ±0.3 dB at 25°C and ±0.5 dB at –15°C to +55°C	
LOG Display		
Dynamic Range	60 dB at 10 dB/Div	



Dotted line: SN B040891 and below.
Solid line: SN B040892 and up.

Fig. 1-2. Measurement Accuracy vs Calibrator Reference Signal. Example: Signals of equal amplitude at 40 MHz and 400 MHz means the 400 MHz signal level is 1.5 dB (mean value) greater than the 40 MHz signal.

Characteristic	Performance Requirement	Supplemental Information
Accuracy	Within 2 dB between any two readings within 60 dB dynamic range	
IF GAIN Control Range		30 dB or more
RF Attenuator Range		
Accuracy		0 dB to 60 dB in 10 dB steps, Within ±(1% of dB reading + 0.2 dB)
Maximum Input Power		
RF ATTEN at 0 dB		−30 dBm (linear operating limit)
RF ATTEN at 60 dB		+30 dBm (power rating of attenuator)
INPUT Impedance		50 Ω
Sweep Range (FREE RUN Mode)		1 sweep/s or less to at least 100 sweeps/s
VIDEO OUTput		1.2 V for full screen deflection
SWEEP VOLTAGES		
Output (FREE RUN or EXT TRIG Mode)		5 V ±0.25 V
EXTernal INput		
Level		0 to 5 V with 0 V corresponding to 0 Hz and +5 V corresponding to 500 MHz
Maximum Sweep Rate		100 sweeps/s
Maximum Input Voltage		10 Volts
GATE Input		
Amplitude (from ground reference)		At least −4 V peak, to not more than −10 V peak
ON-OFF Attenuation Ratio	At least 50 dB with input terminated.	
Minimum On Time		1 μs
Frequency		To 500 kHz (Max.)
Source Impedance		75 Ω (nominal) DC coupled

POWER SOURCE REQUIREMENTS

Characteristic	Performance Requirement
Line Voltage Range	90 V to 136 V AC or 180 V to 272 V AC
Frequency	48 Hz to 440 Hz
Power Consumption	14 watts maximum at 115 V AC
External DC Voltage Range	+6 V to +16 V. Surge current requirement is 1 ampere.
Power Consumption	4.8 watts maximum (External DC Voltage)
Battery Pack	Six, C size NiCd cells
Charge Time	16 hours for full charge
Operating Time (+20°C to +25° charge temperature, +20°C to +30°C operating temperature).	At least 3.5 hours

ENVIRONMENTAL CHARACTERISTICS

Characteristic	Performance Requirement
Temperature	
Non-operating	
With Batteries	−40°C to +60°C
Without Batteries	55°C to +75°C

ENVIRONMENTAL CHARACTERISTICS (cont)

Characteristic	Performance Requirement
Operating	−15°C to +55°C
Charging	0°C to +40°C
Altitude	
Non-operating	To 50,000 feet
Operating	To 30,000 feet; maximum ambient temperature rating must be decreased 1°C per 1000 feet, from 15,000 to 30,000 feet.
Vibration	
Operating	15 minutes along each of the 3 major axes, 0.025 inch peak-to-peak displacement (4 g's at 55 c/s) 10 to 55 to 10 c/s in 1-minute cycles.
Humidity	
Non-operating and Operating	5 cycles (120 hours) to 95% relative humidity reference to MIL-E-16400F (Par. 4.5.9 through 4.5.9.5.1, Class 4).
Electromagnetic	Meets radiated interference requirements of MIL-1-6181D and MIL-1-1690C over the range 150 kHz to one GHz. (Instrument must be battery operated.)

PHYSICAL

Finish	Front-panel has an anodized finish; cabinet is made of paint convered aluminum.

	1401A		323		1401A/323 or 324	
	in.	cm.	in.	cm.	in.	cm.
Height	3-1/2	8.9	3-1/2	8.9	7	17.8
Width w/handle	8-1/2	21.6	8-1/2	21.6	9-3/8	23.8
Depth w/panel cover	10-5/8	27.0	10-5/8	27.0	10-5/8	27.0
Depth w/handle	13	33.0	13	33.0	14-5/8	37.2
	lb.	kg.	lb.	kg.	lb.	kg.
Net approximate weight w/o accessories	≈7 1/2	≈3.4	≈7	≈3.2	≈14 1/2	≈6.6
Domestic shipping weight	≈13	≈5.9	≈13	≈5.9	≈22	≈10.0
Export-packed weight	≈21	≈9.5	≈21	≈9.5	≈30	≈13.6

NOTES

SECTION 2
OPERATING INSTRUCTIONS

Change information, if any, affecting this section will be found at the rear of the manual.

Introduction

This section of the manual describes installation and procedures pertinent to operating the 1401A. It covers function of the controls and connectors, hookup to a companion oscilloscope, battery care, operational procedure for familiarization and some examples of instrument applications.

Accessories

Standard accessories that are included with the 1401A are listed near the back of the manual. The following describes the purpose of items that are not self explanatory.

Panel Cover. A friction fit keeps this cover over the front panel during storage or transporting. The cover can be placed over the rear of the 1401A for storage when the 1401A is in use. The recess in the cover accommodates the accessory pouch strap, and should not be used as a finger grip for cover removal.

Accessory Pouch. This pouch grips to the handle pivots and the cover securing screw at the rear panel. It has sufficient capacity to hold the standard accessories, including the Operators Handbook, with the exception of the standard manual and the Panel Cover.

Strap Assembly. The strap is designed to snap into place for transporting the instrument. It can be used to suspend the 1401A in front of, or alongside, the operator during use. The handle can be extended between the operator and the 1401A, to obtain optimum viewing positions.

BNC to BNC Cable Assemblies. Two short cables are used to connect the 1401A VIDEO OUTPUT and the SWEEP voltage to the Vertical Input and Ext Horiz Input of a companion oscilloscope. A third short cable is used to patch the Calibrator output into the INPUT connectors. The 6 foot coaxial cable is used to connect the signal source to the RF INPUT connector on the 1401A. Cable loss increase with frequency and at 500 MHz the loss is about 1 dB.

Operators Handbook. Designed to fit in your shirt pocket and use as an on-site reference document. Includes prime characteristics, operating instructions, and some applications.

Installation

The 1401A is designed to use with a portable oscilloscope, such as Tektronix Type 323 or 324. It can, however, be used with any oscilloscope that has an external horizontal input or access to the horizontal sweep voltage. Interconnections between the 1401A and companion oscilloscope are illustrated in Fig. 2-4 along with control settings. Compatibility with Tektronix portable oscilloscopes is covered near the end of this section.

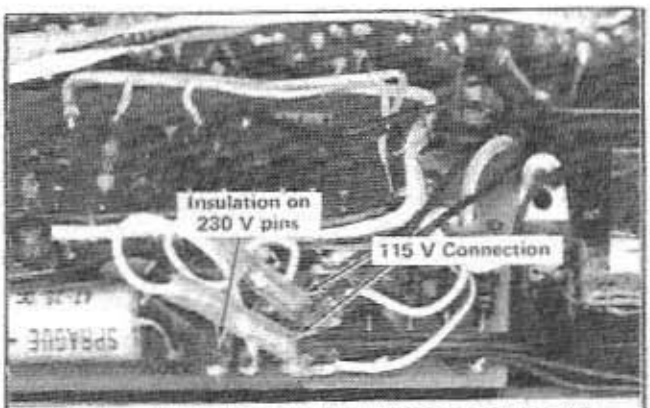
Refer to "Sweeping the Companion Oscilloscope", under General Operating Information for additional information.

POWER SOURCE AND APPLICATION

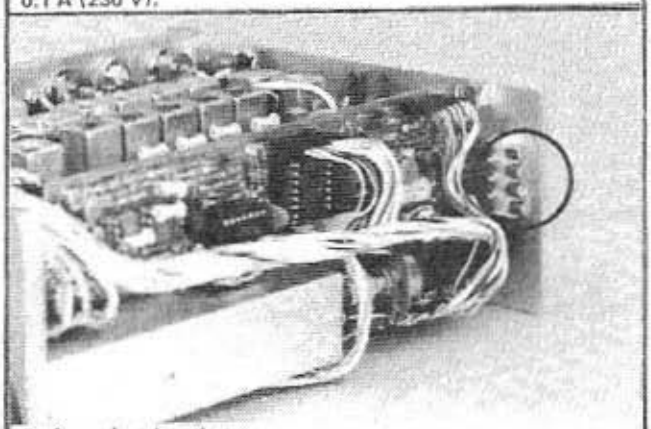
The 1401A requires either an internal power pack or an external (+6 V to +16 V) DC source for power. The power pack consists of a battery and a charging circuit. The charging circuit operates from AC line voltage, to charge the battery or maintain a given charge level after it has been charged. When fully charged, the battery pack will supply the 4.5 watts required by the 1401A and maintain this power output for approximately 3.5 hours operation.

As previously stated, the charging circuit in the power pack operates from either 115 V or 230 V nominal AC power. Slip-on connectors, on the power pack, are used to wire the charging circuit for the voltage to be used. Hookup illustrations and instructions are given in Fig. 2-1. Battery charging occurs whenever AC power is applied to the AC receptacle on the power pack. Charging rate (FULL CHG or TRICKLE CHG) is selected by a three position switch on the back panel of the power pack. Usually the battery is fully charged at the FULL CHG rate, then maintained at this charge level by switching the selector to TRICKLE CHG position. TRICKLE CHG supplies sufficient current to maintain the battery in full charge condition, plus the required power to operate the 1401A. Battery charging is described under Battery Care. The 1401A will not operate from an AC source if the batteries are missing or defective.

The battery can be charged with the power pack out of the instrument. Extra power packs can therefore be charged to serve as spares if desired.



1. 115 V or 230 V AC connections. Fuse size 0.2 A (115 V), 0.1 A (230 V).



2. Spare fuse location.

Fig. 2-1. Preparing the 1401A for 115 V or 230 V nominal AC power.

The 1401A can also be powered from an external DC power source. Set the power pack switch to the EXT DC position, then connect a +6 V to +16 V DC source to the banana jacks above the line cord receptacle (observe polarity markings), and switch the front panel POWER switch to ON. The external DC source will not charge the internal battery, and the 1401A will not operate from the internal battery or an AC source if the selector switch is left in EXT DC position. The battery will, however, charge at full charge rate if AC power is applied when the switch is at the EXT DC position.

POWER PACK REPLACEMENT

WARNING

The battery, in the power pack, is capable of delivering enough energy to cause severe burns if it is short circuited by such items as rings or a watch band. Switching the power selector switch to the EXT DC position reduces this hazard by removing battery voltage from most of the exposed terminals. Set the power selector switch to EXT DC position, or remove rings and watch band before handling the power pack.

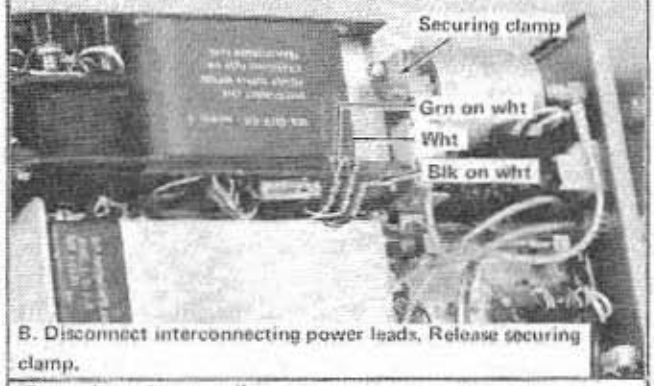
Fig. 2-2 illustrates the procedure required to remove the power pack. Replace the pack by reversing the removal steps. Insure that the wire color code matches that indicated on the terminal mounting.

BATTERY CARE

The power pack uses six sealed NiCd batteries. These cells require little maintenance, have high discharge rate,

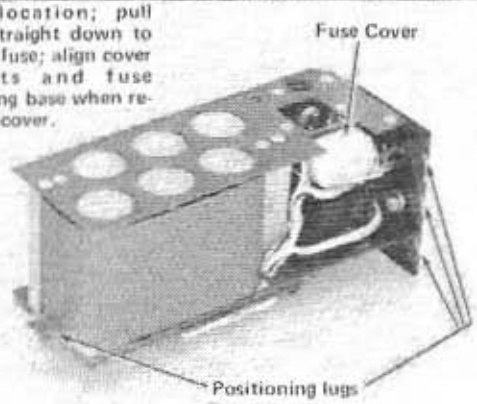
A. Loosen securing screw and pull dust cover off.

Pull power pack back and out of its mounting area. Avoid bumping transformer wires or circuit board against chassis. Observe color code when replacing power unit.



B. Disconnect interconnecting power leads. Release securing clamp.

Fuse location; pull cover straight down to expose fuse; align cover detents and fuse mounting base when replacing cover.



C. Power Pack.

Fig. 2-2. Removing or installing the battery power pack.

accept long term overcharging, and operate over a relatively wide range of temperature. If properly cared for, you can except about 500 to 600 charge/discharge cycles before their capacity drops to about 80% of specified value. Some of the more important battery characteristics are described in the following paragraphs. Battery care information is also provided, to help obtain maximum operating time between recharging cycles.

SELF DISCHARGE is a continuous process, as long as the battery has any charge. The rate of self discharge depends on ambient temperature, state of charge, and impurities in the battery. Self-discharge at 45°C is approximately five times greater than at 20°C. A fully charged NiCd cell may lose 10% to 15% of full capacity during the first 24 hour period. This discharge rate decreases to about 0.68% per day or 10% to 15% per month after the initial discharge. To obtain the maximum operating time, the battery should be fully charged and maintained at this level, by using the TRICKLE CHARGE feature to offset self-discharge until the pack is ready to use.

On FULL CHARGE, the power pack delivers a constant current that is approximately 1/10 the ampere hour rating of the cells in the battery. This charge rate allows the battery to be overcharged without cell damage. CHARGE TIME for the battery is about 14 to 16 hours at the FULL CHARGE rate.

OVERCHARGE is continued charging after the cells have reached full charge. Short periods of overcharging will cause no problems. During the overcharge period, the charge energy is dissipated as heat. If continued for an extended period (over 24 hours), it will dry the electrolyte.

TRICKLE CHARGE maintains the battery or cell at full charge. It will not recharge the cells, because most of the current is used to recover the self-discharge current. Use TRICKLE CHG to maintain the full charge state of the cells.

OPERATING TIME is a function of temperature and charge state. You can expect about 3.5 hours of operation under average conditions. The CHARGE LEVEL indicator on the front panel is an expanded scale voltmeter, with the green sector indicating about 7 1/2 to 6 1/2 volts (full charge to 90% discharge). At about 6 1/2 volts, the voltage starts to decrease rapidly, therefore, after the indicator moves into the red sector, operation should be terminated as soon as possible. This reduces the possibility of any cells becoming reverse charged. Reverse charging occurs when some cells have more charge than others, and overcome the weaker cells.

CHARGE BALANCING consists of charging the cells beyond the period required to bring them up to full charge. This balances the charge of the cells in the battery, and reduces the possibility of any cells reverse charging. Once a month or every 15 charge/discharge cycles, change the charge time to about 24 hours. Any time a cell is replaced, the battery should be overcharged to balance the cells.

Avoid partial charges if possible; however, if only a partial charge is practical, about 30 to 45 minutes of operation can be expected per one hour charge.

STORAGE temperature for the batteries may be between −40°C and +60°C. Cells can be stored either fully charged or partially charged; however, self discharge rate increases with temperature, so a fully charged battery will lose about 50% of its charge at room temperature (70°F) in about three to four months. The battery pack should be recharged, therefore, before it is used, to bring it to full charge.

Additional data regarding maintenance and repair of the power pack and the NiCd cells is furnised in the Maintenance Section.

FUNCTIONS OF CONTROLS, CONNECTORS AND INDICATORS

The following controls and connectors are accessible at the exterior surfaces of the 1401A and are used to operate the instrument (see Fig. 2-3). The names of these controls and connectors, when referred to in the text, are printed in upper case letters so they are easily recognized as belonging to the 1401A. Names of the controls and connectors for associated equipment, such as the companion oscilloscope, are printed using initial capital letters. This format is followed throughout the manual.

Handle	320° rotation. Detents hold the handle in any one of the numerous positions throughout travel arc. Detents automatically unlock in response to rotary pressure on the handle.

Front Panel

POWER	Two position slide switch interrupts or completes power circuit between power pack and 1401A circuitry. Does not affect battery charging circuit.

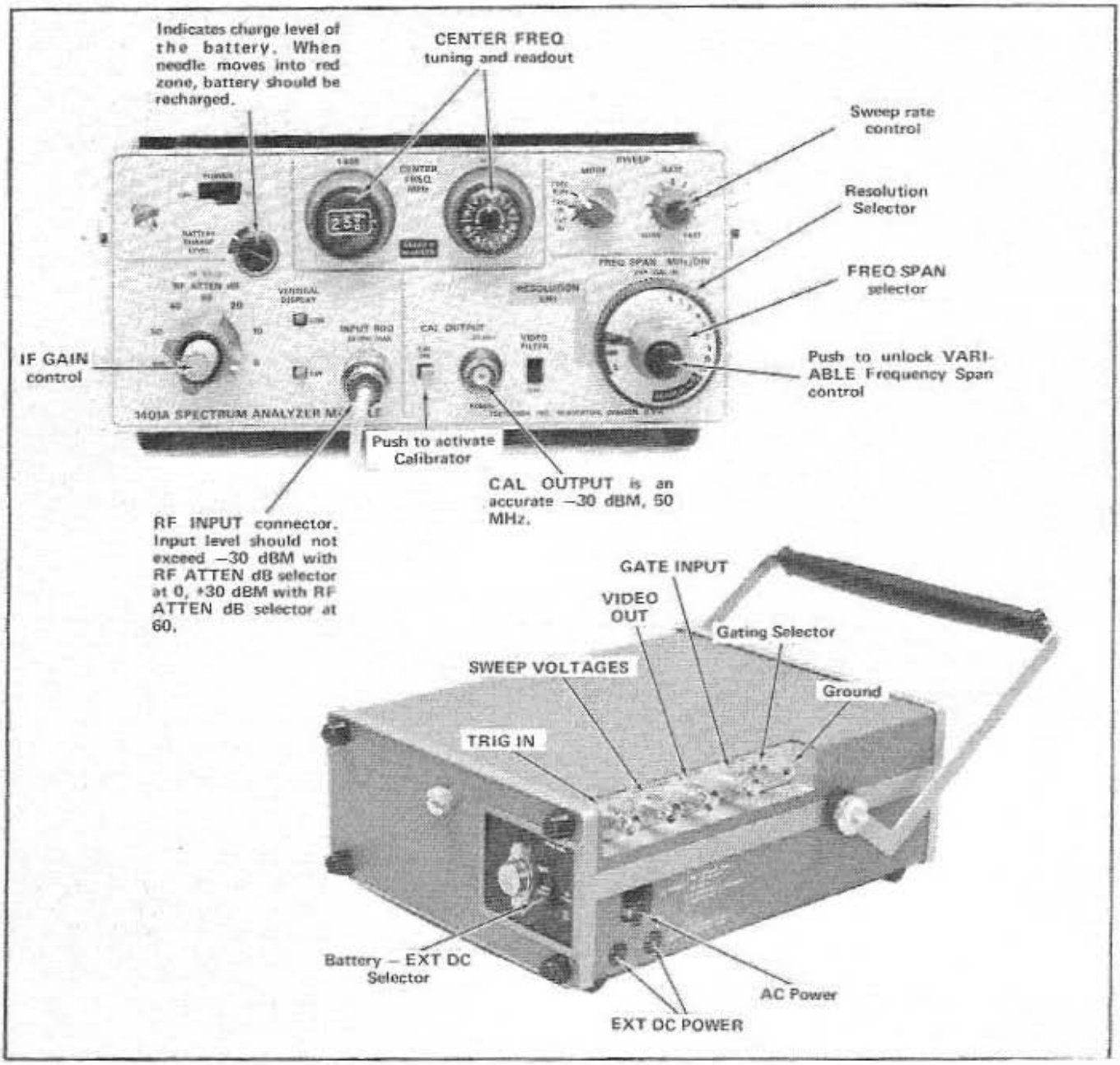


Fig. 2-3. Selectors and connectors on the 1401A.

BATTERY CHARGE LEVEL — An expanded-scale DC voltmeter to monitor battery voltage and charge level. When indicator drops into the red zone, operation should be suspended and the battery recharged. Operation can continue for about 10 minutes after the indicator drops into the red zone; however, operation beyond this time may damage the cells. If the indicator registers in the red zone when an external DC source is used to power the unit, it indicates the source voltage is about +6.5 V or lower.

RF ATTEN dB — Selects amount of signal attenuation between the INPUT connector and the 1st mixer.

IF GAIN — Provides at least 30 dB of variable IF attenuation.

INPUT 50 Ω

RF input connector. Input impedance about 50 Ω. Maximum input signal level, for linear operation, with 0 dB RF ATTEN is −30 dBm. Maximum input signal level with the RF ATTEN at 60 dB is +30 dBm, which is the maximum power rating of the attenuator.

VERTICAL DISPLAY

LIN

When depressed, provides a linear display.

LOG

When depressed, provides logarithmic display 10 dB/div with dynamic range of 60 dB.

CENTER FREQ MHz

1-500 selector is a 10-turn digital type control that selects the center frequency of the display. This center frequency is calibrated to the control readout when the FINE control is at the 0 position. The center frequency is automatically switched to 250 MHz when the FREQ SPAN MHz/DIV selector is switched to the SEARCH position. A search marker appears on the display, which can be positioned by the CENTER FREQ MHz control to that portion of the spectrum which will appear at center screen when the FREQ SPAN is reduced to less than 50 MHz/div.

FINE control is a 10-turn dial type control that provides a fine adjustment of the center frequency. Frequency range of the control is within ±1 MHz of the 1-500 control setting.

SWEEP Controls

MODE Selector

Selects the following sweep modes:

FREE RUN: A free running sweep at a rate determined by the RATE control.

TRIG IN: Enables the sweep to be triggered by a triggering signal applied to the TRIG IN connector (see TRIG IN connector function for trigger-signal limitations).

EXT IN: Enables an external sweep signal that is applied to the SWEEP VOLTAGES connector to sweep the local oscillator. (See SWEEP VOLTAGES connector function for voltage information.)

SWEEP RATE

Varies the internal sweep rate from approximately 1 sweep/second to about 100 sweeps/second.

FREQ SPAN MHz/DIV

Selects frequency width of the display. Calibrated selections are; 50 MHz/DIV to .1 MHz/DIV in a 1, 2, 5 sequence. A 0 Hz position provides time domain information. Accuracy, for a 10 division display, is within 10% of the selection when VARiable control is pushed into the CAL detent.

VAR (CAL IN)

A push-on push-off type control, concentric with FREQ SPAN selector that locks in, when pushed, to provide a calibrated frequency span. When pushed again, the control unlocks and provides a continuous variable frequency span between the FREQ SPAN MHz/DIV selections.

RESOLUTION kHz

Selects 1000 kHz, 100 kHz or 3 kHz resolution bandwidth. Bandwidth selected is within 10% of that specified.

VIDEO FILTER

Switches in an RC filter to reduce noise on the display. Increases the apparent resolution ability of the analyzer by reducing the modulation between two closely spaced (in frequency) signals on the display.

CAL OUTPUT

Provides an accurate 50 MHz signal source when the ON button is depressed. Amplitude level of the fundamental signal is a −30 dBm reference for absolute amplitude measurements.

Side Panel

TRIG IN

BNC connector for applying an external trigger signal. Signal am-

plitude range is +1 V to +10 V, duration at least 100 ns and frequency 1 MHz or less. Used to slave the 1401A sweep to an external device.

SWEEP VOLTAGES — BNC connector that provides a 5 volt sweep ramp whe the SWEEP MODE selector is in FREE RUN or TRIG IN position. When the SWEEP MODE selector is switched to EXT IN position, an external sweep signal must be applied to this connector. A voltage input of 0 V corresponds to 0 frequency, and +5 V corresponds to 500 MHz, when the FREQ SPAN MHz/DIV selector is in the SEARCH position. Maximum input voltage is +10 V and maximum sweep rate is 100 sweeps/s.

VIDEO OUT — This connector provides the analyzer video output signal to the companion oscilloscope. Output level is 1.2 V for full screen deflection.

GATE (ON-OFF) — With the switch in the ON position, and a directly coupled gate signal of −4 V, from a 50 Ω to 100 Ω (nominal) source, applied to the connector; that portion of the spectrum (display) that corresponds to the gate duration and period will be displayed. The remaining part of the spectrum will be blanked out. Switching to the OFF position will complement the action so the gated portion is blanked out and the rest of the spectrum is displayed.

Power Pack Connectors and Switch

AC POWER connector for applying AC power to charge the internal battery and operate the analyzer. Line voltage range is either 90 to 136 V or 180 to 272 V, depending on the internal connections to the power transformer (see instructions for 115 V/230 V operation). Line frequency range is 48 Hz to 440 Hz.

EXT DC POWER connectors (red +, and black −) for applying external DC power source to operate analyzer. Negative (−) connector is connected to analyzer case. The DC voltage input does not charge the internal battery. Reversing the input voltage polarity will blow the power pack fuse. Input voltage range is +6 V to +16 V. Initial surge current, when the instrument is turned on, is approximately 800 mA.

Power Pack Selector

Selects the charge rate for the power pack battery or switches the 1401A to an externally applied DC power source. AC power source will fully charge the battery in 16 hours with the selector at FULL CHARGE position. TRICKLE CHG position will maintain the full charge state. Both positions will also supply the required power to operate the 1401A, as well as charge the battery. EXT DC position disconnects the battery as the power source, and connects the EXT DC connectors to the 1401A power supply so an external DC power source (6 V to 16 V) becomes the supply source.

FIRST TIME OPERATION

This procedure demonstrates the functions of the 1401A controls. It may also be used as an operational check of the instrument operation. If a complete performance check is desired, refer to Section 5, Performance Check.

WARNING

Unless a common ground return is provided between the signal source and the 1401A the case of the 1401A may rise to the signal source potential which can be hazardous. Measurements may also be unreliable. Ground return lead should be disconnected only after all other connections between the 1401A and the signal source have been removed.

The following test equipment is required for this procedure:

A variable output signal source (generator) with a frequency range within the 1 MHz to 500 MHz band, such as Tektronix Constant Amplitude Signal Generator 067-0532-00 or Hewlett-Packard Model 608D.

Pulse generator; pulse repetition frequency within 10 Hz to 1 MHz, output amplitude +1 V to +10 V peak. Tektronix 2101 Pulse Generator.

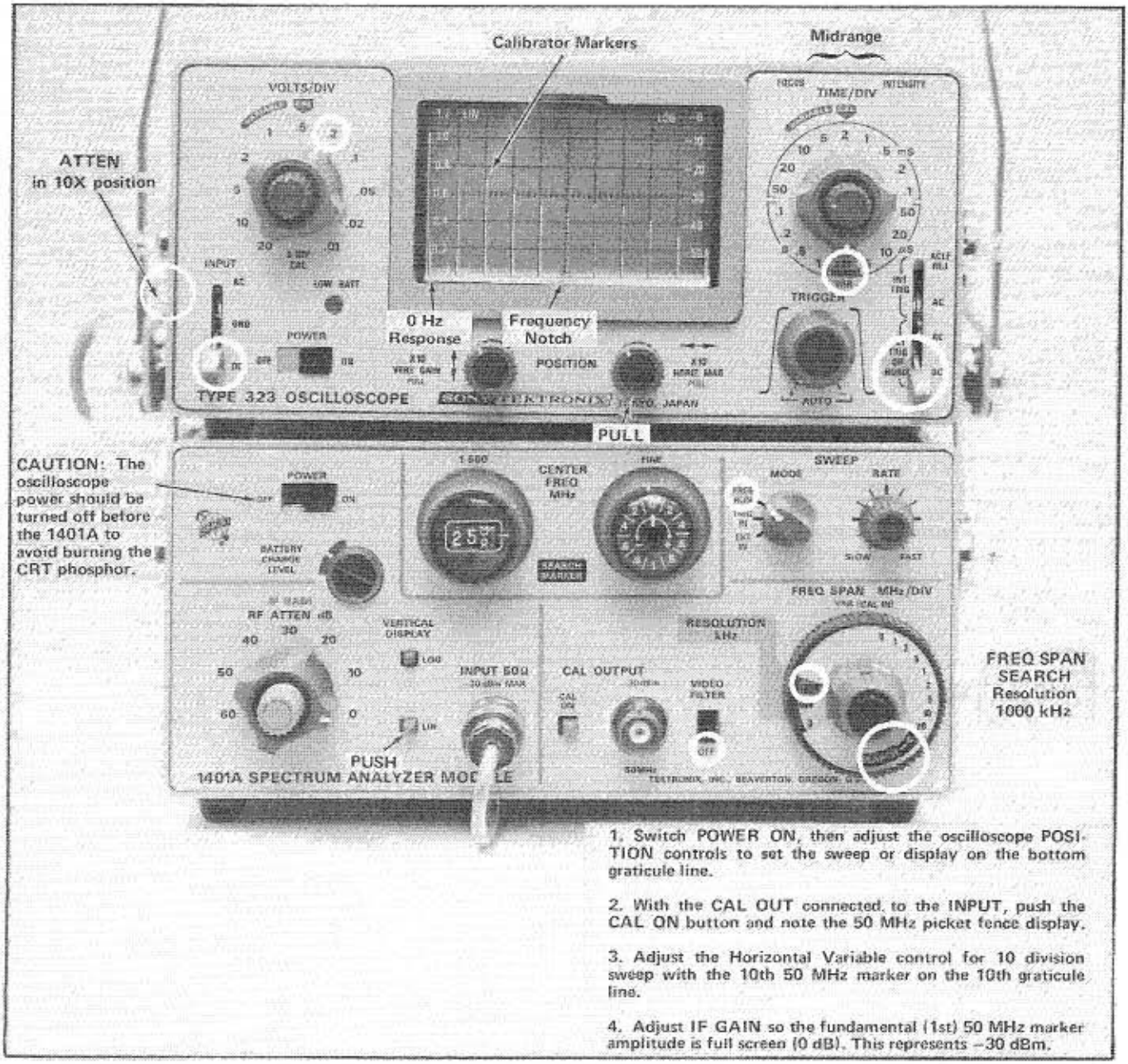


Fig. 2-4A. Front view illustrating control and switch settings.

1. Connect the 1401A to the companion oscilloscope and set the controls of both instruments as illustrated in Fig. 2-4.

2. Check battery charge level as follows:

a. Switch POWER switch to ON.

b. CHECK–BATTERY CHARGE LEVEL indicator. Charge level should indicate in the green sector (see Operating Time, under Battery Care). If battery is low, connect AC source to the power pack and charge the battery to full charge before proceeding with this checkout.

NOTE

Refer to 115 V/230 V AC connector illustration and direction (Fig. 2-1) if power source is 230 V AC.

3. Check Sweep Mode Operation

a. With the SWEEP MODE selector in FREE RUN position, rotate the RATE control through its range.

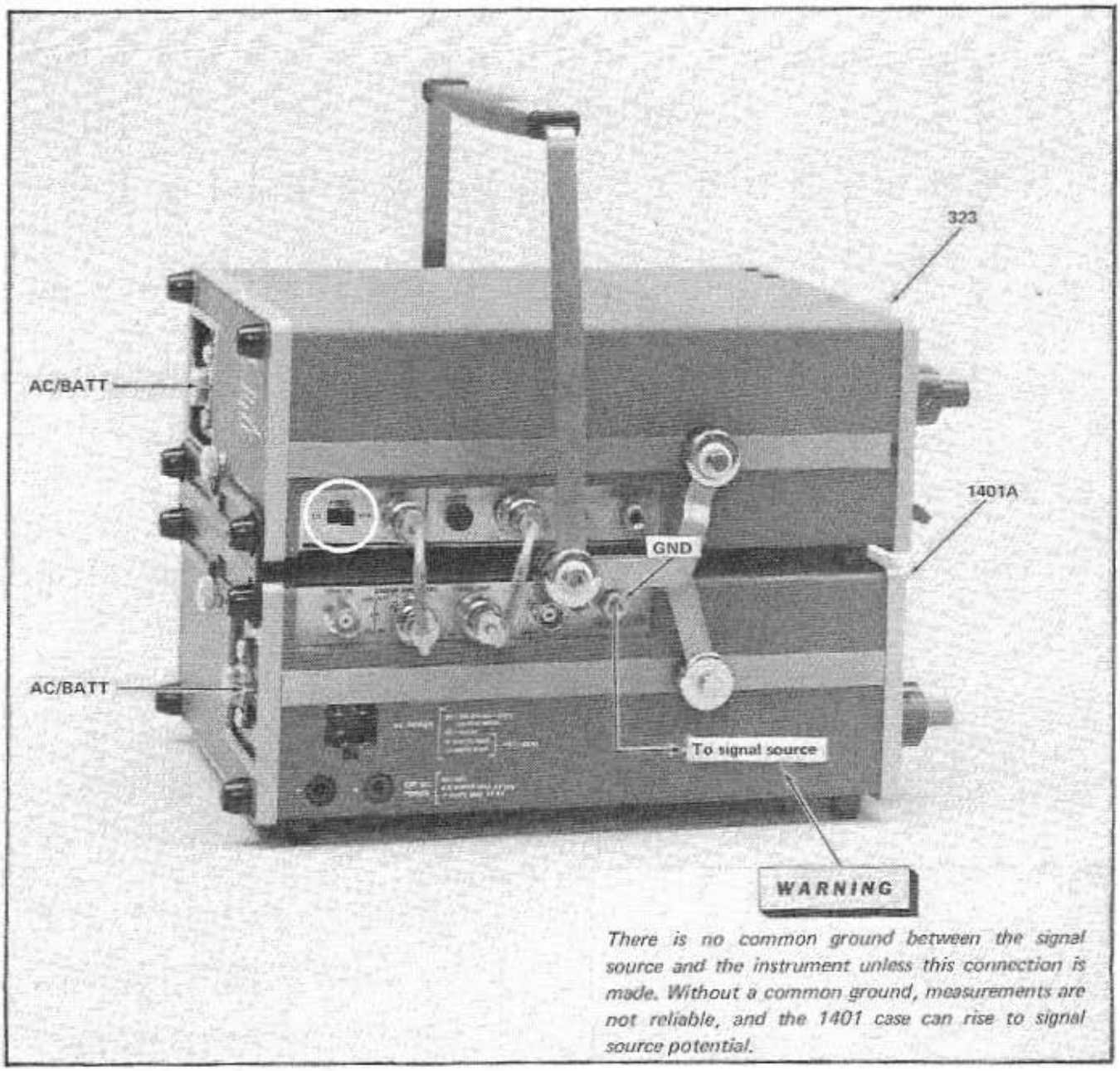


Fig. 2-4B. Side view to illustrate cable interconnections and switch positions.

b. CHECK—The sweep rate should vary from slow to fast (about 1 sweep/second to 100 sweeps/second).

c. Set the RATE control midrange and switch the MODE selector to TRIG IN position.

d. Apply a +1 V to +10 V trigger pulse, with a PRF between 10 Hz and 1 MHz, from a pulse generator to the TRIG IN connector.

e. CHECK—Internal sweep generator should trigger and generate a sweep voltage. (It will count down from the 1 MHz trigger rate.)

f. Remove the external trigger and switch the SWEEP MODE selector back to FREE RUN position.

4. Check Calibrator Operation

a. Using a coaxial cable, apply the output of the Calibrator (CAL OUT) to the INPUT connector. Set the FREQ

SPAN MHz/DIV selector to SEARCH and the CENTER FREQ dial to 250. Set the RF ATTEN dB selector to 0. Depress the LOG display button.

b. Press the Calibrator ON pushbutton and adjust the IF GAIN for a display of approximately 3 divisions. Display should contain a picket fence of 50 MHz markers across the spectrum plus a 0 Hz response at the left edge of the display (see Fig. 2-5).

c. NOTE: The amplitude of the fundamental 50 MHz marker represents an absolute −30 dBm level. You can use the IF GAIN control to set this −30 dBm reference to any graticule line, to measure or compare signals against. Use the same cable for operation as was used to calibrate the output of the Calibrator.

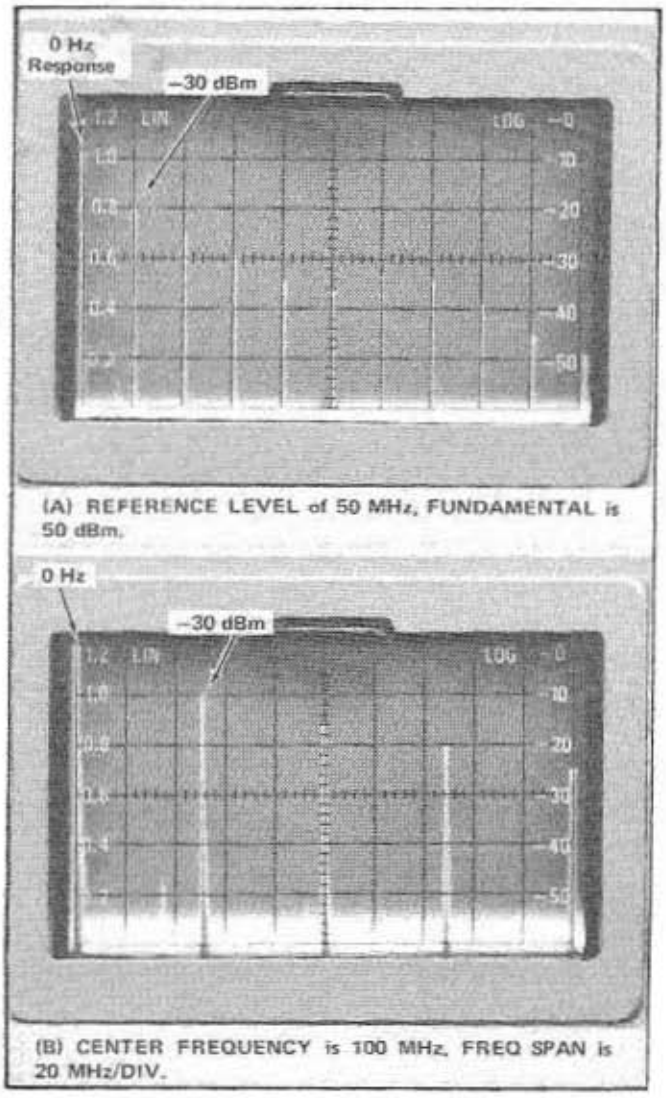


Fig. 2-5. Display of the Calibrator signal showing 0 Hz and 50 MHz picket fence. Frequency span for (A) is 50 MHz/DIV, (B) 20 MHz/DIV.

5. Check and Adjust Frequency Span

a. With the Calibrator output applied to the INPUT of the 1401A, push the CAL ON button and note the picket fence display.

b. With the FREQ SPAN MHz/DIV selector in SEARCH position and the VAR control pushed in (CAL), adjust the Horizontal Position and Gain controls on the companion oscilloscope to position the 500 MHz marker on the 10th graticule line and the 0 Hz signal on the 0 graticule line (see Fig. 2-5). Display should now contain 50 MHz markers at each graticule division.

6. Check Center Frequency Range and Accuracy

a. With the calibrator markers displayed, tune the RF CENTER FREQ MHz towards 000.

b. CHECK—The frequency notch should move towards the left edge of the display and position under the 0 Hz response at a dial reading of 000.

c. Tune the RF CENTER FREQ MHz towards 500. The frequency notch should now move to the right edge and position under the 500 MHz marker (10th harmonic of 50 MHz calibrator signal).

d. Tune the CENTER FREQ to position the frequency notch under the 5th 50 MHz marker. Decrease the FREQ SPAN MHz/DIV setting to 1, keeping the signal centered on screen with the CENTER FREQ MHz controls.

e. CHECK—Center Frequency readout dial should indicate the frequency of the marker (250 MHz) within ±(5 MHz + 5% of the dial readout). FINE control must be in the 0 position.

7. Check Resolution Bandwidth

a. With the calibrator markers displayed, switch the Vertical Display to LIN mode and adjust the IF GAIN control for a marker amplitude of 6 divisions (full screen).

b. CHECK—Bandwidth of the signal, 6 dB down (half amplitude level) should equal about 1 division (1000 kHz ±10%).

c. Increase the resolution by switching the RESOLUTION selector to 100 kHz position, and decrease the FREQ SPAN MHz/DIV setting to .1.

d. CHECK—Resolution bandwidth at 6 dB level should equal about 1 division (100 kHz ±10%).

e. Switch the RESOLUTION to 3 kHz, and decrease the sweep RATE to maximize the signal amplitude.

f. NOTE—The increased resolution. Because of 100 kHz/DIV Freq Span and incidental FM'ing it is not possible to check resolution bandwidth.

g. Return the RESOLUTION selector to 100 kHz position and the FREQ SPAN to SEARCH position.

8. Check RF ATTEN dB Operation and Dynamic Range of LOG Display

a. Apply a signal, within the frequency range of the 1401A, to the INPUT connector. Switch the Vertical Display to LOG mode and set the RF ATTEN dB selector to 0.

b. Tune the CENTER FREQ to the applied signal frequency. Increase the IF GAIN, for optimum gain without displacing the baseline reference of the display, then adjust the signal generator output for a full screen (6 div.) signal amplitude.

c. Increase the RF ATTEN dB selection in 10 dB steps.

d. CHECK—Signal amplitude should decrease, in approximately 1 division steps, as the RF ATTEN dB selection is increased to 60 dB. In the 60 dB position, the signal should still be visible above the noise. (Dynamic range, LOG mode, must equal or exceed 60 dB. Accuracy must equal 10 dB ±2 dB between graticule divisions.)

NOTE

Accuracy of a LOG display depends on VOLTS/DIV calibration. Improve the display by re-adjusting Vertical Cal, or compensating with the Variable control.

e. Return the RF ATTEN dB selector to 0, change the Vertical Display mode to LIN then decrease the signal generator output and the IF GAIN for a full screen display.

9. Check Gating Operation

a. Connect a DC termination (50 Ω to 100 Ω) to the GATE input connector and switch the GATE selector to OFF.

b. Apply a signal to the 1401A INPUT and adjust the GAIN and signal input level for a full screen display.

c. Switch GATE selector to ON position. Signal level should decrease about 50 dB.

GENERAL OPERATING INFORMATION[1]

Signal Application

Connect the signal source to the RF INPUT 50 Ω connector through a 50 Ω coaxial cable with BNC connectors. Unshielded leads or connections, to the RF INPUT connector, may pick-up stray unwanted signals which clutter the display. The input impedance to the analyzer is 50 Ω. Display flatness may be affected because of reflections in the line, if the signal source is other than 50 Ω, or long coaxial cables are used to transport the signal to the RF INPUT. Display flatness can be improved, provided the signal strength is adequate, by increasing the setting of the RF ATTEN or by adding an external 50 Ω attenuator (e.g. 20 dB) at the RF INPUT connector.

Avoid applying high level (above −30 dBm with the RF ATTEN dB selector at 0) signals to the RF INPUT, because they overload the mixer and IF stages, producing spurious signals on the display. Add attenuation, with the RF ATTEN dB selector or if necessary use external attenuators, when signal compression is noticed (no increase in signal amplitude with an increase in input power). Fig. 2-6, a conversion chart, may be used to calculate the input signal level.

CAUTION

+30 dBm is the maximum power rating of the RF ATTENuator. Add external attenuation if necessary to keep the signal input level below +30 dBm.

Spurious responses, due to input signal overload, can be minimized by keeping signal amplitudes within the graticule limits. A recommended procedure is to adjust the IF GAIN control for some baseline noise on the display, then increase the RF ATTEN dB setting until the strongest signals are within the graticule limits.

Resolution and Frequency Span

NOTE

The charging circuit in the battery pack introduces some noise and FM'ing. It is best when operating with narrow frequency spans, to disconnect the 1401A from AC line voltage.

[1] **Tektronix Measurement Concept booklet; "Spectrum Analyzer Measurements", Part No. 062-1070-00, and "Spectrum Analyzer Measurements Theory and Practice", Part No. 062-1334-00, are recommended treatise on applications and measurement evaluation for the 1401A.**

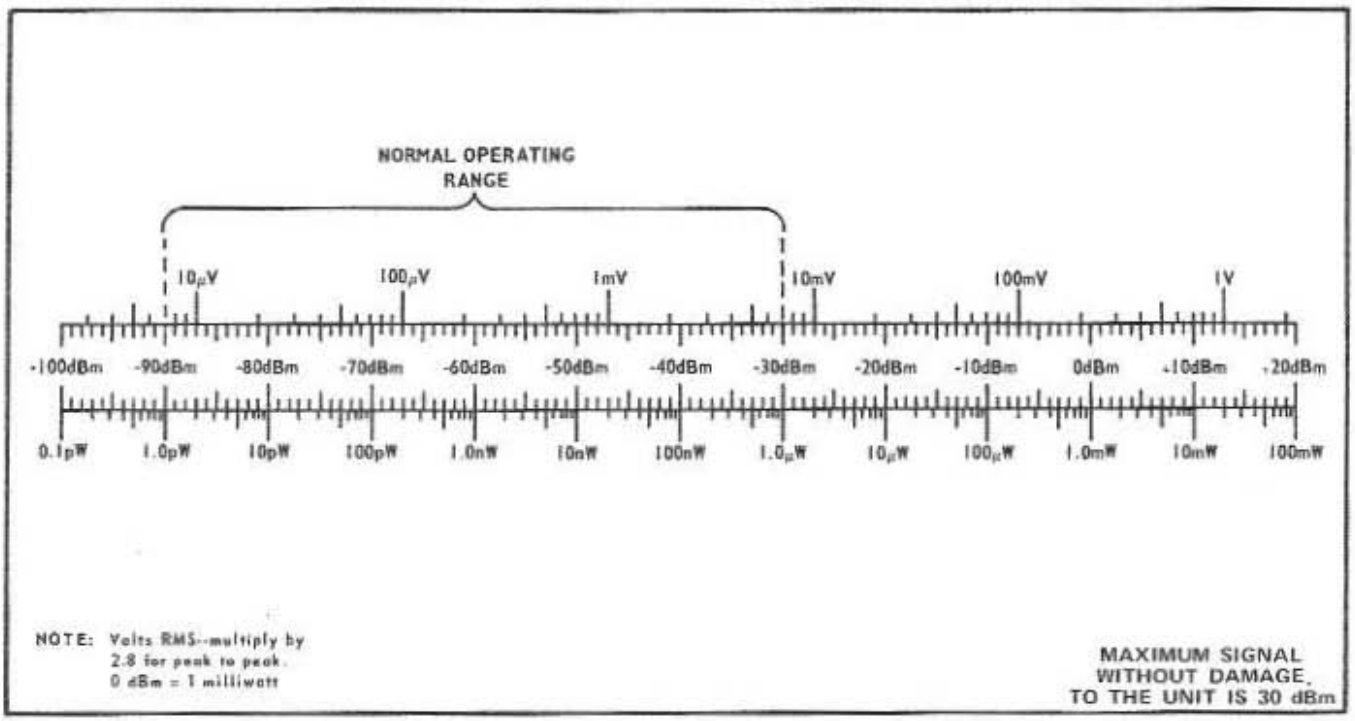


Fig. 2-6. Volts-dBm-Watts conversion chart for 50 Ω impedance.

Resolution is the ability of a spectrum analyzer to discretely display adjacent signals within a frequency span. It is measured, in frequency, as the separation or span between two discrete signals of equal amplitude when the notch or dip between them is 3 dB down. It is a function of analyzer bandwidth, sweep speed, frequency span, and incidental FM.

Resolution bandwidth depends on the most selective amplifier (usually the last IF) stage in the signal patch. It is a measure of the bandwidth at approximately the –6 dB amplitude level (of an amplifier with Gaussian response) when the frequency span and sweep time are adjusted for minimum display bandwidth to a CW signal. Theoretically, resolution and resolution bandwidth become synonymous at very long sweep times.

The resolution capability of a spectrum analyzer not only depends on the resolution bandwidth, but also on incidental FM within the analyzer (usually the local oscillator). Decreasing the resolution bandwidth effectively increases resolution to a point where incidental FM'ing of the signal fills in or overrides the notch between two closely spaced signals. At this point, the analyzer is unable to resolve the signals at or within the resolution bandwidth. The 1401A has a resolution bandwidth of 3 kHz, but at the low frequency end the incidental FM'ing may be as high as 20 kHz. Resolution capability at the low frequency end is, therefore, limited to 20 kHz. The narrow 3 kHz bandwidth provides greater skirt slope to the response, and enhances the resolution capability to the FM limitation.

The following equation illustrates mathematically how frequency span, sweep speed and bandwidth affect the resolution of the analyzer:

$$R = \left[B^2 + 0.195 \left(\frac{\text{Freq Span}}{TB} \right)^2 \right]^{1/2}$$

Where:

R is the apparent resolution bandwidth.

B the actual or measured resolution at very slow sweep speeds.

T is the sweep time across the frequency span. All units are in hertz and seconds.

The effective resolution bandwidth is more than the static bandwidth of the analyzer. For example; a frequency span of 50 MHz, in a time of 1 ms and a measured resolution bandwidth of 100 kHz, when inserted into the equation results in the following effective resolution.

$$\left[(10^5)^2 + 0.195 \left(\frac{5 \times 10^7}{10^{-3} \times 10^5} \right)^2 \right]^{1/2} = 243 \text{ kHz}$$

The best resolution for a given frequency span and sweep time is expressed as:

$$\sqrt{\frac{\text{Frequency Span (in kHz)}}{\text{Sweep Time (in ms)}}}$$

Resolution and Sensitivity

Sensitivity is also affected by the resolution bandwidth and the same variables as resolution. The loss in sensitivity (assuming Gaussian response) due to these factors can be expressed by the following equation:

$$\frac{S}{S_0} = \left[1 + 0.195 \left(\frac{D}{TB^2}\right)^2\right]^{1/4}$$

where S/S_0 is the ratio of the effective sensitivity to the analyzer measured sensitivity, at very slow sweep times or with zero frequency span.

Bandwidth determines both noise level and resolution capability of the analyzer. As the bandwidth decreases, the noise level decreases more than the signal level, so that the signal-to-noise level increases and results in improved sensitivity. Maximum sensitivity, therefore, is obtained at the higher resolution settings.

Using the CAL OUT Signal Reference

The CAL OUT connector is an accurate 50 MHz signal source with a power level of −30 dBm. This signal source is activated when the CAL button is depressed. Connecting this signal source to the INPUT 50 Ω connector supplies a 50 MHz picket fence on the display with the fundamental (50 MHz) signal at an amplitude reference level of −30 dBm. The picket fence of 50 MHz markers can be used to check frequency span and center frequency accuracy and the 50 MHz fundamental signal can be used to establish a reference level on the graticule (see Fig. 2-5).

Using the Calibrator to Measure Absolute Amplitudes of Signals

Since the fundamental 50 MHz Calibrator signal is an accurate −30 dBm reference and the graticule is calibrated in dB (for LOG mode), it is easy to measure absolute amplitude levels (in dBm) of most signals.

NOTE

The amplitude level of an input signal changes with RESOLUTION. Calibrate the display at the RESOLUTION you intend to use.

a. Connect the Calibrator output to the INPUT 50 Ω connector through a coaxial cable. Switch the Vertical Display to LOG mode by depressing the LOG button. Push the Calibrator button and adjust the IF GAIN control to set the fundamental 50 MHz signal to some graticule reference line. This establishes the −30 dBm reference. Do not change the setting of the IF GAIN control once this reference has been set.

NOTE

For maximum accuracy use the cable that is used to calibrate the Calibrator output.

b. Disconnect the Calibrator signal from the INPUT and apply the signal source to the INPUT 50 Ω connector.

c. Measure absolute signal level as the difference in graticule divisions from the −30 dBm reference (graticule calibration is 10 dB/Div ±2 dB).

NOTE

Refer to Fig. 1-2 in Specifications section for correction factor.

d. In some cases it may be necessary to change the setting of the RF ATTEN dB or GAIN selector to bring the signal within the screen height. Add or subtract the change in attenuator setting to the graticule difference reading.

Accurate dB Difference Measurements

This procedure accurately measures the difference level in dB between any two or more signals.

a. Increase deflection sensitivity 4X by setting the oscilloscope deflection factor to 50 mV/Div. Graticule is now calibrated to 2.5 dB/Div.

b. Position the top of the lowest amplitude signal to a reference line within the graticule area with the vertical Position control or the Offset control on some plug-in units.

c. Use the RF ATTEN dB selector to bring the larger of two signals within the graticule window and note the increased attenuation.

d. Measure the signal level from the reference line established for the smaller signal. (Graticule is calibrated to 2.5 dB/Div.) Add the change in RF ATTEN dB reading. This is the difference in dB between the two signals.

Accurate Frequency Measurements

1. With the FREQ SPAN MHz/DIV selector in the 10 position, tune the signal to screen center with the CENTER FREQ 1-500 control. Note the dial reading; for example, 272.

2. Set the CENTER FREQ 1-500 dial to the nearest multiple of 50 MHz; in this case, 250.

3. Remove the signal source from the INPUT and connect the CAL OUT connector to the INPUT through a short coaxial cable.

4. Press the CAL button. Note the correction factor required; for example, 6 MHz.

5. Add or subtract the correction factor to the frequency reading in step 1; (272 ±6, 266 or 278).

Using the Video Filter

The video filter is used to reduce or eliminate noise on the display and, when signals are spaced closely together, the filter will reduce modulation between the two signals. It is also useful to display the envelope of pulsed RF spectra which have a relatively high PRF; however, since the filter is basically an integrating circuit, low PRF signals produce poor results. To adequately resolve pulse spectrum information, the resolution bandwidth should be on the order of 1/10 the side-lobe frequency width, or the reciprocal of the pulse width. The RESOLUTION is usually set after the sweep rate has been adjusted for optimum main lobe detail. Fig. 2-7 and Fig. 2-8 illustrate how the VIDEO FILTER can be used.

Selecting Sweep Rate

The sweep rate for wide resolution bandwidths is usually set above the visual flicker setting. As the FREQ SPAN is increased, the sweep rate will begin to affect resolution and sensitivity; therefore, as the frequency span is increased, sweep rate should also be decreased. With the FREQ SPAN set to 0, the analyzer functions as a fixed tuned receiver and the analyzer displays time domain characteristics of signal modulation, within the bandwidth capabilities of the analyzer. Sweep rate can now be set to examine the modulation pattern. See Fig. 2-9.

Gating the Display with an External Signal

When a signal with an amplitude between −4 V and −10 V peak, from a low impedance source (50 Ω to 100 Ω), is DC coupled to the GATE input connector, it will gate on or off (depending on the switch position) that portion of the display that is coincident with the applied gating signal. The gate, therefore, either blanks out signals within the gate interval, or blanks out all but signals within the gate interval. This allows the operator to examine or analyze discrete segments of a complex signal.

In operations where the gate source is part of the input signal, such as TV composite video analysis, very little delay between gating action and the desired event is permissible. This delay generates some clutter on the display. To minimize delay time, the gating circuit for the 1401A has been located ahead of the resolution circuits. Delay to this point is about 300 ns.

This delay introduces extraneous signals on the display which can be misleading. A pulse equal to the delay time is generated, with its spectrum of frequencies which rides through with the signal to clutter the display. If continuous carrier (CW) information is part of the signal source, the CW will be gated on and off at the same rate as the pulsed information. The resolution circuits will then separate the gated CW signal from the video information and it may appear on the display as pulsed RF with its appropriate side bands. Duration of these side-bands depends on the duration of the gate signal.

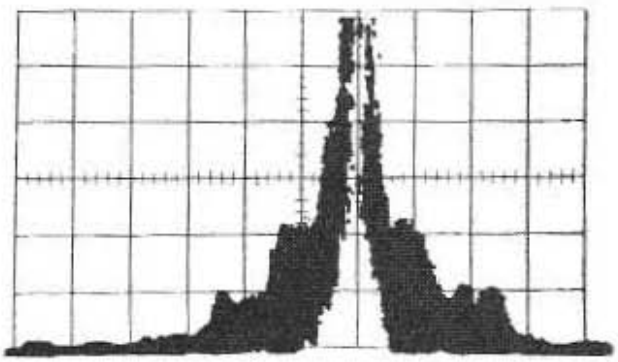
If your gating source has a variable time delay (to about 10 μs), the gating circuit can be moved behind the resolution circuits. This eliminates the above effects. Insert the gate circuit in series with the IF signal at pin connector P370.

The following describes the procedure for gating the display: To blank out all but the gated portion of the display; set the gating switch to the ON position. Apply a DC coupled −4 V to −10 V (from ground) gating signal, from a low impedance (50 Ω to 100 Ω) source, to the GATE connector. Gating signal must be coincident with the portion of the spectrum you desire to observe and must be DC coupled.

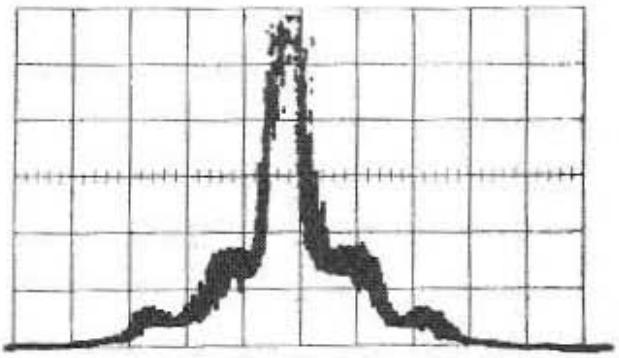
To blank out the gated portion of the display, set the GATE switch to the OFF position and apply the gating signal to the connector. Figure 2-10 illustrates typical operation of the gating circuit.

Triggering the Sweep or Externally Sweeping the 1401A

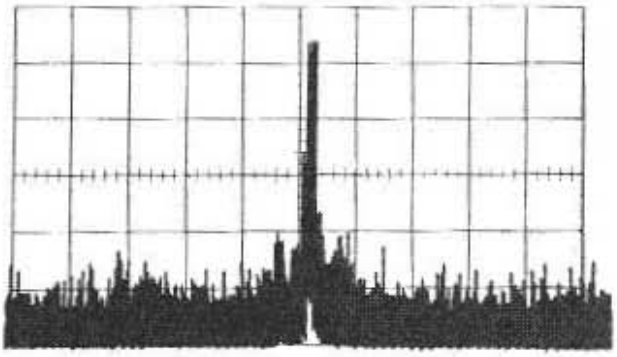
For most applications the SWEEP MODE is set for FREE RUN operation. There may be applications however, where triggered operation may be required, for example; at 0 frequency span, or when slaving the 1401A to a recorder.



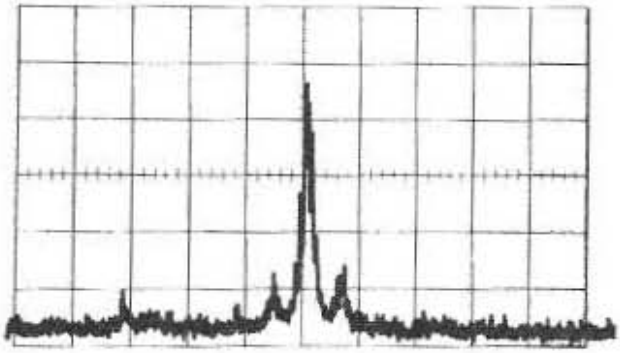
(A) Signal modulated by a 1 kHz signal. VIDEO FILTER OFF. LIN mode.



(B) Same signal as A. VIDEO FILTER ON.



(C) Amplitude modulated signal. Freq. Span uncalibrated approximately 4 kHz/DIV.

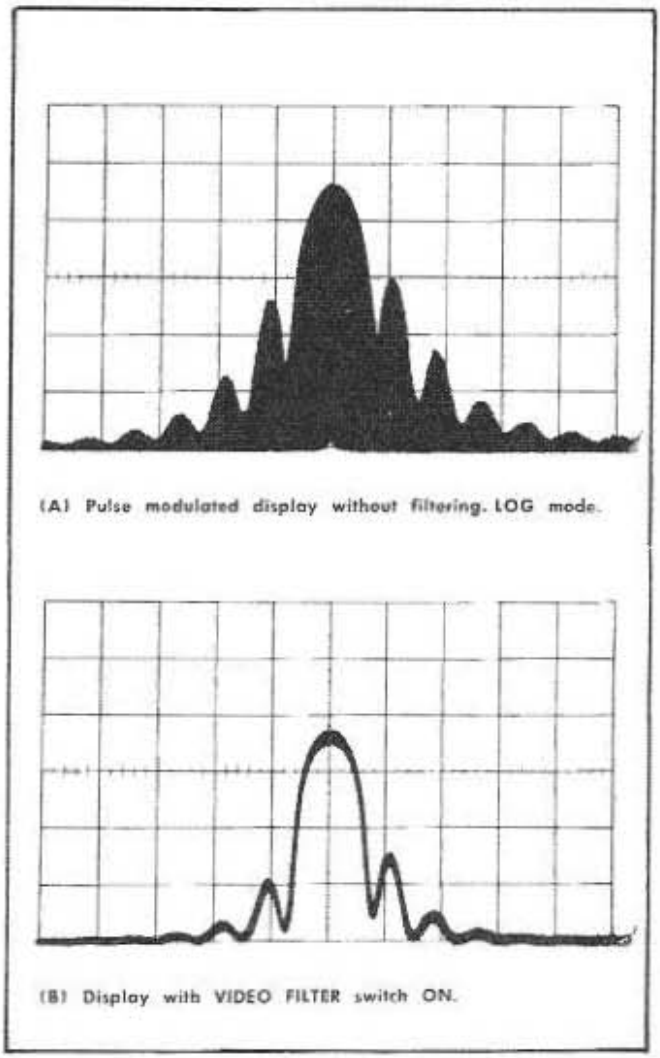


(D) Same signal as C. VIDEO FILTER ON.

Fig. 2-7. Using the VIDEO FILTER to improve the resolution capabilities of the analyzer.

The display can be triggered externally by setting the SWEEP MODE to TRIG IN position and applying a triggering signal, with an amplitude between +1 V and +10 V peak, to the TRIG IN connector. Upper frequency limitation for external trigger is 5 MHz. Pulse duration must equal or exceed 0.1 μs.

The 1401A may be swept externally by switching the SWEEP MODE to EXT IN position, and applying a sweep signal to the SWEEP IN connector. Sweeping the analyzer with a 0 to +5 V signal will sweep the display from 0 Hz to 500 MHz when the FREQ SPAN MHz/DIV is at the SEARCH position. Zero volts input corresponds to 0 Hz, and +5 V corresponds to 500 MHz on the display. A maximum input voltage of +10 V may be applied to the SWEEP IN connector; however, above +5 V the swept oscillator output is not constant, nor the frequency shift linear. Maximum sweep rate is about 100 sweeps/second.



(A) Pulse modulated display without filtering. LOG mode.

(B) Display with VIDEO FILTER switch ON.

Fig. 2-8. Integrating the display with the video filter.

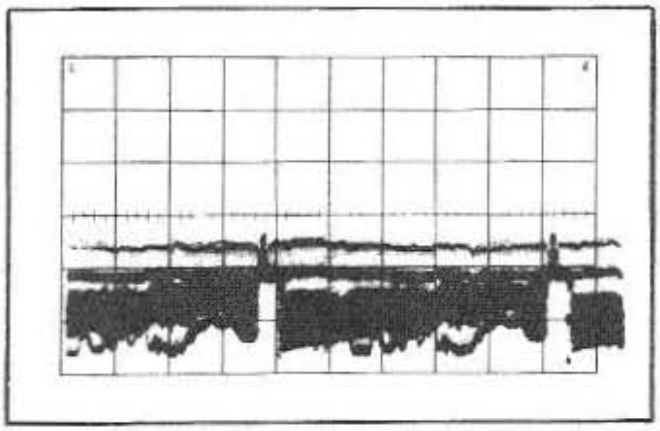


Fig. 2-9. Modulation pattern of a TV video signal.

Sweeping the Companion Oscilloscope

The 1401A 5 V sweep ramp will drive oscilloscopes that have external horizontal sensitivity of 0.5 V/Div (e.g. 323 Oscilloscope). Oscilloscopes with horizontal sensitivity other than 0.5 V/Div require some modification or adapter to make them compatible with the 1401A. The following procedures decribe how the Tektronix Type 422, 453, and 454 portable oscilloscopes can be modified or operated to make them compatible. An alternate procedure is also described which may be used with most oscilloscopes.

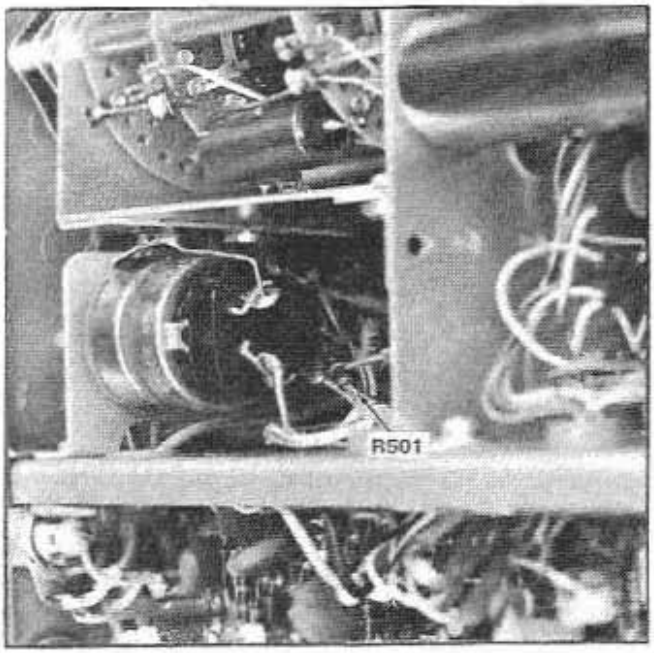
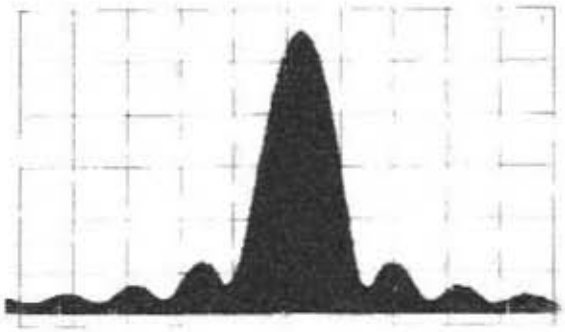


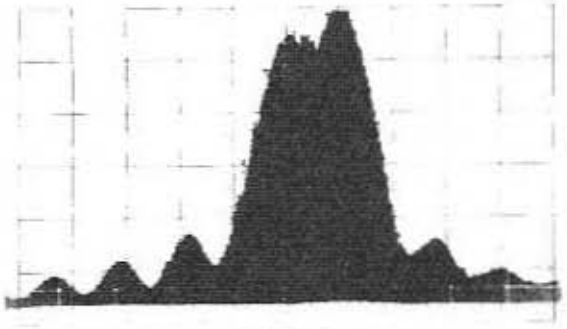
Fig. 2-11. Location of R501 in Type 422 Oscilloscope.

Type 422/1401A Compatibility

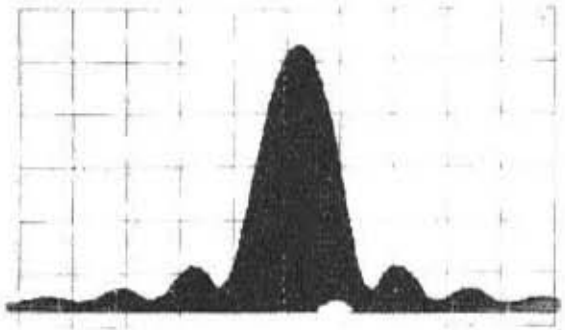
The external horizontal input sensitivity must be increased to make the Type 422 compatible. Change the value of R501 (located on the right side behind the Horiz Atten control, see Fig. 2-11) from 300 k to 120 k. This will provide about 0.4 V/Div horizontal deflection factor with the X10 Mag pulled out.



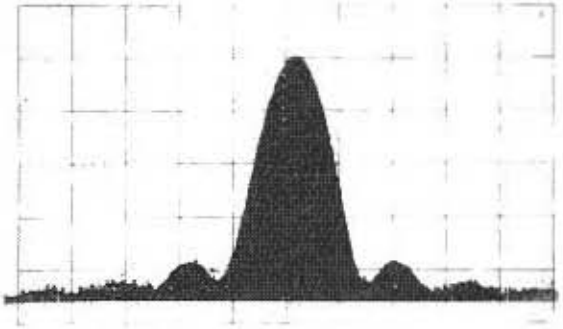
A. Pulsed RF whose basic pulse is used for gating signal. GATE not connected.



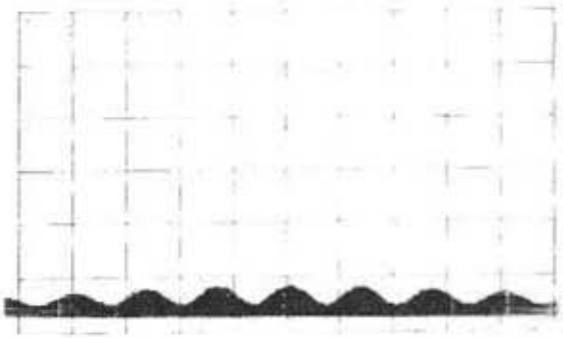
D. Composite of two pulsed RF signals.



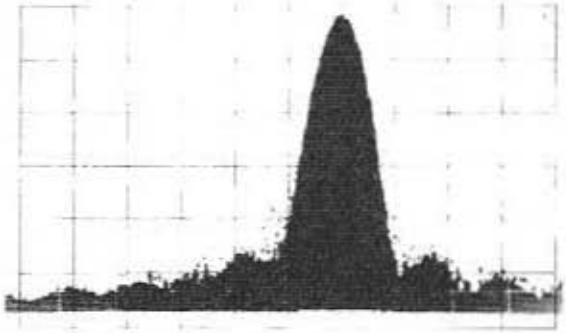
B. GATE connected, selector switch ON.



E. GATE selector ON, gating signal of the composite signal displayed.



C. GATE connected, selector OFF. Side band signals are due to delay between signal source and gating pulse.



F. GATE selector OFF, gating signal attenuated and second signal displayed.

Fig. 2-10. Typical operation of gating function: FREQ SPAN 0.2 MHz/DIV, RESOLUTION 100 kHz, LIN mode.

Type 453/1401A and Type 454/1401A Compatibility

Use the X-Y mode. Apply the 1401A SWEEP voltage to the X Input (Ch 1) and the VIDEO OUT to the Y (Ch 2) Input. Set the oscilloscope controls as follows:

Trigger	Ch 1 Only
Vertical Mode	Ch 2
Input Selector (Ch 1 & Ch 2)	DC
Volts/Div	
Ch 1	.5
Ch 2	.2
Horiz Display	Ext Horiz or X-Y
B Trigger Source	Ch 1
Coupling	DC or AC
Intensity	3/4 range

Set the 1401A FREQ SPAN MHz/DIV selector to SEARCH position and the CENTER FREQ MHz readout to 500. Apply 50 MHz Calibrator signal to the 1401A INPUT then adjust the oscilloscope External Horizontal Gain R645, on the Type 453 (Fig. 2-12) or the X Gain on the right side of the Type 454 for a calibrated sweep length. (0 response at the zero division line and 500 MHz or the frequency notch under the 10th division line.)

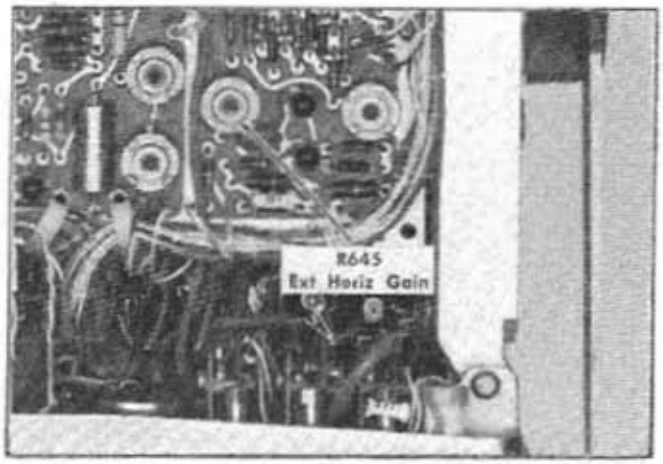


Fig. 2-12. Location of Ext Horiz Gain (R645) in Type 453 Oscilloscope.

Alternative Procedure for Most Oscilloscopes

The negative slope of the blanking pulse that is riding on the VIDEO OUT signal can be used to trigger the oscilloscope sweep. Sweep rate can then by synchronized by using the 1401A SWEEP RATE control to lock the sweeps. For example: Set the 1401A FREQ SPAN MHz/DIV to SEARCH and the CENTER FREQ MHz 1-500 dial to 500. Set the oscilloscope Time/Div to 1 ms. Adjust the 1401A SWEEP RATE for a display span of 10 divisions, or a calibrated sweep length as described above.

NOTES

SECTION 3
CIRCUIT DESCRIPTION

Change information, if any, affecting this section will be found at the rear of the manual.

This section describes circuits used in the 1401A Spectrum Analyzer Module. A block diagram analysis is first presented, to provide an overall concept of the major circuit functions and their relationship to each other. This is followed by more detailed description of the circuits. The objective of this section is to provide enough circuit operation description so the reader can effectively operate, calibrate, and troubleshoot the instrument.

Block diagrams and simplified circuit schematics accompany this description. Detailed drawings are provided in the Diagrams section of the manual. Positive logic is used to describe IC operation.

BLOCK DIAGRAM DESCRIPTION

Fig. 3-1 illustrates the basic function of each major circuit in the 1401A, and provides a signal flow sequence for continuity. A more detailed block diagram is provided in the Diagrams section. The following description refers to both diagrams.

The front end or RF section of the 1401A contains an RF attenuator, low pass filter, wide band mixer, swept local oscillator, bandpass filters, and a second local oscillator and mixer. Frequencies of 500 MHz and below pass through the RF attenuator and low pass filter to the wide band mixer. Frequencies above 500 MHz are attenuated or cut off by the low pass filter.

These signals, within the 500 MHz span, are converted to 695 MHz IF by heterodyning them with the output of a swept frequency oscillator. For the full frequency span of 500 MHz (SEARCH mode), the first local oscillator is swept from 695 MHz to 1195 MHz. The FREQ SPAN selector determines the amplitude of the sweep control voltage to the swept oscillator. This voltage controls the dispersion of the oscillator and the span of frequencies within the 500 MHz spectrum that are converted in the wide band mixer to 695 MHz. The center frequency of the spectrum, when the FREQ SPAN selector is in SEARCH position, is 250 MHz. The center frequency of the display for the other positions of the FREQ SPAN selector is controlled by the CENTER FREQ controls. These controls establish the center point of the sweep voltage to the swept oscillator. This average voltage at the sweep ramp center is a voltage within the 695 MHz to 1195 MHz range of the local oscillator. As the FREQ SPAN MHz/DIV selection is decreased towards 0 dispersion, the sweep voltage to the oscillator circuit decreases so the oscillator swept output approaches the center frequency set by the CENTER FREQ controls. This permits all or any sector of the 1 MHz to 500 MHz spectrum to be displayed. Since the local oscillator sweeps down to 695 MHz, frequencies below 1 MHz (including a 0 Hz marker) may appear on the display; however, this span is very non-linear, so it has no practical significance or application.

Bandwidth of the 695 MHz IF is set by a relatively narrow bandpass filter. It is then heterodyned, in a second mixer, with 720 MHz and converted to 25 MHz IF. The 25 MHz IF is amplified by IF amplifier circuits with gain-controlled stages, then converted a third time to 5 MHz in the third mixer. Bandwidth of the 25 MHz IF is 1 MHz.

A gating circuit in series with the 25 MHz IF is activated by a −4 V to −10 V gate pulse which either gates the IF through or blocks the IF during the pulse interval. This allows the user to blank out a portion of the spectrum, permitting easier analysis of the desired portion.

The 5 MHz IF, with 1 MHz bandwidth, is applied directly (for 1000 kHz resolution bandwidth) or indirectly through resolution bandpass filters (for 100 kHz and 3 kHz bandwidths), to either a linear amplifier stage or a logarithmic amplifier. Dynamic range for the logarithmic amplifier is 60 dB or more (in 10 dB steps). The 100 kHz and 3 kHz resolution bandpass filters are connected in series, by the RESOLUTION selector, for the 3 kHz resolution.

The 5 MHz IF output from the linear amplifier or the logarithmic amplifier is detected and applied, through a video emitter follower stage, to the VIDEO OUT connector. Video signal, with full range amplitude to at least 1.2 volts peak, is then connected through an interconnecting cable to the Vertical Input of a companion oscilloscope. The vertical deflection factor of the oscilloscope is adjusted so 1.2 volts of video signal provides full screen signal deflection.

Control circuits for the 1401A consist of a trigger generator and amplifier, sweep gate generator, frequency span or

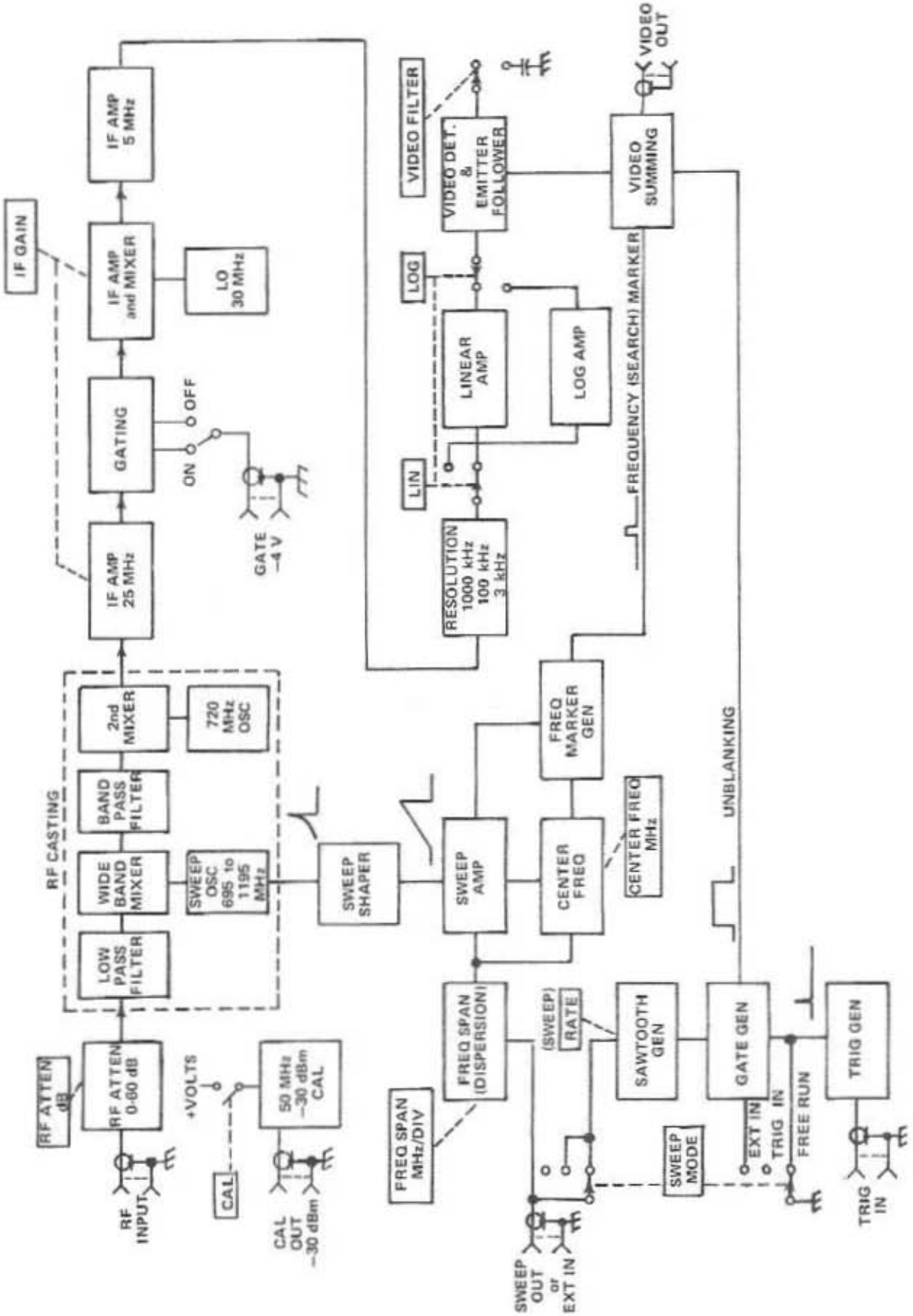


Fig. 3-1. Functional block diagram of the 1401A.

dispersion selection, sweep shaper, and a center frequency search marker generator. The trigger generator and amplifier, plus the sweep gate generator, control the internal sweep generator. The TRIG IN Sweep Mode requires an external trigger signal (+1 V to +10 V peak, with duration of at least 100 ns) applied to the TRIG IN connector to start the sweep generator. This external trigger signal activates an internal trigger generator, which produces a trigger signal that is amplified and used to turn-on the sweep gate generator. The output of the sweep gate generator gates the sweep ramp generator, and initiates the sweep voltage output.

The source of the sweep voltage can be either external or internal. If an external voltage with an amplitude to 5 volts is applied to the SWEEP EXT IN connector, it will sweep the oscillator when the SWEEP MODE switch is in EXT IN position. The internal sweep generator output becomes the sweep source when the SWEEP MODE is switched to TRIG IN or FREE RUN positions.

The sweep voltage (external or internal) is attenuated a calibrated amount by the frequency span or dispersion circuit, then centered about a reference voltage that is set by the Center Frequency controls. In the SEARCH mode, the sweep voltage (0 V to 5 V) is not attenuated, so maximum frequency span is provided. It is also centered about 0 V so it becomes a voltage ramp from −2.5 V to +2.5 V that will sweep the local oscillator from 695 MHz to 1195 MHz.

Because the frequency of the local oscillator is not a linear function of input control voltage, the sweep voltage for the local oscillator must be shaped by shaper circuits so the frequency scan of the oscillator is a linear transition with the horizontal beam deflection. This circuit shapes the sweep voltage for the oscillator, so it approaches an exponential curve; however, the sweep voltage for the horizontal deflection circuit remains linear and the display approaches a linear frequency span.

In the SEARCH mode, a marker is generated by the Center Frequency marker generator, to indicate on the display the relative position of the CENTER FREQ controls. This enables the operator to position the marker under any sector or signal within the 500 MHz search span and read the frequency; or, he can switch down to a narrow frequency span for analysis of any chosen sector. This search marker appears as a notch in the base of the display.

A blanking pulse, generated by the sweep generator, is applied to the Video Output during retrace time. This pulse displaces the trace out of the graticule area during the retrace time.

A 50 MHz crystal-controlled oscillator provides an accurate 50 MHz signal with a calibrated amplitude. When the calibrator output is connected to the INPUT 50 Ω connector and the CAL switch closed, a 50 MHz picket fence is displayed, with the amplitude of the fundamental providing −30 dBm power reference.

The power supply for the 1401A consists of a power pack or external DC source that delivers a DC voltage to a DC-to-pulsed AC converter. The pulse output of the converter is transformer-coupled to four regulated power supplies which furnish +3.6 V, +10 V, −10 V, and −50 V to the 1401A circuits. Internal batteries (in the power pack), external DC, or AC power operation can be selected at the power pack. For AC operation, the power pack rectifies the AC voltage to supply current for the battery-charging circuit and the DC to AC converter. External DC operation applies an external DC source directly to the converter, bypassing the power pack circuits. Voltage range for an external DC source is limited to +6 V to +16 V. The converter also pre-regulates the pulse duration into the transformer, so the power input to the transformer is maintained at a constant value over the +6 V to +16 V range.

DETAILED CIRCUIT DESCRIPTION

RF Section

The RF section receives any frequency within the 1 MHz to 500 MHz spectrum and converts signals within this spectrum to 25 MHz IF, for the IF amplifier circuits. The RF circuits consist of an RF input attenuator, a 500 MHz low pass filter, a 695 MHz to 1195 MHz swept frequency oscillator, a wide band mixer, bandpass filter, 695 MHz filter, and 695 MHz to 25 MHz converter.

The RF attenuator is a turret-type attenuator with a range of 60 dB in 10 dB steps. Characteristic input impedance to the attenuator is 50 Ω. The output of the attenuator connects into a low pass filter made up of a series of inductors distributed on one side of a printed circuit board, with shunt capacitance to a ground plane on the back side of the circuit board.

The first mixer is a broad-band double balanced Star[1] mixer which combines a hybrid junction with a four-diode star. Theoretically, two input signals are required to produce an output from this mixer. This output is the two sideband frequencies. The output of the mixer is tuned to 695 MHz by two bandpass filters. Conversion loss through the wide-band mixer is about 8 dB.

[1] Mouw, R.B., "A Broadband Hybrid Junction and Application to the Star Modulator", IEEE Transactions on Microwave Theory and Techniques, Vol. 16, No. 11, November 1968.

The 695 MHz filter is a comb-line type filter[2]. Because it also passes higher order passbands of its fundamental, a second bandpass filter (consisting of L153, L151, and C152) is used in series with the 695 MHz filter to improve the out-of-band rejection characteristics of the filters.

The second converter consists of a 720 MHz oscillator and mixer section. The resonant circuits for the oscillator and mixer are tuned transmission line resonators. C187 adjusts the oscillator frequency to 720 MHz; C177 (part of an idler circuit) is adjusted for best conversion or maximum power output. R385 is a mixer bias adjustment for diode CR167. It is also adjusted for maximum output or conversion efficiency. C171, across L171, tunes the idler tank circuit to 745 MHz to recover the image signal (695 MHz + 25 MHz) energy.

There is some interaction of adjustments; therefore, after an adjustment has been made, the oscillator frequency adjustment, C187, should be checked to bring the oscillator frequency back to 720 MHz. All adjustments in the mixer section are set for maximum output.

The sweep local oscillator consists of variable tuned oscillator Q113, isolation amplifier stage Q115, and a constant current source Q106 for the oscillator. The oscillator frequency is controlled by variable capacitance diodes CR112 and CR113 in series with C112. A negative-going sweep voltage, from the sweep generator circuit, is applied to the anodes of the two diodes. This negative-going voltage increases the diode back bias and decreases the capacitance of the diodes. Decreasing the diode capacitance increases the oscillator frequency.

The sweep voltage to the junction of the two diodes runs from 0 V to about −45 V amplitude, for the full frequency span (SEARCH position of the FREQ SPAN selector), toward an amplitude of approximately 5 mV as the FREQ SPAN MHz/DIV selector is decreased to 10 kHz/DIV setting. At the 0 Hz position, the input sweep signal to the diodes becomes a constant DC level and the oscillator frequency output becomes constant. For all FREQ SPAN selections other than SEARCH, the sweep voltage is centered about some DC average set by the CENTER FREQ controls.

As previously described, the sweep voltage to the diode junction is shaped by the sweep shaper circuits, so it will produce a linear frequency change with the linear movement of the sweep deflection voltage on the CRT. A lower amplitude negative-going sweep voltage (about −2 V to −7 V) is applied as bias to the base of transistor oscillator Q113. This increasing bias voltage to the base-collector junction, as the frequency increases, stabilizes the oscillator power output. This bias voltage is a linear ramp riding on a DC bias voltage that can be adjusted with the Sweep Linearity adjustment R850 (Sweep Shaper Circuit) to compensate for non-linearity near the zero frequency end of the display.

[2]Tektronix Circuit Concepts, "Spectrum Analyzer Circuits", Morris Engelson, Part No. 062-1055-00.

50 MHz Calibrator

The 50 MHz Calibrator is a crystal controlled oscillator. The oscillator is a multivibrator with the crystal (Y913) in series with the feedback loop. The output of the oscillator is set by adjusting the oscillator current with R905, so the output signal equals −30 dBm. Operating voltages are supplied only when S55 is closed, to conserve battery power. The output impedance is changed to 75 Ω by moving jumper wires from R923-R928 to R924-R929.

IF Circuit

This portion of the circuitry contains two 25 MHz IF amplifier stages, a 1 MHz bandpass filter, 30 MHz oscillator and third mixer stage, and a 5 MHz IF amplifier stage. The IF (25 MHz) from the RF module is coupled through T210 to one gate of dual gate MOSFET Q208. The second gate of Q208 connects to the collector of Q204. Gain of the dual gate MOSFET is a function of channel conductivity, which can be controlled by varying the bias on one of the dual gates. Q204 controls the gain of the stage by setting the bias for one gate of MOSFET Q208.

Transistor Q204, plus Q232 and Q271, distribute the overall gain of the IF circuit. As the GAIN control is increased (rotated towards −10 volts) U260 cuts in first, then U240, and finally Q208 to distribute the gain progressively through the IF amplifier stages.

The 1 MHz bandpass filter consists of four tuned sections coupled together by C222, C224, and C226. The degree of coupling (adjusted with C224) and the resonant frequency of each section shapes the response characteristic of the filter. The filter is tuned for a flat top response with a bandpass of 1 MHz and an off-band attenuation rate of approximately 6 dB per octave per resonant circuit for a total of about 24 dB. This provides a relatively steep skirt slope for good image rejection of the intermediate frequency.

The second stage of the 25 MHz IF consists of integrated-circuit IF amplifier U240 with its input and output tuned to 25 MHz by transformers T240 and T248. Gain of this amplifier stage is controlled, through Q232, by the IF GAIN control as previously described. Current through Q232 sets the voltage at the junction of R234 and R236, which sets the gain control voltage at pin 5 of U240.

25 MHz is converted down to 5 MHz IF by mixing the 25 MHz IF output from T248 with 30 MHz in the 3rd mixer stage, Q258. Q252 and its associated circuitry comprise the 30 MHz oscillator. T252 is the frequency determining component, adjusted to 30 MHz. The 30 MHz output of the oscillator, applied to one gate of dual gate MOSFET Q258, modulates the 25 MHz IF that is applied to the second gate of Q258. The 5 MHz difference frequency is coupled through tuned transformer T258 to amplifier U260.

Gain for the 5 MHz IF is controlled through Q271 in the same way as the gain of U240 is controlled. Bandpass of the 5 MHz IF is the same as the 25 MHz IF bandpass determined by the 1 MHz bandpass filter.

Three resolution bandwidths are selected by RESOLUTION switch S515, which connects the 5 MHz IF output from T260 either directly (for 1000 kHz resolution) or indirectly through bandpass filters (100 kHz and/or 3 kHz) to the base of amplifier Q370.

For 1000 kHz resolution, the 5 MHz IF output of T268 is connected through cam switches 2 and 4 (Power Supply Diagram) directly to the base of Q370 (Log/Linear Circuit Diagram). Switching the RESOLUTION selector to 100 kHz position opens cams 2 and 4 and closes 3 and 1, to apply the 5 MHz IF to the input of a 100 kHz bandpass filter. The output of this filter is amplified by Q294 and applied through cam switches 11, 9, 7, and 6 to the base of Q370. When the RESOLUTION selector is changed to the 3 kHz position, cam switches 1, 3, 5, 8, 10, and 11 close and add the 3 kHz crystal filter in series with the 100 kHz filter.

The 100 kHz filter, like the 1 MHz filter, consists of four tuned sections coupled together by C280, C282, C284, and C286. Each section of the filter is adjusted for best bandpass response. There is about 10 dB loss through this filter so the output from the filter is amplified by wide-band amplifier Q294 to compensate for this 10 dB signal loss. This produces a relatively constant signal amplitude on the display for the three RESOLUTION selector positions.

Gating Circuit

The gating circuit is a diode bridge (with switching circuitry) in series with the 25 MHz IF signal path and is located between the output of Q208 and the 1 MHz Filter. When activated by an externally applied gating signal, the circuit either gates through or blocks the 25 MHz IF to the 1 MHz Filter.

With Gate selector switch S50 in the OFF position and a −4 V gating pulse applied to the GATE (J50) connector, Q954 switches off and Q944 turns on. This action back-biases coupling diodes CR948, CR949 and forward biases shunting diodes CR946 and CR947 so the gating circuit is closed to the IF signal during the gate pulse period.

When a direct coupled gate signal source is connected to the GATE connector and the selector switch S50 is in the ON position, the DC coupled low impedance source of the gate signal pulls the base of Q944 up towards ground potential, which switches Q944 on and Q954 off. During absence of the gate signal the gate is therefore closed and no IF signal gets through. The negative going −4 V gate signal then switches Q944 off and Q954 on, which opens the gate and allows IF signal to couple through to the 1 MHz Filter.

C948 and C949 are adjusted for optimum circuit balance.

In applications where the gate signal source delay time is variable, the gate circuit can be moved so it is after the resolution circuits. Disconnect the gating circuit from P208 and connect it into P370.

Logarithmic Amplifier, Linear Amplifier and Video Detector Circuits

The logarithmic amplifier extends the displayed dynamic range of the 1401A to at least 60 dB. Five stages of amplification, with at least 12 dB dynamic range per stage, are connected in cascade to provide this 60 dB range. Each of the five stages is connected as an operational amplifier with its input resistance (R_i) a function of signal level. Input resistance increases as the signal level increases, which reduces the gain of the stage. A simplified diagram in Fig. 3-2 illustrates the basic operation of each amplifier.

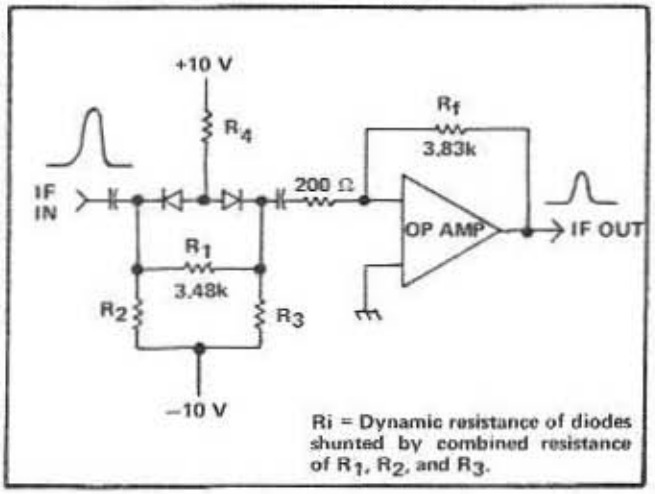


Fig. 3-2. Simplified diagram of one stage of amplification in the logarithmic amplifier.

Two diodes, connected back-to-back and shunted by a 3.48 kΩ resistor, are pre-biased by a voltage divider network between −10 V and +10 V supplies, so the dynamic resistance of the diodes in combination with the 3.48 kΩ shunt resistor and the 200 Ω series resistor, provide an input resistance (R_i) to the operational amplifier of about 960 Ω. Gain of the amplifier, under low level input signal conditions, is therefore about 4(R_f/R_i or 3.83/0.96). As the signal level increases, the back-bias on the diodes increases, and the diodes cut off. This increases the input resistance (R_i) to about 3.8 kΩ and decreases the gain of the stage to about one or unity. The gain of the log amplifier decreases in about 12 dB steps, starting with the last stage, as the input signal level increases. This produces an output that is close to the logarithmic function of the input signal amplitude.

Depressing the LIN pushbutton on the VERTICAL DISPLAY switch applies the 5 MHz IF output from Q370 to a linear amplifier consisting of Q56 and Q62. Gain of this amplifier is set by R55 so the displayed amplitude of a given signal in LIN mode equals the amplitude of a three-quarter screen signal in LOG mode. This amplitude is about 10 dB down.

The video detector consists of diodes CR81 and CR82 connected as a voltage doubler to provide greater efficiency. Detected video is applied, through emitter follower Q84, to the emitter of video output amplifier Q76. In SEARCH mode, the positive-going notch from the frequency marker generator is applied to the base of Q76 and modulates the video. A positive blanking pulse, during retrace time, is applied along with the video signal to the emitter of Q76. This pulse shifts the display off screen during retrace time.

Sweep Generator

The sweep generator provides a 0 to 5 volt sawtooth voltage to drive the sweep oscillator in the 1401A and the horizontal sweep circuits in the companion oscilloscope. The sweep generator circuit also provides a blanking pulse to drive the video amplifier into cutoff, which shifts the display off screen during retrace time.

Three modes of operation are provided; FREE RUN, TRIG IN, and EXT IN. Sweep rate of the free run and external trigger mode is continuously variable from approximately 100 sweeps/second to 1 sweep/second.

The sweep generator circuit contains two "QUAD" two-input NOR gate IC's controlling or gating a Miller runup and delay pick-off IC. A functional logic diagram is illustrated in Fig. 3-3 and a timing diagram is shown in Fig. 3-5. When input (pin 1) of U520 is high (gated on), the IC

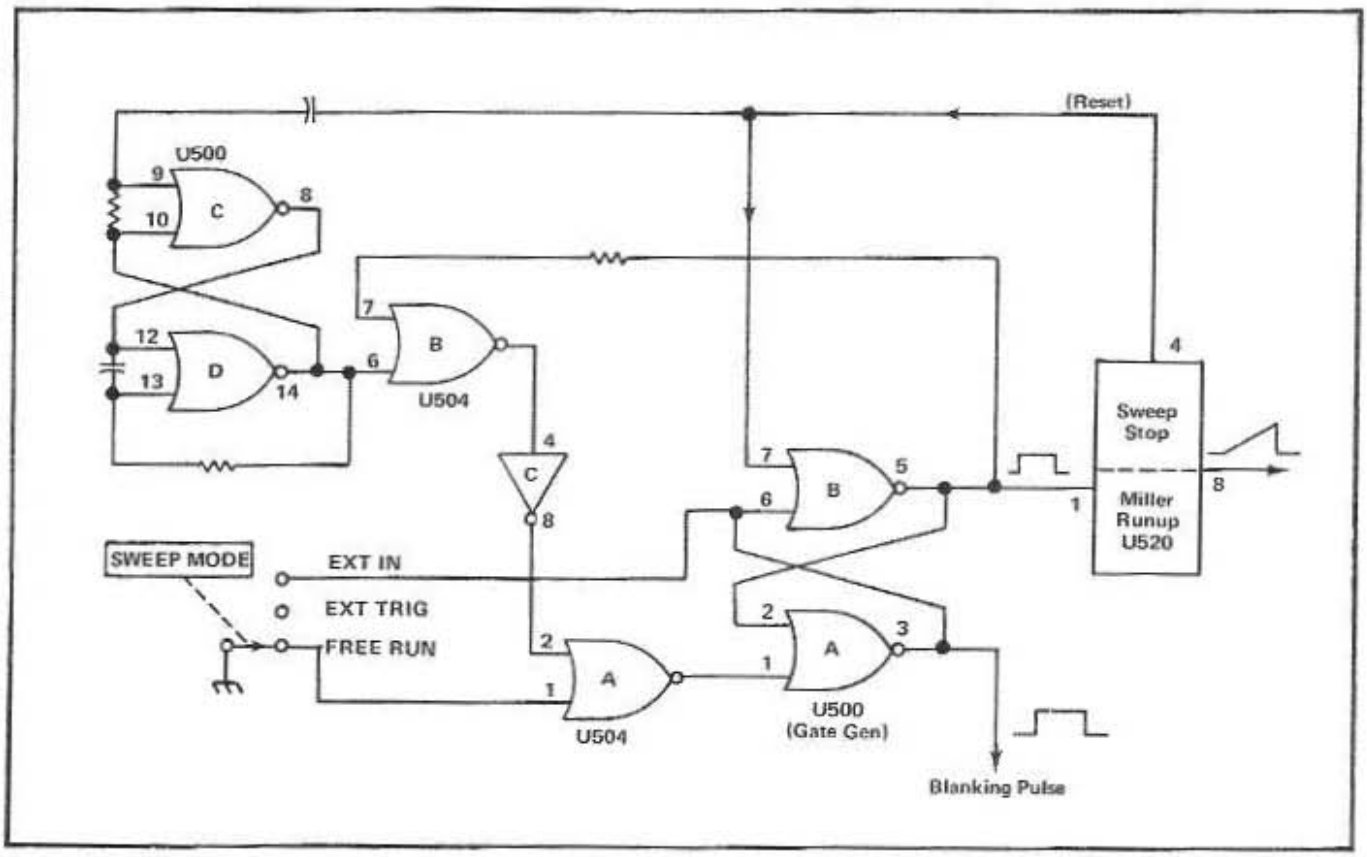


Fig. 3-3. Simplified logic diagram for sweep generator.

output (pin 8) is a sawtooth ramp running from 0 V to the reference voltage set at pin 6 of U520 which, in this case, is 5 volts. When the output sawtooth voltage reaches this 5 volt reference, a reset pulse is generated out of pin 4 of U520 which flips a sweep gate generator (multivibrator) and terminates the input gate to pin 1 and the output sawtooth voltage. After a fixed holdoff period, the sweep gate generator flips back and pulls pin 1 of U520 high. The Miller runup IC then repeats the sweep generating process.

The following sequence of events and the timing diagram of Fig. 3-4 describe the sweep generating process.

1. U520 requires a positive gate or high input on pin 1 to start its sawtooth runup out of pin 8.

2. When the output sawtooth voltage reaches the voltage reference level at pin 6, established by the voltage divider circuit, a positive-going, short duration reset pulse is generated out of pin 4 of U520.

3. This reset pulse is applied to the input of two NOR gates (pins 7 and 9 of U500B and U500C) which are half of two flip-flop circuits, the sweep gate generator and the sweep holdoff generator.

4. The pulse switches the two generators. Pin 4 of U500B switches low, which terminates the sawtooth voltage output of Miller runup IC U520. Pins 3 and 6 of U500 switch high and hold the gate generator in this state.

5. Pin 8 of NOR gate U500C switches low. This low is directly applied to one input of U500D and coupled through C501 to the other input of the NOR gate to flip the holdoff generator. Pin 14 of U500D now switches high.

6. The charge on C501 decays through R501, letting the input (pin 13) go high. The multivibrator switches back, producing a positive holdoff pulse out of U500D with a duration equal to the time constant of C501 and R501.

7. The positive holdoff pulse applied to input (pin 6) of U504B holds the output of this NOR gate low for the duration of the pulse. The other input (pin 7) is low, because it is connected through R507 to pin 5 of U500B.

8. At the end of the holdoff pulse, both inputs are low and the output of U504B switches high. This high is inverted by U504C and both inputs to U504A switch low.

9. The output of U504A goes high and toggles the sweep gate generator. The output of U500B switches high, which generates the positive gate for the input (pin 1) to U520. The sweep starts its runup, and the sweep process repeats.

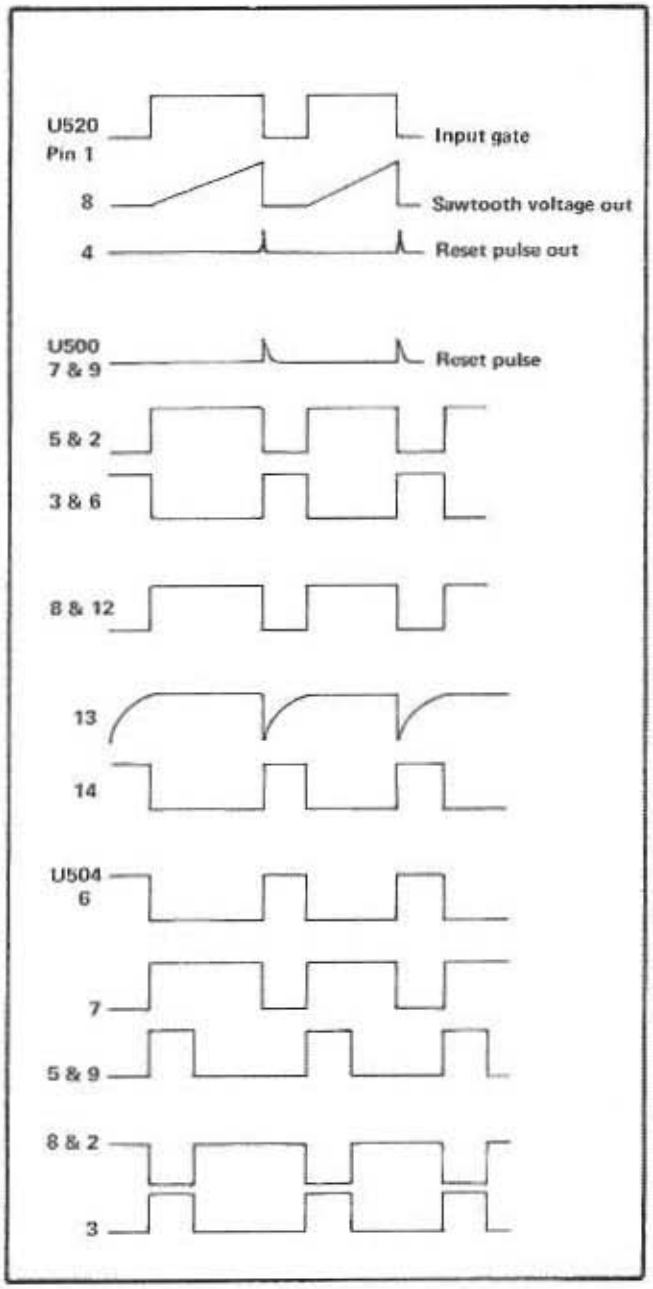


Fig. 3-4. Time diagram for the sweep generating circuit.

10. Frequency or sweep rate of the sweep generator is set by current source Q536 and Q532. The sweep timing depends on C520 and current source Q536. As the SWEEP RATE control is rotated towards ground, more current is supplied by Q536, decreasing the charging time and increasing the sweep rate.

When the SWEEP MODE switch is switched to the TRIG IN position, pin 1 of U504A is pulled high and remains high until a positive trigger pulse is applied to the TRIG IN connector. Pin 6 of U500B is also pulled high, and sets the

sweep gate multivibrator state so its output to pin 1 of sweep generator U520 is low, and no sweep is generated. A positive trigger pulse to the TRIG IN connector is inverted by Q514 and pulls pin 1 of U504A low. This pulls pin 1 of U500A high and flips the sweep gate generator, producing a positive gate into the sweep generator IC, U520. The sweep generator IC can now start its runup to generate a sweep output.

Switching the SWEEP MODE to EXT IN position grounds pin 6 and pin 3 of U500. The output of the sweep gate generator, at pin 5 of U500B, locks high and the output of the sweep generator runs to its high state and locks.

Frequency Span and Center Frequency

Sweep voltage, from either the internal sweep source or an externally applied signal, is attenuated a calibrated amount by the FREQ SPAN MHz/DIV selector circuit, then applied through an operational amplifier to the sweep shaper circuit. The frequency span of the display depends on the amount the sweep oscillator is swept by the sweep voltage. The amplitude of the sweep voltage, in turn, is a function of the attenuation selected by the FREQ SPAN selector.

A simplified functional circuit is illustrated in Fig. 3-5. The sweep voltage is centered around a DC voltage level of 0 volts at the junction of R544 and R549 by the constant current source Q540. The sweep voltage amplitude at this point depends on the attenuation switched in by the FREQ SPAN MHz/DIV selector. In the SEARCH mode, this amplitude is 2.5 V (−1.25 V to +1.25 V). Gain of the operational amplifier is the ratio of the feedback resistance (R558) to the input resistance (R549) which is equivalent to 20 kΩ/10 kΩ or two. This provides a 5 V sweep signal out of the operational amplifier for the sweep shaper circuit.

The setting of CENTER FREQ MHz control R25 determines the offset current to the input of operational amplifier U574, which drives operational amplifier U554. This current and the current supplied by Q540 are summed at the input to U554. The output DC reference level of the sweep ramp to the sweep shaper circuit and the sweep oscillator is therefore shifted by the Center Frequency controls, and sets the center frequency of the swept oscillator. The input to U554 is the summing point for Center Frequency controls R25, R26, and calibration adjustments R550 (Search CF) and R555 (CF Centering).

Control of the sweep center is provided when cam switches 3 and 5 are closed. These switches are closed for

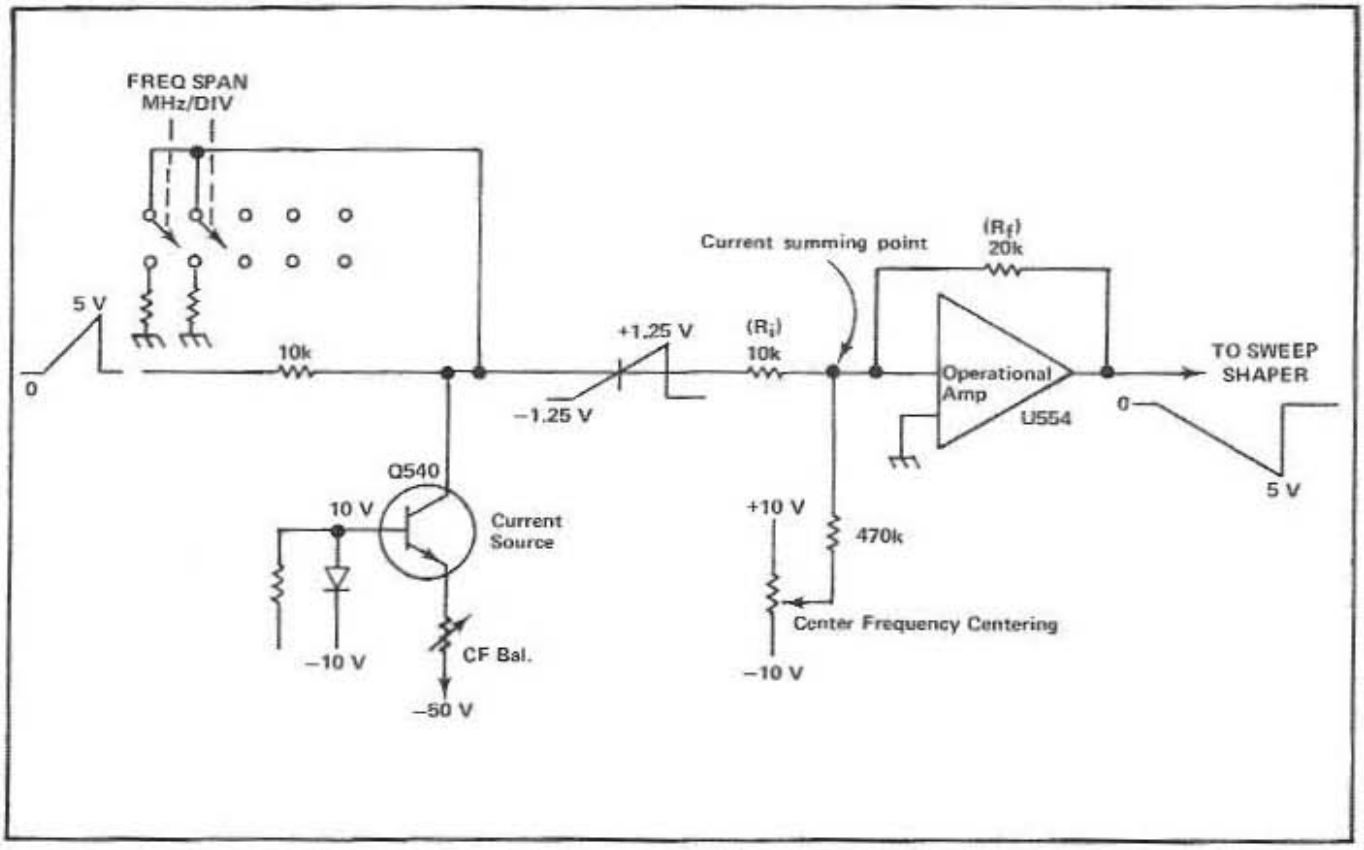


Fig. 3-5. Simplified diagram of frequency span and center frequency circuits.

all positions of the FREQ SPAN MHz/DIV selector except SEARCH. In this position, the center frequency is controlled and calibrated to 250 MHz by Search CF adjustment R550.

Marker Generator

The marker generator provides a frequency notch on the SEARCH mode display to indicate the CENTER FREQUENCY control setting, so the desired portion of the frequency spectrum will be displayed when the FREQ SPAN selector is switched from the SEARCH to MHz/DIV selections. As the CENTER FREQUENCY is tuned through its range, the frequency notch or marker moves across the display.

The marker generator consists of double comparator U590 and NOR gate U504D. A functional block diagram is shown in Fig. 3-6. Refer to schematic 4 in the Diagrams Section also. The sweep sawtooth voltage is compared against the DC output level of the CENTER FREQUENCY control, and when the sweep voltage amplitude reaches the reference level of the CENTER FREQUENCY control, an output is applied to the input of the NOR gate which produces a short positive output pulse. This pulse or gate is applied to the video amplifier stage, and appears as a notch on the display.

CENTER FREQ (R25) through operational amplifier U574, and FINE (R26), control the DC input voltage to a second operational amplifier U584. The output of U584 drives one side of the two comparators U590A–U590B and U590C–U590D (pins 2 and 9). This voltage (between approximately 0 V and –5 V) sets the bias level for U590A and U590D.

A negative-going sweep ramp from the output of U554 drives the other side of the two comparators (pins 4 and 6 of U590). This negative-going voltage ramp is running from approximately 0 V to –5 V. With no sweep voltage input to the comparator, the bias at the base of U590B is about 0 V and because of the divider network, R591 and R592 to –50 V supply, the bias at the base of U590C is approximately 0.2 volt more negative. U590C and U590B are therefore conducting or on, and U590A and U590D are off. The bias of U590B is about 0.2 volt greater than the bias of U590D.

When the negative-going sweep voltage reaches the reference voltage set by the CENTER FREQ MHz controls (on one side of both comparators) the two comparators switch state. Comparator U590C and U590D switch a few volts before comparator U590A and U590B switches. The output (at pin 11 of U590) of comparator U590C and

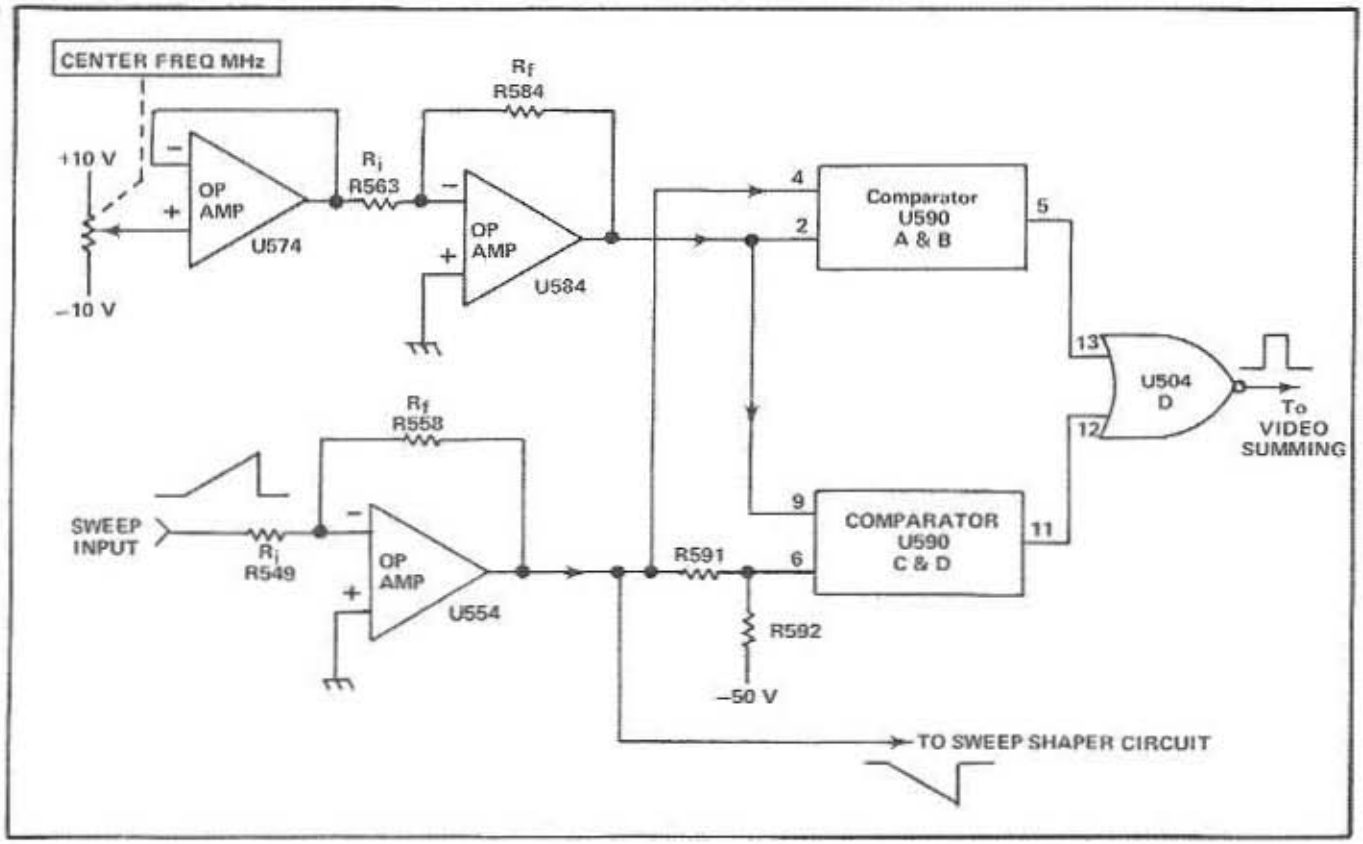


Fig. 3-6. Simplified block diagram for Marker Generator (SEARCH mode).

U590D steps low a fraction sooner (because of the bias difference between comparators) than the output (pin 5) of comparator U590A and U590B steps high.

The two outputs, separated in time and frequency, are applied to the input of NOR gate U504D. The output of the NOR gate is a positive pulse during the time the two inputs to the gate are low. This positive pulse is applied to the base of Q76 and inverted so that it produces a negative notch on the display indicating the position of the CENTER FREQ MHz controls. Switching the FREQ SPAN MHz/DIV selector off SEARCH position opens cam switches 2, 4, and 19, which disables the marker generator, and closes cam switches 3 and 5 so the DC reference level of the sweep sawtooth shifts to the level selected by the CENTER FREQUENCY MHz controls.

Diodes CR594 and CR597 clamp the output of the double comparator to about 0.6 volt above the reference set by U590E, or about 1.0 volt total.

Sweep Shaper

[1]The sweep oscillator requires a nonlinear control voltage to its frequency determining components to generate a linear frequency output-versus-time relationship. This nonlinear sweep voltage requirement is primarily due to the variable capacitance diodes that are used to vary the oscillator frequency. The linear voltage ramp from the sweep generator is, therefore, shaped by the sweep shaper circuit so a linear frequency change is produced out of the oscillator with the horizontal beam movement across the screen. A comparison of the two sweep voltages is illustrated in Fig. 3-7.

The sweep shaper circuit consists of an active divider circuit that changes resistance as the input sweep sawtooth increases in amplitude from 0 V to its peak 5 V level. This divider circuit shunts a passive resistor network and is part of the input resistance for an operational amplifier. Changing the input resistance to the operational amplifier changes the closed loop gain for the stage, thus shaping the sweep voltage that drives the variable capacitance diodes in the tuning circuit for the oscillator.

A functional diagram of the sweep shaper circuit is illustrated in Fig. 3-7. The input resistance (R_i) consists of the combination of the series resistance of R403 and R405 shunted by the active divider circuit. The active divider contains pre-biased diodes that turn on at a preset input voltage level. When the diode turns on, the effective input

[1]A treatise on frequency linearization technique is provided in Circuit Concept booklet on Spectrum Analyzer Circuits. Tektronix Part No. 062-1055-00.

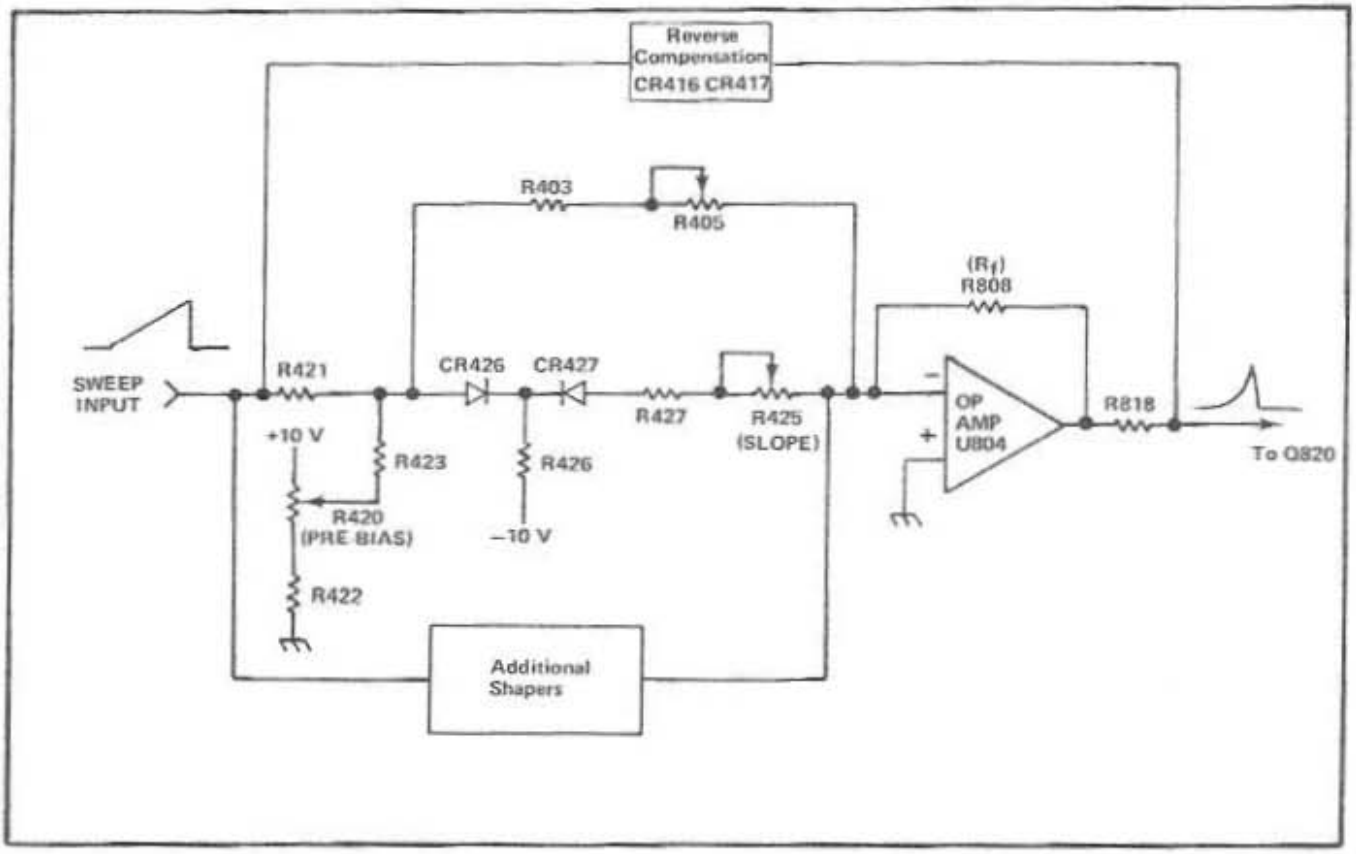


Fig. 3-7. Simplified diagram of one sweep shaper stage in the shaper circuit.

resistance to the operational amplifier decreases, which increases the gain of the stage.

A pre-bias voltage at the junction of the two diodes (CR426 and CR427) is set by R420. This pre-bias determines the break point on an incoming sweep ramp, at which the divider circuit changes resistance. With no input sweep voltage, the bias is positive enough to turn diode CR427 off. As the input ramp runs towards −5 V, the voltage at the diode junction is offset a proportionate amount until CR427 turns on. Additional current through CR427, R427, R425 is added to the current through R403, R405 at the summing point of operational amplifier U804. This additional current increases the feedback current through R_f (R808) and increases the gain of the amplifier. The amount of current added by the active divider is set by R425 which sets the slope or rate of the break.

As the input ramp increases towards −5 V the next divider circuit, containing CR436 and CR437 cuts in, and so forth down through the remaining networks, producing a shaped sweep voltage for the sweep oscillator, so its output frequency is linear with time.

One section of the sweep shaper, containing diodes CR416 and CR417, bypasses operational amplifier U804. This provides out-of-phase compensation, at the sweep start, to decrease the slope of that portion and slow down the frequency change of the oscillator over this section of the frequency span which improves the frequency span linearity.

The shaped output sweep voltage from U804 is amplified by a second operational amplifier consisting of the common emitter amplifier Q820 and Q822, driving Q826. R829 is the feedback (R_f) resistance for this amplifier, and R818 the input resistance. Q830 is a constant current source for the output amplifier Q826. R800 sets the output DC level, and is adjusted for −2 V to −3 V at the output. This voltage starts the 0 Hz reference point for the variable capacitance diodes in the sweep oscillator.

The sweep ramp from the sweep generator is also amplified by operational amplifier U850. This amplifier sets the bias for the variable capacitance diode in the sweep oscillator circuit, and operates with the shaped sweep voltage from Q826 to linearize the frequency span. R850 sets the output DC level, and is adjusted for best linearity over the first portion of the frequency span.

Power Supply

Power for the 1401A is derived from an internal battery pack or an external +6 V to +16 V DC source. The battery or DC source is converted to AC by a converter and pre-regulator circuit, then transformer-coupled to four regulated power supplies. The regulated supplies furnish a regulated +10 V, +3.6 V, −10 V, and −50 V to the 1401A circuitry.

DC voltage from the battery pack or external source is applied through the POWER switch S30 and P701 to the converter pre-regulator circuit. The converter consists of an astable multivibrator, Q712 and Q714, driving a current amplifier, Q716 and Q718, to furnish pulsating current to the primary winding of T700. The on-off time ratio of the multivibrator determines the voltage output of the converter. This in turn is regulated by a feedback loop to an error sensing amplifier Q708 and emitter follower Q710.

The base of Q708 is connected to a voltage divider circuit (R706, R705, and R704) between −6.4 V and +10 V preregulated supply. The −6.4 V is set by Zener diode CR782. Any change in the +10 V preregulated output is amplified by Q708 and applied through emitter follower Q710 to the base of Q712.

The emitter voltage of Q710 affects the holdoff time of the multivibrator. Increasing the emitter current increases the holdoff time of Q712. During holdoff time, Q712 is turned off and Q714 on. Current through Q716, Q718 and the primary of T700 is minimum. As the +10 V pre-regulated voltage drops, the emitter voltage of Q710 decreases, and Q712 turns on to flip the multivibrator. When Q714 turns off, a current pulse is generated through Q718 and the primary of T700. Duration for this current pulse is set by the recovery time for C715. Frequency of the multivibrator depends on the input DC voltage level and ranges from 18 kHz to 30 kHz. Adjustment R705 affects the holdoff time, and is set so the +10 V pre-regulated supply is between 10.6 and 11.0 volts.

Four secondary windings on T700 provide the source voltage, through half-wave rectifiers, for the +10 V pre-regulated and regulated supplies. All except the −50 V supply are short-circuit protected by means of current limiting in the regulators.

The −10 V regulated supply is the prime supply and reference voltage source for the other regulated supplies; therefore, its operation is described first.

Error sensing is accomplished by comparator Q766 which drives differential amplifier Q764. The output of differential amplifier Q764 is inverted by Q774, which sets the bias and conduction of pass transistor Q776.

Each side of comparator Q766 is referenced to the −10 V regulated output; however, one side is connected through Zener diode VR765 to the regulated output and the full effect of any change in the output is transmitted to this side of the comparator. The other side is connected through a voltage divider to the regulated output, so it will sense only a portion of the change. This side sets the voltage output level of the regulator.

Any change in the −10 V output is transmitted through VR765 to the comparator Q766, producing an error signal on the collector which is the inverse of the initial voltage change. An error signal of opposite polarity is developed on the other collector of Q766. The push-pull output of the comparator drives differential amplifier Q764. Q774 inverts the signal and regulates the bias of Q776 to correct and compensate for the initial voltage change.

Q762 increases the common mode gain of the differential amplifier. −10 Volt Adjust R775 sets the regulated output voltage to −10 volts. Since this voltage is the reference for the other supplies, it affects all voltages for the 1401.

The voltage divider consisting of R782 and CR782, between the −10 V unregulated supply and ground, supplies the −6.4 V regulated output for the comparator in the preregulated converter circuit.

The +10 V preregulated supply consists of the half-wave rectifier CR721 and the pi filter network consisting of L721, L722, and C721, C722.

The regulated +10 V supply, containing transistors Q724, Q726, Q728, and Q730, use the +10 V preregulated supply as its source. Transistor Q726 compares a sample of the +10 V regulated output, at the junction of R731 and R732, against the −10 V reference on the common emitters. Any error voltage sensed by the comparator is amplified by Q728 and applied as a corrective signal to the base of pass transistor Q730. Q724, in cascade with Q726, increases collector impedance and the regulator loop gain.

The +3.6 V supply and regulator are very similar to the circuits in the +10 V supply. Q746 is the comparator, Q748 the error amplifier, and Q750 the pass transistor.

The −50 V supply consists of rectifier CR791, a pi filter circuit, and its regulator circuit. The base of Q794 is connected through a voltage divider to the −50 V regulated output and provides the corrective signal to the pass transistor Q796.

The battery charge level indicator M30 is connected across a voltage expander circuit. Voltage range of the indicator is approximately 6.5 V to 7.5 V in the green area and 5.5 V to 6.5 V in the red area. Diode CR354 protects the meter movement if the voltage source should exceed 7.5 volts.

POWER PACK

Basic Operation

The power pack includes six 1.8 Ah NiCd cells for portable operation, an AC to DC converter, to recharge the batteries and furnish instrument power when the power pack is connected to an AC power source, and provisions to connect an external DC voltage source to the pack for external DC power operation of the 1401A. The batteries can not be charged by the external DC power source.

S612 selects the power source and the charge rate for the batteries, when the power pack is connected to an AC source. In the EXT DC position, the EXT DC INPUT jacks are connected directly to the power output jacks, and the internal batteries plus the battery charging circuit are disconnected from the load.

The power pack AC to DC converters consist of a 115 V or 230 V AC power transformer, a half wave and full wave rectifier and a charging circuit for the batteries. The full wave rectifier supplies the current to charge the battery plus the power to operate the 1401A. The half wave rectifier supplies a voltage reference for the battery charging circuit.

The battery charging circuit consists of 1) a comparator that compares the battery voltage level against a reference and delivers a current control signal to 2) an amplifier and driver stage which drives the pass or series regulator transistor which supplies the charge current to 3) the battery plus the operating current for the 1401A, if the 1401A POWER switch is ON. Battery charging is independent of the 1401A POWER switch position.

Detailed Description

The primary windings of T601 are connected in parallel for 115 V AC operation and in series for 230 V AC operation. Two secondary windings on T601 furnish the voltage for a half wave rectifier and a full wave rectifier supply. The full wave bridge rectifier supplies the power for the battery charging circuit and the 1401A circuits during AC operation. The half wave rectifier supplies the voltage reference for the comparator in the battery charging circuit. The voltage output of the half wave rectifier (CR605) is stacked on the battery voltage, and the combined voltage of the two appears across R605 and 6.2 V Zener diode D649.

The 6.2 volt reference, across VR649, is applied across R643 and R644. Charge Rate adjustment R644 sets the reference voltage input to one side of a comparator containing transistors Q636 and Q634. The base of Q634 (the other side of the comparator) is connected through R630 to the negative side of the battery and one side of R615. Battery charge current, through pass transistor Q617 develops a voltage drop across R615 which is sensed by the comparator to generate a corrective signal output that is fed back through driver amplifier Q621 and Q620 to the base of pass transistor Q617, and regulates the charge current at a predetermined value set by R644.

Power supply current required for the 1401A operation also passes through Q617; however, this current does not flow through R615, but bypasses the charging circuit. It is, therefore, completely independent of the charging circuit requirements. Any change in the 1401A current requirements adds to or subtracts from the charge current. This change in charge current is sensed by the comparator so the charge circuit also regulates the voltage output for the 1401A.

With selector switch S612 set for FULL CHG, the Charge Rate adjustment R644 is set for about 180 mA of charge current through R615. When the switch is changed to the TRICKLE CHG position a voltage divider network, consisting of R630 and R633 to the 6.2 volt reference, is switched in. This decreases the charge current through R615 to about 66 mA. Operation of the charge current regulator circuit is as follows: An increase of current through R615 in excess of the regulator setting, will decrease the forward bias of Q634, which decreases the current through Q634 and increases the current through Q636. The output of the comparator is applied across the base-to-emitter junction of Q621 to decrease its forward bias and the current through Q621 and Q620. This decreases the current drive to the base of Q617, which decreases current through the series regulator and resistor R615, to maintain a constant charge current to the battery.

Battery temperature and charge state affect the internal resistance of the cells, which will change the charge rate set by Charge Rate adjustment R644; however, the circuit is capable of supplying current over a fairly wide range.

Charge current through R615 is a pulsating current produced by the output of rectifier CR610. Capacitor C636, across the inputs to the comparator, filters the pulsating voltage across R615 to an average voltage level for the comparator. The output of the full wave rectifier is elevated to the reference voltage established by the half wave rectifier; however, during part of the voltage output cycle the charge current to the battery decreases to 0 and the battery must supply current for the power pack load. During this period, current reverses through R615, which increases the forward bias of Q634 and Q636. Diodes CR637 and CR638 turn on to supply collector current for the transistors during this period.

NOTES

SECTION 4
MAINTENANCE

Change information, if any, affecting this section will be found at the rear of the manual.

Introduction

This section describes recommended procedure for reducing or preventing instrument malfunction, troubleshooting, and corrective maintenance to repair the instrument. 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.

Access to the Interior

Position the carry handle up and back on the instrument. Unscrew the securing screw at the back of the instrument. Grasp the back of the cover and the front panel and pull the cover free. See Fig. 4-1.

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 the instrument is operated in 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

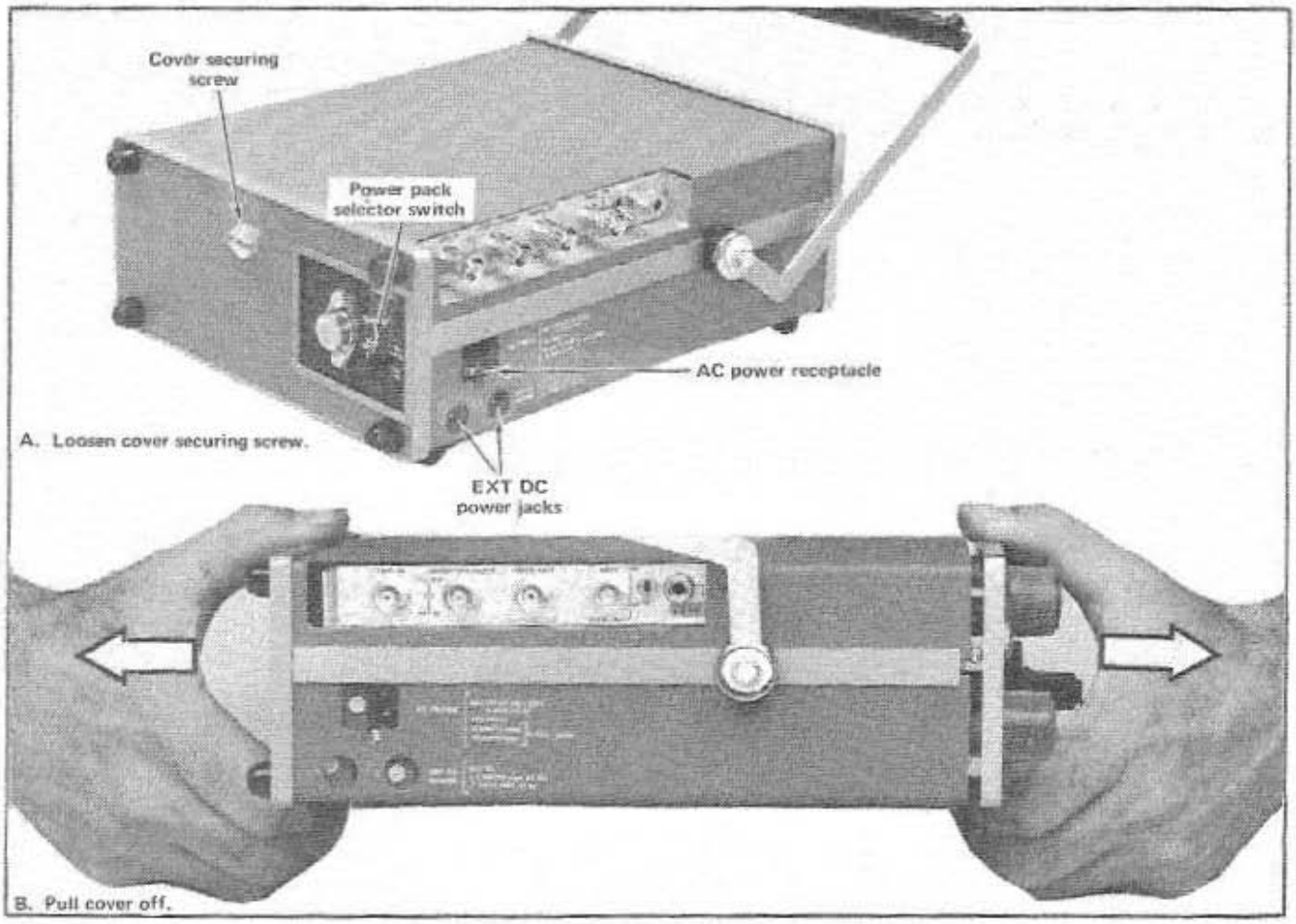


Fig. 4-1. Removing the cover.

insulating blanket and prevents efficient heat dissipation, and if it becomes damp it may provide electrical high resistance leakage paths between conductors and/or components.

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. Normally the interior of the instrument will not require cleaning unless the cover has been left off the instrument for an extended period of time. 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 should not be used, because it may damage some components. Hardened dirt or grease may be removed with a cotton tipped applicator dampened with a solution of mild detergent in water. Abrasive cleaners should not be used. To gain access to board assemblies for cleaning, refer to disassembly instructions under Corrective Maintenance in this section.

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

CAUTION

Do not get water inside any enclosed component such as; the cam switch, RF casting, potentiometers, transformers, etc. Instructions for disassembling the cam switches and repairing 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. These compounds may damage the plastic.

Lubrication

No components in this instrument require lubrication. The cam switches are self-lubricating.

Visual Inspection

After cleaning, the instrument should be carefully checked for such defects as poor 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, determine the cause of over-heating before the damaged parts are 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, and any substandard transistors or integrated circuits will usually be detected at that time.

Performance Checks and Recalibration

To ensure accuracy, the instrument performance should be checked after each 1000 hours of operation or every six months if the instrument is used intermittently. The Performance Check and Calibration Procedure will assist in locating troubles that may not be apparent during regular operation. Instructions for conducting a performance check or calibration are provided in Section 5 and 6.

TROUBLESHOOTING

The ability to recognize and locate trouble is acquired through experience and familiarity with the instrument. The following describes a few aids that may assist in locating a trouble. After the defective component has been located, refer to Corrective Maintenance procedures for removal and replacement instructions.

Troubleshooting Aids

Diagrams. Complete circuit diagrams are provided on foldout pages in the Diagrams section. The component numbers and electrical values are shown on the diagrams along with significant voltages and waveforms. Each major circuit is assigned a series of numbers for the electrical components. Circuits mounted on circuit boards are outlined with a dashed blue line.

NOTE

Corrections and modifications to the circuits are described on inserts bound into the rear of the manual. Check for changes to the manual or the instrument. Verify component values by checking their descriptions in the Electrical Parts List in Section 7.

Circuit Board Illustrations. Each electrical component and test point is identified on pictorial circuit board illustrations on the inside fold of the corresponding circuit diagram. These illustrations together with circuit diagrams allow the troubleshooter to methodically trace the operation of each circuit.

Wiring Color Code. Color coded wire is used to aid circuit tracing. Power supply, DC voltage leads have either a

white background for positive voltage or a violet background for negative voltage. The EIA standard color code is used to signify the approximate voltage value on the wire. The widest strip denotes the first significant figure.

Signal wires and coaxial cables use an identifying one-band or two-band color code.

Power Cord Conductor Identification

Conductor	Color	Alternate Color
Ungrounded (Line)	Brown	Black
Grounded (Neutral)	Blue	White
Grounding (Earthing)	Green-Yellow	Green-Yellow

Multiple Terminal Connector Holders. Most inter-circuit connections, between the circuit boards or between the boards and chassis mounted components, are made through pin connectors. The terminals in the connector holder are identified with numbers. Connector orientation to the circuit board is keyed with triangles, one on the holder and one on the circuit board. See Fig. 4-2. Most connectors consist of more than one section, so sections of a connector can be disconnected for troubleshooting. Wiring color code for these connectors are shown at the end of this section. The connectors are mounted with the open side facing the front or the right side (looking from the front) of the board.

Resistor Color Code. In addition to the brown composition resistors, some metal-film resistors (identifiable by their gray body color) and some wire-wound resistors (usually light blue or gray-green) are used in the 1401A. The resistance value of a wire-wound resistor is printed on the body of the component. The resistance value of a composition resistor or metal-film resistor is color-coded on the component with EIA color-code (some metal-film resistors may have the value printed on the body).

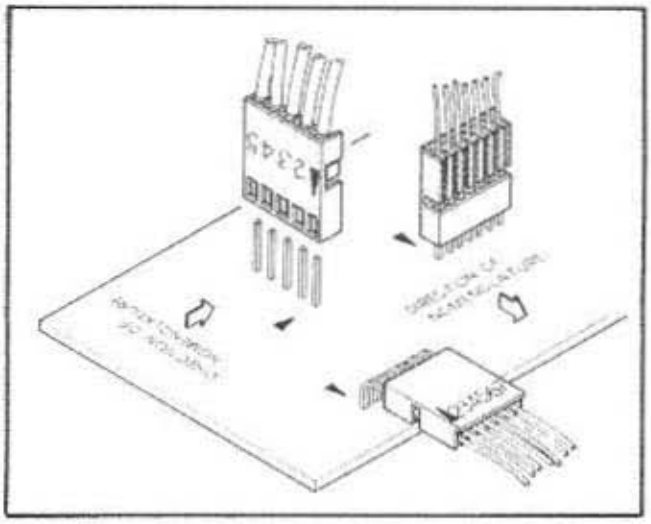


Fig. 4-2. Multipin circuit board connectors.

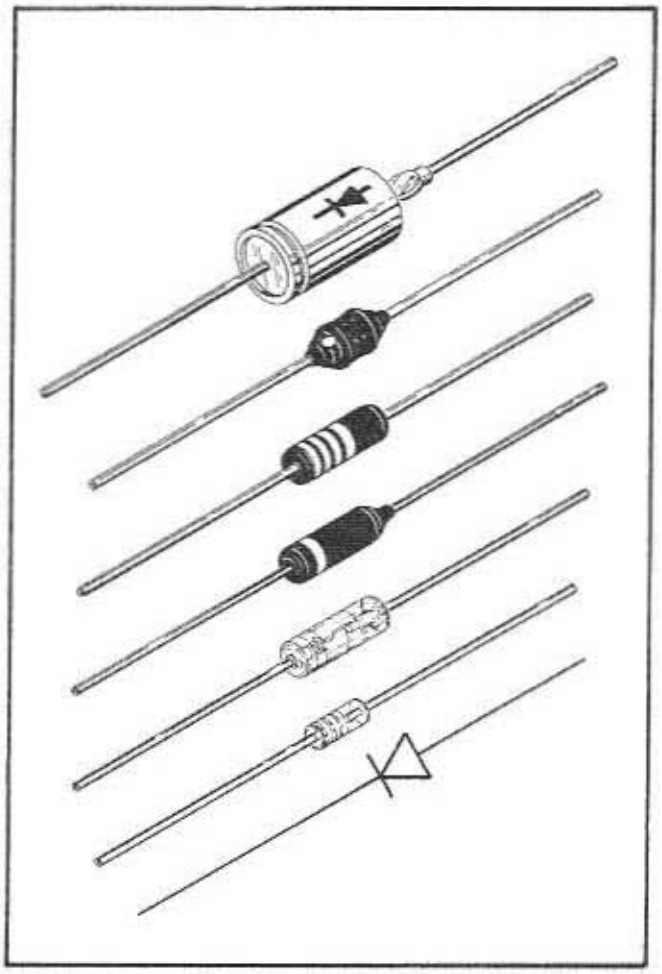


Fig. 4-3. Diode polarity markings.

Capacitor Marking. The capacitance value of a common disc capacitor or small electrolytic is marked in microfarads on the side of the component body. The white ceramic capacitors are color coded in picofarads.

Diode Color Code. The cathode of each glass encased diode is indicated by a stripe, a series of stripes or a dot. Fig. 4-3 illustrates types of diodes used in this instrument.

Transistor and Integrated Circuit Electrode Configuration. Lead identification for the transistors and IC's are shown in Fig. 4-4 and Fig. 4-5.

General

If trouble occurs in the 1401A, the following procedure should facilitate locating the problem and expedite repairs.

1. Insure that the malfunction exists in the instrument. Check operation of the associated equipment and the operating procedure of the 1401A (see Operating Instructions).

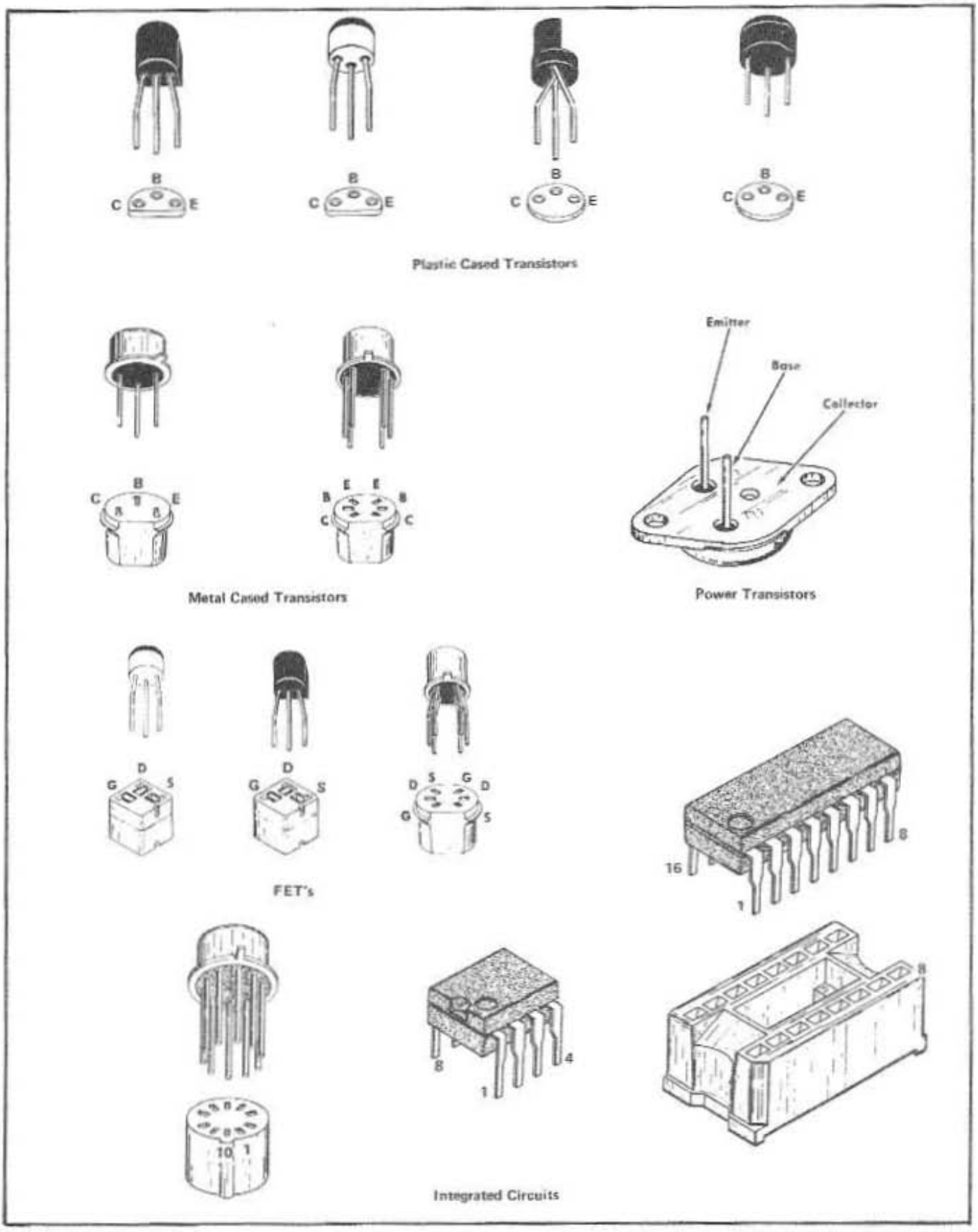


Fig. 4-4. Electrode configuration for socket mounted transistors, FET's, and IC's.

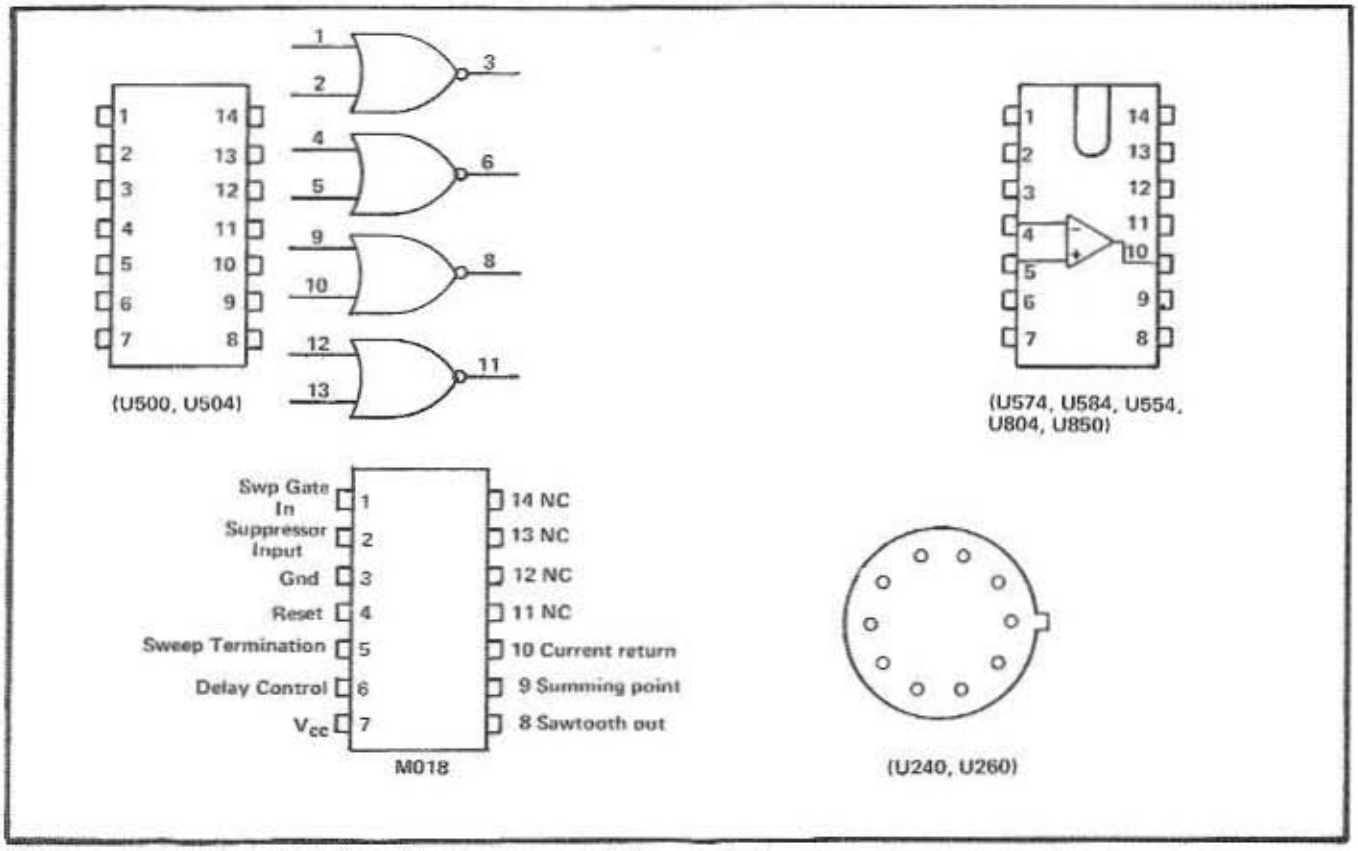


Fig. 4-5. Lead configuration for the IC's used in the 1401.

2. Determine and evaluate all trouble symptoms. Try to isolate the problem to a circuit or assembly. For example: Absence of a frequency marker notch in SEARCH position, could indicate a malfunction in the video summing stage or the marker generator. A test oscilloscope will quickly check the input to the video summing stage and isolate the problem to one or the other of the two circuits. The block diagram in the Diagrams section, is an aid for signal or circuit isolation.

3. Visually inspect the area or the assembly for such defects as broken or loose connections, improperly seated components, over-heated or burned components, chafed insulation or cracked insulators, etc. Repair or replace all obvious defects. In the case of overheated parts, try to determine the cause of overheating and correct before applying power.

4. Check fuses, power supply voltages, then circuit voltages and waveforms. Fuse location and sizes are shown in Fig. 4-6. The schematic diagrams contain pertinent voltages and waveforms for this purpose. Component locations and test points are shown on circuit board callout illustrations.

NOTE

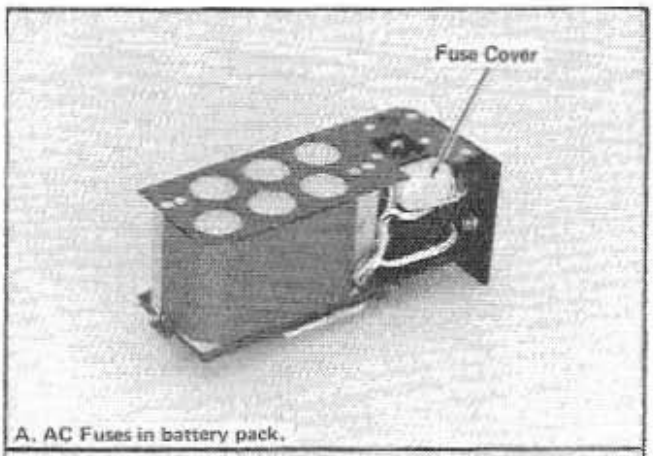
Voltage and waveform illustrations on the diagrams are not absolute and may vary between instruments. The first diagrams page lists the conditions set to obtain the illustrations on the diagram.

CAUTION

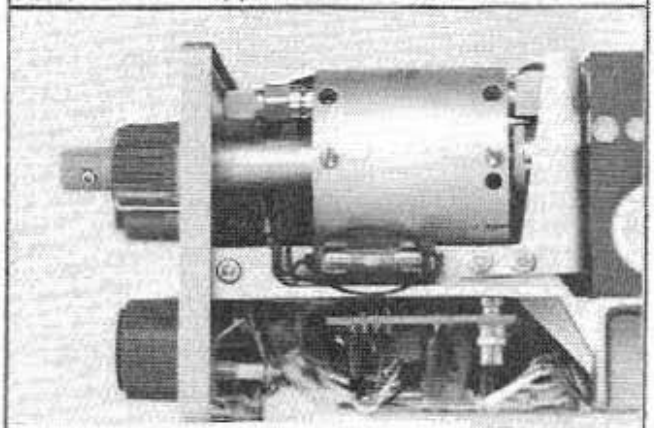
When measuring voltages and waveforms, use extreme care in placing meter leads or probes. Because of high component density, and the limited access within the instrument, an inadvertent movement of the leads or probe can cause a short circuit, producing transient voltages that may destroy many components.

5. Check calibration adjustments of the affected circuit, if applicable. Before changing any adjustment, note its position so it can be returned to the original setting if adjustment has no effect on the trouble. This will facilitate recalibration after locating and repairing the trouble.

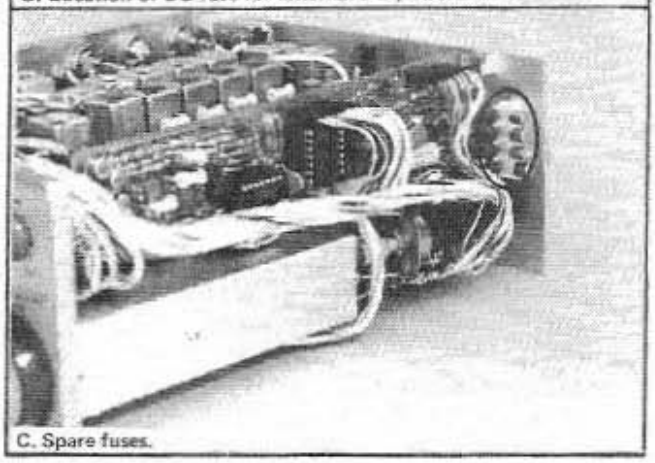
If trouble has not been found and corrected by the foregoing procedure, a more detailed analysis must be per-



A. AC Fuses in battery pack.



B. Location of DC fuse for external DC power.



C. Spare fuses.

Fig. 4-6. Location and size of fuses in 1401A.

formed. The Circuit Description section describes the operational theory of each circuit and should aid in the evaluation of the problem.

Semiconductor failures account for the majority of electronic equipment failures. Because most semiconductor devices (transistors and IC's) are socket-mounted, substitution is often the most practical means of checking their performance. The following guide lines should be followed when substituting these components:

1. Determine first that circuit voltages are safe for the substituted component, so the replacement will not be damaged. (Refer to instruction on replacing transistors with heat dissipators under Corrective Maintenance.)

2. Use only good components for substitution.

3. Turn the power off before a component is substituted.

4. Be sure the component is inserted properly in the socket (see Fig. 4-4).

5. Return good components to their original sockets. This will reduce calibration time and run-in period.

6. Check calibration and performance after a faulty component has been replaced.

If a substitute is not available, check the transistor or 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 resistance ratios across semiconductor junctions if no other method is available. Use the high resistance ranges (R X 1 k or higher) so the external current is limited to less than 2 mA. If uncertain, measure the external 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 the voltage 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. If necessary, unsolder one end of the diode and lift it clear so the ratio can be taken. Observe suggested solder practices (using a heat sink) when soldering or unsoldering 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 tunnel diodes or mixer diodes.

Integrated Circuit (IC) Checks. Integrated circuits are most easily checked by direct replacement. When substitution is impossible, check input and output signal states as described in the circuit description and on the diagram. Lead configuration and data for the IC's used in this instrument are provided by Fig. 4-4 and Fig. 4-5.

CORRECTIVE MAINTENANCE

Corrective maintenance consist 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 replacements can be obtained through your local Tektronix Field Office or representative. Many of the standard electronic components, however, can be obtained locally in less time than that required to order from Tektronix, Inc. Before purchasing or ordering replacement parts, consult the Parts List for value, tolerance and rating. The Parts section contains instructions on how to order these replacement parts.

NOTE

When selecting the replacement parts, it is important to remember that the physical size and shape of the component may affect its performance in the circuit.

It is best to duplicate the original component as closely as possible. Parts orientation and lead dress should also duplicate those of the original part because some components are oriented to reduce or control circuit capacitance and inductance. After repair, the circuits of the instrument may need recalibration.

Soldering Technique

WARNING

Disconnect the instrument from the power pack before soldering.

Circuit Boards. Use ordinary 60/40 solder and a 15 watt pencil type soldering iron on the circuit boards. The tip of the iron should be clean and properly tinned for best heat transfer to the solder joint. A higher wattage soldering iron may separate the wiring from the base material. Most components can be replaced without removing the boards from the instrument.

The following procedure is recommended to replace a component on a circuit board.

1. Grip the component lead with long-nose pliers. Touch the soldering iron to the lead at the solder connection.

2. When the solder begins to melt, pull the lead out gently. This should leave a clean hole in the board. If not, the hole can be cleaned by reheating the solder and placing a sharp object such as a toothpick into the hole. A vacuum-type desoldering tool can also be used for this purpose.

3. Bend the new component leads to fit the holes in the board. If the board is mounted in the instrument, cut the leads so they will just protrude through the board. Insert the leads into the holes in the board so the component is firmly seated (or as positioned originally). If it does not seat properly, heat the solder and gently press the component into place.

4. Heat-sensitive components are protected by holding the lead between the component body and the solder joint with a pair of long-nose pliers or other heat sink. Touch the iron to the connection and apply a small amount of solder to make a firm solder joint.

5. Clip the excess leads that protrude through the board.

6. Clean the area around the solder connection with a flux-remover solvent. Be careful not to remove information printed on the board.

Power Pack

The Power Pack can be removed from the 1401A by disconnecting three square-pin connectors at the circuit board, and releasing the clamp at the front of the power pack. Switch the power selector switch (at the rear of the power pack) to the EXT DC position during removal. This minimizes the number of exposed points to which the internal battery is connected.

WARNING

The battery used in the power pack is capable of delivering a large amount of energy. Rings, watch bands, or other metallic items, which may short-circuit the battery, can rapidly become hot enough to cause severe burns.

Circuit Board. Components on the battery charger circuit board can be replaced without removing the board. To

reach the under-side of the board, remove the three nuts which hold the board in place. Turn the power pack over to permit the washers to fall free of the board.

After the nuts and washers have been removed, the outer end of the board can be lifted up, pivoting it on the wiring cable. Be careful that the screw near the transformer does not bind on the corner of the board. If the board must be completely removed, the wire color code should be recorded before any wires are unsoldered.

Transformer. To remove the transformer, unsolder its eight leads from the circuit board. Remove the power pack cover plate, from the opposite side by removing the six screws from it. Then remove the two transformer mounting bolts. The transformer can then be lifted out through the holes in the side plate. See Fig. 2-1 in the Operating section for 115-230 V wiring information.

Fuse. Access to the fuse can be obtained by pulling the plastic cap off toward the bottom. When replacing it, be sure that the grooves in the cap align with the fuse mounting board. See Fig. 2-2 for 115-230 V fusing information.

Battery. The battery in the power pack is made up of six 1.25 V nickel-cadmium (NiCd) cells strapped together, series-aiding. See Fig. 4-7. Background information regarding these cells is given in the Operating Instruction section, and should be read before any servicing is performed on the battery.

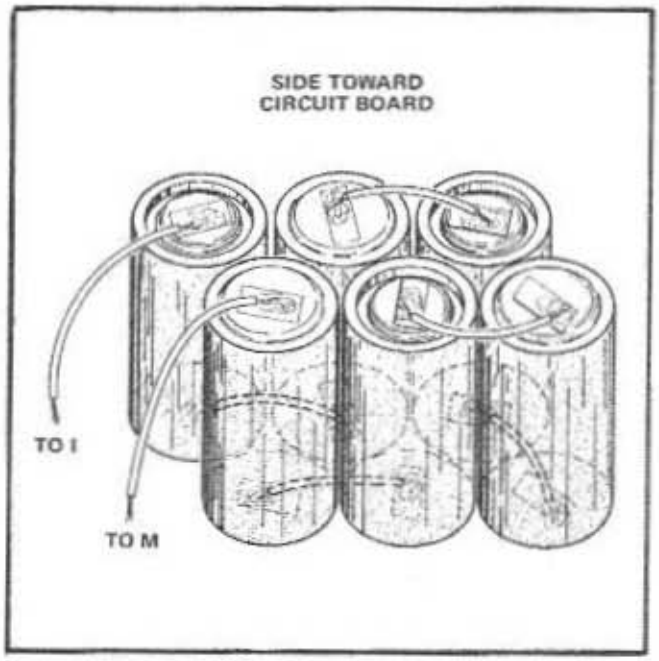


Fig. 4-7. Battery wiring.

Battery Pack Removal. Unsolder the two leads which connect the battery pack to terminals I and M on the circuit board. Free one lead from the cable clamp. Tape one lead end (creating minimum bulk) so that the two leads cannot come in contact with each other. Remove the nine screws and the cover plate from the power connector side of the power pack. Remove the three battery pack screws through the access holes in the circuit board, freeing the pack. Separate the pack from the rest of the unit, pulling the pack leads through the hole in the circuit board. The battery holding bracket can now be removed by removing one screw from each end. The pack can be re-installed by reserving the procedure.

Servicing the Battery. The cells which make up the battery have been selected to meet specific performance requirements, and can be expected to maintain relatively equal capabilities throughout the battery operating life. Upsetting this balance of equality, by introducing a strong cell into a weak battery, or a weak cell into a strong battery, will enhance the possibility of reverse charging of the weakest cells, as explained in the Operating Instructions.

If one cell is defective and fails, while the rest of the battery is still quite new, that cell may be replaced without undue concern. The Tektronix Field Representative or Office should be consulted before individual cells are replaced, especially if the warranty is in effect.

Gas evolution and recombination takes place during battery charging. This creates a pressure within the cells which they normally withstand. If a cell becomes defective, or a circuit causes the recommended charge rate to be exceeded, excessive pressure builds up. This excessive pressure may rupture a relief vent, exhausting the gas, which may shorten the life of the cell and cause corrosion in the surrounding area.

The battery should be inspected every six months or every 500 operating hours, whichever occurs first. Individual cells or the entire battery should be replaced if venting or corrosion has occurred. The cover plate, on the power connector side, must be removed to expose one side of the battery. Check between the cells for corrosion. If a more thorough check is desired, remove the battery in accordance with the Battery Pack Removal instructions.

Individual Cell Replacement. Individual cells can be removed and replaced by cutting the straps which connect the two ends of the cell to the pack and soldering a new cell in its place. See Fig. 4-7. The replacement cell must be the type specified in the parts list. Other types may not function properly, despite operating claims. Operating time and/or temperature performance may be degraded. However, if a substitution must be made, the cell must be able to with-

stand a 180 mA charge rate. The cells should only be used as long as it takes to obtain the prescribed replacement. Charge the battery for 24 hours at a FULL CHG rate after a cell has been replaced to balance the cells.

REPLACING CIRCUIT BOARDS OR SUBASSEMBLIES

Most assemblies and circuit boards in this instrument can be easily removed and replaced.

The following procedure describes the removal or installation of each circuit board or major assembly in the 1401A.

Power Regulator Board

1. Remove the power pack.

2. Remove the power regulator shield cover by pressing it on the side walls of the shield, below the two indentations on the cover, and lift the cover off.

3. Disconnect all multi-pin connectors, and the coaxial plugs that extend through the board into the jacks on the RF Casting.

4. Unscrew the four mounting screws and lift the board out of the instrument.

5. Replace by reversing this procedure. Check wiring illustration at the end of this section to insure that the multi-pin connectors are installed correctly before applying power.

IF Board

1. Disconnect all multi-pin connectors, and the coaxial plugs (J161 & J175) that extend through the board to the RF casting.

2. Unscrew the plug connectors to the VIDEO OUT and TRIG IN, BNC connectors and pull the center pin out. Unsolder the lead to the SWEEP connector.

3. Unscrew the six board mounting screws, slide and lift the IF board out of the instrument.

4. Replace the board by reversing this procedure and check with the wiring illustration at the end of this section to insure that the connectors are installed correctly before applying power.

RF Casting

1. Remove the power regulator board and the IF board.

NOTE

Access to the oscillator, mixer, and other sections of the RF casting can be gained by removing the power regulator board, then the hex screws that hold the desired section of the RF casting together.

2. Disconnect the coaxial cable to the RF Attenuator (J141).

3. Remove the back panel by removing all the mounting screws.

4. Loosen the two Allen set screws that hold the RF casting to the front panel (see Fig. 4-8).

5. Slide the RF casting back and out of the instrument.

RF Attenuator

1. Remove the control knobs and the front panel mounting nut with the washer.

2. Remove the mounting bracket at the rear of the attenuator.

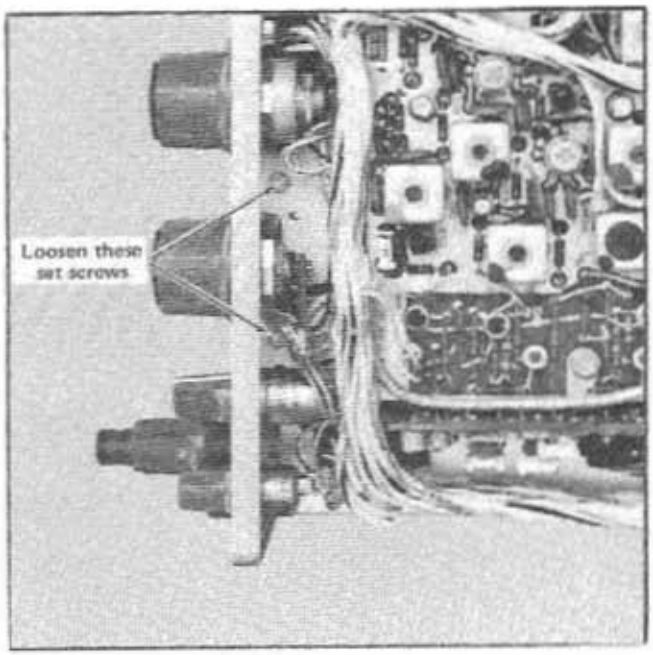


Fig. 4-8. Location of the set screws holding the RF casting to the front panel.

3. Slide the attenuator back and out of the instrument.

NOTE

The IF GAIN control potentiometer can be removed from the attenuator assembly by loosening the Allen set screws at the rear of the attenuator body and sliding the potentiometer with its long shaft out the back of the attenuator body.

Vertical Display Board

1. Remove the battery pack, RF Attenuator mounting bracket, then disconnect the multi-pin connector to the board.

2. Push in the delrin latch assembly (see Fig. 4-9) and pull the board and switch back and out of the instrument.

3. Replace by holding the latch in until the switch assembly is in place, then release. Check to insure the board and switch assembly is latched in place.

Sweep Circuit Board

1. Disconnect all the multi-pin connectors.

2. Remove the FREQ SPAN and RESOLUTION control knobs.

3. Remove the back panel and circuit board mounting screws.

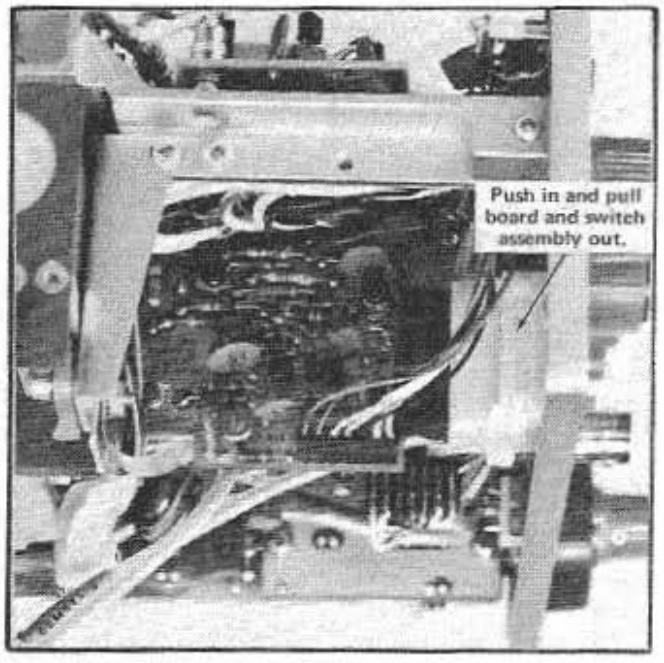


Fig. 4-9. Latch assembly for the vertical display board and switch assembly.

4. Slide the circuit board back and out of the instrument.

5. Replace the circuit board by reversing the procedure. Check to insure multi-pin connections are correct before applying power.

Calibrator Board

1. Disconnect all the multipin connectors.

2. Unsolder the leads to CAL OUT connector and VIDEO FILTER.

3. Remove the two mounting screws and lift the board out.

4. Replace the board by reversing the procedure.

Center Frequency Controls

1. Unplug the three pin connector and remove the grounding lug.

2. Loosen and remove the mounting nut, then remove the control from the front panel.

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 swaged 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 or 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 (.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 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.

Cam Switch Repair or Replacement

CAUTION

Because the alignment and spring tension of the cam switch contacts are critical and must be carefully maintained for proper operation, the repair of these switches should be undertaken only by experienced maintenance personnel. A cam-type switch repair kit, including replacement contacts, alignment tools and instructions is available from Tektronix, Inc. Order Part No. 040-0541-00. If assistance is desired, contact your local Tektronix Field Office or representative.

The cam switches consists of a rotating cam and a set of contacts mounted on the adjacent circuit board. These switch contacts are actuated by lobes on the cam. The cam switches can be disassembled for inspection, cleaning, repair or replacement as follows:

REMOVAL:

1. Remove the VARIABLE and FREQ SPAN knobs, watch for bushing sleeve inside the FREQ SPAN knob.

2. Loosen the RESOLUTION knob and remove it and the plastic dial plate with its keyed shaft.

3. Remove shaft mounting nut to the front panel.

4. Loosen one set-screw of the potentiometer coupler nearest the cam switch.

5. Remove the .08 inch inner shaft from the switch front.

6. Loosen and remove 6 each mounting screws and washers from the bottom of the board. Keep these screws separated because the 3 mounting screws with only one washer are mounted toward the center of the board.

7. Carefully remove the cam switches and cover assembly.

INSTALLATION:

Reverse the removal procedure to replace the cam switch assembly. When the knobs are installed, check to insure they are oriented properly to coincide with the dial readout.

RF Module

The RF Module consists of five sub-units within a cast module. We recommend replacing the sub-units or the complete assembly if any part of the module fails to function properly. Return the defective unit or module to your Tektronix Field office or representative.

CAUTION

We do not recommend replacing any discrete component soldered to the substrate. Excess heat will loosen and warp the substrate and may upset critical circuit balance and tuning. If a component must be replaced use no more than a 15 watt soldering iron and extreme care. Components that can be replaced are listed in the Electrical Parts Section under the RF Module.

Replacing Wide Band Mixer Components

Mixer balance is obtained by adding a twisted wire pair to one or more of the diodes. The twisted wire pair adds capacity to ground. Length of the wire or amount of capacity is selected at the factory. If any of the diodes or discrete components in the mixer are replaced, the location and length of this select component will change.

Miscellaneous Maintenance Information

The power transformer in this instrument is warranted for the life of the instrument. If defective, contact your local Tektronix Field Office or representative for replacement (see Warranty note in the front of this manual). Use only a direct replacement Tektronix transformer. Be sure to label the leads as they are unsoldered from the transformer terminals.

Recalibration After Repair

When any electrical component is replaced, the calibration of the associated circuit and other related or dependent circuits must be checked. If the power supply has been repaired, all circuits are affected and their performance should be checked. Use the procedures described in Section 5 of this manual to check the performance of any circuit.

PHYSICAL LOCATION OF COMPONENTS

The majority of components for the instrument are mounted on the circuit board. Circuit numbers for adjustments, active components (such as transistors, diodes, etc.), plugs, and voltage test points are screened or labeled on the circuit board. The locations of the circuit board components are illustrated in the pictorial diagrams with the circuit diagrams at the end of this manual.

REPACKAGING FOR SHIPMENT

If the Tektronix instrument is to be shipped to a Tektronix Service Center for service or repair, attach a tag showing: owner (with address) and the name of an individual at your firm that can be contacted. Include complete instrument serial number and a description of the service required.

Save and re-use the package in which your instrument was shipped. If the original packaging is unfit for use or not available, repackage the instrument as follows:

Surround the instrument with polyethylene sheeting to protect the finish of the instrument. Obtain a carton of corrugated cardboard of the correct carton strength and having inside dimensions of no less than six inches more than the instrument dimensions. Cushion the instrument by tightly packing three inches of dunnage or urethane foam between carton and instrument, on all sides. Seal carton with shipping tape or industrial stapler.

The carton test strength for your instrument is 200 pounds.

SECTION 5
PERFORMANCE CHECK

Change information, if any, affecting this section will be found at the rear of the manual.

Introduction

This section is a step by step procedure that checks the performance specifications of the instrument. It does not include any internal adjustments or checks. If the instrument fails to meet a specified performance requirement, the adjustment procedure for the related circuits will be found under a similar title in Section 6. Reference is also made in this procedure to the pertinent calibration step.

Complete or Partial Check

Perform all steps in sequence for a complete check. To make a partial check, refer to the preceding setup for the initial equipment setup and control positions, then make the changes listed up to the start of the desired check.

History Information

The instrument and manual are subjected to a program of constant evaluation and updating. Circuits, as well as procedures, are modified. The history procedure and information applicable to earlier instruments are included either as deviations within the steps or as subparts of steps. These are clearly indicated in the procedure.

Equipment and Test Fixtures Required and Recommended

The following list of equipment is required to perform a complete performance check. Test equipment specifications are minimum requirements for accurate checks or calibration. Substitute equipment must meet or exceed these minimum requirements.

Special Tektronix calibration fixtures are used to facilitate the procedure. These are available from Tektronix Inc., and may be ordered through your local Tektronix Field Office or representative.

In some cases, a compromise may be made when the equipment needed to check or verify a high tolerance specification is expensive or impractical to obtain. Notification of this compromise is made as a footnote to the equipment list, along with a statement that high tolerance specification cannot be checked because of compromise.

Equipment List

1. Indicator Oscilloscope: Oscilloscope with 6 division vertical display that can be swept by an external 5 volt sweep signal for a 10 division display. Vertical sensitivity must equal 1.2 V for full-screen deflection. (Tektronix 323 Oscilloscope is used as part of this system.)

2. Test Oscilloscope: Sensitivity .01 V/Div, frequency response DC to 50 MHz. Tektronix 400, 500, or 7000 series with a dual trace vertical plug-in unit. For example: 547 with 1A1, 7504 with 7A12, or the 453 portable oscilloscope.

3. Time-Mark Generator: Marker outputs, 0.5 s to 0.1 µs and frequency outputs of 20 MHz, 50 MHz, 200 MHz, 500 MHz; accuracy 0.001%. Tektronix 2901 with Harmonic Modulator 067-0640-00[1] or Tektronix Type 184 with Harmonic Generator 067-0594-00.

4. Audio Signal Generator: Frequency range 10 Hz to 1 MHz, variable output amplitude to at least 10 volts peak to peak, accuracy ±3%. General Radio Model 1310A or Hewlett Packard Model 241A.

5. VHF Signal Generator: Frequency range 10 MHz to 400 MHz, accuracy ±1%; calibrated variable output attenuator 0 to 120 dBm. Hewlett Packard Model 608D or 608E.

6. Constant Amplitude Signal Generator: 1 MHz to 100 MHz, output amplitude 1 V to 5 V peak to peak. Tektronix Type 191 Constant Amplitude Signal Generator.

7. UHF Signal Generator: Frequency range 400 MHz to 500 MHz, accuracy ±1%; calibrated variable output attenuator. Hewlett Packard Model 612A.

8. Pulse Generator: Pulse amplitude +1 V to +10 V and −4 V peak; minimum pulse duration, 100 ns. Tektronix 2101 Pulse Generator.

9. Power Meter: Capable of measuring −30 dBm within 0.1 dB; such as General Microwave Model 454A. A power

[1] **The 067-0640-00 Calibration Fixture is used to modulate the sine-wave Marker Output frequencies of the 2901 Time Mark Generator. The Marker Output is modulated by the Trigger Output to produce sidebands and their harmonics.**

meter capable of measuring −10 dBm with a calibrated 20 dB attenuator can be used; such as Hewlett Packard Model 432A.

10. DC Voltmeter: 0 to 10 V range, accuracy within 3%. Triplett Model 630 PL or Simpson Model 262.

11. Variable DC Power Supply: 6 V to 15 V, current output to 1 ampere. Trygon Electric Model HR 40-750.

12. Two, 10:1 Attenuators: Tektronix Part No. 011-0031-00.

13. Two, 5:1 Attenuators: Tektronix Part No. 001-0032-00.

14. BNC "T" connector: Tektronix Part No. 103-0030-00.

15. Patch cord (two), with banana plug-jack on both ends: Tektronix Part No. 012-0031-00.

16. 50 Ω coaxial cable (four): Length 42 inches, BNC connectors, Tektronix Part No. 012-0057-01.

NOTE

The RF ATTENuator dB selector is checked at the factory to insure accuracy within the stated specifications. Any change in tolerance would be caused by component failure; therefore, high-tolerance attenuators are not used in this procedure to check the attenuator. If the exact attenuator error of the selector is required, the recommended attenuator must be calibrated by the user or the manufacturer, or an attenuator with more rigid specifications must be used.

PERFORMANCE RECORD AND INDEX

The following abridged procedure provides a record for and index to the performance checks on the 1401A. It can also serve as a guide for the experienced checker or calibrator.

SHORT FORM PROCEDURE

1401A Serial No. _____

Data _____

Checked By _____

1. Battery Charge Level Operation — Page 5-4

   Red zone between +6.3 V and +6.7 V.

2. Center Frequency Range and Accuracy — Page 5-5

   Accuracy within ±(5 MHz + 5% of dial readout).

   Range 1 MHz to 500 MHz

3. Frequency Span — Page 5-6

   Accuracy; within 10% of that selected by the FREQ SPAN MHz/DIV selector with 10 division display.

4. Resolution Bandwidth — Page 5-7

   Within 10% of RESOLUTION kHz selection

5. Incidental FM — Page 5-7

   No more than 20 kHz

6. Video Filter Operation — Page 5-8

7. Dynamic Range of Vertical Display Modes and Range of IF GAIN control — Page 5-8

   LOG ≥60 dB, IF GAIN control ≥30 dB

8. RF ATTENuator Operation — Page 5-9

   Accuracy; within ±(0.5 dB ± 1% of dB reading)

9. Video Output Level — Page 5-9

   1.2 volt or more for full screen display.

10. Sensitivity — Page 5-9

    Resolution

1000 kHz	−78 dBm
100 kHz	−85 dBm

11. Display Flatness Page 5-9

Maximum amplitude variation within 3 dB

12. Spurious Response Page 5-10

Down at least 50 dB

13. Intermodulation Distortion Page 5-10

At least 55 dB down for two −30 dBm (+25 dBmV 1401A-1) signals at 1 MHz separation.

14. Sweep Rate and Output Amplitude Page 5-10

Sweep rate; 1 sweep/second or less to 100 sweeps/second or more. Output amplitude 5 V ±0.25 V.

15. External Trigger Operation Page 5-11

Sweep will run from an external trigger source of +1 V to +10 V, with a duration at least 100 ns and a frequency 1 MHz or less.

16. External Sweep Voltage Operation Page 5-12

External voltage of 0 to +5 V will sweep the 1401 with 0 V corresponding to 0 Hz and +5 V corresponding to 500 MHz.

17. Check Gate Operation Page 5-12

Ratio between gated and non-gated portion of display is 50 dB or more.

18. Check/Adjust Calibrator Output Level and Frequency Page 5-13

Output level −30 dBm ±0.5 dB

General

The sequence of this procedure permits the 1401A performance to be checked with minimum reconnection of equipment. The titles for checks of the prime characteristics or characteristics that have calibration adjustments are printed in capital letters and reference to the calibration step is indicated. Performing the complete procedure will verify all characteristics listed in the Specification section.

Test equipment setup illustrations precede groups of similar checks. Control settings and equipment hookup changes follow from the preceding step(s) unless noted.

Control or connector titles that pertain to the 1401A are capitalized (e.g. POWER) and associated test equipment control titles are initial capitalized (e.g. Time/Div).

To insure instrument accuracy, check the performance every 1000 hours of operation or every six months, whichever occurs sooner. If the instrument is used in a dusty or damp environment with extreme changes in temperature, it should be checked more frequently.

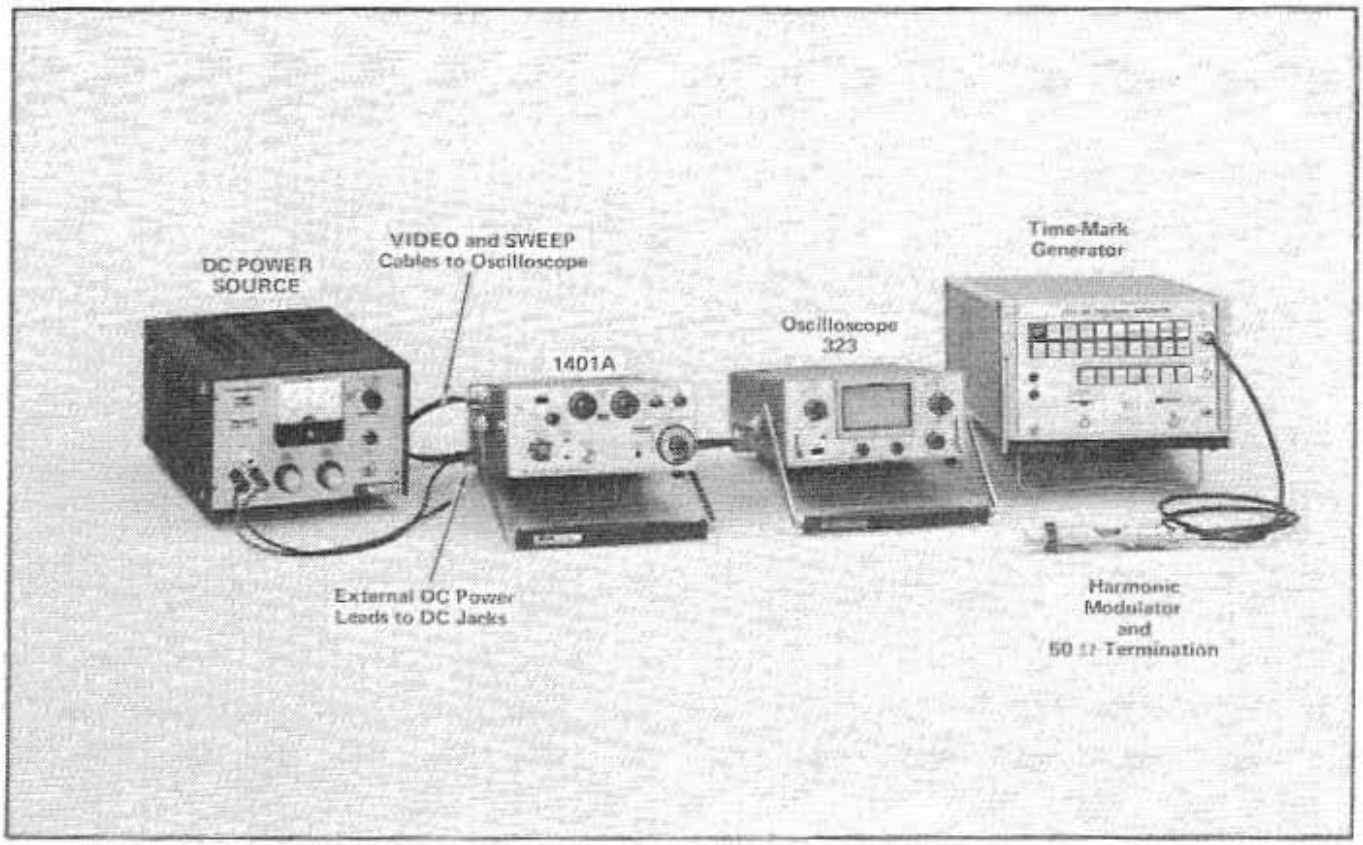


Fig. 5-1. Initial equipment setup for steps 1 through 5.

Preliminary Procedure

a. Connect the 1401A to the indicator oscilloscope as illustrated in Fig. 5-1, and set the front panel controls as follows:

1401A

RF ATTEN dB	20
IF GAIN	Counterclockwise
VERTICAL DISPLAY	LIN
CENTER FREQ MHz	
1-500	250
FINE	0
SWEEP	
MODE	FREE RUN
RATE	Midrange
FREQ SPAN MHz/DIV	SEARCH
RESOLUTION kHz	1000

Indicator Oscilloscope

Volts/Div (6 div. screen)	.2
Input	DC
Time/Div	Ext Horiz
Trigger	Ext Horiz
Horiz Mag	Pulled Out to X10 position
Ext Horiz Input Attenuation	10X

b. Connect the 1401A to the external DC power source (+6 V to +16 V) and switch the battery pack selector to EXT DC position. Connect the indicator oscilloscope to its power source, and switch POWER on for both instruments.

c. Adjust Position and Time/Div Variable controls for a 10 division display at the bottom graticule line. Position the 0 Hz response at the 0 graticule line, adjust the CENTER FREQ MHz control to 500 and adjust the Variable Horiz Gain (Variable Time/Div) control to position the frequency notch at the 10th division line. When correctly adjusted, the display will be slightly more than 10 divisions with 0 Hz response at the zero division line, and the frequency marker (notch) behind the tenth division line.

d. Allow the 1401A to warm up 25 minutes before checking frequency accuracy or stability.

1. Battery Charge Level Indicator Operation

This is an operational check, not a specification requirement.

a. Decrease the voltage level of the external DC power source until the CHARGE LEVEL indicator reads in the red zone.

b. CHECK–The input voltage to the 1401A should measure between 6.3 V and 6.7 V.

c. The 1401A may now be connected to the battery pack for the remaining checks. Switch the selector switch to AC/BATT position.

NOTE

The 1401A must be operated with fully charged battery power, or from an external DC power source to check performance.

2. CHECK CENTER FREQUENCY RANGE AND ACCURACY

Requirement–Range of the FINE control is ±1 MHz within 10% and the 1-500 control range is 500 MHz. Accuracy of the 1-500 dial readout, with the FINE control at 0 is ± (5 MHz + 5% of the indicated frequency). Refer to steps 3 and 4 of Calibration Procedure if the instrument does not meet requirements.

a. Connect the Harmonic Generator Test Fixture to the INPUT 50 Ω connector on the 1401A, and apply 10 ns and 20 ns markers from the time-mark generator to the Harmonic Generator.

b. Switch the VERTICAL DISPLAY to LOG and adjust the IF GAIN control for a display showing the 50 and 100 MHz signals and harmonics (Fig. 5-2).

c. CHECK–A 0 Hz response should be displayed at the left edge of the display along with 50 and 100 MHz signals plus harmonics.

d. Adjust the CENTER FREQ MHz 1-500 control to position the frequency marker under the 0 Hz signal. Decrease the FREQ SPAN MHz/DIV setting to 10 and center the 0 Hz marker on screen.

e. CHECK–Dial readout should indicate 000 ± 5 MHz.

f. Increase the CENTER FREQ MHz 1-500 control setting until the 100 MHz marker signal is centered on screen.

g. CHECK–Dial readout should indicate 100 ±(10 MHz).

h. CHECK–Dial calibration at each 100 MHz increments, using the 100 MHz marker harmonics as check points. 1-500 control dial readout should indicate frequency within ±(5 MHz + 5% of the indicated position).

i. With the CENTER FREQ MHz 1-500 control adjusted to the 5th harmonic, switch the FREQ SPAN selector to SEARCH position.

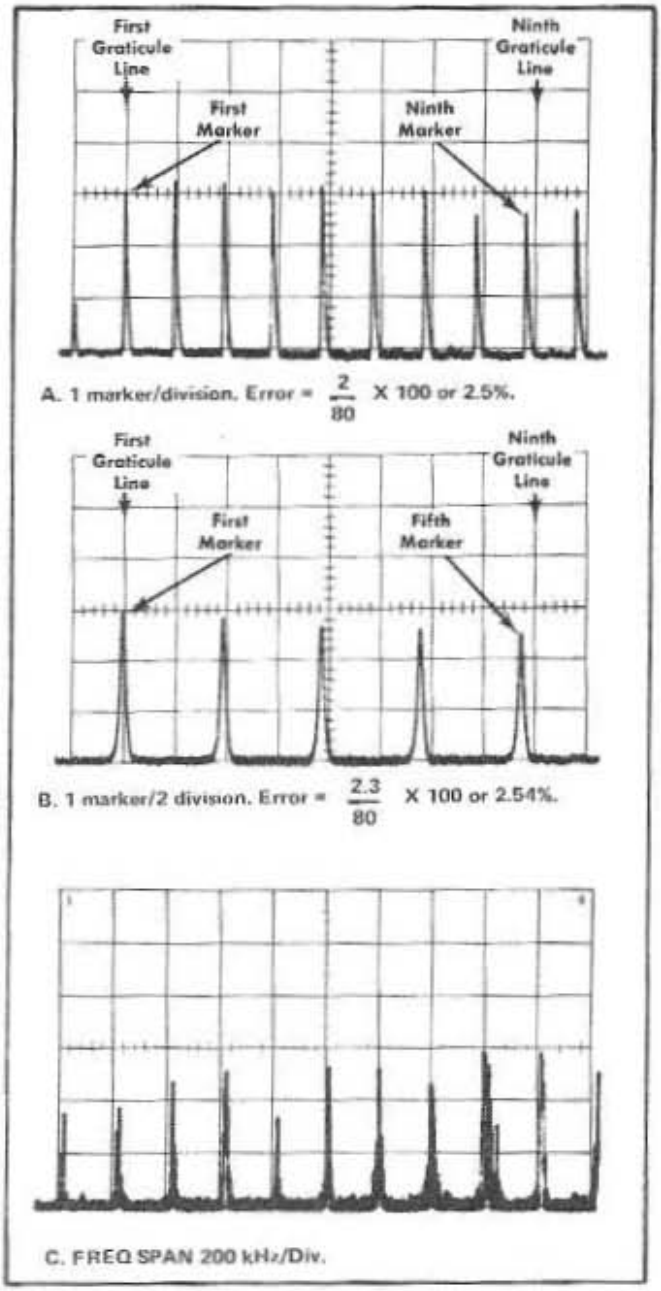


Fig. 5-2. Typical displays when checking frequency span and center frequency accuracies.

j. CHECK–Frequency marker and the 500 MHz signal should appear at the right edge of the display.

k. Return the CENTER FREQ MHz 1-500 control to 000 position, switch the FREQ SPAN MHz/DIV selector to 1 and the RESOLUTION kHz to 100. Check that the 0 Hz marker is on screen.

l. Remove the Harmonic Generator, and apply 1 µs markers from the time-mark generator to the INPUT 50 Ω connector. Center one of the 1 MHz markers on screen with the 1-500 control.

m. Turn the CENTER FREQ FINE control fully clockwise, and note the number of divisions the 1 MHz markers move.

n. CHECK—Range of the FINE control must equal 1 MHz (1 div.) within 10%.

o. Turn the CENTER FREQ FINE control fully counterclockwise.

p. CHECK—Range of the control must equal 1 MHz within 10% of its centered or 0 position. Return the control to its 0 position.

3. CHECK FREQUENCY SPAN WITH 10 DIVISION DISPLAY

Requirement—Range: 500 MHz to 0 Hz in calibrated steps. Accuracy within 10% with 10 division display. Refer to step 5 of the Calibration Procedure if this requirement is not met.

a. Set the front panel controls as follows:

RF ATTEN dB	0
VERTICAL DISPLAY	LOG
FREQ SPAN MHz/DIV	50 (SEARCH)
CENTER FREQ MHz	50

b. Connect the Harmonic Generator Test Fixture to the INPUT 50 Ω connector and apply 20 ns markers from the time-mark generator to the Harmonic Generator and INPUT of the 1401A.

NOTE

The 067-0640-00 Calibration Fixture is used as follows with the 2901.

1. Connect the MARKER connector of the Calibration Fixture onto the Marker Out connector of the 2901 Time Mark Generator then apply the 2901 Trigger Out signal through a short 50 Ω coaxial cable to the TRIGGER connector of the Harmonic Modulator.

2. Apply the SIGNAL OUT through a coaxial cable and 20 dB attenuator to the RF Input of the appropriate Spectrum Analyzer.

3. Use an appropriate Marker Out signal (such as 100 MHz or 200 MHz) and modulate this frequency with the trigger frequency that corresponds to the frequency span you desire to check.

4. Tune the Spectrum Analyzer Center Frequency through the band checking frequency span accuracy and linearity as described in the instrument instruction manual using the Type 184 Time-Mark Generator.

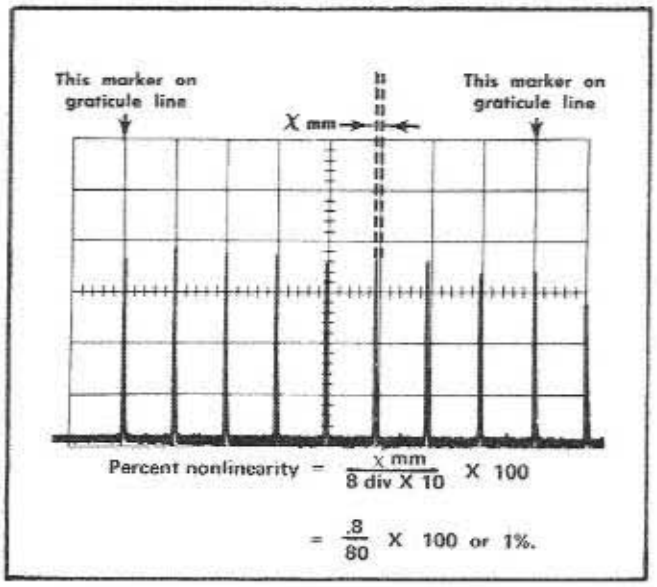


Fig. 5-3. Display illustrates frequency span linearity measurements.

c. CHECK—The display should contain 1 marker/division within 1.0 division over 10 division display. (Adjust the Horizontal Position control to align markers behind their respective graticule lines.) Check across the CENTER FREQ MHz tuning range. Fig. 5-2 and Fig. 5-3 illustrate how frequency span accuracies and linearity are measured.

d. Change the FREQ SPAN MHz/DIV selector setting to 20. Press the 20 ns and 50 ns marker buttons.

e. CHECK—The display should contain 1 marker/division, within 1 division, for a 10 division display over the complete tuning range of the CENTER FREQ MHz control.

f. CHECK—The accuracy of the remaining FREQ SPAN MHz/DIV selector positions by setting the selector to the positions indicated in Table 5-1, and applying the respective markers to the INPUT of the 1401A. Limitations are listed in Table 5-1.

TABLE 5-1

FREQ SPAN MHz/DIV	Markers	Display (Markers Div)	Limitation (Within 10%) 10 div display	Supplementary Information
10	20 ns & .1 µs	1	±0.1 div	
5		1 marker/2 div	±0.2 div	
2	20 ns & .5 µs	1	±0.1 div	
1	20 ns & 1 µs	1	±0.1 div	
.5	20 ns & 5 µs	1 marker/2 div	±0.2 div	VIDEO FILTER ON
.2	20 ns & 5 µs	1	±0.1 div	
.1	20 ns & 5 µs	1 marker/2 div	±0.1 div	

4. CHECK RESOLUTION BANDWIDTH

Requirement–Bandwidth at the 50% amplitude point is within 10% of RESOLUTION kHz selected. Refer to step 3 of Calibration Procedure if bandwidth is incorrect.

a. Set the front panel controls as follows:

RF ATTEN dB	20
VERTICAL DISPLAY	LIN
FREQ SPAN MHz/DIV	1
RESOLUTION kHz	1000
CENTER FREQ MHz	10
VIDEO FILTER	ON

b. Apply .5 µs markers from the time-mark generator to the INPUT 50 Ω connector. Adjust the IF GAIN control for a full screen display of one marker. (Disregard the 0 Hz marker and other .5 µs markers.)

c. Adjust the CENTER FREQ MHz control to position the display so the bandwidth at the –6 dB (50% amplitude) point can be measured. See Fig. 5-4.

d. CHECK–Bandwidth must equal 1000 kHz ± 100 kHz or 0.5 times the distance between two .5 µs markers ± 10%.

e. Switch the FREQ SPAN MHz/DIV selector to .2 and the RESOLUTION kHz to 100. Apply 1 µs markers to the INPUT of the 1401A.

f. CHECK–Bandwidth of the display must equal 100 kHz ± 10 kHz or 0.1 times the distance between the two markers within 10%.

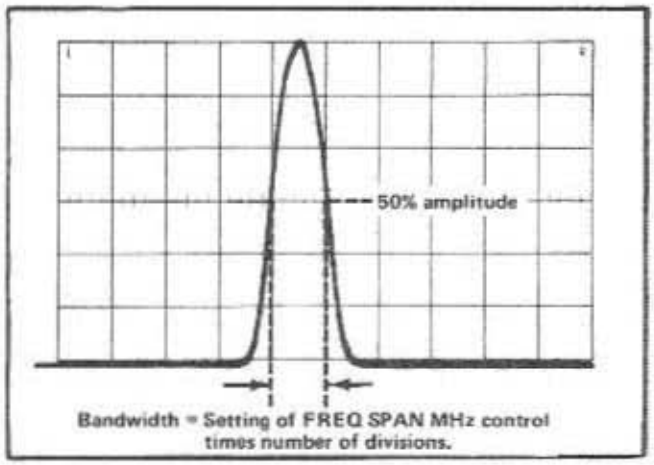


Fig. 5-4. Measuring resolution bandwidth.

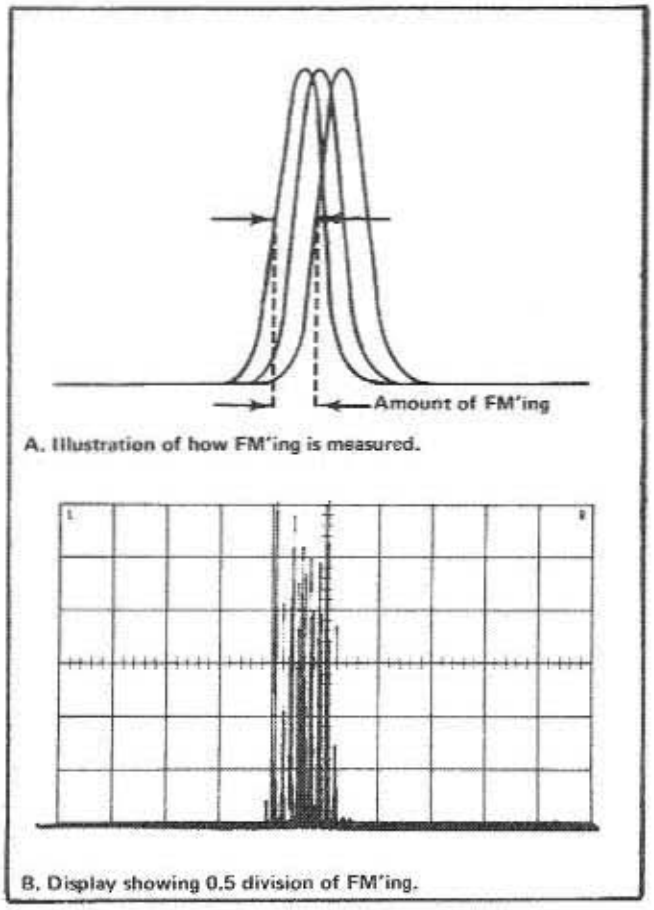


Fig. 5-5. Measuring incidental FM'ing.

g. Switch the FREQ SPAN MHz/DIV selector to .01 and the RESOLUTION kHz to 3. Apply .1 ms markers to the 1401A INPUT.

h. CHECK–Bandwidth of the display must equal 3 kHz ± 300 Hz or 0.3 times the distance between two markers.

NOTE

Because incidental FM'ing is more than the resolution bandwidth at 3 kHz, the bandwidth will be difficult to measure. See Fig. 5-5A.

5. Check Incidental FM

Requirement–No more than 20 kHz. Instrument must be on battery power or external DC power source for this check.

a. Set the CENTER FREQ MHz selector to 1, FREQ SPAN MHz/DIV to .1, RESOLUTION kHz to 3, VERTICAL DISPLAY to LIN and VIDEO FILTER to OFF position.

b. Apply 1 μs markers from the time-mark generator to the 1401A INPUT. Adjust the CENTER FREQ MHz control to tune the 1 MHz marker to the center of the screen, and adjust the IF GAIN control and RF ATTEN dB selector for a full screen display.

c. CHECK—FM'ing of the displayed marker (Fig. 5-5B) must not exceed 20 kHz (1 minor division, see Fig. 5-5A for measurement method).

6. Check Operation of Video Filter

There is no specification for this check.

a. Set the front panel controls as follows:

RF ATTEN dB	20
VERTICAL DISPLAY	LIN
CENTER FREQ MHz	10
FREQ SPAN MHz/DIV	0
RESOLUTION kHz	1000

b. Apply 10 MHz from the VHF signal generator to the INPUT of the 1401.

c. Amplitude modulate the VHF signal generator at 50% with a 1.6 kHz signal from the audio signal generator. Adjust the output of the VHF signal generator and the 1401 IF GAIN control for a full screen display.

d. CHECK—VIDEO FILTER time constant by switching the VIDEO FILTER on and noting that the display amplitude decreases approximately 70.7% (3 dB).

7. CHECK DYNAMIC RANGE OF DISPLAY FUNCTIONS

Requirement—LOG display is at least 60 dB. Refer to step 6 of Calibration procedure if Linearity mode is incorrect.

NOTE

Accuracy of LOG display depends on the Vertical deflection factor (Volts/Div) which should be 0.2 V/Div. Improve the display by re-adjusting Vertical Cal, or compensate with the Variable control.

a. Change the VHF signal generator frequency to 200 MHz and remove the 1.6 kHz modulation. Decrease the signal generator output level to about −80 dBm.

Set the front panel controls as follows:

RF ATTEN dB	0
FREQ SPAN MHz/DIV	1
RESOLUTION kHz	100
CENTER FREQ MHz	200
VERTICAL DISPLAY	LOG

b. Adjust the IF GAIN control clockwise from the full counterclockwise position, until the baseline starts to shift up (approximately 0.25 div of noise), then adjust the Position controls to place the baseline of the display at the bottom graticule line.

c. Adjust the signal generator output and the CENTER FREQ MHz controls for a full screen (6 div) signal amplitude (signal should not limit).

d. Increase the RF ATTEN dB selection in 10 dB steps.

e. CHECK—Signal amplitude should decrease, in 1 division steps ±0.2 division, as the RF ATTEN dB selector is rotated towards 60 dB. In the 60 dB position, the signal should be visible above the noise. (Dynamic range, LOG display, must equal or exceed 60 dB and accuracy between two readings must be within 2 dB).

f. Change the VERTICAL DISPLAY to LIN. Increase the IF GAIN setting until there is some noise on the baseline, and position the baseline of the display at the bottom graticule line.

g. Increase the signal generator output level until the signal amplitude is again full screen (6 divisions).

h. CHECK—LIN mode linearity by decreasing the signal generator output 6 dB. Note that the signal amplitude decreases half screen.

i. Turn the IF GAIN control fully clockwise, and adjust the signal generator output for a full screen display.

j. Turn the IF GAIN control fully counterclockwise. Note the signal amplitude.

k. Return the IF GAIN control to maximum (fully clockwise) and reduce the generator output level 30 dB.

l. CHECK—Range of the IF GAIN control must equal or exceed 30 dB. Signal amplitude should equal or exceed the amplitude noted in step i.

8. Check RF ATTENuator dB

NOTE

The RF ATTENuator dB accuracy is checked at the factory to insure accuracy specifications. This step will detect component failure, but it will not check the tolerance characteristics of this attenuator. If the exact attenuation error or the characteristics of the selector is required, a reference attenuator must be calibrated by the user or manufacturer, or an attenuator having more rigid specifications must be used.

Requirement–This check is an operational check. Accuracy of the attenuator is within ±(0.5 dB + 1% of the dB readout).

a. Set the front panel controls as follows:

RF ATTEN dB	60
VERTICAL DISPLAY	LIN
CENTER FREQ MHz	200
FREQ SPAN MHz/DIV	1
RESOLUTION	100

b. Apply 200 MHz from the VHF signal generator to the INPUT of the 1401A.

c. Adjust the IF GAIN control for a display amplitude of 4 divisions.

d. CHECK–The RF ATTEN dB selector through each 10 dB step, by decreasing the RF ATTEN dB selector setting and increasing the signal generator Variable Attenuator setting by 10 dB. The display amplitude should remain at 4 divisions ± 1 division.

9. Check Video Output Level

Requirement–At least 1.2 V for full screen deflection.

a. Set the RF ATTEN dB selector to 10, VERTICAL DISPLAY at LOG. Change the Indicator oscilloscope Volts/Div selection to .5.

b. Apply 200 MHz signal from the signal generator. Adjust the generator output and IF GAIN control until the signal display saturates (amplitude does not increase with increase in gain or signal level).

c. CHECK–Signal amplitude at the point of saturation, should equal or exceed 1.2 volts peak.

d. Return the oscilloscope Volts/Div to .2.

10. CHECK SENSITIVITY

Requirement–At least 78 dBm with resolution of 1000 kHz, and –85 dBm with 100 kHz resolution. Refer to alignment procedure, step 4 in Calibration procedure if instrument fails to meet requirements.

a. Set the front panel controls as follows:

RF ATTEN dB	0
CENTER FREQ MHz	10
VERTICAL DISPLAY	LIN
FREQ SPAN MHz/DIV	1
RESOLUTION	1000

b. Apply 10 MHz signal from the VHF signal generator to the INPUT of the 1401A.

c. Adjust the IF GAIN control for about 0.5 division of noise, and center the 10 MHz signal on screen with the CENTER FREQ MHz control.

d. Decrease the signal generator output level until the signal amplitude plus noise is 1 division.

e. CHECK–Signal input level (analyzer sensitivity) should not exceed –78 dBm.

f. Switch the RESOLUTION kHz selector to 100 and the FREQ SPAN MHz/DIV to .1. Repeat the above procedure to measure sensitivity.

g. CHECK–Signal input level should not exceed –85 dBm.

h. Repeat the sensitivity checks at frequencies of 250 MHz and 400 MHz for each resolution bandwidth setting.

11. CHECK DISPLAY FLATNESS

Requirement–SN B040891 and below. Maximum amplitude variation through entire frequency range is within 1.5 dB to 200 MHz and 3.0 dB to 500 MHz. SN B040892 and up. Measured with respect to the level at 50 MHz, within +0.75 dB from 1 MHz to 200 MHz and within +0 dB to –3.0 dB from 200 MHz to 500 MHz. Refer to step 4 of Calibration procedure if requirement is not met.

a. Set the front panel controls as follows:

CENTER FREQ MHz	50
VERTICAL DISPLAY	LOG
RF ATTEN dB	10
FREQ SPAN MHz/DIV	50 (SEARCH)
RESOLUTION kHz	1000

b. Change Vertical deflection sensitivity to .05/Div (X5 for deflection of 2.5 dB/Div).

c. Apply 50 MHz signal from the VHF signal generator to the INPUT of the 1401A.

d. Adjust the IF GAIN control for about 0.25 division of noise, then adjust the signal generator output level for a signal amplitude of four divisions.

e. CHECK—Flatness by slowly tuning signal generator frequency from 1 MHz towards 200 MHz, maintaining a constant generator output level, noting maximum variation of signal amplitude. Maximum ratio of amplitude variation across 1 MHz to 200 MHz display must not exceed 1.5 dB (0.6 div) for SN B040891 and below and ±0.75 dB for SN B040892 and up.

f. CHECK—Flatness response by slowly tuning the signal generator frequency from 200 MHz towards 500 MHz. Maximum ratio of amplitude variation across the display must not exceed 3 dB (1.2 div) for SN B040891 and below and +0 dB to −3.0 dB for SN B040892 and up.

NOTE

Change to UHF signal generator for frequencies above 400 MHz.

g. Return the Vertical deflection to .2 V/Div.

12. Check Spurious Response (Operational check only)

a. Remove the signal generator signal from the INPUT connector of the 1401A and set the front panel controls as follows:

RF ATTEN dB	60
CENTER FREQ MHz	250
FREQ SPAN MHz/DIV	50 (SEARCH)
RESOLUTION kHz	100
VERTICAL DISPLAY	LIN

b. Adjust IF GAIN control for 1 division of noise. Check display for no spurious responses other than 0 Hz marker.

13. Check Intermodulation Distortion

Requirement—Intermodulation sideband amplitude must not exceed 1 division from signals that are 55 dB above a reference amplitude of 1 division, LOG mode. Refer to step 4 of Calibration procedure if requirement is not met.

a. Set the front panel controls as follows:

RF ATTEN dB	0
VERTICAL DISPLAY	LOG
CENTER FREQ MHz	100
FREQ SPAN MHz/DIV	10
RESOLUTION kHz	100
VIDEO FILTER	OFF

b. Apply 100 MHz signal, with an output level of −30 dBm, from the VHF signal generator to the INPUT of the 1401A. Adjust the 1401A IF GAIN control for a full screen display (signal plus noise) amplitude. This sets the input signal level reference.

c. Remove the signal generator signal from the INPUT and switch the RF ATTEN dB selector to 50.

d. Apply signals of 90 MHz and 110 MHz or any two signals down to 1 MHz separation from two signal generators through two 5X attenuators for isolation then through a BNC "T" connector to the 1401 INPUT. See Fig. 5-6.

e. Adjust the Output of the signal generators so the amplitude of both displayed signals plus noise equals 1 division.

f. Change the RF ATTEN dB selector setting to 0.

g. CHECK—Intermodulation distortion, by noting the amplitude of the sidebands. Amplitude must not exceed 0.6 division; see Fig. 5-7.

NOTE

The additional 5 dB is an approximate calculation. If a more accurate check is desired, use the Variable Attenuator on the signal generator to establish the 5 dB differential reference level.

14. Check Sweep Rate Range and Output Amplitude

The SWEEP RATE control should vary the rate from 1 sweep/second or less to 100 sweeps/second or more. Output amplitude should equal 5 V peak ±0.25 V.

a. Connect the SWEEP VOLTAGE from the 1401A to the vertical Input of the test oscilloscope. Set the front panel controls as follows:

1401A

SWEEP MODE	FREE RUN

Test Oscilloscope

Volts/Div (Calibrated)	1
Time/Div	1 s
Triggering	Internal

b. Adjust the test oscilloscope triggering controls for a triggered display.

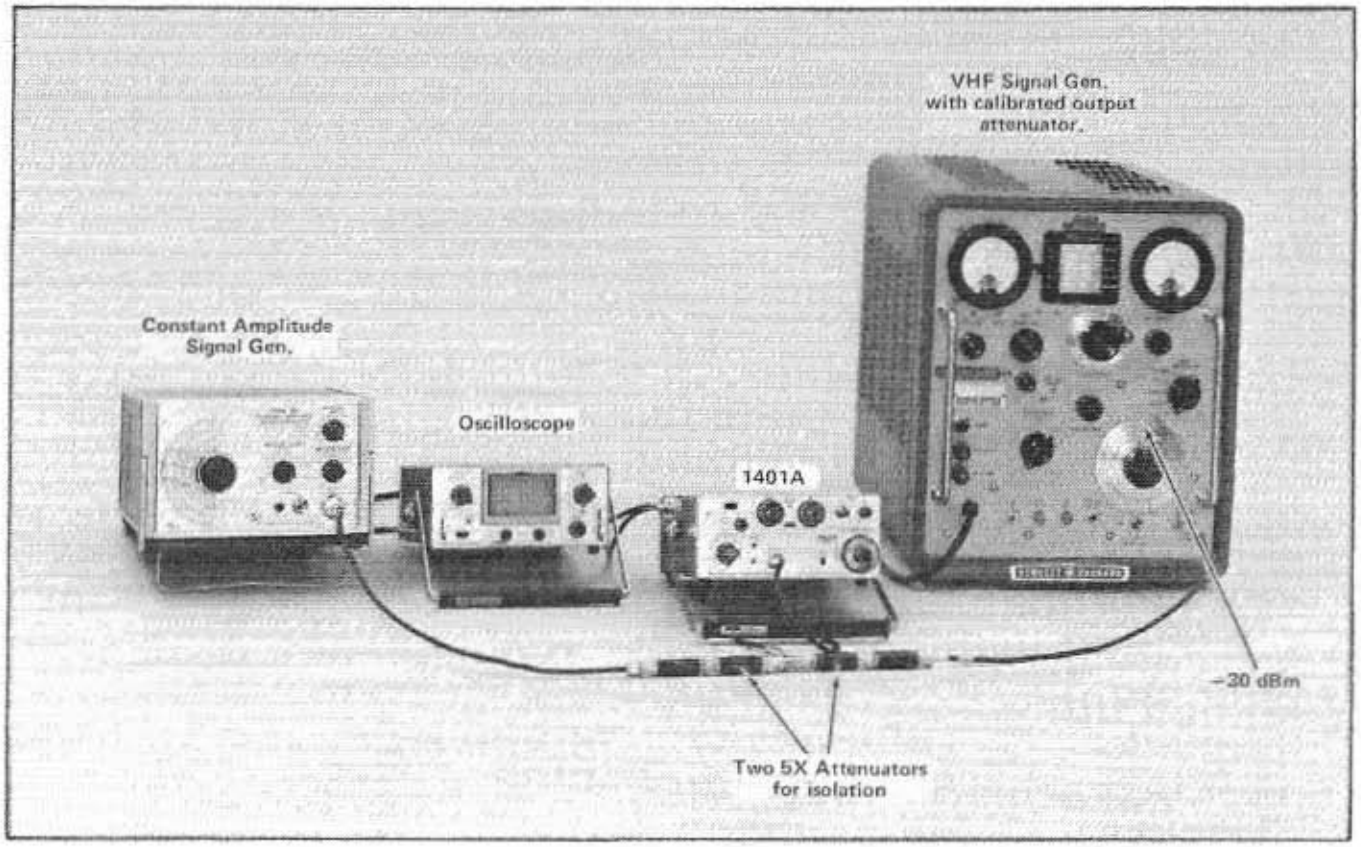


Fig. 5-6. Equipment setup to check intermodulation distortion.

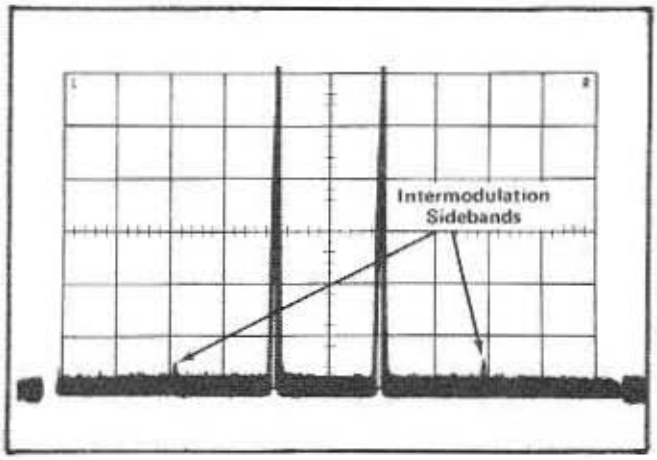


Fig. 5-7. Typical display when measuring intermodulation distortion.

c. Turn the SWEEP RATE control through its range and change the oscilloscope Time/Div setting to check the range of the RATE control. Sweep rate should vary from about 1 sweep/second to 100 sweeps/second or more.

d. CHECK—The sweep voltage amplitude must equal 5 V peak to ±0.35 V.

15. Check External Trigger Operation

Requirement—Sweep will run when the 1401A is triggered from an external +1 V to +10 V source, with a duration at least .1 μs and a frequency 1 MHz or less (period 1 μs or more).

a. Apply the Output of the pulse generator through a coaxial cable, a BNC "T" connector, and a 50 Ω termination, to the TRIG IN connector of the 1401A. Connect one vertical Input of the dual trace test oscilloscope to the open end of the BNC "T" connector so the pulse generator output level can be monitored.

b. Connect the other vertical Input of the dual trace test oscilloscope to the SWEEP VOLTAGE output connector on the 1401A. Set the front panel controls as follows:

	1401A
SWEEP MODE	TRIG IN
SWEEP RATE	FAST

Test Oscilloscope	
Time/Div	1 ms
Volts/Div	
Ch 1	1
Ch 2	2
Mode	Alt

c. Apply a +1 V pulse with a duration of 2 ms and a period of 4 ms to the TRIG IN connector of the 1401A.

d. CHECK—The test oscilloscope display for a sweep output.

e. CHECK—The external trigger amplitude range by varying the pulse generator output from +1 V to +10 V. Return the output level to +1 V.

f. CHECK—The minimum duration characteristic by decreasing the pulse duration to 1 µs.

g. CHECK—The frequency characteristic by decreasing the period to 1 µs (pulse duration must equal 1 µs for 50% duty factor).

16. Check External Sweep-Voltage-In Operation

Requirement—An external voltage of 0 V to 5 V will sweep the 1401A with 0 V corresponding to 0 Hz, and 5 V corresponding to 500 MHz.

a. Set the front panel controls as follows:

FREQ SPAN MHz/DIV	50 (SEARCH)
RESOLUTION kHz	1000
VERTICAL DISPLAY	LIN
RF ATTEN dB	50

b. Apply 2 ns markers (500 MHz) from the time-mark generator to the INPUT 50 Ω connector of the 1401 and adjust the IF GAIN control for full screen display amplitude.

c. Disconnect the time-mark generator output signal to the INPUT connector of the 1401 and apply 1 MHz from the constant amplitude signal generator. Adjust the generator output for a full screen display amplitude.

d. Switch the SWEEP MODE to EXT IN position. Apply an external 0 V to 5 V DC voltage source (2101 Pulse Generator Pulse Mode in Output Latched On position) through a BNC "T" connector to the SWEEP VOLTAGE EXT IN connector. Monitor this voltage with a DC coupled test oscilloscope, by connecting the test oscilloscope input to the open end of the BNC connector.

e. Increase the voltage of the DC source from 0 V until the display baseline shifts to the top of the screen, indicating the 1401A is tuned to 1 MHz. Input voltage should measure approximately 1 volt.

f. Disconnect the 1 MHz signal and apply 500 MHz (2 ns) from the time-mark generator to the 1401A INPUT.

g. Increase the DC source voltage towards 5 volts checking for baseline shift to the top of the screen near 5 volts, to indicate the 1401A is tuned to receive 500 MHz.

17. Check Gate Operation

Ratio between gated and non-gated portion of the display should equal or exceed 50 dB.

a. Apply a signal to the 1401A INPUT. Tune the CENTER FREQ to the signal, then open the display by switching the FREQ SPAN selector to about 1 MHz/DIV.

b. Switch VERTICAL DISPLAY to LOG then adjust signal level and/or the GAIN of the 1401A so the signal amplitude is full screen.

c. Switch GATE ON and OFF and note whether it affects the display. Without a termination on the GATE input connector, the switch position should have no effect.

d. Connect a DC termination (50 Ω to 100 Ω) on the GATE connector.

e. CHECK—Switch in the OFF position should not affect the display; however, with the switch in the ON position, the signal level should decrease 50 dB or more.

f. Apply a –4 V gate signal to the termination or a –4 V gate from a DC coupled low-impedance source (2101 Pulse Generator) directly to the connector.

g. CHECK—Gating signal should reverse the function. With the switch in the OFF position, signal should be down 50 dB during the gating action.

18. Check Calibrator Output Level and Frequency

The frequency of 50 MHz can be checked with an accurate frequency counter, such as Tektronix 7000 Series Oscilloscope with 7D14 Counter Plug-In Unit. The output is checked by comparing it to an accurate reference level. The accurate reference level is established by using an accurate power meter capable of measuring −30 dBm within 0.1 dB to set the signal generator output; such as General Microwave Power Meter Model 454A. An accurate power meter that will measure −10 dBm, such as Hewlett Packard Model 432A, can also be used with a calibrated attenuator to set the −30 dBm reference level. The following procedures describe these two methods:

The Calibrator output level is affected by the −10 V supply; therefore, the supply voltage should be checked if the Calibrator output level is not within specifications before making any adjustment.

Because the Calibrator output contains harmonics of the 50 MHz fundamental, power output can not be measured directly.

Using an accurate (within 0.1 dB) −30 dBm, 50 Ω Signal Source: (signal source can be calibrated with an accurate power meter).

a. Change the vertical deflection factor of the oscilloscope (Volts/Div from 0.2 V to .02; 20 mV/Div). This gain of 10 changes the graticule calibration from 10 dB/Div to 1 dB/Div.

b. Apply a −30 dBm signal to the INPUT 50 Ω connector of the 1401A. Signal frequency should equal approximately 50 MHz.

c. Set the VERTICAL DISPLAY to LOG and switch the VIDEO FILTER ON.

d. Tune the CENTER FREQ to the input signal and position the top of the signal on the graticule center line with the Gain or RF ATTEN dB selector and oscilloscope Position control. Open the display to about 1 MHz/Div with the FREQ SPAN selector for more accurate positioning. This establishes −30 dBm reference.

e. Remove the reference signal from the INPUT 50 Ω connector, then connect a coaxial cable between the CAL OUTPUT and INPUT 50 Ω connectors.

f. Push the CAL ON button and tune the 50 MHz calibrator signal on screen so its amplitude can be compared against the reference.

g. CHECK—Calibrator 50 MHz fundamental signal level must equal −30 dBm ±0.3 dB (within 0.5 major division of the reference).

This completes the performance check for the 1401A and indicates, when completed, that the instrument has performed within the specifications listed in Section 1.

NOTES

SECTION 6
CALIBRATION ADJUSTMENT PROCEDURE

Change information, if any, affecting this section will be found at the rear of the manual.

This section provides procedural information on internal checks and adjustments. Performing the complete procedure will recalibrate the instrument to its original specifications. After calibration, its performance should be verified by the Performance Check.

Limits, tolerances, and waveforms provided in the calibration steps are guides or aids to calibrating the instrument. They are not intended as instrument specifications; for example, power supply voltages and ripple tolerance. Actual values may exceed the listed tolerance with no loss in instrument performance.

Complete or Partial Calibration

Before performing a complete calibration, the instrument should be cleaned and inspected as outlined in the Maintenance section. Perform all checks and adjustments in sequence for a complete calibration, then verify the performance of the instrument by the Performance Check.

Some circuits within this instrument are inherently stable, and some require extensive facilities with expensive test equipment for calibration. For this reason, it may be desirable to perform only a partial calibration. For partial calibration, turn to the desired step and prepare the instrument for adjustment by referring to the nearest setup figure and control instructions preceding the step.

History Information

The manual and instrument are subjected to a program of constant evaluation and updating, circuits are modified, etc. This requires changes in calibration procedures. History information applicable to earlier instruments is included either as a deviation within the step(s) or as a subpart to a step. These are clearly indicated.

Interaction

Adjustments that interact are noted and reference made to the affected adjustments.

Equipment Required

Equipment necessary for this procedure is the same as the performance check requirements plus the following:

DC Voltmeter, checked to within 1% at 3.6 V, 10 V, and 50 V. For example; Triplett Model 630-NA.

Adapter: BNC female to subminiature (Sealectro ®) male. Sealectro Part No. 51-077-6801.

Adapter: Sealectro to multi-pin connector. Tektronix Part No. 175-1204-00 (Cable assembly W175 between J175 and P210 can be used).

Adapter: Jumper cable, 6 inches long, with two pin connectors on each end. Use to connect between P208 (pins 3 and 4) to P228 (pins 1 and 2).

CALIBRATION RECORD AND INDEX

The following abridged procedure provides a calibration record, an index to help locate steps within the procedure, and a guide for the experienced calibrator.

SHORT FORM PROCEDURE

1401A, Serial No. _____

Calibration Date _____

Calibrator _____

Preliminary Procedure

NOTE

The following calibration/adjustment procedure is applicable over an ambient temperature range of +20°C to +30°C after the instrument has a warmup period, with power ON, of at least 25 minutes.

1. Check the front panel controls for smooth operation and proper indexing.

2. Remove the cabinet from the 1401A.

3. Using the AC power cord, connect the power pack of the 1401 to an AC line voltage source which is within the voltage and frequency requirements of the instrument.

NOTE

The power pack is used only for the first two power supply and regulator adjustments.

4. Connect the VIDEO OUT from the 1401A to the Input for one channel of a dual trace test oscilloscope. Set the Volts/Div selector to .2. Connect a test probe to the second channel of the dual trace test oscilloscope and set the Volts/Div to 1. Connect the SWEEP OUT to the Ext Horiz Input on the test oscilloscope and switch the Horizontal Display to External Horizontal 1X position.

5. Apply 500 MHz signal (2 ns time-markers) to the INPUT 50 Ω connector of the 1401A.

6. Adjust the IF GAIN control and the RF ATTEN dB selector until the 0 Hz response and the 500 MHz signal are visible.

7. Position the 0 Hz response at the zero vertical graticule line, then adjust the oscilloscope Variable Horizontal Gain to position the 500 MHz signal under the last (10th) division line. This calibrates the sweep length to the frequency span of the 1401A. Some overlap may be visible at the start and end of the display.

POWER SUPPLY

Power supply voltages and ripple tolerance are maintenance guides and not performance specifications. Actual voltage values can vary outside these listed tolerances with no adverse effects on the instrument performance. Changing voltage levels may affect the calibration of some circuits; therefore, performance should be checked if any voltage levels are changed.

1. Set Battery Charging Current for Power Pack

a. Remove the battery pack from the instrument and connect it to an AC power source. Switch the battery pack charge selector to FULL CHG position.

b. Connect the DC voltmeter across R615 (Fig. 6-1). The positive lead should be connected to the bottom of R615. Be sure the negative lead of the voltmeter is isolated from ground.

c. Check—Meter should read 54 millivolts, ±3 millivolts (180 milliamps, ±10 milliamps).

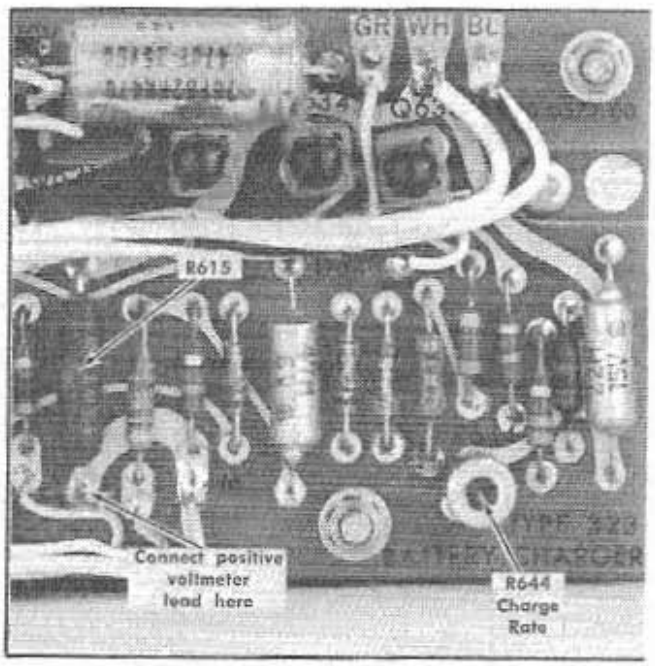


Fig. 6-1. Location of R615 and Charge Rate adjustment (Power Pack board).

d. ADJUST—Charge Rate adjustment, R644 (Fig. 6-1), for a meter reading of 54 millivolts.

e. Set the Power Pack switch (rear panel of power pack) to TRICKLE CHG.

f. CHECK—Meter reading should read approximately 20 millivolts.

g. Disconnect the DC voltmeter and re-install the battery pack. Connect the battery pack to an AC power source and set the charge selector to TRICKLE CHG position.

2. Check/Adjust Power Regulation Voltages

NOTE

The output level of the Calibrator is proportional to the −10 V supply (about 1 dB/Volt). The Calibrator output must be checked and adjusted if the −10 V supply is changed.

a. Remove the power regulator shield cover by pressing in on the side wall of the shield box just below the cover indentation, and lifting off. (A small screwdriver will reach the side wall without taking the power pack out.)

b. Connect an accurate (within 1%) voltmeter between chassis ground and the +10 V pre-regulated supply (Fig. 6-2).

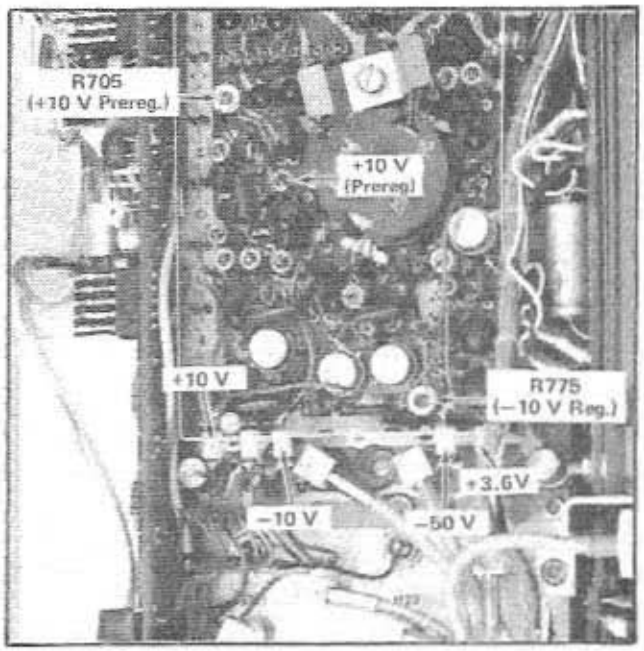


Fig. 6-2. Power regulator test points and adjustments.

c. CHECK—Voltage level should measure between 10.7 V and 11.0 V.

d. Adjust R705 (Fig. 6-2), if necessary, to bring the +10 V pre-regulated supply within limits.

e. Connect the voltmeter between −10 V regulated supply and ground.

f. CHECK—Voltage must measure −10 V ±0.1 V.

g. Adjust R775 (Fig. 6-2) to bring −10 V supply within limits.

h. CHECK—Voltage of remaining regulated supplies (+10 V, +3.6 V, −50 V, −6.4 V). See Fig. 6-2. Voltages should measure within 2% of that specified.

i. Connect test oscilloscope probe to the −10 V, +10 V and +3.6 V regulated supplies and check ripple content. Ripple should not exceed 15 mV.

j. Insure that the heat sink is properly installed on transistor Q718, then replace the cover on the power regulator shield.

IF AMPLIFIER AND RF CIRCUIT ALIGNMENT (Sensitivity and Resolution Bandwidth)

Most instruments will require only minor adjustments to be within sensitivity or bandpass specifications; therefore, two procedures are provided. The first procedure is detailed enough to bring a completely misaligned instrument within the requirements for the second procedure. The second is a general alignment procedure that is applicable for an instrument that is partially aligned.

Preparing the 1401A for RF and IF Alignment

The battery pack must be removed and placed on top of the power regulator (see Fig. 6-6) to gain access to the RF alignment adjustments, or an external DC power source must be used to replace the battery pack.

3. Detailed Alignment Procedure to Prepare for General Alignment

This procedure should be used to prepare a badly misaligned instrument for the general alignment procedure.

a. Test equipment setup is shown in Fig. 6-3.

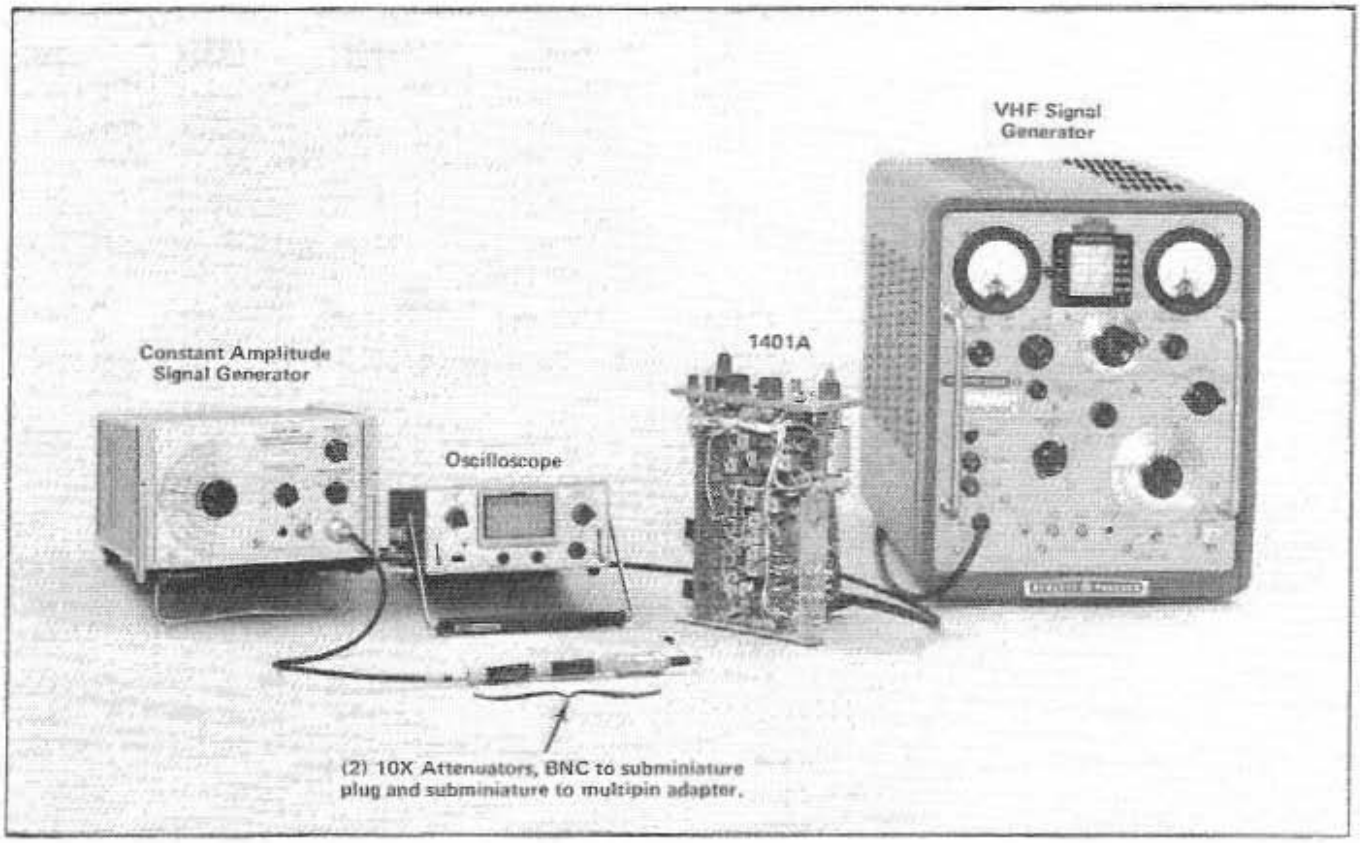


Fig. 6-3. Equipment setup for RF and IF alignment.

b. Apply a 5 MHz signal from the Constant Amplitude Signal Generator, through two (2) 10X attenuators, a 50 Ω coaxial cable, BNC to Sealectro adapter (see Equipment Required list), and a Sealectro to multi-pin connector cable (Part No. 175-1204-00), to the input of the 100 kHz filter, at J280 (Fig. 6-4). Set the RESOLUTION kHz selector to 100 position.

NOTE

Cable assembly W175 between J175 and P210 can be removed and used as the Sealectro to multi-pin connector adapter.

c. Carefully tune the signal generator to 5 MHz for maximum deflection. Insure that the circuit responds to only 5 MHz by decreasing the input signal level until only one response is present as you tune across 5 MHz, then switch the RESOLUTION kHz selector to 3 kHz position and carefully adjust the signal generator frequency for maximum response. (This will be a very sharp response point, due to the filter action of the 5 MHz crystal in the 3 kHz filter.)

d. With the RESOLUTION kHz selector at the 3 kHz position, adjust the 100 kHz filter, with T288, T286, T284, T282, and T280 (Fig. 6-4), for maximum response. Decrease the input signal level as needed to keep the display on screen. Oscilloscope deflection factor should be 0.2 V/Div.

e. Adjust 5 MHz IF transformer T370 (Fig. 6-4) for maximum response.

f. Remove the signal generator connection to J280 and replace multi-pin connector P280.

g. Remove P228 (Fig. 6-4) and apply 25 MHz signal from the VHF signal generator to the input of T240.

h. Change the RESOLUTION kHz selector to 100 and adjust the IF GAIN control for some indication of noise.

i. Adjust T252 (30 MHz oscillator) for maximum response, then adjust T258, T268, T248, and T240 for maximum sensitivity.

Decrease the signal input level as the IF stages are aligned, and tune about 25 MHz to insure you are not

Fig. 6-4. IF circuit board, showing location of test points and adjustments.

observing some spurious signal that may be generated within the IF stages when they are overdriven.

j. Remove the signal generator connection to J228 and reconnect multi-pin connector P228. Remove P210 and apply 25 MHz signal from the signal generator to J210 (Fig. 6-4).

k. Adjust T208, T210, T240, T248, and the 1 MHz filter, T222, T224, T226, T228 (Fig. 6-4) for maximum sensitivity or response to the 25 MHz signal.

Insure again that the signal level is not overdriving the IF stages and generating spurious signals.

l. Remove the signal generator connection to J210 and re-connect multi-pin connector P210. Remove P161 and apply 695 MHz, from the UHF signal generator to J161 (input to 695 MHz filter, see Fig. 6-5).

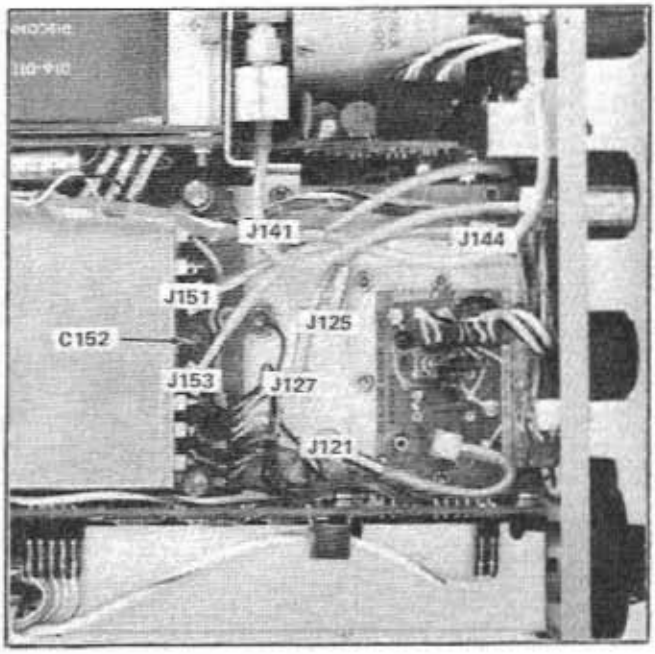


Fig. 6-5. Connections to the RF circuits and location of bandpass filter adjustment C152 (Gate Calibrator board removed).

m. Carefully tune to 695 MHz and adjust the generator output until some response is noted.

n. Adjust the 720 MHz oscillator with C187 (Fig. 6-6), until the signal generator frequency for maximum response is 695 MHz.

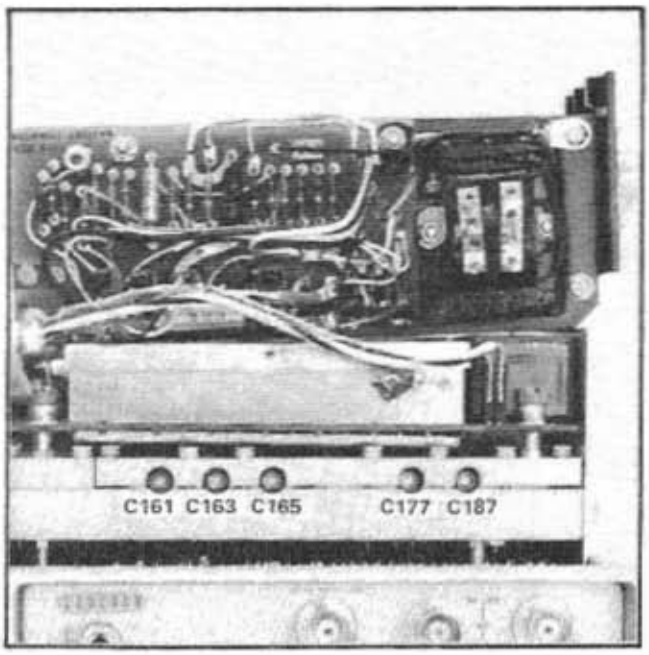


Fig. 6-6. 695 MHz Filter, 720 MHz oscillator, and 2nd converter adjustments (Power pack removed).

o. Keeping the input signal level as low as practical, adjust the 695 MHz filter, with C161, C163, and C165 (Fig. 6-6) plus the converter adjustments R385 (Fig. 6-7), C177 (Fig. 6-6), and C171 (Fig. 6-8) for optimum sensitivity.

p. Remove the signal generator connection to J161, and reconnect P161.

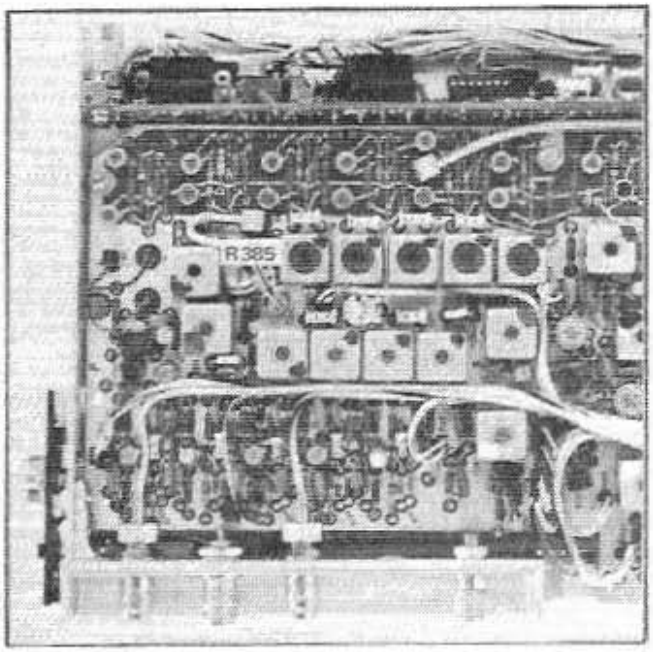


Fig. 6-7. Mixer bias adjustment R385.

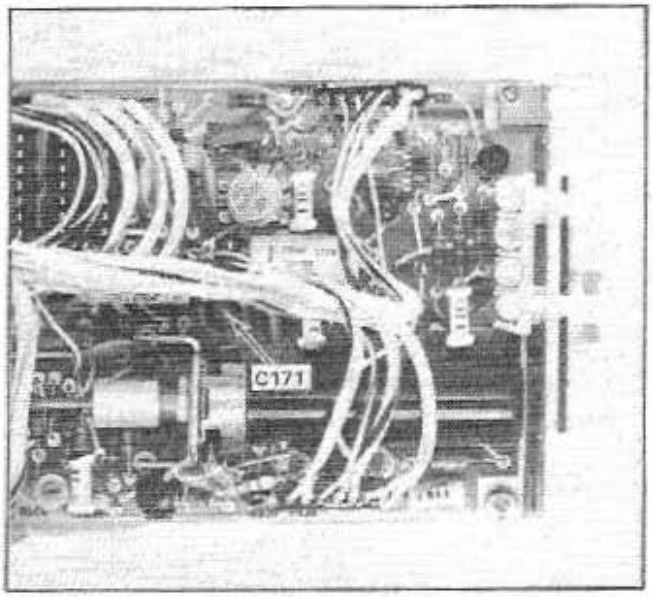


Fig. 6-8. Location of C171 for idler tank circuit adjustment.

This completes the preliminary alignment for the RF and IF circuits. Proceed with the general alignment procedure to complete the alignment.

4. General Alignment of RF and IF Sections

If the sensitivity is approximately 50 dBm down, or the bandpass characteristics are outside specifications, the following procedure can be used to align the IF and RF circuits.

Before proceeding with the IF alignment, insure that the RF ATTENuator is not the problem by checking the sensitivity with the attenuator bypassed. Apply the signal to J141 to bypass the RF Attenuator.

a. Use the VHF signal generator with the variable output attenuator. Apply a signal within 1 MHz to 500 MHz frequency range, to the INPUT 50 Ω connector of the 1401A.

b. Set the 1401A front panel controls as follows:

CENTER FREQ MHz	Frequency of the applied signal
FREQ SPAN MHz/DIV	.5
RESOLUTION kHz	100
VERTICAL DISPLAY	LIN

c. Adjust the IF GAIN control and the RF ATTEN dB selector for about 2 divisions of signal amplitude. Center the signal in the graticule area with the CENTER FREQ MHz control or the signal generator frequency control.

d. If sensitivity is within specifications but bandwidth is incorrect, proceed to step h.

e. The following describes the procedure to use when aligning the RF circuits. Adjusting the mixer efficiency in the converter or the output of the 695 MHz filter will pull the 720 MHz oscillator. Correct this by adjusting C187. Adjust each adjustment for maximum sensitivity. Most adjustments will require retouching because of interaction.

1) Adjust the 695 MHz Filter, with C161, C163, C165 (Fig. 6-6) for maximum sensitivity.

2) Adjust Band Pass Filter with C152 (Fig. 6-5) for maximum response.

3) Adjust mixer bias with R385 (Fig. 6-8) and mixer coupling with C177 for maximum sensitivity. Note how much the adjustment pulls the 720 MHz converter oscillator.

4) Adjust the idler tank circuit with C171 (Fig. 6-9) for maximum response then readjust the oscillator frequency with C187 to return the oscillator to approximately the same frequency. The main objective in this procedure is optimum sensitivity, the oscillator can therefore be off frequency a few kHz (approximately 200) if the sensitivity is improved.

5) Retouch the mixer bias R385, C177, and C187 in the output section of the 695 MHz filter.

6) Adjust the Band Pass Filter, with C152, for maximum sensitivity.

f. The following steps describe the adjustment procedure for the IF amplifier and filter circuits.

1) Adjust the IF transformers, T268, T258, T248, T240, T208, T210, (Fig. 6-4) and the 100 kHz filter with T280, T282, T284, T286, T288 for maximum sensitivity.

2) Switch the RESOLUTION to 3 kHz position then adjust the 30 kHz oscillator, with T252, for maximum response. Return the RESOLUTION kHz selector to the 100 position. The 100 kHz response must appear directly over the 3 kHz response, if it does not, retouch the IF and filter adjustments.

g. Remove the signal generator connection to the INPUT connector, then apply 20 ns and 1 µs markers from the time-mark generator to the INPUT of the 1401. Switch the VIDEO FILTER selector ON.

h. Adjust the VARIABLE FREQ SPAN control so the graticule is calibrated to 100 kHz/Div (one 1 µs marker/10 divisions). Tune one of the signals to the graticule center so bandwidth can be checked.

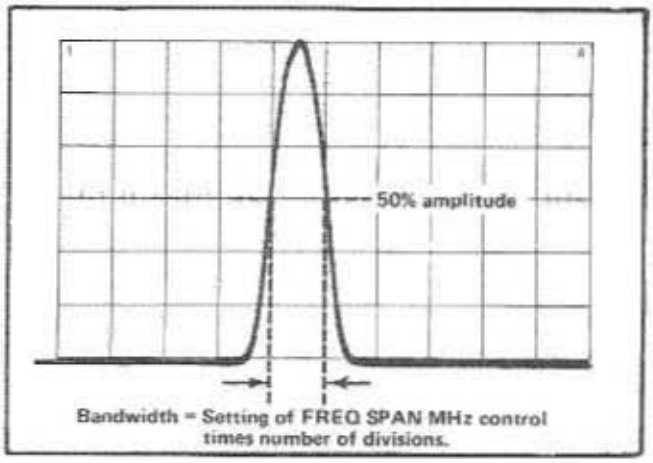


Fig. 6-9. Measuring resolution bandwidth.

i. CHECK—The bandwidth (6 dB down point) of the response. Bandwidth should equal 100 kHz ±10%, see Fig. 6-9.

j. Change the time-markers to 20 ns and .1 µs and switch the FREQ SPAN MHz/DIV selector to 2 MHz position. Calibrate the display to 1000 kHz/Div by adjusting the VARIABLE (FREQ SPAN) control for 1 marker/10 divisions.

k. Pull multipin connectors P228 and P208 (Fig. 6-4). Bypass the 1 MHz filter by connecting a cable (jumper cable with multipin connector at each end) between P208 (pins 3 and 4) and P228 (pins 1 and 2).

l. Tune a marker to the center of the display, switch the RESOLUTION kHz selector to 1000 and adjust the IF GAIN control so the signal amplitude is full screen (6 div), LIN mode.

m. Stagger tune T258, T268 and T370 to increase the bandwidth of the signal to at least 1 MHz at the 6 dB (half amplitude) level. Tune the adjustments for optimum symmetry. Signal level will decrease as the bandwidth is increased, therefore, the IF GAIN will require re-adjustment to maintain full screen signal amplitude. Usually 1 MHz bandwidth is obtained when the signal level has dropped about 6 dB.

n. Remove the jumper cable around the 1 MHz filter and reconnect P208 and P228. Signal bandwidth and amplitude will decrease with the filter installed. Return the signal amplitude to full screen with the IF GAIN control.

o. Adjust the 1 MHz coupling capacitor C224 for optimum bandwidth with symmetrical skirts.

p. Stagger tune the 1 MHz filter transformers (T224 and T226) symmetrically to obtain 1 MHz bandwidth. Switch to LOG mode and observe the skirt base to make the final filter adjustments for optimum symmetry. Bandwidth must equal 1000 kHz ±10%.

This completes the alignment of the RF and IF circuits. Refer to the Performance section and check the instrument sensitivity and bandwidth characteristics.

5. Frequency Span and Center Frequency Accuracy

Frequency span and center frequency adjustments interact; therefore, this step is divided into four sub-steps under

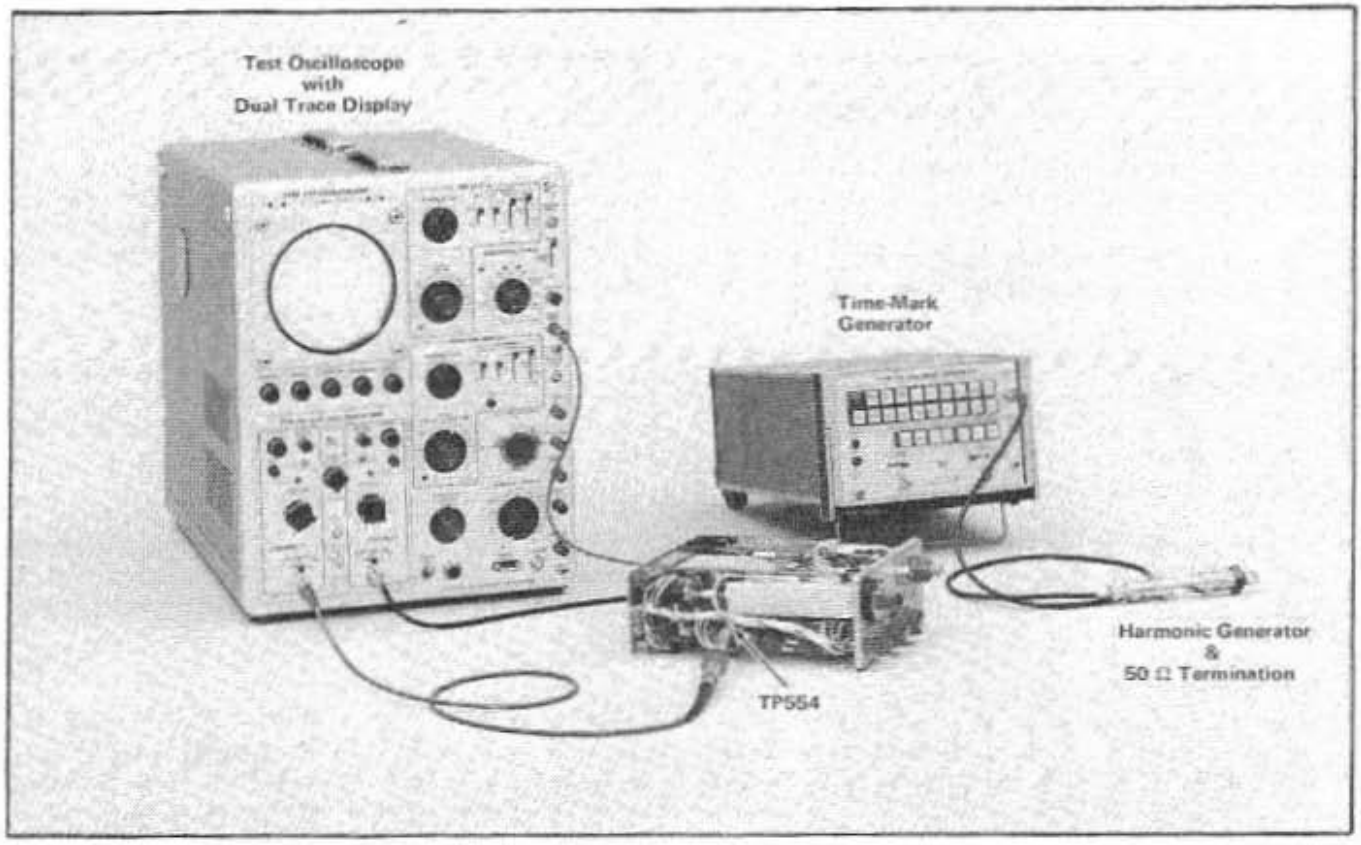


Fig. 6-10. Equipment setup for frequency span and center frequency adjustments.

this general heading. Each sub-step may be performed individually provided the other circuits are calibrated.

a. Preliminary adjustment.

1) Test equipment setup is shown in Fig. 6-10.

2) Connect the VIDEO output to Ch 1 Input of a dual trace test oscilloscope and a 10X probe to Ch 2 Input. Connect the SWEEP output of the 1401 to the Ext Horiz Input and set the front panel controls as follows:

1401

FREQ SPAN MHz/DIV	0
CENTER FREQ MHz	000
SWEEP MODE	FREE RUN
RATE	Fully clockwise

Oscilloscope

Vertical Mode	Chop
Volts/Div	
Ch 1	.2
Ch 2	.1
Horiz Display	Ext Horiz

3) Connect the probe to TP554 (Fig. 6-11) and preset CF Bal R540 to midrange. Adjust the test oscilloscope External Horizontal Gain for about 10.5 division display with equal overscan at each end.

4) Adjust R555, CF Centering (Fig. 6-11) for 0 V at TP 554.

5) Switch the FREQ SPAN MHz/DIV selector to SEARCH position and adjust R550, Search CF, so the sweep sawtooth crosses 0 V at the 0 division line. See Fig. 6-12.

6) Switch FREQ SPAN MHz/DIV to 20 and adjust the CENTER FREQ MHz control until the center of the sweep crosses a graticule reference point.

7) Adjust R540 CF Bal, so the sweep rotates around its center point as the FREQ SPAN MHz/DIV is switched between 20 and 0 positions.

8) Turn sweep shaper adjustments R415 (Fig. 6-13) and Sweep Linearity adjustment R850 (Fig. 6-11) fully counterclockwise. Turn the remaining sweep shaper adjustments R405, R410 through R475 (Fig. 6-13) fully clockwise.

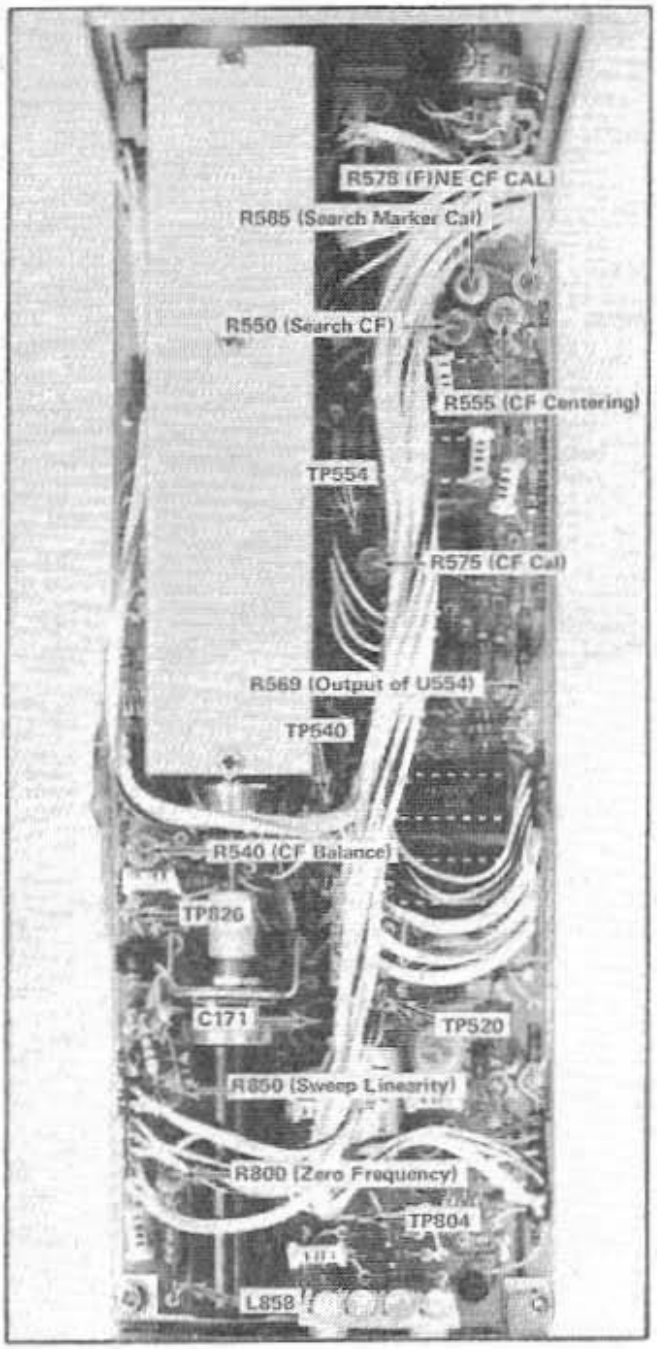


Fig. 6-11. Location of test points and adjustments on the sweep circuit board.

9) Remove the probe from TP 554 and connect it to TP 826 (Fig. 6-11). Set the vertical sensitivity for the probe channel to 0.5 V/Div. Switch the Input Coupling to GND position and position the sweep to the top graticule line for 0 V reference. Switch the Input Coupling to DC position and the FREQ SPAN MHz/DIV to SEARCH. The display should resemble the illustration of Fig. 6-14.

10) Set the FREQ SPAN MHz/DIV selector to SEARCH position. Adjust R800 (Zero Freq adjustment)

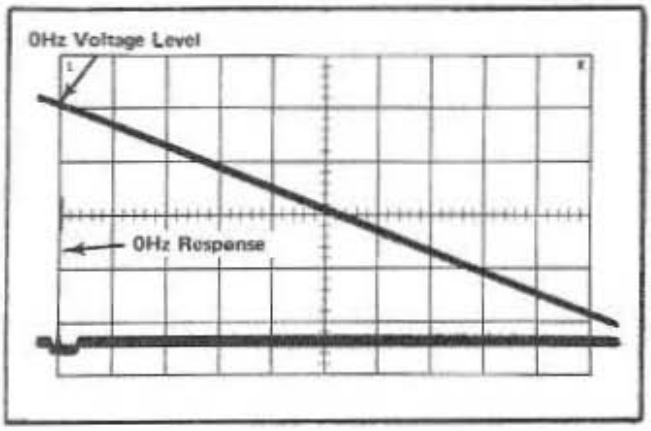


Fig. 6-12. Display when adjusting center frequency adjustment R550.

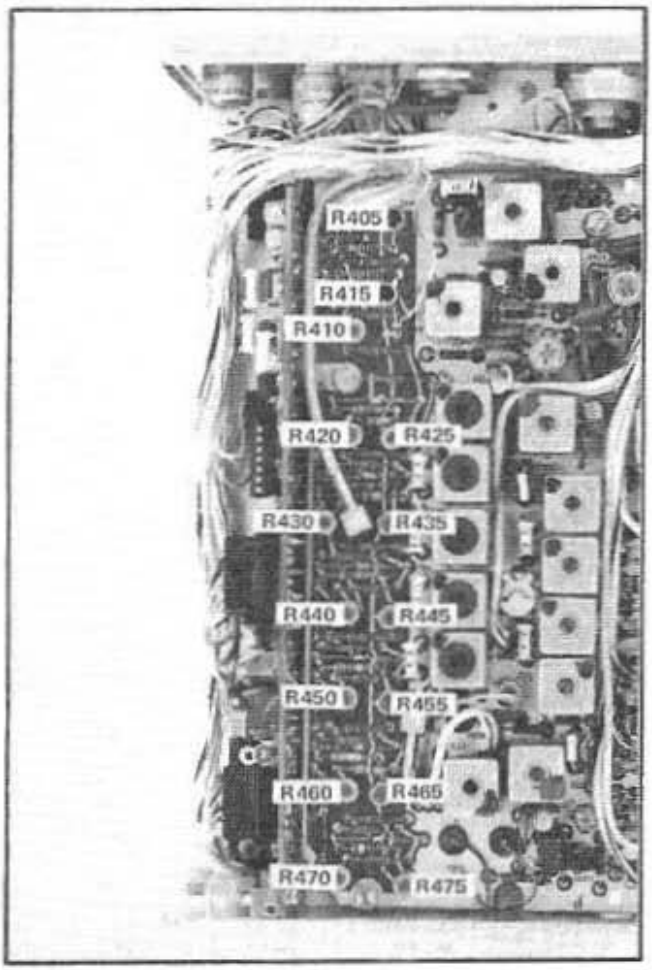


Fig. 6-13. Location of the sweep shaper adjustments.

so the sweep ramp start level, at the far left graticule line, is approximately −2.2 volts. (There should be about 0.25 div. over-scan at the left and right graticule edges.)

11) Adjust R850 (Sweep Linearity, see Fig. 6-11) clockwise until the 0 Hz response appears at the left edge of the video display. (See Fig. 6-14.) It may be necessary to decrease the setting of R800 if 0 Hz can not be brought on screen. At this time move the probe back to TP554 and check to insure the sweep ramp crosses 0 V at the 0 Hz response position. Re-adjust R555 and R550 if necessary.

12) Check the voltage difference between the ends of resistor R108, (Fig. 6-15) on the oscillator current source board, with a DC coupled probe. Voltage difference should equal about 0.5 volt. Re-adjust R850 and R800 if necessary. (This voltage indicates the current drawn by the variable capacitance diodes in the oscillator circuit.) The amount of compensating current required for optimum frequency span linearity can only be determined when adjusting the sweep shaper reverse compensation in step b.

b. Adjust the Sweep Shaper

1) Set the FREQ SPAN MHz/DIV selector to 10 and adjust the CENTER FREQ MHz control to position the 0 Hz response to the 1st division line.

2) Apply 10 ns and .1 µs markers through the Harmonic Generator to the INPUT of the 1401.

3) Adjust R405 (Fig. 6-13) counterclockwise, to increase the sweep slope, until the frequency span (dispersion) of the first one or two markers pulls into 1 marker/division. Fig. 6-14 illustrates a typical display at this point.

4) Adjust the sweep shaper reverse compensation (slope) with R410 and R415 for optimum linearity over the first few divisions (usually 20 to 50 MHz) of dispersion. R415 and R410 adjust the amount of reverse slope to the sweep ramp and compensate for the current that the varactors draw near 0 V. Their effect on the display is opposite to the effect that will be noticed with the remaining sweep shaper adjustments.

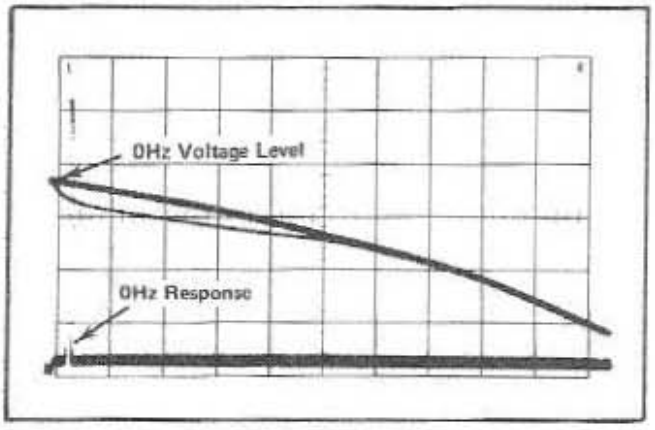


Fig. 6-14. Typical display of waveform at TP826 when sweep shaper adjustments are turned fully clockwise.

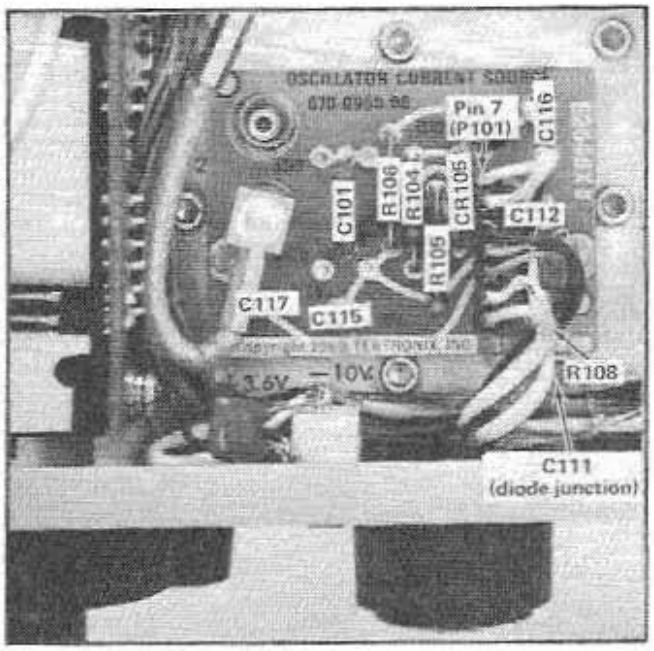


Fig. 6-15. Oscillator current source circuit board showing location R108 (C111) and P101 (Gate Calibrator board removed).

Adjust R410 to bring the break point of the compensation into the sector of the display that needs to be expanded then adjust R415 for the amount of expansion. It will be necessary to re-adjust R405 for best dispersion accuracy. If the dispersion between the 0 Hz response and the 1st marker is greater than the dispersion between the 1st and 2nd marker, decrease the current through the diodes by resetting the bias level with R800 and R850 (steps a-10, a-11, and a-12). This level is critical so shift only a small amount at a time.

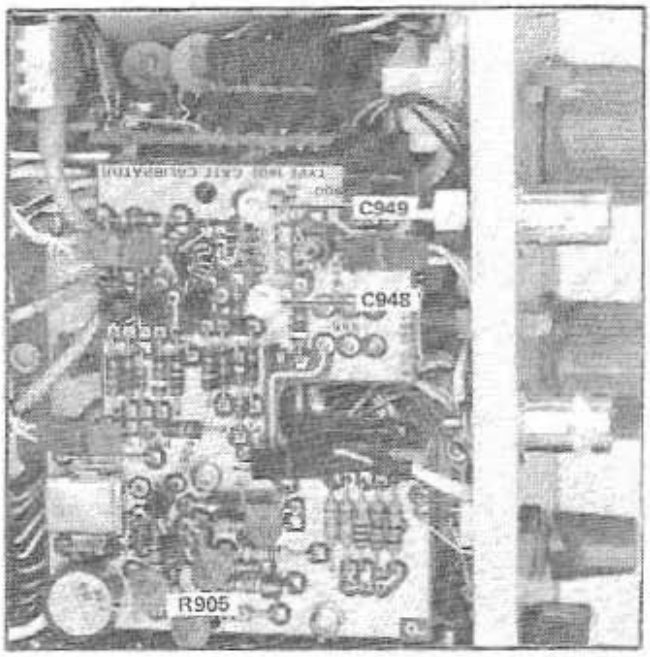


Fig. 6-16. Location of gate balancing adjustments.

5) Tune the display higher in frequency with the CENTER FREQ MHz control to the next portion that requires correction. Adjust the sweep compensation with R420 and R425 for optimum frequency span accuracy and linearity. Turn R425 slightly counterclockwise then adjust R420 to bring the break point into the sector that needs correction. Adjust R425 for amount of correction.

6) Continue tuning the display up in frequency towards 500 MHz, progressively adjusting the remaining shaper circuits for best dispersion accuracy and linearity.

7) Apply 2 ns (500 MHz) signal from the time-mark generator to the INPUT of the 1401A and check to insure the frequency span includes 500 MHz. If it does not, reset the bias level of the varactor diodes with R800 and R850 and repeat the procedure.

8) Recheck the frequency span accuracy and linearity. If any portion is not within specifications (±10%) preset all adjustments back to this point and repeat the procedure from this point forward.

c. Calibrate CENTER FREQ MHz Control

1) Apply 20 ns markers through the Harmonic Generator to the INPUT of the 1401A. Insure that the FINE control dial is set to 0.

2) Select 250 MHz signal (5th marker from 0 Hz) and set the CENTER FREQ MHz 1-500 dial to read 250; then, open the display by decreasing the FREQ SPAN MHz/DIV setting to about 1.

3) Adjust R555, CF Centering, (Fig. 6-11) to position a 250 MHz signal at screen center.

4) Switch the FREQ SPAN MHz/DIV selector back to SEARCH position.

5) Adjust R550, Search CF, (Fig. 6-11) to position the 250 MHz signal at the center graticule line.

6) Tune the CENTER FREQ MHz control to select another frequency, such as 400 MHz, on the display. Adjust R575, CF Cal, (Fig. 6-11) to position the signal at the center graticule line as the FREQ SPAN MHz/DIV selector setting is decreased towards 0.

d. Adjust Search Marker

1) Tune the CENTER FREQ MHz to any signal on the display. Open the display by decreasing the FREQ SPAN MHz/DIV selection towards 0, keeping the signal centered on screen with the CENTER FREQ MHz control.

2) Switch the FREQ SPAN MHz/DIV selector back to SEARCH position.

3) Adjust R585 (Fig. 6-11) to position the frequency marker (notch) under the selected signal.

e. Calibrate FINE Control Range

1) Apply 20 MHz and .1 µs markers through the Harmonic Generator to the INPUT of the 1401.

2) Set the FREQ SPAN MHz/DIV selector to 1 MHz. Turn the FINE control to the −1 MHz position (fully counterclockwise).

3) Select one of the 1 MHz markers and position it to a reference graticule line with the CENTER FREQ MHz 1-500 control.

4) Turn the FINE control through its range to the +1 MHz position (fully clockwise) and note the shift in MHz of the 1 MHz marker.

5) Adjust R578 so the control range for the FINE control is 2 MHz (±1 MHz from 0).

6) Return the FINE control to 0 setting.

This completes the frequency span and center frequency adjustments

6. Adjust Linearity Amplifier Gain

a. Set the front panel selectors of the 1401A as follows:

VERTICAL DISPLAY	LOG
RF ATTEN dB	60
FREQ SPAN MHz/DIV	SEARCH
RESOLUTION kHz	1000

b. Apply a 200 MHz signal from the VHF signal generator or time-mark generator to the INPUT of the 1401.

c. Adjust the IF GAIN control, from a fully counterclockwise position, clockwise until the noise level starts to shift the baseline of the display (approximately 0.25 div. noise).

d. Decrease the RF ATTEN dB selector position until the signal amplitude is approximately 3/4 screen. Decrease FREQ SPAN MHz/DIV selector setting to 1 to open the display.

e. Switch the VERTICAL DISPLAY to LIN and adjust Lin Cal R55, on the Linear Amplifier circuit board, for a signal amplitude that equals the LOG display (3/4 screen).

7. Adjust Balance of Gating Circuit

a. Apply a signal to the 1401A INPUT. Tune the CENTER FREQ to the signal frequency and open the display to about 1 MHz/DIV with the FREQ SPAN selector.

b. Switch the VERTICAL DISPLAY to LOG. Adjust the signal level and/or GAIN of the 1401A so the signal amplitude is full screen.

c. Connect a DC termination (50 Ω to 100 Ω) to the GATE input connector and switch the GATE function switch ON.

d. Adjust C948 and C949 (Fig. 6-16) for minimum signal amplitude.

8. Check and Adjust Calibrator Output Level and Frequency

The frequency of 50 MHz can be checked with an accurate frequency counter, such as Tektronix 7000 Series Oscilloscope with 7D14 Counter Plug-In Unit. The output is checked by comparing it to an accurate reference level. The accurate reference level is established by using an accurate power meter capable of measuring −30 dBm within 0.1 dB to set the signal generator output; such as General Microwave Power Meter Model 454A. An accurate power meter that will measure −10 dBm, such as Hewlett Packard Model 432A, can also be used with a calibrated attenuator to set the −30 dBm reference level. The following procedures describe these two methods:

The Calibrator output level is affected by the −10 V supply; therefore, the supply voltage should be checked if the Calibrator output level is not within specifications before making any adjustment.

Because the Calibrator output contains harmonics of the 50 MHz fundamental, power output can not be measured directly.

Method 1: Using an accurate (within 0.1 dB) −30 dBm, 50 Ω Signal Source; (signal source can be calibrated with an accurate power meter).

a. Change the vertical deflection factor of the oscilloscope (Volts/Div from 0.2 V to .02; 20 mV/Div). This gain of 10 changes the graticule calibration from 10 dB/Div to 1 dB/Div.

b. Apply a −30 dBm signal to the INPUT 50 Ω connector of the 1401A. Signal frequency should equal approximately 50 MHz.

c. Set the VERTICAL DISPLAY to LOG and switch the VIDEO FILTER ON.

d. Tune the CENTER FREQ to the input signal and position the top of the signal on the graticule center line with the Gain or RF ATTEN dB selector and oscilloscope Position control. Open the display to about 1 MHz/Div with the FREQ SPAN selector for more accurate positioning. This establishes −30 dBm reference.

e. Remove the reference signal from the INPUT 50 Ω connector, then connect a coaxial cable between the CAL OUTPUT and INPUT 50 Ω connectors.

f. Push the CAL ON button and tune the 50 MHz calibrator signal on screen so its amplitude can be compared against the reference.

g. CHECK—Calibrator 50 MHz fundamental signal level must equal −30 dBm ±0.3 dB (within 0.5 major division of the reference).

h. ADJUST—If necessary, remove the instrument from its case and adjust the output level of the calibrator with R905 (Fig. 6-17) until it equals −30 dBm.

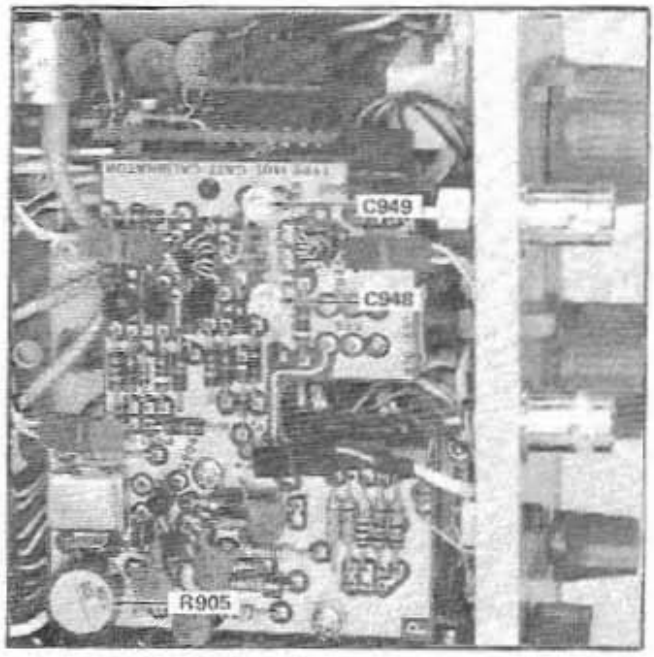


Fig. 6-17 Calibrator and Gating circuit adjustments.

Method 2: If power meter is calibrated to −10 dBm.

This method requires a pre-calibrated 20 dB attenuator, a power meter accurate to −10 dBm and a 50 MHz signal source with a variable output to at least −10 dBm.

a. Use a power meter to set the output of a 50 MHz signal source so its output plus the calibrated attenuator equals −30 dBm. −30 dBm = (Generator Output + Calibrated Attenuator.)

b. Apply the above calibrated signal to the 1401A INPUT and establish a reference level on the graticule as described in Method 1.

c. Apply the CAL OUT signal to the INPUT and compare.

d. ADJUST—If necessary, adjust R905 until the CAL OUTPUT equals −30 dBm.

NOTE

For maximum accuracy the same cable that is used to calibrate the Calibrator output should be used to connect to the signal source.

This concludes the Calibration procedure. The instrument should now meet all requirements called for in the Performance section.

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.

SPECIAL NOTES AND SYMBOLS

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

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

ACTR	ACTUATOR	PLSTC	PLASTIC
ASSY	ASSEMBLY	QTZ	QUARTZ
CAP	CAPACITOR	RECP	RECEPTACLE
CER	CERAMIC	RES	RESISTOR
CKT	CIRCUIT	RF	RADIO FREQUENCY
COMP	COMPOSITION	SEL	SELECTED
CONN	CONNECTOR	SEMICOND	SEMICONDUCTOR
ELCTLT	ELECTROLYTIC	SENS	SENSITIVE
ELEC	ELECTRICAL	VAR	VARIABLE
INCAND	INCANDESCENT	WW	WIREWOUND
LED	LIGHT EMITTING DIODE	XFMR	TRANSFORMER
NONWIR	NON WIREWOUND	XTAL	CRYSTAL

CROSS INDEX—MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City. State. Zip
0000M	SONY/TEKTRONIX CORPORATION	P O BOX 14, HANEDA AIRPORT	TOKYO 149, JAPAN
00853	SANGAMO ELECTRIC CO., S. CAROLINA DIV.	P O BOX 128	PICKENS, SC 29671
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
04222	AVX CERAMICS, DIVISION OF AVX CORP.	P O BOX 867, 19TH AVE. SOUTH	MURTLE BEACH, SC 29577
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
05091	TRI-ORDINATE CORPORATION	343 SNYDER AVENUE	BERKELEY HEIGHTS, NJ 07922
07263	FAIRCHILD SEMICONDUCTOR, A DIV. OF FAIRCHILD CAMERA AND INSTRUMENT CORP.	464 ELLIS STREET	MOUNTAIN VIEW, CA 94042
07910	TELEDYNE SEMICONDUCTOR	12515 CHADRON AVE.	HAWTHORNE, CA 90250
10369	CHICAGO SWITCH, INC.	2035 WABANSIA AVE.	CHICAGO, IL 60647
12969	UNITRODE CORPORATION	580 PLEASANT STREET	WATERTOWN, MA 02172
14140	EDISON ELECTRONICS DIV., MCGRAW EDISON CO.	GRENIER FIELD-MUNICIPAL AIRPORT	MANCHESTER, NH 03130
19209	GENERAL ELECTRIC CO., ELECTRONIC CAPACITOR AND BATTERY PRODUCTS DEPT. BATTERY PRODUCTS SEC.	P. O. BOX 114	GAINESVILLE, FL 32601
24136	INTERNATIONAL ELECTRONIC CORP.	316 S SERVICE RD,HUNTINGTON STA	MELVILLE, L.I., NY 11746
27014	NATIONAL SEMICONDUCTOR CORP.	2900 SEMICONDUCTOR DR.	SANTA CLARA, CA 95051
28480	HEWLETT-PACKARD CO., CORPORATE HQ.	1501 PAGE MILL RD.	PALO ALTO, CA 94304
32436	SYSCON INTERNATIONAL, INC.	205 SYCAMORE ST.	SOUTH BEND, IN 46622
32997	BOURNS, INC., TRIMPOT PRODUCTS DIV.	1200 COLUMBIA AVE.	RIVERSIDE, CA 92507
56289	SPRAGUE ELECTRIC CO.		NORTH ADAMS, MA 01247
60418	TORSION BALANCE COMPANY	125 ELLSWORTH P O BOX 535	CLIFTON, NJ 07012
72982	ERIE TECHNOLOGICAL PRODUCTS, INC.	644 W. 12TH ST.	ERIE, PA 16512
73138	BECKMAN INSTRUMENTS. INC., HELIPOT DIV.	2500 HARBOR BLVD.	FULLERTON, CA 92634
73899	JFD ELECTRONICS COMPONENTS CORP.	PINETREE ROAD	OXFORD, NC 27565
74970	JOHNSON, E. F., CO.	299 10TH AVE. S. W.	WASECA, MN 56093
75042	TRW ELECTRONIC COMPONENTS, IRC FIXED RESISTORS, PHILADELPHIA DIVISION	401 N. BROAD ST.	PHILADELPHIA, PA 19108
75915	LITTELFUSE, INC.	800 E. NORTHWEST HWY	DES PLAINES, IL 60016
76493	BELL INDUSTRIES, INC., MILLER, J. W., DIV.	19070 REYES AVE., P O BOX 5825	COMPTON, CA 90224
78488	STACKPOLE CARBON CO.		ST. MARYS, PA 15857
80009	TEKTRONIX, INC.	P O BOX 500	BEAVERTON, OR 97077
80294	BOURNS, INC., INSTRUMENT DIV.	6135 MAGNOLIA AVE.	RIVERSIDE, CA 92506
80740	BECKMAN INSTRUMENTS, INC.	2500 HARBOR BLVD.	FULLERTON, CA 92634
81483	INTERNATIONAL RECTIFIER CORP.	9220 SUNSET BLVD.	LOS ANGELES, CA 90069
91637	DALE ELECTRONICS, INC.	PO BOX 609	COLUMBUS, NE 68601
91836	KINGS ELECTRONICS CO., INC.	40 MARBLEDALE ROAD	TUCKAHOE, NY 10707
98291	SEALECTRO CORPORATION	225 HOYT	MAMARONECK, NY 10544

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
	119-0233-00			CKT BOARD ASSY:HYBRID OSCILLATOR	80009	119-0233-00
	670-0330-00			CKT BOARD ASSY:SECOND CONVERTER	80009	670-0330-00
	670-0331-00			CKT BOARD ASSY:695 MHZ FILTER	80009	670-0331-00
	670-0332-00			CKT BOARD ASSY:LOW PASS FILTER	80009	670-0332-00
	670-0334-00			CKT BOARD ASSY:WIDE BAND MIXER	80009	670-0334-00
	670-0364-00			CKT BOARD ASSY:VARIABLE RESISTOR SOCKET	80009	670-0364-00
	670-0577-00			CKT BOARD ASSY:BATTERY CHARGER	80009	670-0577-00
	670-0950-00			CKT BOARD ASSY:OSCILLATOR CURRENT	80009	670-0950-00
A1	119-0240-00			RF MODULE ASSY:	80009	119-0240-00
A2	670-0329-01			CKT BOARD ASSY:IF	80009	670-0329-01
A3	670-0327-00			CKT BOARD ASSY:VERTICAL DISPLAY	80009	670-0327-00
A4	670-0333-02	B020400	B040979	CKT BOARD ASSY:SWEEP	80009	670-0333-02
A4	670-0333-03	B040980	B071489	CKT BOARD ASSY:SWEEP	80009	670-0333-03
A4	670-0333-04	B071490		CKT BOARD ASSY:SWEEP	80009	670-0333-04
A5	670-0328-00	B020400	B049999	CKT BOARD ASSY:POWER REGULATOR	80009	670-0328-00
A5	670-0328-01	B050000	B069999	CKT BOARD ASSY:POWER REGULATOR	80009	670-0328-01
A6	670-0328-02	B070000		CKT BOARD ASSY:POWER REGULATOR	80009	670-0328-02
A6	670-1651-00			CKT BOARD ASSY:GATE CALIBRATOR	80009	670-1651-00
A7	016-0119-02			CKT CARD ASSY:W/BATTERY SET	80009	016-0119-02
AT5	119-0231-01			ATTENUATOR,VAR:0-60 DB IN 10DB STEPS	04423	8181-S
AT10[1]	119-0303-00			ATTENUATOR,FXD:50-75 OHM,W/CAP	80009	119-0303-00
BT611	146-0011-01			BATTERY,DRY:	19209	41B002AA63
C30	283-0167-00			CAP.,FXD,CER DI:0.1UF,10%,100V	72982	8131N145X5R0104K
C40	283-0167-00			CAP.,FXD,CER DI:0.1UF,10%,100V	72982	8131N145X5R0104K
C52	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-558Z5U-103Z
C53	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-558Z5U-103Z
C59	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	72982	831-516E102P
C62	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-558Z5U-103Z
C66	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	72982	831-516E102P
C82	283-0060-00			CAP.,FXD,CER DI:100PF,5%,200V	72982	855-535U2J101J
C101	283-0059-00			CAP.,FXD,CER DI:1UF,+80-20%,25V	72982	8141N037Z5U0105Z
C110[2]						
C111	281-0720-01			CAP.,FXD,CER DI:1750PF,+80-20%,250V	80009	281-0720-01
C112	281-0720-01			CAP.,FXD,CER DI:1750PF,+80-20%,250V	80009	281-0720-01
C113[2]						
C114[2]						
C115	281-0720-01			CAP.,FXD,CER DI:1750PF,+80-20%,250V	80009	281-0720-01
C116	281-0720-01			CAP.,FXD,CER DI:1750PF,+80-20%,250V	80009	281-0720-01
C117	281-0720-01			CAP.,FXD,CER DI:1750PF,+80-20%,250V	80009	281-0720-01
C121	283-0156-00			CAP.,FXD,CER DI:1000PF,+100-0%,200V	72982	8111A208Z5U0102Z
C123	283-0156-00			CAP.,FXD,CER DI:1000PF,+100-0%,200V	72982	8111A208Z5U0102Z
C125	283-0156-00			CAP.,FXD,CER DI:1000PF,+100-0%,200V	72982	8111A208Z5U0102Z
C127	283-0156-00			CAP.,FXD,CER DI:1000PF,+100-0%,200V	72982	8111A208Z5U0102Z
C128	281-0720-01			CAP.,FXD,CER DI:1750PF,+80-20%,250V	80009	281-0720-01
C129	281-0720-01			CAP.,FXD,CER DI:1750PF,+80-20%,250V	80009	281-0720-01
C131	283-0260-00			CAP.,FXD,CER DI:5.6PF,5%,200V	72982	8111B200C0G569C
C133	283-0260-00			CAP.,FXD,CER DI:5.6PF,5%,200V	72982	8111B200C0G569C
C135	283-0260-00			CAP.,FXD,CER DI:5.6PF,5%,200V	72982	8111B200C0G569C
C137	283-0260-00			CAP.,FXD,CER DI:5.6PF,5%,200V	72982	8111B200C0G569C
C139	283-0260-00			CAP.,FXD,CER DI:5.6PF,5%,200V	72982	8111B200C0G569C
C141	283-0260-00			CAP.,FXD,CER DI:5.6PF,5%,200V	72982	8111B200C0G569C

[1] 1401A-1 only.
[2] Replaceable under 155-0041-00.

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
C143	283-0260-00			CAP.,FXD,CER DI:5.6PF,5%,200V	72982	8111B200C0G569C
C145	283-0260-00			CAP.,FXD,CER DI:5.6PF,5%,200V	72982	8111B200C0G569C
C147	283-0260-00			CAP.,FXD,CER DI:5.6PF,5%,200V	72982	8111B200C0G569C
C149	283-0260-00			CAP.,FXD,CER DI:5.6PF,5%,200V	72982	8111B200C0G569C
C152	281-0165-00			CAP.,VAR,AIR DI:0.8-10PF,250V	73899	MVM-010W
C161	281-0164-00			CAP.,VAR AIR DI:0.6-6PF,250V	73899	MVM-006W
C163	281-0164-00			CAP.,VAR AIR DI:0.6-6PF,250V	73899	MVM-006W
C165	281-0164-00			CAP.,VAR AIR DI:0.6-6PF,250V	73899	MVM-006W
C171	281-0164-00			CAP.,VAR AIR DI:0.6-6PF,250V	73899	MVM-006W
C173	281-0720-01			CAP.,FXD,CER DI:1750PF,+80-20%,250V	80009	281-0720-01
C174	283-0156-00			CAP.,FXD,CER DI:1000PF,+100-0%,200V	72982	8111A208Z5U0102Z
C176	283-0135-00			CAP.,FXD,CER DI:100PF,5%,500V	56289	40C321A
C177	281-0164-00			CAP.,VAR AIR DI:0.6-6PF,250V	73899	MVM-006W
C179[1]						
C181	281-0720-01			CAP.,FXD,CER DI:1750PF,+80-20%,250V	80009	281-0720-01
C183	281-0609-00			CAP.,FXD,CER DI:1PF,+/-0.1PF,500V	72982	374-005C0K0109B
C184	281-0720-01			CAP.,FXD,CER DI:1750PF,+80-20%,250V	80009	281-0720-01
C185	281-0670-00			CAP.,FXD,CER DI:1.8PF,+/-0.1PF,500V	72982	374-005C0K0189B
C186	283-0135-00			CAP.,FXD,CER DI:100PF,5%,500V	56289	40C321A
C187	281-0164-00			CAP.,VAR AIR DI:0.6-6PF,250V	73899	MVM-006W
C189[1]						
C205	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	72982	831-516E102P
C208	283-0004-00			CAP.,FXD,CER DI:0.02UF,+80-20%,150V	72982	855-558-Z5V0203Z
C209	283-0026-00			CAP.,FXD,CER DI:0.2UF,+80-20%,25V	56289	274C3
C212	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-558Z5U-103Z
C222	281-0592-00			CAP.,FXD,CER DI:4.7PF,+/-0.5PF,500V	72982	301-023C0H0479D
C224	281-0076-00			CAP.,VAR,AIR DI:1.2-3.5PF,800V	74970	189-1-5
C226	281-0592-00			CAP.,FXD,CER DI:4.7PF,+/-0.5PF,500V	72982	301-023C0H0479D
C238	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-558Z5U-103Z
C240	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	72982	831-516E102P
C244	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-558Z5U-103Z
C246	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-558Z5U-103Z
C247	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-558Z5U-103Z
C251	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-558Z5U-103Z
C253	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-558Z5U-103Z
C254	283-0600-00			CAP.,FXD,MICA D:43PF,5%,500V	00853	D105E430J0
C256	281-0580-00			CAP.,FXD,CER DI:470PF,10%,500V	04222	7001-1374
C258	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-558Z5U-103Z
C259	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-558Z5U-103Z
C261	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-558Z5U-103Z
C264	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-558Z5U-103Z
C266	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-558Z5U-103Z
C267	283-0059-00			CAP.,FXD,CER DI:1UF,+80-20%,25V	72982	8141N037Z5U0105Z
C278	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-558Z5U-103Z
C280	281-0592-00			CAP.,FXD,CER DI:4.7PF,+/-0.5PF,500V	72982	301-023C0H0479D
C282	281-0604-00			CAP.,FXD,CER DI:2.2PF,+/-0.25PF,500V	72982	301-000C0J0229C
C284	281-0604-00			CAP.,FXD,CER DI:2.2PF,+/-0.25PF,500V	72982	301-000C0J0229C
C286	281-0592-00			CAP.,FXD,CER DI:4.7PF,+/-0.5PF,500V	72982	301-023C0H0479D
C291	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-558Z5U-103Z
C297	283-0059-00			CAP.,FXD,CER DI:1UF,+80-20%,25V	72982	8141N037Z5U0105Z
C299	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-558Z5U-103Z
C303	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	72982	831-516E102P
C305	281-0599-00			CAP.,FXD,CER DI:1PF,+/-0.25PF,500V	72982	374001C0H109C

[1]Furnished as a unit with 670-0330-XX.

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
C308	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	72982	831-516E102P
C313	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	72982	831-516E102P
C315	281-0599-00			CAP.,FXD,CER DI:1PF,+/-0.25PF,500V	72982	374001C0H109C
C318	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	72982	831-516E102P
C323	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	72982	831-516E102P
C325	281-0599-00			CAP.,FXD,CER DI:1PF,+/-0.25PF,500V	72982	374001C0H109C
C328	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	72982	831-516E102P
C333	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	72982	831-516E102P
C335	281-0599-00			CAP.,FXD,CER DI:1PF,+/-0.25PF,500V	72982	374001C0H109C
C338	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	72982	831-516E102P
C343	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	72982	831-516E102P
C345	281-0599-00			CAP.,FXD,CER DI:1PF,+/-0.25PF,500V	72982	374001C0H109C
C348	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	72982	831-516E102P
C353	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	72982	831-516E102P
C361	283-0059-00			CAP.,FXD,CER DI:1UF,+80-20%,25V	72982	8141N037Z5U0105Z
C363	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-558Z5U-103Z
C367	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-558Z5U-103Z
C373	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-558Z5U-103Z
C376	283-0059-00			CAP.,FXD,CER DI:1UF,+80-20%,25V	72982	8141N037Z5U0105Z
C501	285-0629-00			CAP.,FXD,PLSTC:0.047UF,20%,100V	56289	410P47301
C502	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	72982	831-516E102P
C507	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	72982	831-516E102P
C516	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	72982	831-516E102P
C520	285-0809-00			CAP.,FXD,PLSTC:1UF,10%,50V	56289	LP66A1A105K
C521	281-0513-00			CAP.,FXD,CER DI:27PF,+/-5.4PF,500V	72982	301-000P2G0270M
C523	283-0026-00			CAP.,FXD,CER DI:0.2UF,+80-20%,25V	56289	274C3
C525	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-558Z5U-103Z
C529	283-0026-00			CAP.,FXD,CER DI:0.2UF,+80-20%,25V	56289	274C3
C554	281-0513-00			CAP.,FXD,CER DI:27PF,+/-5.4PF,500V	72982	301-000P2G0270M
C558	281-0513-00			CAP.,FXD,CER DI:27PF,+/-5.4PF,500V	72982	301-000P2G0270M
C574	281-0513-00			CAP.,FXD,CER DI:27PF,+/-5.4PF,500V	72982	301-000P2G0270M
C576	283-0026-00			CAP.,FXD,CER DI:0.2UF,+80-20%,25V	56289	274C3
C599	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	72982	831-516E102P
C605	290-0287-00			CAP.,FXD,ELCTLT:47UF,20%,25V	56289	30D476X0025CC4
C623	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-558Z5U-103Z
C636	290-0114-01			CAP.,FXD,ELCTLT:47UF,6V	0000M	290-0114-01
C701	290-0309-00			CAP.,FXD,ELCTLT:100UF,20%,25V	56289	109D107X0025F2
C704	283-0051-00			CAP.,FXD,CER DI:0.0033UF,5%,100V	72982	8131N145C0G033AJ
C709	283-0238-00			CAP.,FXD,CER DI:0.01UF,10%,50V	72982	8121N075X7R0103K
C713	283-0114-00			CAP.,FXD,CER DI:0.0015UF,5%,200V	72982	805-509B152J
C715	283-0114-00			CAP.,FXD,CER DI:0.0015UF,5%,200V	72982	805-509B152J
C721	290-0134-00			CAP.,FXD,ELCTLT:22UF,20%,15V	56289	150D226X0015B2
C722	290-0134-00			CAP.,FXD,ELCTLT:22UF,20%,15V	56289	150D226X0015B2
C727	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-558Z5U-103Z
C731	283-0059-00			CAP.,FXD,CER DI:1UF,+80-20%,25V	72982	8141N037Z5U0105Z
C738	283-0059-00			CAP.,FXD,CER DI:1UF,+80-20%,25V	72982	8141N037Z5U0105Z
C739	290-0167-00			CAP.,FXD,ELCTLT:10UF,20%,15V	56289	150D106X0015B2
C741	290-0134-00			CAP.,FXD,ELCTLT:22UF,20%,15V	56289	150D226X0015B2
C742	290-0134-00			CAP.,FXD,ELCTLT:22UF,20%,15V	56289	150D226X0015B2
C749	283-0059-00			CAP.,FXD,CER DI:1UF,+80-20%,25V	72982	8141N037Z5U0105Z
C752	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8121-N088Z5U104M
C758	283-0164-00			CAP.,FXD,CER DI:2.2UF,20%,25V	72982	8141N037Z5U0225M
C759	290-0167-00			CAP.,FXD,ELCTLT:10UF,20%,15V	56289	150D106X0015B2

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
C761	290-0134-00			CAP.,FXD,ELCTLT:22UF,20%,15V	56289	150D226X0015B2
C762	290-0134-00			CAP.,FXD,ELCTLT:22UF,20%,15V	56289	150D226X0015B2
C765	283-0059-00			CAP.,FXD,CER DI:1UF,+80-20%,25V	72982	8141N037Z5U0105Z
C772	283-0059-00			CAP.,FXD,CER DI:1UF,+80-20%,25V	72982	8141N037Z5U0105Z
C776	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8121-N088Z5U104M
C778	290-0134-00			CAP.,FXD,ELCTLT:22UF,20%,15V	56289	150D226X0015B2
C779	290-0167-00			CAP.,FXD,ELCTLT:10UF,20%,15V	56289	150D106X0015B2
C782	283-0059-00			CAP.,FXD,CER DI:1UF,+80-20%,25V	72982	8141N037Z5U0105Z
C791	290-0305-00			CAP.,FXD,ELCTLT:3UF,20%,150V	56289	109D305X0150C2
C792	290-0305-00			CAP.,FXD,ELCTLT:3UF,20%,150V	56289	109D305X0150C2
C798	283-0178-00			CAP.,FXD,CER DI:0.1UF,+80-20%,100V	72982	8131N145 E 104Z
C799	290-0327-00			CAP.,FXD,ELCTLT:0.56UF,20%,100V	56289	150D564X0100A2
C804	281-0513-00			CAP.,FXD,CER DI:27PF,+/-5.4PF,500V	72982	301-000P2G0270M
C808	281-0513-00			CAP.,FXD,CER DI:27PF,+/-5.4PF,500V	72982	301-000P2G0270M
C821	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-558Z5U-103Z
C827	283-0190-00			CAP.,FXD,CER DI:0.47UF,5%,50V	72982	8141N077X7R0474J
C829	281-0547-00			CAP.,FXD,CER DI:2.7PF,10%,500V	72982	301-000C0J0279C
C833	283-0047-00			CAP.,FXD,CER DI:270PF,5%,500V	72982	0831522Z5D00271J
C836	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-558Z5U-103Z
C850	281-0513-00			CAP.,FXD,CER DI:27PF,+/-5.4PF,500V	72982	301-000P2G0270M
C901	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	72982	831-516E102P
C904	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	72982	831-516E102P
C907	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	72982	831-516E102P
C913	283-0176-00			CAP.,FXD,CER DI:0.0022UF,20%,50V	72982	8121B058X7R0222M
C921	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	72982	831-516E102P
C945	283-0191-00			CAP.,FXD,CER DI:0.022UF,20%,50V	72982	8121N075Z5U0223M
C948	281-0151-00			CAP.,VAR,CER DI:1-3PF,100V	72982	518-600A1-3
C949	281-0151-00			CAP.,VAR,CER DI:1-3PF,100V	72982	518-600A1-3
C956	283-0191-00			CAP.,FXD,CER DI:0.022UF,20%,50V	72982	8121N075Z5U0223M
C960	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	72982	831-516E102P
C962	283-0191-00			CAP.,FXD,CER DI:0.022UF,20%,50V	72982	8121N075Z5U0223M
CR12	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR81	152-0322-00			SEMICOND DEVICE:SILICON,15V,HOT CARRIER	28480	5082-2672
CR82	152-0322-00			SEMICOND DEVICE:SILICON,15V,HOT CARRIER	28480	5082-2672
CR105	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR112[1]						
CR113[1]						
CR121	153-0044-00			SEMICOND DVC SE:SILICON,15V,MATCHED	80009	153-0044-00
CR123	153-0044-00			SEMICOND DVC SE:SILICON,15V,MATCHED	80009	153-0044-00
CR125	153-0044-00			SEMICOND DVC SE:SILICON,15V,MATCHED	80009	153-0044-00
CR127	153-0044-00			SEMICOND DVC SE:SILICON,15V,MATCHED	80009	153-0044-00
CR167	152-0322-00			SEMICOND DEVICE:SILICON,15V,HOT CARRIER	28480	5082-2672
CR201	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR303	152-0322-00			SEMICOND DEVICE:SILICON,15V,HOT CARRIER	28480	5082-2672
CR306	152-0322-00			SEMICOND DEVICE:SILICON,15V,HOT CARRIER	28480	5082-2672
CR313	152-0322-00			SEMICOND DEVICE:SILICON,15V,HOT CARRIER	28480	5082-2672
CR316	152-0322-00			SEMICOND DEVICE:SILICON,15V,HOT CARRIER	28480	5082-2672
CR323	152-0322-00			SEMICOND DEVICE:SILICON,15V,HOT CARRIER	28480	5082-2672
CR326	152-0322-00			SEMICOND DEVICE:SILICON,15V,HOT CARRIER	28480	5082-2672
CR333	152-0322-00			SEMICOND DEVICE:SILICON,15V,HOT CARRIER	28480	5082-2672
CR336	152-0322-00			SEMICOND DEVICE:SILICON,15V,HOT CARRIER	28480	5082-2672
CR343	152-0322-00			SEMICOND DEVICE:SILICON,15V,HOT CARRIER	28480	5082-2672

[1] Replaceable under 155-0041-00.

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
CR346	152-0322-00			SEMICOND DEVICE:SILICON,15V,HOT CARRIER	28480	5082-2672
CR394	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR401	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR416	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR417	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR426	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR427	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR436	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR437	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR446	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR447	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR456	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR457	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR466	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR467	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR476	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR477	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR511	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR512	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR514	152-0402-00			SEMICOND DEVICE:TUNNEL,2.2MA,25PF	80009	152-0402-00
CR542	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR594	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR597	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR605	152-0107-00			SEMICOND DEVICE:SILICON,400V,400MA	80009	152-0107-00
CR610A-D	152-0107-00			SEMICOND DEVICE:SILICON,400V,400MA	80009	152-0107-00
CR637	152-0008-00			SEMICOND DEVICE:GERMANIUM,75V,60MA	80009	152-0008-00
CR638	152-0008-00			SEMICOND DEVICE:GERMANIUM,75V,60MA	80009	152-0008-00
CR715	152-0008-00			SEMICOND DEVICE:GERMANIUM,75V,60MA	80009	152-0008-00
CR721	152-0180-00			SEMICOND DEVICE:SILICON,10V,5A	80009	152-0180-00
CR741	152-0180-00			SEMICOND DEVICE:SILICON,10V,5A	80009	152-0180-00
CR761	152-0180-00			SEMICOND DEVICE:SILICON,10V,5A	80009	152-0180-00
CR791	152-0061-00			SEMICOND DEVICE:SILICON,175V,100MA	80009	152-0061-00
CR795	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR826	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR832	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR941	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR946 CR947 CR948 CR949	153-0044-00			SEMICOND DVC SE:SILICON,15V,MATCHED	80009	153-0044-00
CR951	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
CR953	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	80009	152-0141-02
F30	159-0064-00			FUSE,CARTRIDGE:1A,250V,10 SEC	75915	212001
F601	159-0080-00			FUSE,CARTRIDGE:0.2A,250V,SLOW BLOW	75915	213.200
F601	159-0074-00			FUSE,CARTRIDGE:0.1A,250V,200% SLOW-BLOW	75915	213.100
FL700	119-0230-00	B020400	B049999	FILTER,BANDPASS:5MHZ,CTR FREQ,3KHZ,6DB	80009	119-0230-00
FL700	119-0683-00	B050000		FILTER,BANDPASS:CTR FREQ 5MHZ,-6DB 10KHZ	34630	001-25220
J10	131-0818-00			CONNECTOR,RCPT,:BNC,FEMALE	91836	KC19-153BNC
J12	131-0818-00			CONNECTOR,RCPT,:BNC,FEMALE	91836	KC19-153BNC
J20	131-0955-00			CONNECTOR,RCPT,:BNC,FEMALE,W/HARDWARE	05091	31-279
J50	131-0955-00			CONNECTOR,RCPT,:BNC,FEMALE,W/HARDWARE	05091	31-279
J55	131-0955-00			CONNECTOR,RCPT,:BNC,FEMALE,W/HARDWARE	05091	31-279

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
J119	131-0938-00			CONNECTOR,RCPT,:50 OHM MALE SNAP-ON	98291	051-043-0349
J120	131-0938-00			CONNECTOR,RCPT,:50 OHM MALE SNAP-ON	98291	051-043-0349
J121	131-0951-00			CONNECTOR,RCPT,:SNAP-ON MALE	98291	051-051-0159-220
J125	131-0951-00			CONNECTOR,RCPT,:SNAP-ON MALE	98291	051-051-0159-220
J127	131-0951-00			CONNECTOR,RCPT,:SNAP-ON MALE	98291	051-051-0159-220
J141	131-0938-00			CONNECTOR,RCPT,:50 OHM MALE SNAP-ON	98291	051-043-0349
J149	131-0938-00			CONNECTOR,RCPT,:50 OHM MALE SNAP-ON	98291	051-043-0349
J151	131-0938-00			CONNECTOR,RCPT,:50 OHM MALE SNAP-ON	98291	051-043-0349
J153	131-0938-00			CONNECTOR,RCPT,:50 OHM MALE SNAP-ON	98291	051-043-0349
J161	131-0938-00			CONNECTOR,RCPT,:50 OHM MALE SNAP-ON	98291	051-043-0349
J175	131-0938-00			CONNECTOR,RCPT,:50 OHM MALE SNAP-ON	98291	051-043-0349
J611	136-0139-00			JACK,TIP:BANANA STYLE,W/RED CAP	80009	136-0139-00
J612	136-0140-00			JACK,TIP:BANANA STYLE,CHARCOAL GRAY CA	80009	136-0140-00
L20	276-0557-00			CORE,FERRITE:0.23 ID X 0.12 ID X 0.125	78488	57-0131
L21	276-0557-00			CORE,FERRITE:0.23 ID X 0.12 ID X 0.125	78488	57-0131
L30	108-0598-00	XB070000		COIL,RF:200UH	80009	108-0598-00
L32	108-0598-00	XB070000		COIL,RF:200UH	80009	108-0598-00
L110[1]						
L111[1]						
L112[1]						
L113[1]						
L115[1]						
L116	276-0528-00			SHIELDING BEAD,:0.1UH	02114	56-0590-65C/3B
L117[1]						
L151	108-0622-00			COIL,RF:20NH	80009	108-0622-00
L153	108-0622-00			COIL,RF:20NH	80009	108-0622-00
L171[1]						
L173	108-0249-00			COIL,RF:12UH	76493	70F125A1
L174	108-0262-00			COIL,RF:0.6UH	80009	108-0262-00
L181	108-0623-00			COIL,RF:180NH	80009	108-0623-00
L205	276-0528-00			SHIELDING BEAD,:0.1UH	02114	56-0590-65C/3B
L611A,B	108-0488-00			COIL,RF:150UH	80009	108-0488-00
L721	120-0382-00			XFMR,TOROID:14 TURNS,SINGLE	80009	120-0382-00
L722	120-0382-00			XFMR,TOROID:14 TURNS,SINGLE	80009	120-0382-00
L741	120-0382-00			XFMR,TOROID:14 TURNS,SINGLE	80009	120-0382-00
L742	120-0382-00			XFMR,TOROID:14 TURNS,SINGLE	80009	120-0382-00
L761	120-0382-00			XFMR,TOROID:14 TURNS,SINGLE	80009	120-0382-00
L762	120-0382-00			XFMR,TOROID:14 TURNS,SINGLE	80009	120-0382-00
L778	108-0493-00			COIL,RF:625UH	80009	108-0493-00
L791	120-0382-00			XFMR,TOROID:14 TURNS,SINGLE	80009	120-0382-00
L792	120-0382-00			XFMR,TOROID:14 TURNS,SINGLE	80009	120-0382-00
L858	108-0173-00	B020400	B071489	COIL,RF:1.59MH	80009	108-0173-00
L858	108-0691-00	B071490		COIL,RF:1.8MH	76493	70F183A1
L901	108-0666-00			COIL,RF:900NH	80009	108-0666-00
L907	276-0507-00			SHIELDING BEAD,:0.6UH	78488	57-0180-7D 500B
L908	276-0507-00			SHIELDING BEAD,:0.6UH	78488	57-0180-7D 500B
L913	108-0538-00			COIL,RF:2.7UH	76493	70F276A1
M30	149-0031-00	B020400	B059999	METER,BTRY LVL:0-350UA,15%,0.50 DIA,SCALE	24138	P-202
M30	149-0044-02	B060000		METER,BTRY LVL:1MA,345 OHMS,0.5 DIA	0000M	MURATA MC-12M
P601	131-0552-00			CONTACT,ELEC:SPL 3 PRONG MALE	0000M	131-0552-00
Q56	151-0198-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS918	80009	151-0198-00

[1] Replaceable under 155-0041-00.

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
Q62	151-0188-00			TRANSISTOR:SILICON,PNP	80009	151-0188-00
Q76	151-0190-01			TRANSISTOR:SILICON,NPN	80009	151-0190-01
Q84	151-0190-01			TRANSISTOR:SILICON,NPN	80009	151-0190-01
Q106	151-0190-01			TRANSISTOR:SILICON,NPN	80009	151-0190-01
Q113 [1]						
Q115 [1]						
Q184	151-0282-00	B020400	B039999	TRANSISTOR:SILICON,NPN	80009	151-0282-00
Q184	151-0367-00	B040000		TRANSISTOR:SILICON,NPN,SEL FROM 3571TP	80009	151-0367-00
Q204	151-0190-01			TRANSISTOR:SILICON,NPN	80009	151-0190-01
Q208	151-1040-00			TRANSISTOR:SILICON,FET,N-CHANNEL	02735	3N140
Q232	151-0190-01			TRANSISTOR:SILICON,NPN	80009	151-0190-01
Q252	151-0198-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS918	80009	151-0198-00
Q258	151-1040-00			TRANSISTOR:SILICON,FET,N-CHANNEL	02735	3N140
Q271	151-0190-01			TRANSISTOR:SILICON,NPN	80009	151-0190-01
Q294	151-0198-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS918	80009	151-0198-00
Q310	151-0277-00			TRANSISTOR:SILICON,NPN	04713	SRF774
Q320	151-0277-00			TRANSISTOR:SILICON,NPN	04713	SRF774
Q330	151-0277-00			TRANSISTOR:SILICON,NPN	04713	SRF774
Q340	151-0277-00			TRANSISTOR:SILICON,NPN	04713	SRF774
Q350	151-0277-00			TRANSISTOR:SILICON,NPN	04713	SRF774
Q370	151-0198-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS918	80009	151-0198-00
Q514	151-0190-01			TRANSISTOR:SILICON,NPN	80009	151-0190-01
Q532	151-0188-00			TRANSISTOR:SILICON,PNP	80009	151-0188-00
Q536	151-0190-01			TRANSISTOR:SILICON,NPN	80009	151-0190-01
Q540	151-0190-01			TRANSISTOR:SILICON,NPN	80009	151-0190-01
Q617	151-0356-00			TRANSISTOR;SILICON,NPN	0000M	151-0356-00
Q620	151-0219-00			TRANSISTOR:SILICON,PNP	80009	151-0219-00
Q621	151-0224-00			TRANSISTOR:SILICON,NPN	80009	151-0224-00
Q634	151-0219-00			TRANSISTOR:SILICON,PNP	80009	151-0219-00
Q636	151-0219-00			TRANSISTOR:SILICON,PNP	80009	151-0219-00
Q708	151-0190-01			TRANSISTOR:SILICON,NPN	80009	151-0190-01
Q710	151-0190-01			TRANSISTOR:SILICON,NPN	80009	151-0190-01
Q712	151-0190-01			TRANSISTOR:SILICON,NPN	80009	151-0190-01
Q714	151-0190-01			TRANSISTOR:SILICON,NPN	80009	151-0190-01
Q716	151-0207-00			TRANSISTOR:SILICON,NPN	80009	151-0207-00
Q718	151-0290-00			TRANSISTOR:SILICON,NPN	80009	151-0290-00
Q724	151-1006-00			TRANSISTOR:SILICON,JFE,N-CHANNEL	80009	151-1006-00
Q726A,B	151-0232-00			TRANSISTOR:SILICON,NPN,DUAL	80009	151-0232-00
Q728	151-0190-01			TRANSISTOR:SILICON,NPN	80009	151-0190-01
Q730	151-0164-00			TRANSISTOR:SILICON,PNP	80009	151-0164-00
Q746A,B	151-0232-00			TRANSISTOR:SILICON,NPN,DUAL	80009	151-0232-00
Q748	151-0190-01			TRANSISTOR:SILICON,NPN	80009	151-0190-01
Q750	151-0207-00			TRANSISTOR:SILICON,NPN	80009	151-0207-00
Q762	151-1004-00			TRANSISTOR:SILICON,JFE,N-CHANNEL	80009	T128CS
Q764A,B	151-0232-00			TRANSISTOR:SILICON,NPN,DUAL	80009	151-0232-00
Q766A,B	151-0232-00			TRANSISTOR:SILICON,NPN,DUAL	80009	151-0232-00
Q774	151-0188-00			TRANSISTOR:SILICON,PNP	80009	151-0188-00
Q776	151-0207-00			TRANSISTOR:SILICON,NPN	80009	151-0207-00
Q794	151-0228-00			TRANSISTOR:SILICON,PNP,SEL FROM 2N4888	80009	151-0228-00
Q796	151-0228-00			TRANSISTOR:SILICON,PNP,SEL FROM 2N4888	80009	151-0228-00
Q820	151-0190-01			TRANSISTOR:SILICON,NPN	80009	151-0190-01
Q822	151-0190-01			TRANSISTOR:SILICON,NPN	80009	151-0190-01
Q826	151-0228-00			TRANSISTOR:SILICON,PNP,SEL FROM 2N4888	80009	151-0228-00

[1] Furnished as a unit with 670-0300-XX.

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
Q830	151-0190-01			TRANSISTOR:SILICON,NPN	80009	151-0190-01
Q904	151-0198-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS918	80009	151-0198-00
Q912	151-0198-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS918	80009	151-0198-00
Q944	151-0195-00			TRANSISTOR:SILICON,NPN	80009	151-0195-00
Q954	151-0195-00			TRANSISTOR:SILICON,NPN	80009	151-0195-00
Q960	151-0195-00			TRANSISTOR:SILICON,NPN	80009	151-0195-00
R5	311-1110-00			RES.,VAR,NONWIR:10K OHM,20%,0.50W	80294	BA207-002
R15[1]	311-1054-01			RES.,VAR,NONWIR:10K OHM,10%,0.50W	80009	311-1054-01
R16	321-0285-00			RES.,FXD,FILM:9.09K OHM,1%,0.125W	91637	MFF1816G90900F
R20	311-1045-00			RES.,VAR,NONWIR:250K OHM,20%,0.50W	01121	W-7605A
R25	311-1061-00	B020400	B059999	RES.,VAR,NONWIR:10K OHM,5%,1.5W	80294	3610S420103000
R25	311-1061-01	B060000		RES.,VAR,NONWIR:PNL,10K OHM,5%1.5W	32997	3610S-535-103
R26	311-1062-00			RES.,VAR,NONWIR:10K OHM,5%,1.5W	80294	3610S403103000
R30	315-0101-00	B020400	B059999X	RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R32	315-0107-00	XB070000		RES.,FXD,CMPSN:100M OHM,5%,0.25W	01121	CB1075
R34	315-0107-00	XB070000		RES.,FXD,CMPSN:100M OHM,5%,0.25W	01121	CB1075
R51	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R52	315-0510-00			RES.,FXD,CMPSN:51 OHM,5%,0.25W	01121	CB5105
R53	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R55	311-0633-00			RES.,VAR,NONWIR:5K OHM,10%,0.50W	73138	82-30-0
R56	315-0302-00			RES.,FXD,CMPSN:3K OHM,5%,0.25W	01121	CB3025
R57	315-0302-00			RES.,FXD,CMPSN:3K OHM,5%,0.25W	01121	CB3025
R59	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R61	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R62	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R64	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R66	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R71	315-0334-00			RES.,FXD,CMPSN:330K OHM,5%,0.25W	01121	CB3345
R72	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R73	321-0285-00			RES.,FXD,FILM:9.09K OHM,1%,0.125W	91637	MFF1816G90900F
R74	321-0281-00			RES.,FXD,FILM:8.25K OHM,1%,0.125W	91637	MFF1816G82500F
R76	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R78	321-0253-00			RES.,FXD,FILM:4.22K OHM,1%,0.125W	91637	MFF1816G42200F
R79	321-0222-00			RES.,FXD,FILM:2K OHM,1%,0.125W	91637	MFF1816G20000F
R82	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R84	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R86	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R87	321-0285-00			RES.,FXD,FILM:9.09K OHM,1%,0.125W	91637	MFF1816G90900F
R104	315-0302-00			RES.,FXD,CMPSN:3K OHM,5%,0.25W	01121	CB3025
R105	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R106	315-0680-00			RES.,FXD,CMPSN:68 OHM,5%,0.25W	01121	CB6805
R108	321-0239-00			RES.,FXD,FILM:3.01K OHM,1%,0.125W	91637	MFF1816G30100F
R110[2]						
R111[2]						
R112[2]						
R113[2]						
R114[2]						
R115[2]						
R116[2]						
R117[2]						
R118[2]						
R119[2]						

[1]Furnished as a unit with S15.
[2]Replaceable under 155-0041-00.

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R121	317-0163-00			RES.,FXD,CMPSN:16K OHM,5%,0.125W	01121	BB1635
R123	317-0163-00			RES.,FXD,CMPSN:16K OHM,5%,0.125W	01121	BB1635
R125	317-0163-00			RES.,FXD,CMPSN:16K OHM,5%,0.125W	01121	BB1635
R127	317-0163-00			RES.,FXD,CMPSN:16K OHM,5%,0.125W	01121	BB1635
R147	317-0120-00			RES.,FXD,CMPSN:12 OHM,5%,0.125W	01121	BB1205
R148	317-0431-00			RES.,FXD,CMPSN:430 OHM,5%,0.125W	01121	BB4315
R149	317-0431-00			RES.,FXD,CMPSN:430 OHM,5%,0.125W	01121	BB4315
R183	317-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.125W	01121	BB1005
R184	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
R201	315-0123-00			RES.,FXD,CMPSN:12K OHM,5%,0.25W	01121	CB1235
R202	315-0243-00			RES.,FXD,CMPSN:24K OHM,5%,0.25W	01121	CB2435
R203	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R204	315-0163-00			RES.,FXD,CMPSN:16K OHM,5%,0.25W	01121	CB1635
R205	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R208	315-0331-00			RES.,FXD,CMPSN:330 OHM,5%,0.25W	01121	CB3315
R209	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R211	315-0912-00			RES.,FXD,CMPSN:9.1K OHM,5%,0.25W	01121	CB9125
R212	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R221	315-0510-00			RES.,FXD,CMPSN:51 OHM,5%,0.25W	01121	CB5105
R231	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R234	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R236	315-0303-00			RES.,FXD,CMPSN:30K OHM,5%,0.25W	01121	CB3035
R241	315-0510-00			RES.,FXD,CMPSN:51 OHM,5%,0.25W	01121	CB5105
R247	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R248	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R251	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R252	315-0124-00			RES.,FXD,CMPSN:120K OHM,5%,0.25W	01121	CB1245
R253	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R256	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R258	315-0121-00			RES.,FXD,CMPSN:120 OHM,5%,0.25W	01121	CB1215
R259	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R261	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R267	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R271	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R272	315-0333-00			RES.,FXD,CMPSN:33K OHM,5%,0.25W	01121	CB3335
R274	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R276	315-0203-00			RES.,FXD,CMPSN:20K OHM,5%,0.25W	01121	CB2035
R291	315-0510-00			RES.,FXD,CMPSN:51 OHM,5%,0.25W	01121	CB5105
R292	315-0123-00			RES.,FXD,CMPSN:12K OHM,5%,0.25W	01121	CB1235
R296	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R297	315-0331-00			RES.,FXD,CMPSN:330 OHM,5%,0.25W	01121	CB3315
R299	315-0390-00			RES.,FXD,CMPSN:39 OHM,5%,0.25W	01121	CB3905
R301	315-0510-00			RES.,FXD,CMPSN:51 OHM,5%,0.25W	01121	CB5105
R304	321-0385-00			RES.,FXD,FILM:100K OHM,1%,0.125W	91637	MFF1816G10002F
R305	321-0249-00			RES.,FXD,FILM:3.83K OHM,1%,0.125W	91637	MFF1816G38300F
R306	321-0356-00			RES.,FXD,FILM:49.9K OHM,1%,0.125W	91637	MFF1816G49901F
R307	321-0385-00			RES.,FXD,FILM:100K OHM,1%,0.125W	91637	MFF1816G10002F
R308	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
R309	315-0123-00			RES.,FXD,CMPSN:12K OHM,5%,0.25W	01121	CB1235
R311	315-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
R312	321-0251-00			RES.,FXD,FILM:4.02K OHM,1%,0.125W	91637	MFF1816G40200F
R314	321-0385-00			RES.,FXD,FILM:100K OHM,1%,0.125W	91637	MFF1816G10002F
R315	321-0245-00			RES.,FXD,FILM:3.48K OHM,1%,0.125W	91637	MFF1816G34800F

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R316	321-0356-00			RES.,FXD,FILM:49.9K OHM,1%,0.125W	91637	MFF1816G49901F
R317	321-0385-00			RES.,FXD,FILM:100K OHM,1%,0.125W	91637	MFF1816G10002F
R318	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
R319	315-0123-00			RES.,FXD,CMPSN:12K OHM,5%,0.25W	01121	CB1235
R321	315-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
R322	321-0249-00			RES.,FXD,FILM:3.83K OHM,1%,0.125W	91637	MFF1816G38300F
R324	321-0385-00			RES.,FXD,FILM:100K OHM,1%,0.125W	91637	MFF1816G10002F
R325	321-0245-00			RES.,FXD,FILM:3.48K OHM,1%,0.125W	91637	MFF1816G34800F
R326	321-0356-00			RES.,FXD,FILM:49.9K OHM,1%,0.125W	91637	MFF1816G49901F
R327	321-0385-00			RES.,FXD,FILM:100K OHM,1%,0.125W	91637	MFF1816G10002F
R328	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
R329	315-0123-00			RES.,FXD,CMPSN:12K OHM,5%,0.25W	01121	CB1235
R331	315-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
R332	321-0249-00			RES.,FXD,FILM:3.83K OHM,1%,0.125W	91637	MFF1816G38300F
R334	321-0385-00			RES.,FXD,FILM:100K OHM,1%,0.125W	91637	MFF1816G10002F
R335	321-0245-00			RES.,FXD,FILM:3.48K OHM,1%,0.125W	91637	MFF1816G34800F
R336	321-0356-00			RES.,FXD,FILM:49.9K OHM,1%,0.125W	91637	MFF1816G49901F
R337	321-0385-00			RES.,FXD,FILM:100K OHM,1%,0.125W	91637	MFF1816G10002F
R338	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
R339	315-0123-00			RES.,FXD,CMPSN:12K OHM,5%,0.25W	01121	CB1235
R341	315-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
R342	321-0249-00			RES.,FXD,FILM:3.83K OHM,1%,0.125W	91637	MFF1816G38300F
R344	321-0385-00			RES.,FXD,FILM:100K OHM,1%,0.125W	91637	MFF1816G10002F
R345	321-0245-00			RES.,FXD,FILM:3.48K OHM,1%,0.125W	91637	MFF1816G34800F
R346	321-0356-00			RES.,FXD,FILM:49.9K OHM,1%,0.125W	91637	MFF1816G49901F
R347	321-0385-00			RES.,FXD,FILM:100K OHM,1%,0.125W	91637	MFF1816G10002F
R348	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
R349	315-0123-00			RES.,FXD,CMPSN:12K OHM,5%,0.25W	01121	CB1235
R351	315-0751-00			RES.,FXD,CMPSN:750 OHM,5%,0.25W	01121	CB7515
R352	321-0249-00			RES.,FXD,FILM:3.83K OHM,1%,0.125W	91637	MFF1816G38300F
R354	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R361	307-0104-00			RES.,FXD,CMPSN:3.3 OHM,5%,0.25W	01121	CB33G5
R363	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R367	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R371	315-0510-00			RES.,FXD,CMPSN:51 OHM,5%,0.25W	01121	CB5105
R373	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R376	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R384	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R385	311-0607-00			RES.,VAR,NONWIR:10K OHM,10%,0.50W	73138	82P-59-4-103K
R391	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R393	315-0562-00			RES.,FXD,CMPSN:5.6K OHM,(NOM VALUE),SEL	01121	CB5625
R396	315-0152-00	B020400	B059999	RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
R396	315-0201-00	B060000		RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
R403	321-0318-00			RES.,FXD,FILM:20K OHM,1%,0.125W	91637	MFF1816G20001F
R405	311-0607-00			RES.,VAR,NONWIR:10K OHM,10%,0.50W	73138	82P-59-4-103K
R410	311-0607-00			RES.,VAR,NONWIR:10K OHM,10%,0.50W	73138	82P-59-4-103K
R411	321-0318-00			RES.,FXD,FILM:20K OHM,1%,0.125W	91637	MFF1816G20001F
R412	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R413	321-0361-00			RES.,FXD,FILM:56.2K OHM,1%,0.125W	91637	MFF1816G56201F
R415	311-0613-00			RES.,VAR,NONWIR:100K OHM,10%,0.50W	73138	82-27-0
R416	321-0385-00			RES.,FXD,FILM:100K OHM,1%,0.125W	91637	MFF1816G10002F
R417	321-0251-00			RES.,FXD,FILM:4.02K OHM,1%,0.125W	91637	MFF1816G40200F
R420	311-0607-00			RES.,VAR,NONWIR:10K OHM,10%,0.50W	73138	82P-59-4-103K

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R421	321-0318-00			RES.,FXD,FILM:20K OHM,1%,0.125W	91637	MFF1816G20001F
R422	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R423	321-0356-00			RES.,FXD,FILM:49.9K OHM,1%,0.125W	91637	MFF1816G49901F
R425	311-0606-00			RES.,VAR,NONWIR:500K OHM,30%,0.50W	73138	82-24-0
R426	321-0385-00			RES.,FXD,FILM:100K OHM,1%,0.125W	91637	MFF1816G10002F
R427	321-0335-00			RES.,FXD,FILM:30.1K OHM,1%,0.125W	91637	MFF1816G30101F
R430	311-0607-00			RES.,VAR,NONWIR:10K OHM,10%,0.50W	73138	82P-59-4-103K
R431	321-0318-00			RES.,FXD,FILM:20K OHM,1%,0.125W	91637	MFF1816G20001F
R432	315-0303-00			RES.,FXD,CMPSN:30K OHM,5%,0.25W	01121	CB3035
R433	321-0356-00			RES.,FXD,FILM:49.9K OHM,1%,0.125W	91637	MFF1816G49901F
R435	311-0606-00			RES.,VAR,NONWIR:500K OHM,30%,0.50W	73138	82-24-0
R436	321-0385-00			RES.,FXD,FILM:100K OHM,1%,0.125W	91637	MFF1816G10002F
R437	321-0349-00			RES.,FXD,FILM:42.2K OHM,1%,0.125W	91637	MFF1816G42201F
R440	311-0607-00			RES.,VAR,NONWIR:10K OHM,10%,0.50W	73138	82P-59-4-103K
R441	321-0318-00			RES.,FXD,FILM:20K OHM,1%,0.125W	91637	MFF1816G20001F
R442	315-0303-00			RES.,FXD,CMPSN:30K OHM,5%,0.25W	01121	CB3035
R442	315-0623-00			RES.,FXD,CMPSN:62K OHM,5%,0.25W	01121	CB6235
R443	321-0339-00			RES.,FXD,FILM:33.2K OHM,1%,0.125W	91637	MFF1816G33201F
R445	311-0606-00			RES.,VAR,NONWIR:500K OHM,30%,0.50W	73138	82-24-0
R446	321-0385-00			RES.,FXD,FILM:100K OHM,1%,0.125W	91637	MFF1816G10002F
R447	321-0331-00			RES.,FXD,FILM:27.4K OHM,1%,0.125W	91637	MFF1816G27401F
R450	311-0607-00			RES.,VAR,NONWIR:10K OHM,10%,0.50W	73138	82P-59-4-103K
R451	321-0318-00			RES.,FXD,FILM:20K OHM,1%,0.125W	91637	MFF1816G20001F
R453	321-0339-00			RES.,FXD,FILM:33.2K OHM,1%,0.125W	91637	MFF1816G33201F
R455	311-0606-00			RES.,VAR,NONWIR:500K OHM,30%,0.50W	73138	82-24-0
R456	321-0385-00			RES.,FXD,FILM:100K OHM,1%,0.125W	91637	MFF1816G10002F
R457	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R460	311-0607-00			RES.,VAR,NONWIR:10K OHM,10%,0.50W	73138	82P-59-4-103K
R461	321-0318-00			RES.,FXD,FILM:20K OHM,1%,0.125W	91637	MFF1816G20001F
R462	315-0623-00			RES.,FXD,CMPSN:62K OHM,5%,0.25W	01121	CB6235
R463	321-0336-00			RES.,FXD,FILM:30.9 OHM,1%,0.125W	91637	MFF1816G30901F
R465	311-0613-00			RES.,VAR,NONWIR:100K OHM,10%,0.50W	73138	82-27-0
R466	321-0385-00			RES.,FXD,FILM:100K OHM,1%,0.125W	91637	MFF1816G10002F
R467	321-0260-00			RES.,FXD,FILM:4.99K OHM,1%,0.125W	91637	MFF1816G49900F
R470	311-0607-00			RES.,VAR,NONWIR:10K OHM,10%,0.50W	73138	82P-59-4-103K
R471	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R472	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R473	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R475	311-0644-00			RES.,VAR,NONWIR:20K OHM,10%,0.50W	73138	MODEL 82P
R476	321-0385-00			RES.,FXD,FILM:100K OHM,1%,0.125W	91637	MFF1816G10002F
R477	321-0097-00			RES.,FXD,FILM:100 OHM,1%,0.125W	91637	MFF1816G100R0F
R501	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R502	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R503	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R506	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R507	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R508	315-0332-00			RES.,FXD,CMPSN:3.3K OHM,5%,0.25W	01121	CB3325
R509	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R511	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R512	315-0332-00			RES.,FXD,CMPSN:3.3K OHM,5%,0.25W	01121	CB3325
R513	315-0332-00			RES.,FXD,CMPSN:3.3K OHM,5%,0.25W	01121	CB3325
R516	315-0203-00			RES.,FXD,CMPSN:20K OHM,5%,0.25W	01121	CB2035
R517	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025

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R523	307-0111-00			RES.,FXD,CMPSN:3.6 OHM,5%,0.25W	01121	CB36G5
R524	315-0203-00			RES.,FXD,CMPSN:20K OHM,5%,0.25W	01121	CB2035
R525	315-0203-00			RES.,FXD,CMPSN:20K OHM,5%,0.25W	01121	CB2035
R526	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R527	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R529	315-0241-00			RES.,FXD,CMPSN:240 OHM,5%,0.25W	01121	CB2415
R531	321-0356-00			RES.,FXD,FILM:49.9K OHM,1%,0.125W	91637	MFF1816G49901F
R532	321-0193-00			RES.,FXD,FILM:1K OHM,1%,0.125W	91637	MFF1816G10000F
R533	315-0105-00			RES.,FXD,CMPSN:1M OHM,5%,0.25W	01121	CB1055
R536	321-0365-00			RES.,FXD,FILM:61.9K OHM,1%,0.125W	91637	MFF1816G61901F
R540	311-0613-00			RES.,VAR,NONWIR:100K OHM,10%,0.50W	73138	82-27-0
R541	315-0753-00			RES.,FXD,CMPSN:75K OHM,5%,0.25W	01121	CB7535
R542	315-0473-00			RES.,FXD,CMPSN:47K OHM,5%,0.25W	01121	CB4735
R544	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R546	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R547	321-0381-00			RES.,FXD,FILM:90.9K OHM,1%,0.125W	91637	MFF1816G90901F
R548A	321-0262-00			RES.,FXD,FILM:5.23K OHM,1%,0.125W	91637	MFF1816G52300F
R548B	321-0222-00			RES.,FXD,FILM:2K OHM,1%,0.125W	91637	MFF1816G20000F
R548C	321-0176-00			RES.,FXD,FILM:665 OHM,1%,0.125W	91637	MFF1816G665R0F
R548D	321-0130-00			RES.,FXD,FILM:221 OHM,1%,0.125W	91637	MFF1816G221R0F
R548E	321-0099-00			RES.,FXD,FILM:105 OHM,1%,0.125W	91637	MFF1816G105R0F
R548F	321-0174-00			RES.,FXD,FILM:634 OHM,1%,0.125W	91637	MFF1816G634R0F
R548G	321-0130-00			RES.,FXD,FILM:221 OHM,1%,0.125W	91637	MFF1816G221R0F
R548H	321-0099-00			RES.,FXD,FILM:105 OHM,1%,0.125W	91637	MFF1816G105R0F
R549	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R550	311-1035-00			RES.,VAR,NONWIR:50K OHM,10%,0.50W	80740	62-62-3
R551	315-0474-00			RES.,FXD,CMPSN:470K OHM,5%,0.25W	01121	CB4745
R553	321-0385-00			RES.,FXD,FILM:100K OHM,1%,0.125W	91637	MFF1816G10002F
R554	321-0385-00			RES.,FXD,FILM:100K OHM,1%,0.125W	91637	MFF1816G10002F
R555	311-1035-00			RES.,VAR,NONWIR:50K OHM,10%,0.50W	80740	62-62-3
R556	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R558	321-0318-00			RES.,FXD,FILM:20K OHM,1%,0.125W	91637	MFF1816G20001F
R559	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R561	321-0365-00			RES.,FXD,FILM:61.9K OHM,1%,0.125W	91637	MFF1816G61901F
R562	321-0393-00			RES.,FXD,FILM:121K OHM,1%,0.125W	91637	MFF1816G12102F
R563	321-0365-00			RES.,FXD,FILM:61.9K OHM,1%,0.125W	91637	MFF1816G61901F
R564	321-0393-00			RES.,FXD,FILM:121K OHM,1%,0.125W	91637	MFF1816G12102F
R571	321-0173-00			RES.,FXD,FILM:619 OHM,1%,0.125W	91637	MFF1816G619R0F
R573	321-0173-00			RES.,FXD,FILM:619 OHM,1%,0.125W	91637	MFF1816G619R0F
R574	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R575	311-1035-00	B020400	B059999	RES.,VAR,NONWIR:50K OHM,10%,0.50W	80740	62-62-3
R575	311-1268-00	B060000		RES.,VAR,NONWIR:10K OHM,10%,0.50W	32997	3329P-L58-103
R576	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R577	315-0203-00			RES.,FXD,CMPSN:20K OHM,5%,0.25W	01121	CB2035
R578	311-0622-00			RES.,VAR,NONWIR:100 OHM,10%,0.50W	32997	3326H-C48-101
R579	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
R582	321-0385-00			RES.,FXD,FILM:100K OHM,1%,0.125W	91637	MFF1816G10002F
R583	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R584	321-0318-00			RES.,FXD,FILM:20K OHM,1%,0.125W	91637	MFF1816G20001F
R585	311-1035-00			RES.,VAR,NONWIR:50K OHM,10%,0.50W	80740	62-62-3
R586	321-0356-00			RES.,FXD,FILM:49.9K OHM,1%,0.125W	91637	MFF1816G49901F
R591	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R592	315-0274-00			RES.,FXD,CMPSN:270K OHM,5%,0.25W	01121	CB2745

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R593	315-0134-00			RES.,FXD,CMPSN:130K OHM,5%,0.25W	01121	CB1345
R594	315-0183-00			RES.,FXD,CMPSN:18K OHM,5%,0.25W	01121	CB1835
R596	315-0134-00			RES.,FXD,CMPSN:130K OHM,5%,0.25W	01121	CB1345
R597	315-0183-00			RES.,FXD,CMPSN:18K OHM,5%,0.25W	01121	CB1835
R599	315-0362-00			RES.,FXD,CMPSN:3.6K OHM,5%,0.25W	01121	CB3625
R605	315-0472-01			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	0000M	315-0472-01
R615	308-0463-00			RES.,FXD,WW:0.3 OHM,1%,3W	91637	RS2B-KR3000F
R619	315-0100-01			RES.,FXD,CMPSN:10 OHM,5%,0.25W	0000M	315-0100-01
R620	315-0102-01			RES.,FXD,CMPSN:1K OHM,5%,0.25W	0000M	315-0102-01
R623	315-0471-02			RES.,FXD,CMPSN:40 OHM,5%,0.25W	0000M	315-0471-02
R630	315-0272-02			RES,FXD,CMPSN:2.7K OHM,5%,0.25W	01121	CB2725
R633	321-0445-00			RES.,FXD,FILM:422K OHM,1%,0.125W	91637	MFF1816G42202F
R635	315-0752-01			RES.,FXD,CMPSN:7.5K OHM,5%,0.25W	0000M	315-0752-01
R637	315-0102-01			RES.,FXD,CMPSN:1K OHM,5%,0.25W	0000M	315-0102-01
R638	315-0102-01			RES.,FXD,CMPSN:1K OHM,5%,0.25W	0000M	315-0102-01
R639	315-0152-01			RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	0000M	315-0152-01
R641	315-0272-02			RES,FXD,CMPSN:2.7K OHM,5%,0.25W	01121	CB2725
R643	321-0341-30			RES.,FXD,CMPSN:34.8K OHM,1%,0.125W	0000M	321-0341-30
R644	311-0635-00			RES.,VAR,NONWIR:1K OHM,10%,0.50W	73138	82-32-0
R704	321-0347-00			RES.,FXD,FILM:40.2K OHM,1%,0.125W	91637	MFF1816G40201F
R705	311-0633-00			RES.,VAR,NONWIR:5K OHM,10%,0.50W	73138	82-30-0
R707	307-0103-00			RES.,FXD,CMPSN:2.7 OHM,5%,0.25W	01121	CB27G5
R708	321-0325-00			RES.,FXD,FILM:23.7K OHM,1%,0.125W	91637	MFF1816G23701F
R708	315-0224-00			RES.,FXD,CMPSN:220K OHM,5%,0.25W	01121	CB2245
R709	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R710	315-0223-00			RES.,FXD,CMPSN:22K OHM,5%,0.25W	01121	CB2235
R711	315-0822-00			RES.,FXD,CMPSN:8.2K OHM,5%,0.25W	01121	CB8225
R712	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
R713	315-0223-00			RES.,FXD,CMPSN:22K OHM,5%,0.25W	01121	CB2235
R714	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
R715	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R716	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R717	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R718	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R719	307-0103-00			RES.,FXD,CMPSN:2.7 OHM,5%,0.25W	01121	CB27G5
R724	315-0822-00			RES.,FXD,CMPSN:8.2K OHM,5%,0.25W	01121	CB8225
R726	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R727	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R728	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
R731	321-0356-00			RES.,FXD,FILM:49.9K OHM,1%,0.125W	91637	MFF1816G49901F
R732	321-0356-00			RES.,FXD,FILM:49.9K OHM,1%,0.125W	91637	MFF1816G49901F
R746	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R747	315-0512-00			RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
R748	315-0512-00			RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
R749	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R751	321-0246-00			RES.,FXD,FILM:3.57K OHM,1%,0.125W	91637	MFF1816G35700F
R752	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R764	315-0473-00			RES.,FXD,CMPSN:47K OHM,5%,0.25W	01121	CB4735
R765	321-0249-00			RES.,FXD,FILM:3.83K OHM,1%,0.125W	91637	MFF1816G38300F
R766	315-0683-00			RES.,FXD,CMPSN:68K OHM,5%,0.25W	01121	CB6835
R768	315-0473-00			RES.,FXD,CMPSN:47K OHM,5%,0.25W	01121	CB4735
R769	315-0473-00			RES.,FXD,CMPSN:47K OHM,5%,0.25W	01121	CB4735
R771	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015

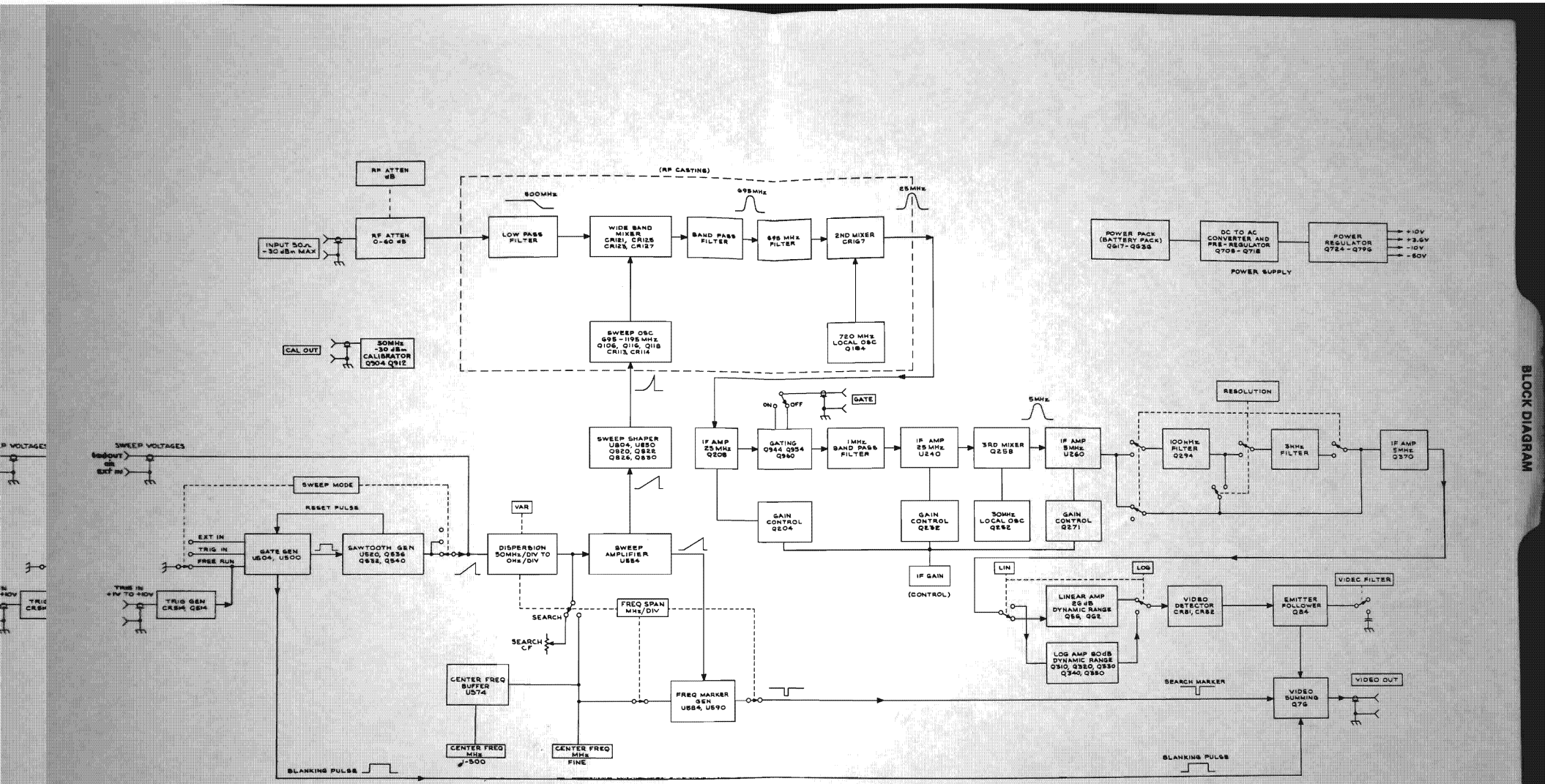
Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R773	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R774	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
R775	311-0609-00			RES.,VAR,NONWIR:2K OHM,10%,0.50W	73138	82-26-0
R776	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R777	321-0314-00			RES.,FXD,FILM:18.2K OHM,1%,0.125W	91637	MFF1816G18201F
R782	315-0432-00			RES.,FXD,CMPSN:4.3K OHM,5%,0.25W	01121	CB4325
R792	315-0474-00			RES.,FXD,CMPSN:470K OHM,5%,0.25W	01121	CB4745
R794	315-0473-00			RES.,FXD,CMPSN:47K OHM,5%,0.25W	01121	CB4735
R795	321-0396-00			RES.,FXD,FILM:130K OHM,1%,0.125W	91637	MFF1816G13002F
R796	321-0452-00			RES.,FXD,FILM:499K OHM,1%,0.125W	91637	MFF1816G49902F
R800	311-0613-00			RES.,VAR,NONWIR:100K OHM,10%,0.50W	73138	82-27-0
R801	321-0414-00			RES.,FXD,FILM:200K OHM,1%,0.125W	91637	MFF1816G20002F
R802	321-0356-00			RES.,FXD,FILM:49.9K OHM,1%,0.125W	91637	MFF1816G49901F
R806	321-0260-00			RES.,FXD,FILM:4.99K OHM,1%,0.125W	91637	MFF1816G49900F
R808	321-0318-00			RES.,FXD,FILM:20K OHM,1%,0.125W	91637	MFF1816G20001F
R818	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R821	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R822	321-0399-00			RES.,FXD,FILM:140K OHM,1%,0.125W	91637	MFF1816G14002F
R824	321-0385-00			RES.,FXD,FILM:100K OHM,1%,0.125W	91637	MFF1816G10002F
R826	315-0272-00			RES.,FXD,CMPSN:2.7K OHM,5%,0.25W	01121	CB2725
R829	321-0368-00			RES.,FXD,FILM:66.5K OHM,1%,0.125W	91637	MFF1816G66501F
R830	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R831	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R832	315-0392-00			RES.,FXD,CMPSN:3.9K OHM,5%,0.25W	01121	CB3925
R833	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R836	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R850	311-0607-00			RES.,VAR,NONWIR:10K OHM,10%,0.50W	73138	82P-59-4-103K
R851	321-0318-00			RES.,FXD,FILM:20K OHM,1%,0.125W	91637	MFF1816G20001F
R854	321-0335-00			RES.,FXD,FILM:30.1K OHM,1%,0.125W	91637	MFF1816G30101F
R856	321-0277-00			RES.,FXD,FILM:7.5K OHM,1%,0.125W	91637	MFF1816G75000F
R857	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R858	315-0392-00	XB071490		RES.,FXD,CMPSN:3.9K OHM,5%,0.25W	01121	CB3925
R859	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R904	321-0240-00			RES.,FXD,FILM:3.09K OHM,1%,0.125W	91637	MFF1816G30900F
R905	311-0540-00			RES.,VAR,WW:2.5K OHM,5%,1W	80294	3345P-1-252
R907	321-0001-00			RES.,FXD,FILM:10 OHM,1%,0.125W	75042	CEAT0-10R00F
R908	321-0193-00			RES.,FXD,FILM:1K OHM,1%,0.125W	91637	MFF1816G10000F
R909	321-0193-00			RES.,FXD,FILM:1K OHM,1%,0.125W	91637	MFF1816G10000F
R911	321-0066-00			RES.,FXD,FILM:47.5 OHM,1%,0.125W	91637	MFF1816G47R50F
R912	321-0240-00			RES.,FXD,FILM:3.09K OHM,1%,0.125W	91637	MFF1816G30900F
R921	321-0001-00			RES.,FXD,FILM:10 OHM,1%,0.125W	75042	CEAT0-10R00F
R923	321-0078-00			RES.,FXD,FILM:63.4 OHM,1%,0.125W	91637	MFF1816G63R40F
R924	321-0100-00			RES.,FXD,FILM:107 OHM,1%,0.125W	91637	MFF1816G107R0F
R926	321-0128-00			RES.,FXD,FILM:210 OHM,1%,0.125W	91637	MFF1816G210R0F
R928	321-0078-00			RES.,FXD,FILM:63.4 OHM,1%,0.125W	91637	MFF1816G63R40F
R929	321-0100-00			RES.,FXD,FILM:107 OHM,1%,0.125W	91637	MFF1816G107R0F
R942	315-0243-00			RES.,FXD,CMPSN:24K OHM,5%,0.25W	01121	CB2435
R943	315-0753-00			RES.,FXD,CMPSN:75K OHM,5%,0.25W	01121	CB7535
R944	315-0912-00			RES.,FXD,CMPSN:9.1K OHM,5%,0.25W	01121	CB9125
R945	315-0391-00			RES.,FXD,CMPSN:390 OHM,5%,0.25W	01121	CB3915
R951	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R952	315-0333-00			RES.,FXD,CMPSN:33K OHM,5%,0.25W	01121	CB3335
R953	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R954	315-0912-00			RES.,FXD,CMPSN:9.1K OHM,5%,0.25W	01121	CB9125
R956	315-0750-00			RES.,FXD,CMPSN:75 OHM,5%,0.25W	01121	CB7505
R960	315-0431-00			RES.,FXD,CMPSN:430 OHM,5%,0.25W	01121	CB4315
R961	315-0363-00			RES.,FXD,CMPSN:36K OHM,5%,0.25W	01121	CB3635
R962	315-0752-00			RES.,FXD,CMPSN:7.5K OHM,5%,0.25W	01121	CB7525
S12	260-1139-00			SWITCH,ROTARY:DPDT,PUSH-PUSH	14140	28KM3C500N
S15 [1]	311-1054-01			RES.,VAR,NONWIR:10K OHM,10%,0.50W	80009	311-1054-01
S30	260-0903-00			SWITCH,SLIDE:DPDT,0.5A,125V	0000M	260-0903-00
S40	260-1116-00			SWITCH,SLIDE:SPDT,W/DETENT	10389	23-021-144
S50	260-0643-00			SWITCH,TOGGLE:SPDT,50VDC	83332	SP3
S55	260-1308-00			SWITCH,PUSH:DPDT,MOMENTARY	80009	260-1308-00
S500	263-1100-00			SW CAM ACTR AS:FREQUENCY SPAN	80009	263-1100-00
S515	263-1100-00			SW CAM ACTR AS:FREQUENCY SPAN	80009	263-1100-00
S612	260-0902-00			SWITCH,SLIDE:DP3T,0.5A,125V	0000M	260-0902-00
T113 [2]						
T120	120-0689-00			XFMR,TOROID:	80009	120-0689-00
T126	120-0689-00			XFMR,TOROID:	80009	120-0689-00
T208	120-0661-00			XFMR,RF:0.67UH,25MHZ	32436	8E-015-4
T210	120-0662-00			XFMR,RF:4UH,25MHZ	32436	8E-015-5
T222	114-0297-00			COIL,RF:1.1UH,NOMINAL VALUE	32436	8E-015-2
T224	114-0297-00			COIL,RF:1.1UH,NOMINAL VALUE	32436	8E-015-2
T226	114-0297-00			COIL,RF:1.1UH,NOMINAL VALUE	32436	8E-015-2
T228	114-0297-00			COIL,RF:1.1UH,NOMINAL VALUE	32436	8E-015-2
T240	120-0661-00			XFMR,RF:0.67UH,25MHZ	32436	8E-015-4
T248	120-0662-00			XFMR,RF:4UH,25MHZ	32436	8E-015-5
T252	120-0663-00			XFMR,RF:0.65UH,30MHZ	32436	8E-015-3
T258	120-0660-00			XFMR,RF:16UH,5MHZ	32436	8E-015-6
T268	120-0659-00			XFMR,RF:5UH,5MHZ	32436	8E-015-7
T280	114-0296-00			COIL,RF:1.5UH,NOMINAL VALUE	32436	8E015-1
T282	114-0296-00			COIL,RF:1.5UH,NOMINAL VALUE	32436	8E015-1
T284	114-0296-00			COIL,RF:1.5UH,NOMINAL VALUE	32436	8E015-1
T286	114-0296-00			COIL,RF:1.5UH,NOMINAL VALUE	32436	8E015-1
T288	114-0296-00			COIL,RF:1.5UH,NOMINAL VALUE	32436	8E015-1
T294	120-0688-00			XFMR,TOROID:6 TURN,QUADFILAR	80009	120-0688-00
T370	120-0659-00			XFMR,RF:5UH,5MHZ	32436	8E-015-7
T601	120-0503-00			XFMR,PWR,STPDN:	0000M	120-0503-00
T700	120-0687-00			XFMR,SDN/SU:	80009	120-0687-00
T940	120-0734-00			XFMR,TOROID:3 WINDINGS	80009	120-0734-00
T942	120-0734-00			XFMR,TOROID:3 WINDINGS	80009	120-0734-00
U500	156-0018-00			MICROCIRCUIT,DI:QUAD 2-INPUT GATE	04713	MC817P
U504	156-0018-00			MICROCIRCUIT,DI:QUAD 2-INPUT GATE	04713	MC817P
U520	155-0042-02	B020400	B071489	MICROCIRCUIT,LI:MILLER INTEGRATOR	80009	155-0042-02
U520	155-0028-00	B071490		MICROCIRCUIT,LI:ML,MILLER INTEGRATOR	80009	155-0028-00
U554	156-0105-00			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0105-00
U574	156-0105-00			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0105-00
U590	156-0048-00			MICROCIRCUIT,LI:FIVE NPN TRANSISTOR ARRAY	80009	156-0048-00
U804	156-0105-00			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0105-00
U850	156-0105-00			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0105-00
U854	156-0067-00			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-00
VR392	152-0175-00			SEMICOND DEVICE:ZENER,0.4W,5.6V,5%	80009	152-0175-00
VR649	152-0166-00			SEMICOND DEVICE:ZENER,0.4W,6.2V,5%	81483	69-9035
VR765	152-0464-00			SEMICOND DEVICE:ZENER,0.4W,6.4V,5%	04713	1N4570
VR782	152-0464-00			SEMICOND DEVICE:ZENER,0.4W,6.4V,5%	04713	1N4570

[1] Furnished as a unit with R15.
[2] Replaceable under 155-0041-00.

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
W5	175-1162-00			CABLE ASSY,SP:5.5 INCH LONG	80009	175-1162-00
W10	175-1161-00			CABLE ASSY,SP:4.75 INCH LONG	80009	175-1161-00
W120	175-0358-00			LEAD,ELECTRICAL:2.812 INCH LONG,50 OHM	80009	175-0358-00
W125	175-0358-00			LEAD,ELECTRICAL:2.812 INCH LONG,50 OHM	80009	175-0358-00
W149	175-0358-00			LEAD,ELECTRICAL:2.812 INCH LONG,50 OHM	80009	175-0358-00
W153	175-0416-00			LEAD,ELECTRICAL:11 INCH LONG	80009	175-0416-00
W175	175-1204-00			CABLE ASSY,RF:2.5 INCH LONG	80009	175-1204-00
Y913	158-0068-00			XTAL UNIT,QTZ:5MHZ,0.01%	80009	158-0068-00
Z161[1]						
Z163[1]						
Z165[1]						
Z177[1]						
Z187[1]						

[1]Furnished as a unit with 670-0331-XX.


RF ATTEN dB
(RF CASTING)
500MHz
995MHz
25MHz
INPUT 50Ω -30 dBm MAX
RF ATTEN 0-60 dB
LOW PASS FILTER
WIDE BAND MIXER CR121, CR125 CR123, CR127
BAND PASS FILTER
695 MHz FILTER
2ND MIXER CR117
POWER PACK (BATTERY PACK) Q617-Q638
DC TO AC CONVERTER AND PRE-REGULATOR Q708-Q718
POWER REGULATOR Q724-Q796
+10V
+3.6V
-10V
-50V
POWER SUPPLY
CAL OUT
50MHz -30 dBm CALIBRATOR Q904 Q912
SWEEP OSC 695-1195 MHz Q106, Q116, Q118 CR113, CR114
720 MHz LOCAL OSC Q184
RESOLUTION
GATE
ON
OFF
5MHz
SWEEP VOLTAGES
SWEEP SHAPER U804, U850 Q820, Q828 Q826, Q850
IF AMP 25 MHz Q208
GATING Q944, Q954 Q960
1MHz BAND PASS FILTER
IF AMP 25 MHz U240
3RD MIXER Q258
IF AMP 5MHz U260
100kHz FILTER Q294
3kHz FILTER
IF AMP 5MHz Q370
SWEEP MODE
RESET PULSE
VAR
GAIN CONTROL Q204
GAIN CONTROL Q238
30MHz LOCAL OSC Q252
GAIN CONTROL Q271
EXT IN
TRIG IN
FREE RUN
GATE GEN U504, U500
SAWTOOTH GEN U820, Q836 Q832, Q840
DISPERSION 50MHz/DIV TO 0Hz/DIV
SWEEP AMPLIFIER U854
IF GAIN
(CONTROL)
LIN
LOG
TRIG IN +4V TO +10V
TRIG GEN CR814 Q814
SEARCH
SEARCH C.F
FREQ SPAN MHz/DIV
LINEAR AMP 86dB DYNAMIC RANGE Q56, Q62
VIDEO DETECTOR CR81, CR82
EMITTER FOLLOWER Q84
VIDEO FILTER
LOG AMP 80dB DYNAMIC RANGE Q310, Q330, Q350 Q340, Q380
CENTER FREQ BUFFER U574
FREQ MARKER GEN U884, U890
SEARCH MARKER
VIDEO SUMMING Q76
VIDEO OUT
CENTER FREQ MHz
-500
CENTER FREQ MHz FINE
BLANKING PULSE
BLANKING PULSE

SECTION 8

DIAGRAMS, CIRCUIT BOARDS, MECHANICAL and REPACKAGING PARTS ILLUSTRATIONS

Symbols and Reference Designators

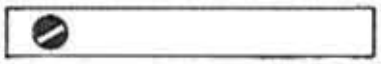
Electrical components shown on the diagrams are in the following units unless noted otherwise:

Capacitors =	Values one or greater are in picofarads (pF). Values less than one are in microfarads (μF).
Resistors =	Ohms (Ω)

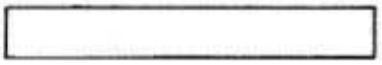
Symbols used on the diagrams are based on USA Standard Y32.2-1967.

Logic symbology is based on MIL-STD-806B in terms of positive logic. Logic symbols depict the logic function performed and may differ from the manufacturer's data.

The following special symbols are used on the diagrams:



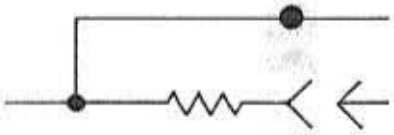
External screwdriver adjustment



External control or connector.

Clockwise control rotation in direction of arrow.

Refer to diagram number indicated in diamond.



Connection soldered to circuit board.

Connection made to circuit board with interconnecting pin.

Blue tint encloses components located on circuit board.

P/O circuit board

The following prefix letters are used as reference designators to identify components or assemblies on the diagrams.

A	Assembly, separable or repairable (circuit board, etc.)
AT	Attenuator, fixed or variable
CR	Diode, signal or rectifier
DS	Indicating device (lamp)
FL	Filter
H	Heat dissipating device (heat sink, heat radiator, etc.)
M	Meter
TP	Test point
U	Assembly, inseparable or non-repairable (integrated circuit, etc.)
Y	Crystal

1401A WAVEFORM and VOLTAGE INFORMATION

Waveforms shown on the diagrams are photographs taken with a Tektronix Trace Recording Camera equipped with a projected graticule. Voltages were taken with a non-loading voltmeter. Voltages and waveforms (shown in blue) are not absolute and can vary between instruments depending on the measuring device and circuit differences between instruments.

The Volts/Div and Time/Div settings for the test oscilloscope are noted on each waveform photograph. Comparison of the waveforms must be taken under the following conditions:

Diagrams 1 through 5

1401A

FREQ SPAN MHz/DIV	SEARCH
SWEEP MODE	EXT IN
SWEEP RATE	Midrange
DISPLAY MODE	LIN

Trigger the 1401A and the test oscilloscope with 50 ms markers from the time-mark generator.

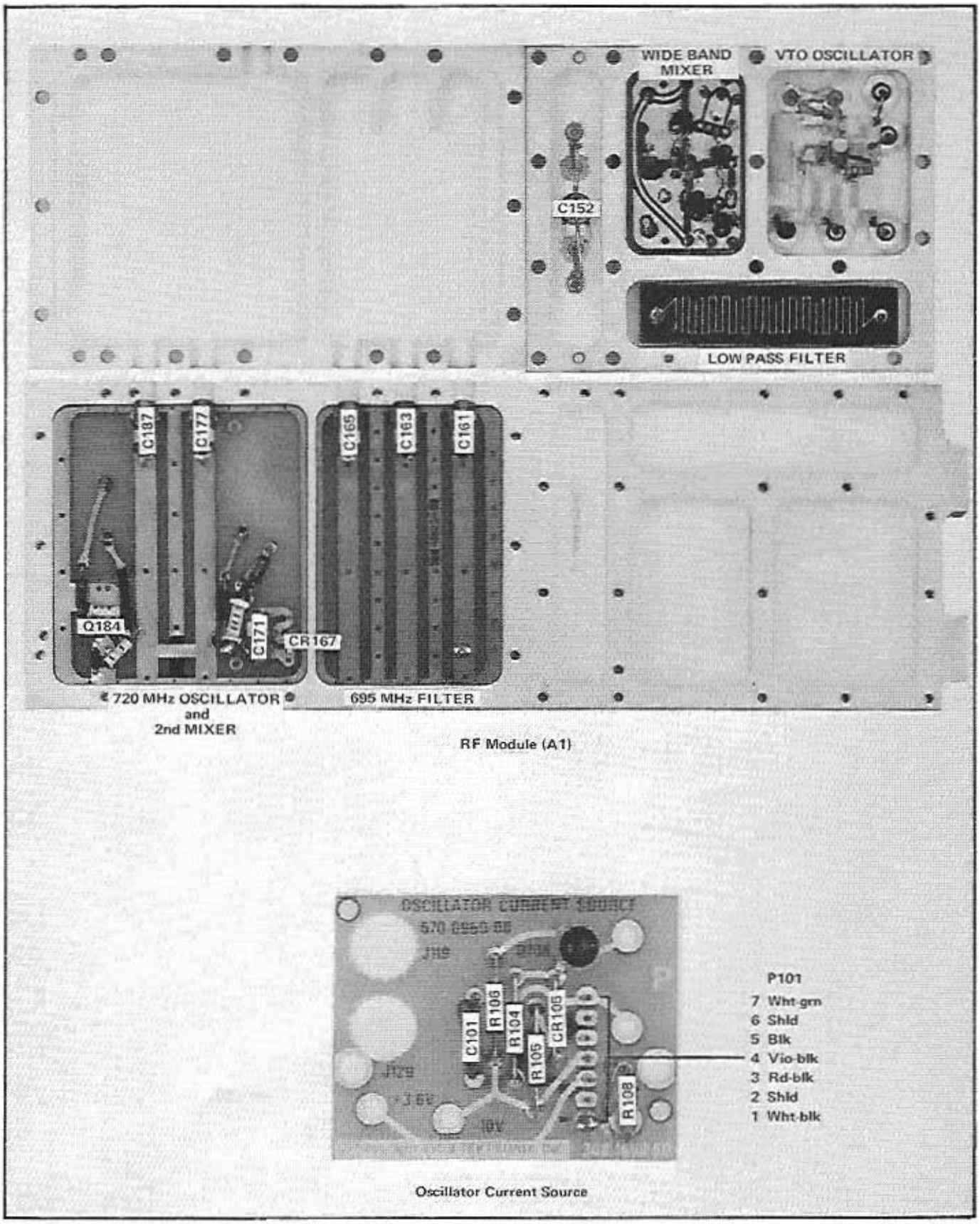
Diagram 6 (Power Regulator).

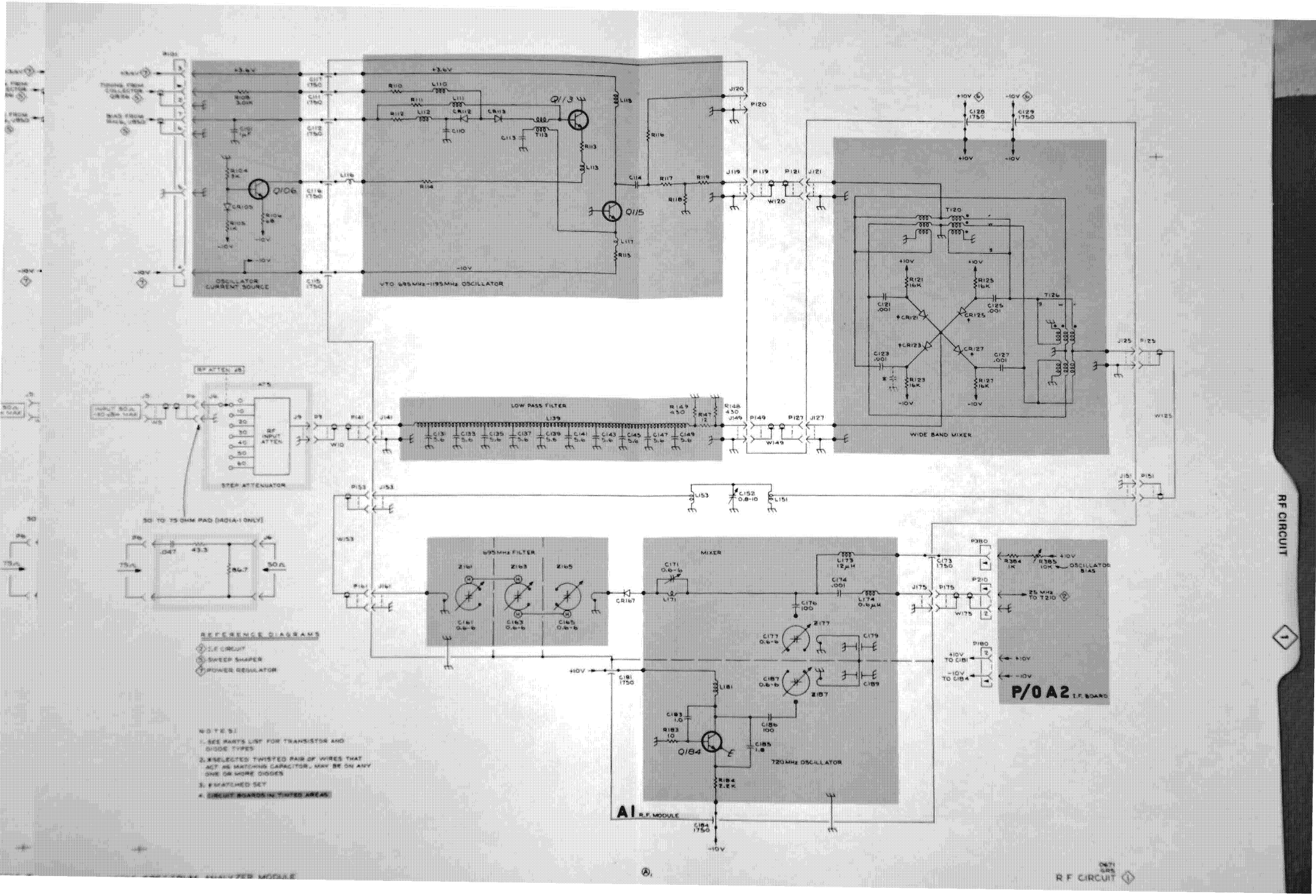
Operate the 1401A on battery power only. Trigger the test oscilloscope internally on the input signal.

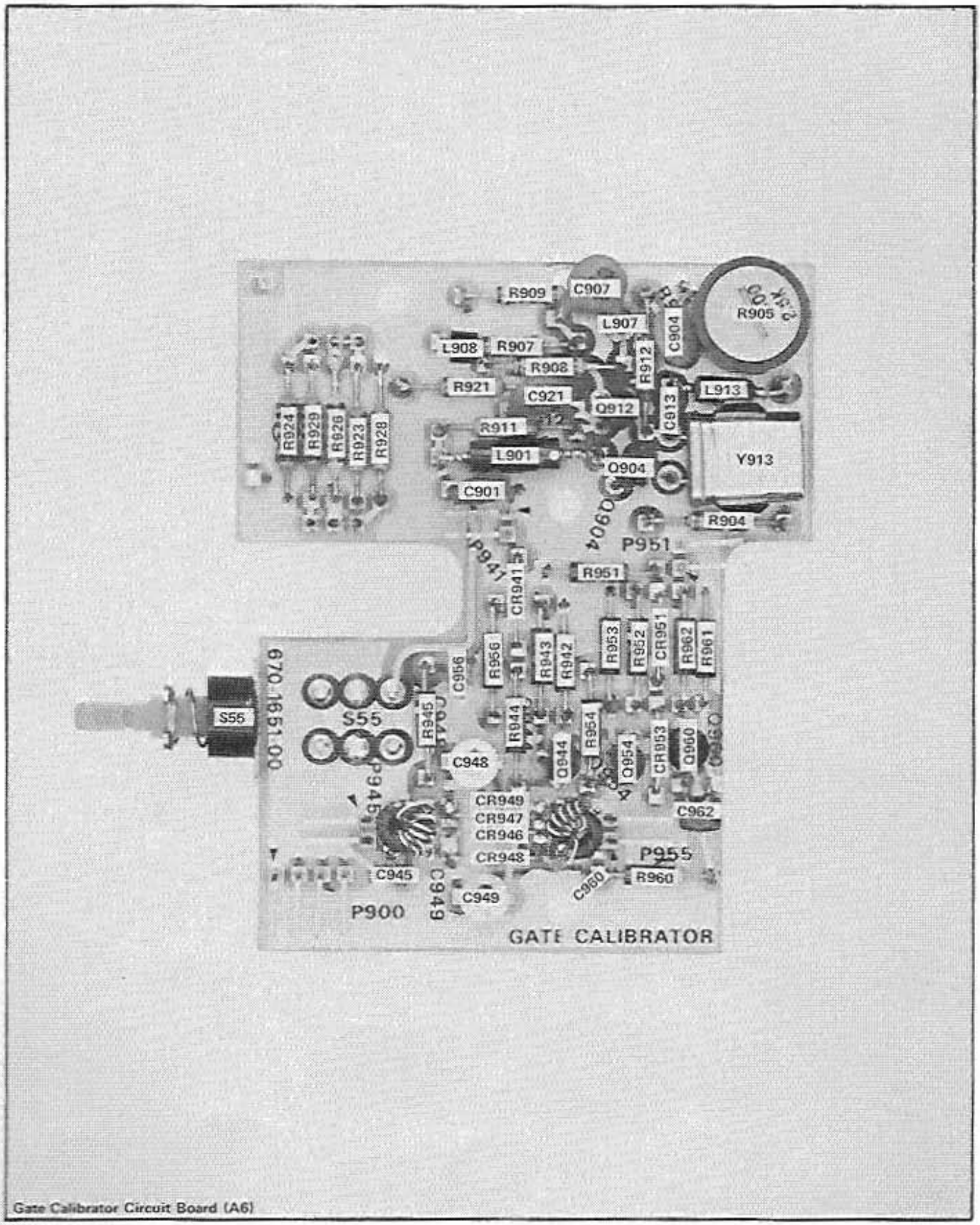
Diagram 7 (Power Pack)

Remove the power pack from the instrument, connect it to the AC line power and set the selector to FULL CHARGE position.

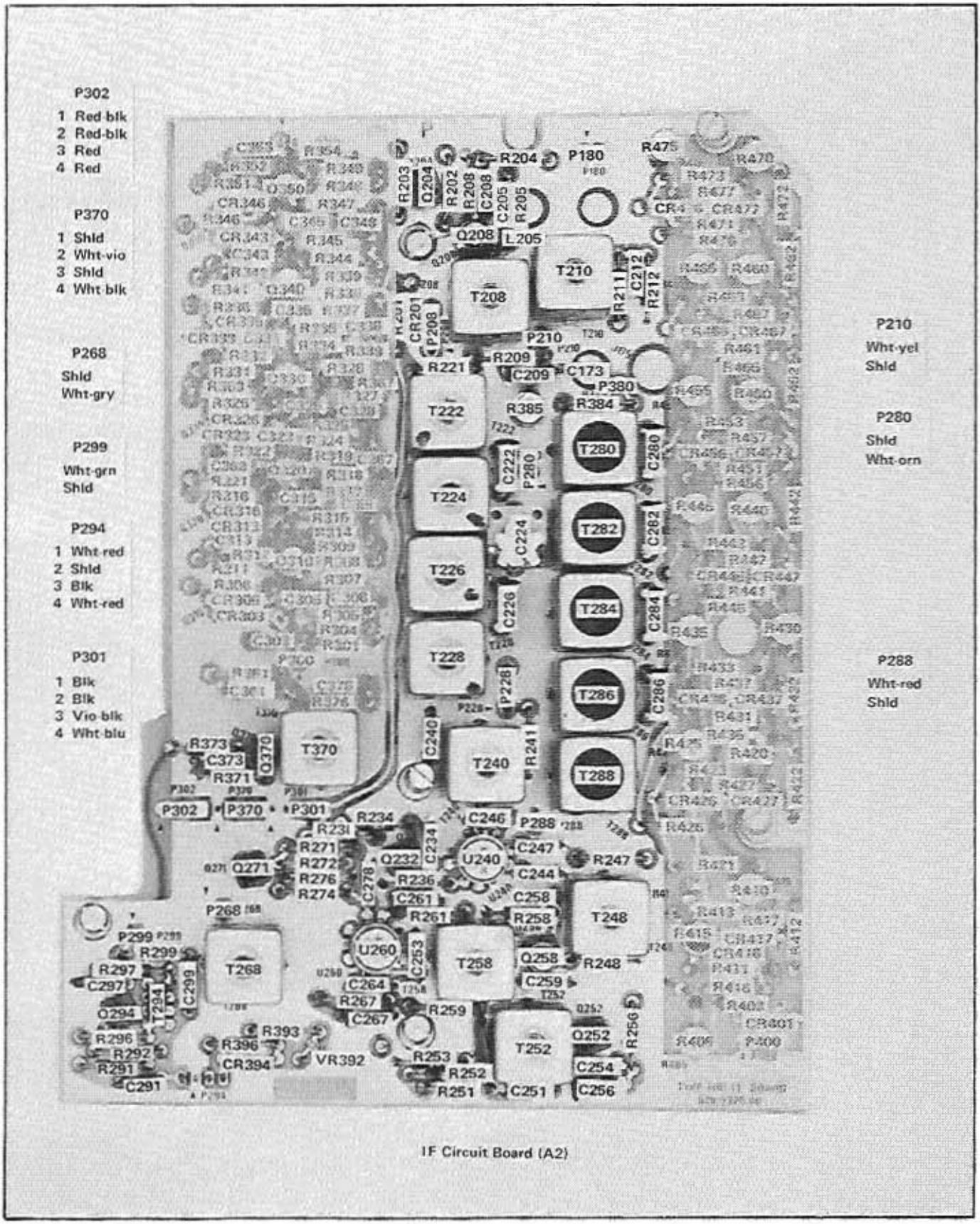
1401A


WIDE BAND MIXER
VTO OSCILLATOR
C152
LOW PASS FILTER
C187
C177
C165
C163
C161
Q184
C171
CR167
720 MHz OSCILLATOR and 2nd MIXER
695 MHz FILTER
RF Module (A1)
OSCILLATOR CURRENT SOURCE
C101
R106
R104
R105
CR105
R108
P101
7 Wht-grn
6 Shld
5 Blk
4 Vio-blk
3 Rd-blk
2 Shld
1 Wht-blk
Oscillator Current Source

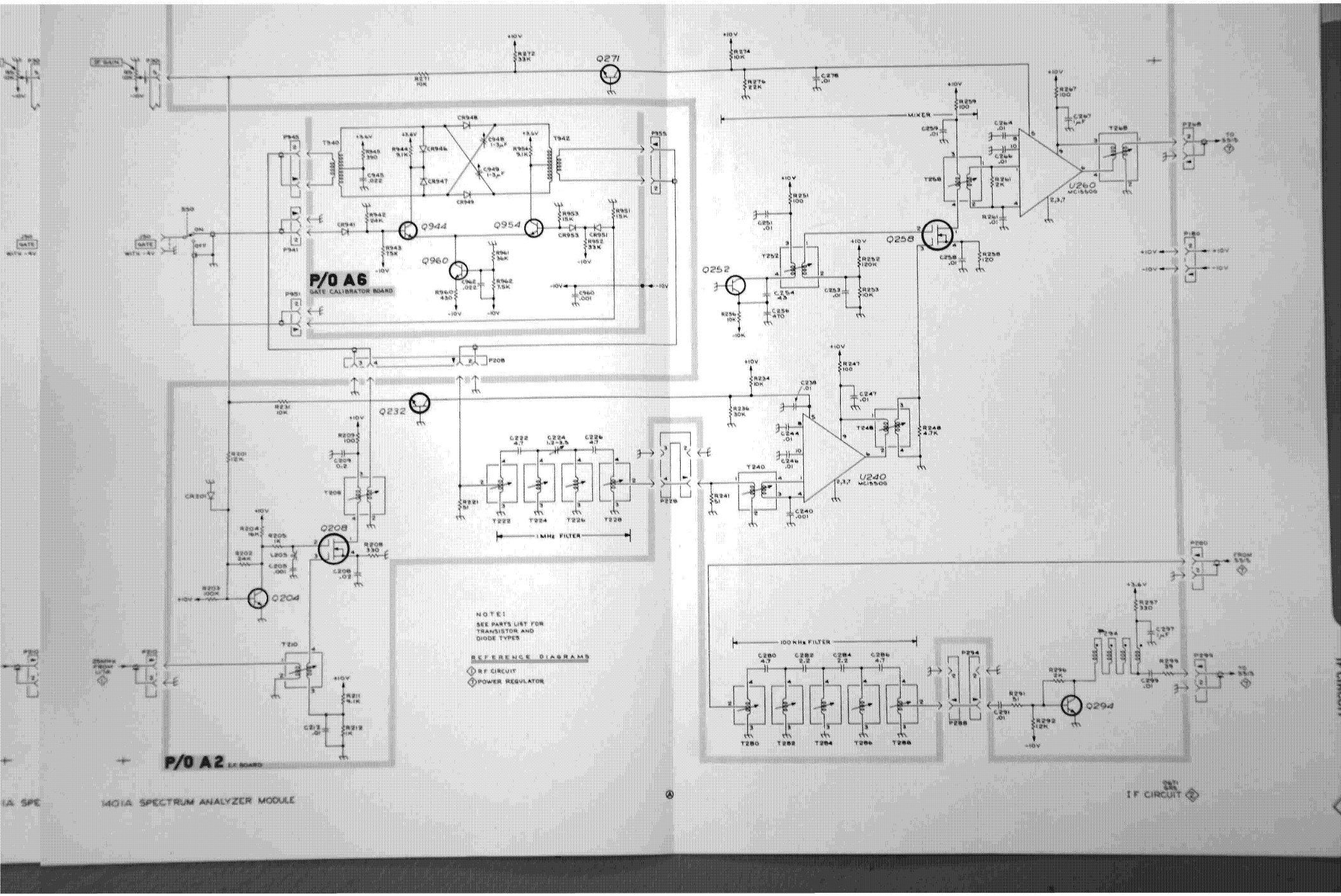

OSCILLATOR CURRENT SOURCE
VTO 695MHz-1195MHz OSCILLATOR
Q106
Q113
Q115
LOW PASS FILTER
WIDE BAND MIXER
STEP ATTENUATOR
50 TO 75 OHM PAD (140A-1 ONLY)
695MHz FILTER
MIXER
720MHz OSCILLATOR
A1 R.F. MODULE
P/O A2 I.F. BOARD
25 MHz TO T210
OSCILLATOR BIAS
REFERENCE DIAGRAMS
1 I.F. CIRCUIT
5 SWEEP SHAPER
7 POWER REGULATOR
NOTES:
1. SEE PARTS LIST FOR TRANSISTOR AND DIODE TYPES.
2. SELECTED TWISTED PAIR OF WIRES THAT ACT AS MATCHING CAPACITOR, MAY BE ON ANY ONE OR MORE DIODES.
3. # MATCHED SET.
* CIRCUIT BOARDS ARE PLATED AREAS.
RF CIRCUIT 1
RF CIRCUIT

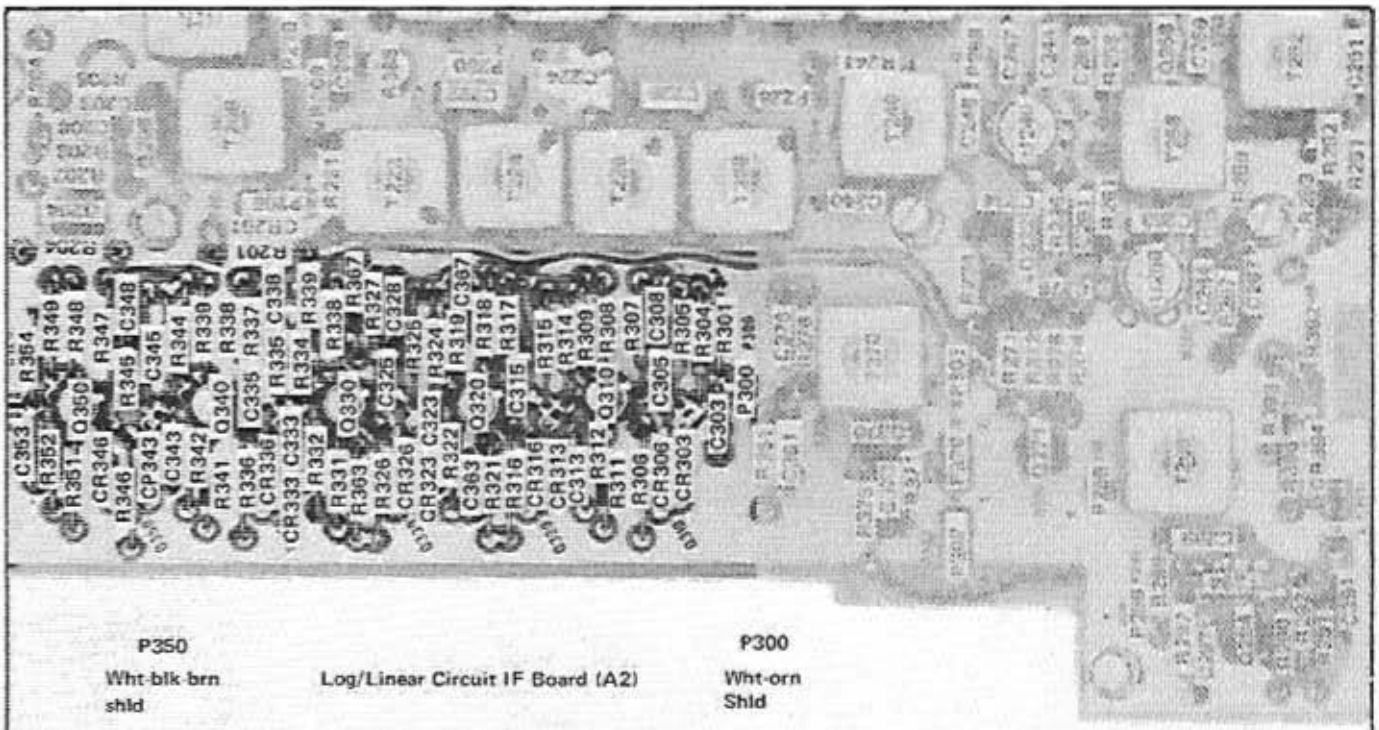


Gate Calibrator Circuit Board (A6)



IF Circuit Board (A2)


P/O A6
GATE CALIBRATOR BOARD
P/O A2
I.F. BOARD
MIXER
1 MHz FILTER
100 KHz FILTER
NOTE:
SEE PARTS LIST FOR TRANSISTOR AND DIODE TYPES
REFERENCE DIAGRAMS
RF CIRCUIT
POWER REGULATOR
Q271
Q944
Q954
Q960
Q232
Q208
Q204
Q258
Q252
Q294
U260
MC1550G
U240
MC1550G
T940
T942
T208
T210
T222
T224
T226
T228
T240
T248
T258
T280
T282
T284
T286
T288
P/O A6 GATE CALIBRATOR BOARD
P/O A2 I.F. BOARD
MOIA SPECTRUM ANALYZER MODULE
IF CIRCUIT



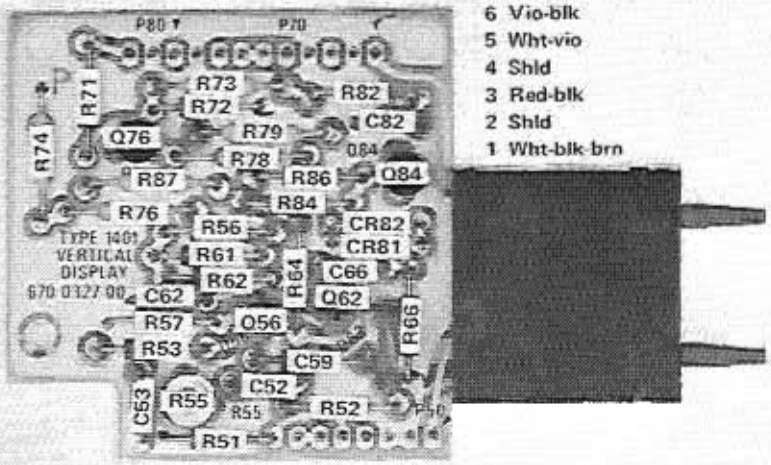
P350
Wht-blk-brn
shld

Log/Linear Circuit IF Board (A2)

P300
Wht-orn
Shld

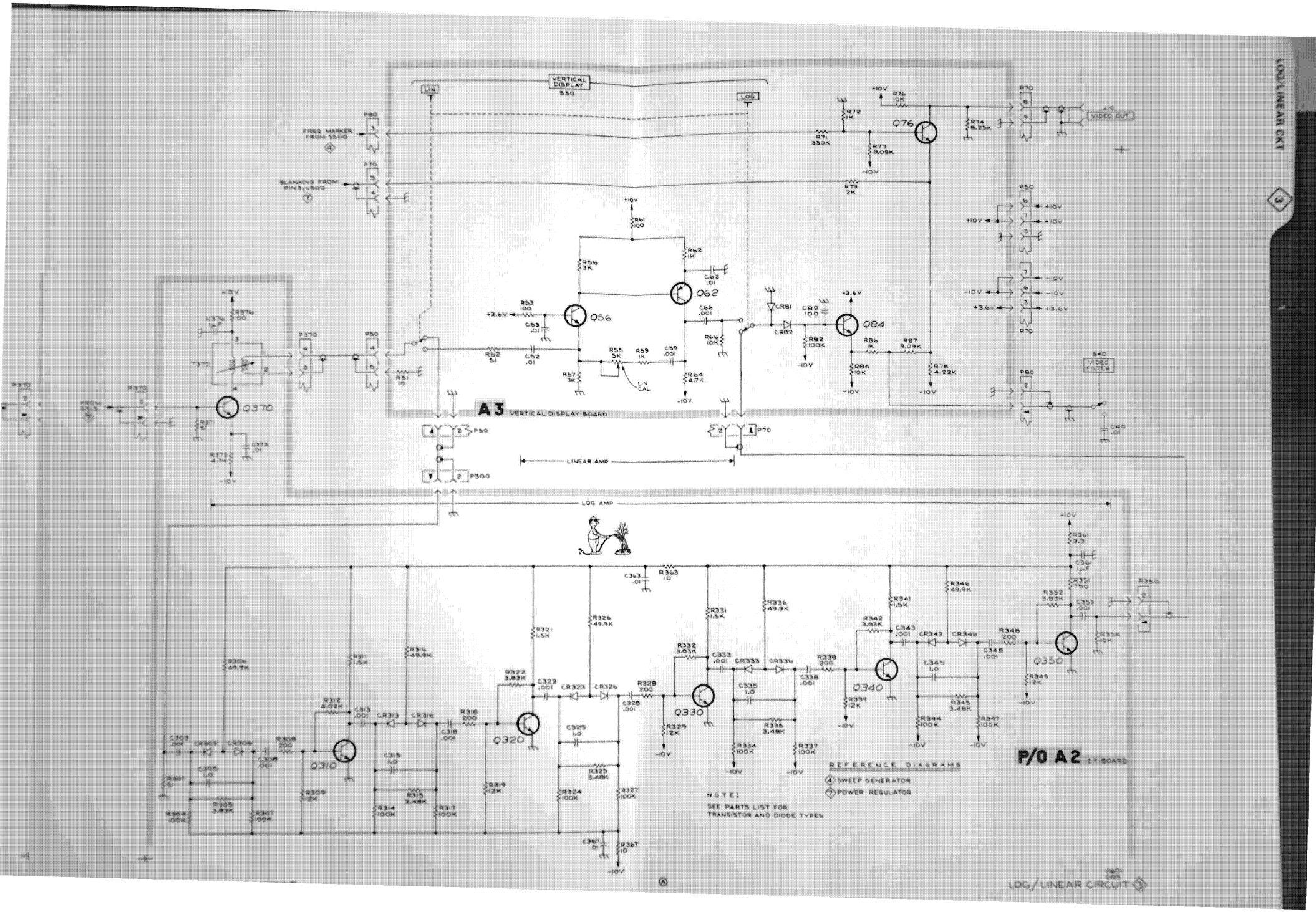
P80
3 Wht-grn
2 Shld
1 Wht-blu

P70
9 Shld
8 Wht-brn
7 Vio-blk
6 Vio-blk
5 Wht-vio
4 Shld
3 Red-blk
2 Shld
1 Wht-blk-brn

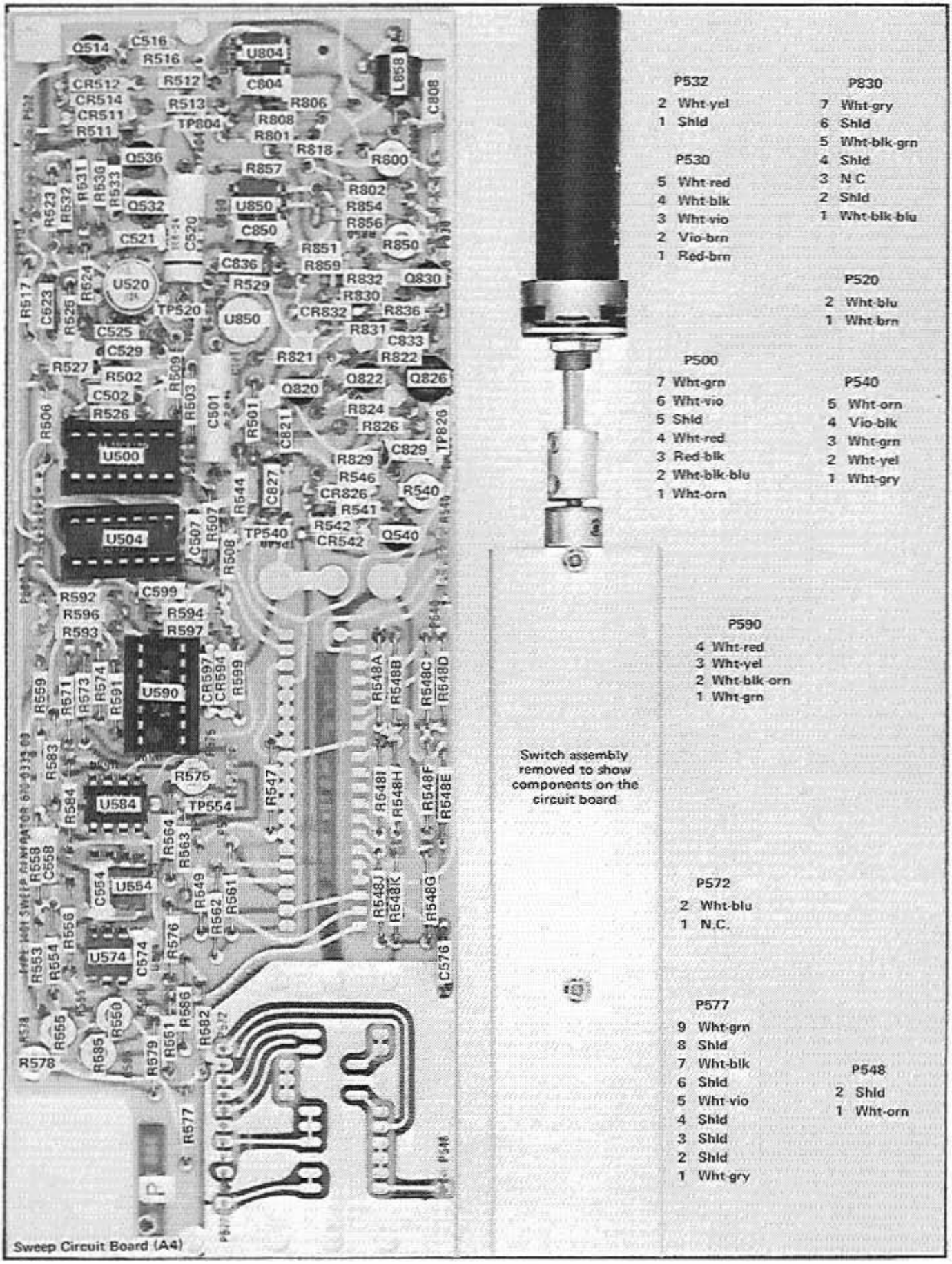


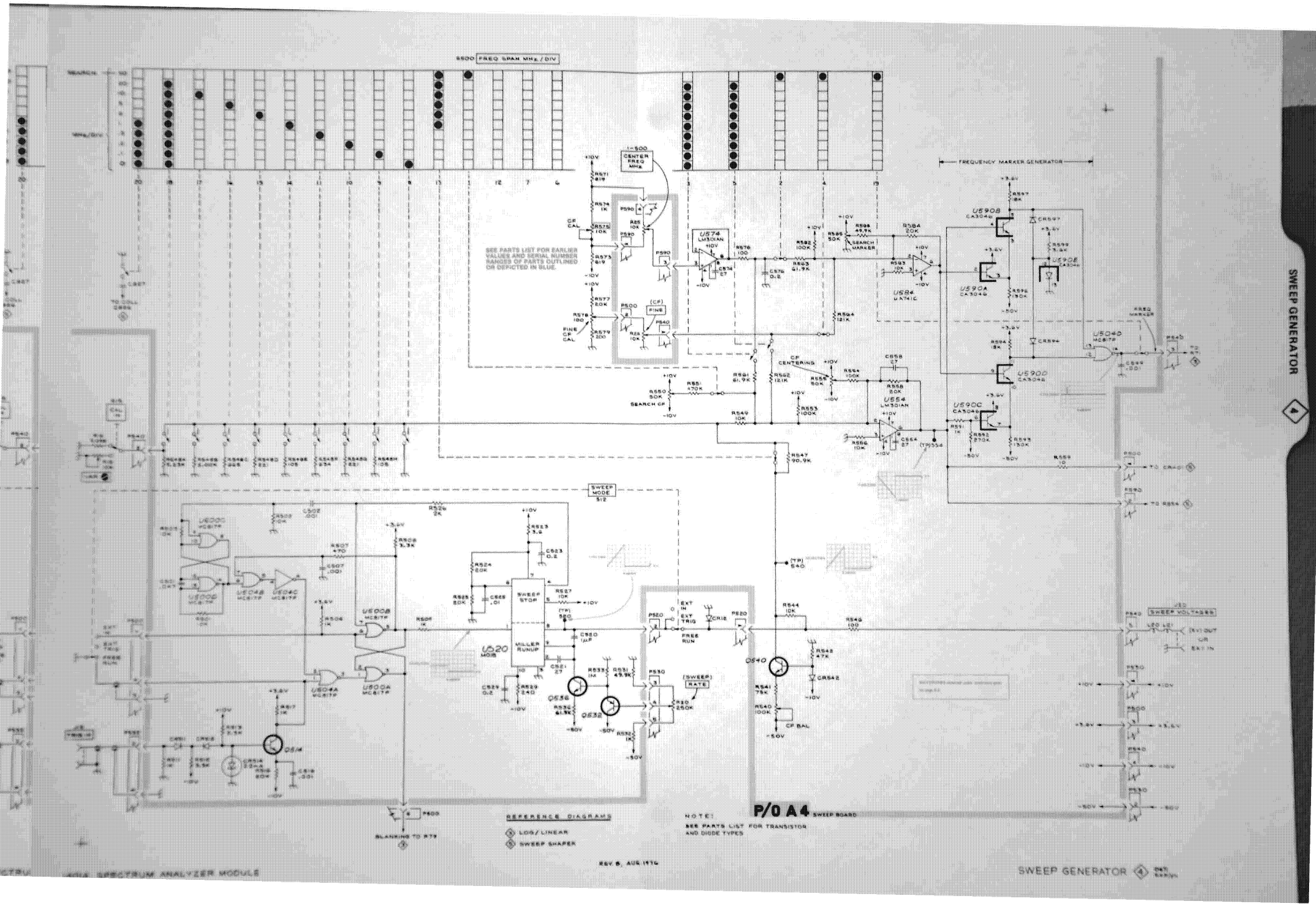
Vertical Display Circuit Board (A3)

P50
7 Red-brn
6 Red-brn
5 Shld
4 Wht-blk-red
3 Blk
2 Shld
1 Wht-orn

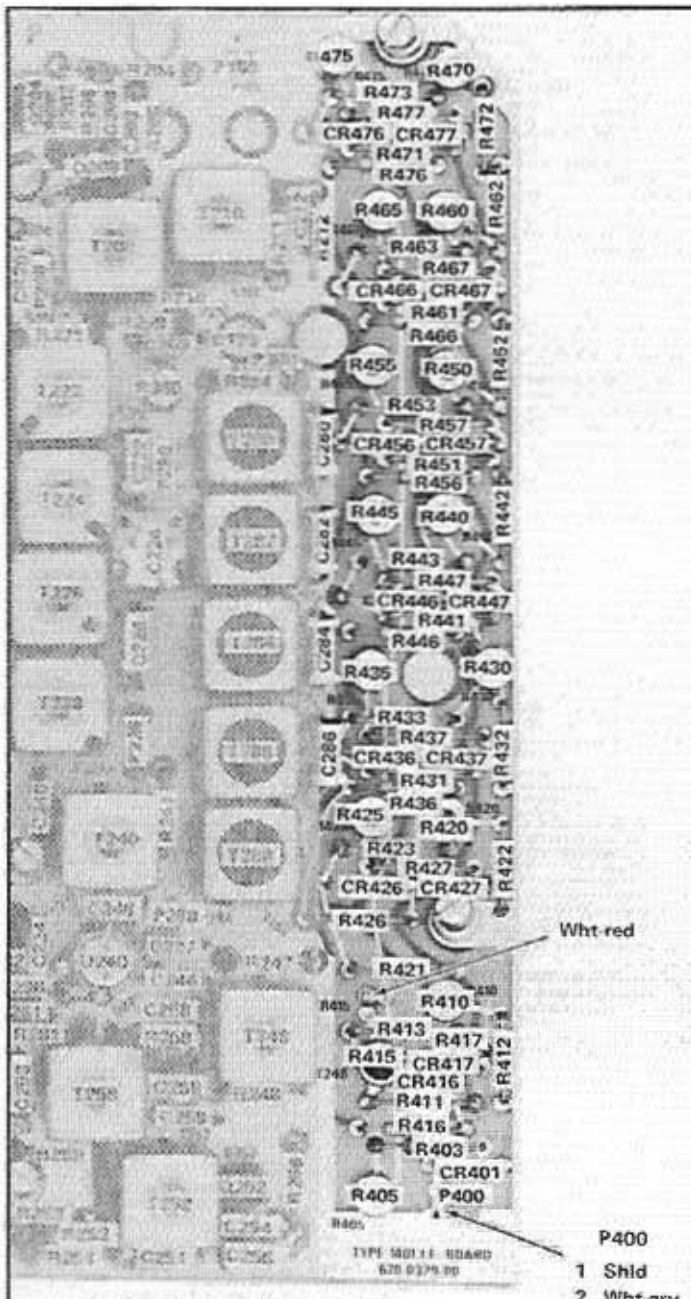

LOG/LINEAR CKT 3
VERTICAL DISPLAY 550
LIN
LOG
FREQ MARKER FROM 5500
BLANKING FROM PIN 3, U500
VIDEO OUT
A3 VERTICAL DISPLAY BOARD
LINEAR AMP
LOG AMP
Q370
Q310
Q320
Q330
Q340
Q350
Q56
Q62
Q76
Q84
P/O A2 2Y BOARD
REFERENCE DIAGRAMS
4 SWEEP GENERATOR
7 POWER REGULATOR
NOTE:
SEE PARTS LIST FOR TRANSISTOR AND DIODE TYPES
LOG/LINEAR CIRCUIT 3

1401A

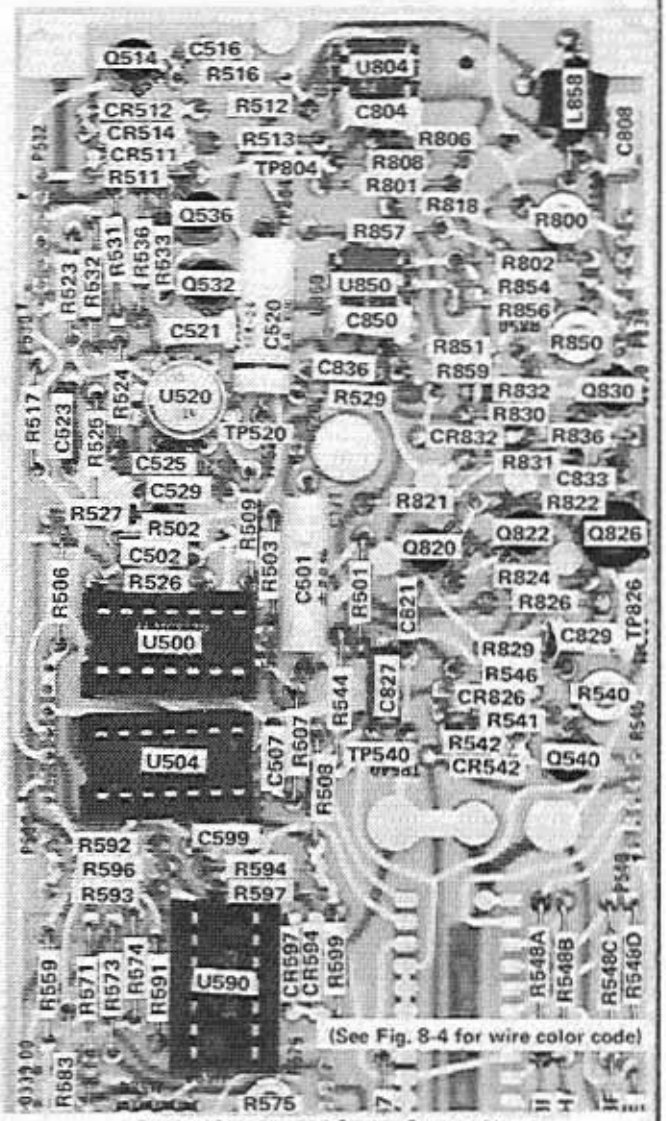

P532
2 Wht-yel
1 Shld
P530
5 Wht-red
4 Wht-blk
3 Wht-vio
2 Vio-brn
1 Red-brn
P830
7 Wht-gry
6 Shld
5 Wht-blk-grn
4 Shld
3 N.C
2 Shld
1 Wht-blk-blu
P520
2 Wht-blu
1 Wht-brn
P500
7 Wht-grn
6 Wht-vio
5 Shld
4 Wht-red
3 Red-blk
2 Wht-blk-blu
1 Wht-orn
P540
5 Wht-orn
4 Vio-blk
3 Wht-grn
2 Wht-yel
1 Wht-gry
P590
4 Wht-red
3 Wht-yel
2 Wht-blk-orn
1 Wht-grn
Switch assembly removed to show components on the circuit board
P572
2 Wht-blu
1 N.C.
P577
9 Wht-grn
8 Shld
7 Wht-blk
6 Shld
5 Wht-vio
4 Shld
3 Shld
2 Shld
1 Wht-gry
P548
2 Shld
1 Wht-orn
Sweep Circuit Board (A4)


SWEEP GENERATOR
4
FREQUENCY MARKER GENERATOR
SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS OUTLINED OR DEPICTED IN BLUE.
P/O A 4 SWEEP BOARD
REFERENCE DIAGRAMS
4 LOG/LINEAR
5 SWEEP SHAPER
NOTE:
SEE PARTS LIST FOR TRANSISTOR AND DIODE TYPES
REV B, AUG 1976
SWEEP GENERATOR 4

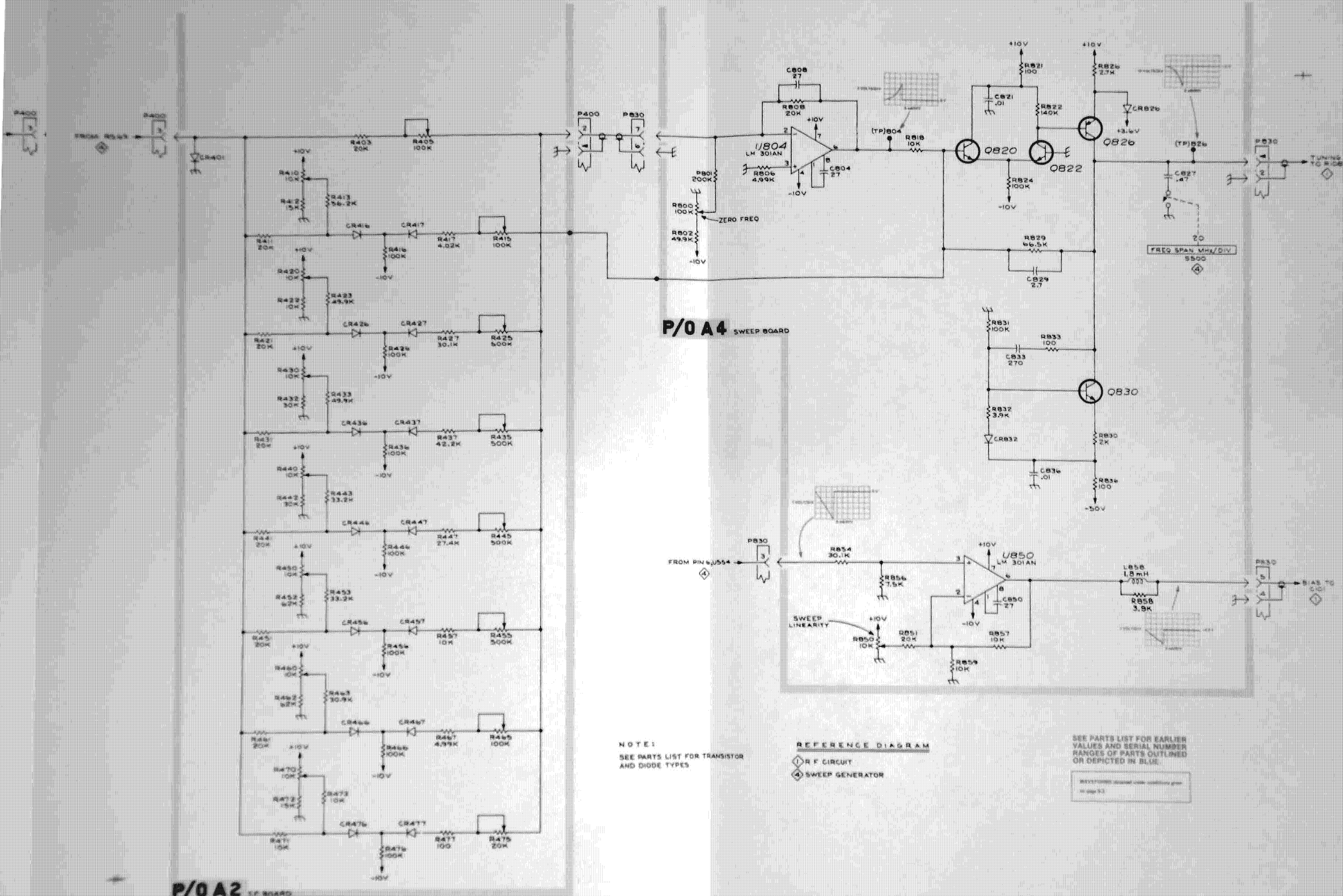
Tab5 Sweep Shaper



Sweep Shaper on IF Board (A2)



Sweep Linearity and Sweep Output Circuits on Sweeper Circuit Board (A4)



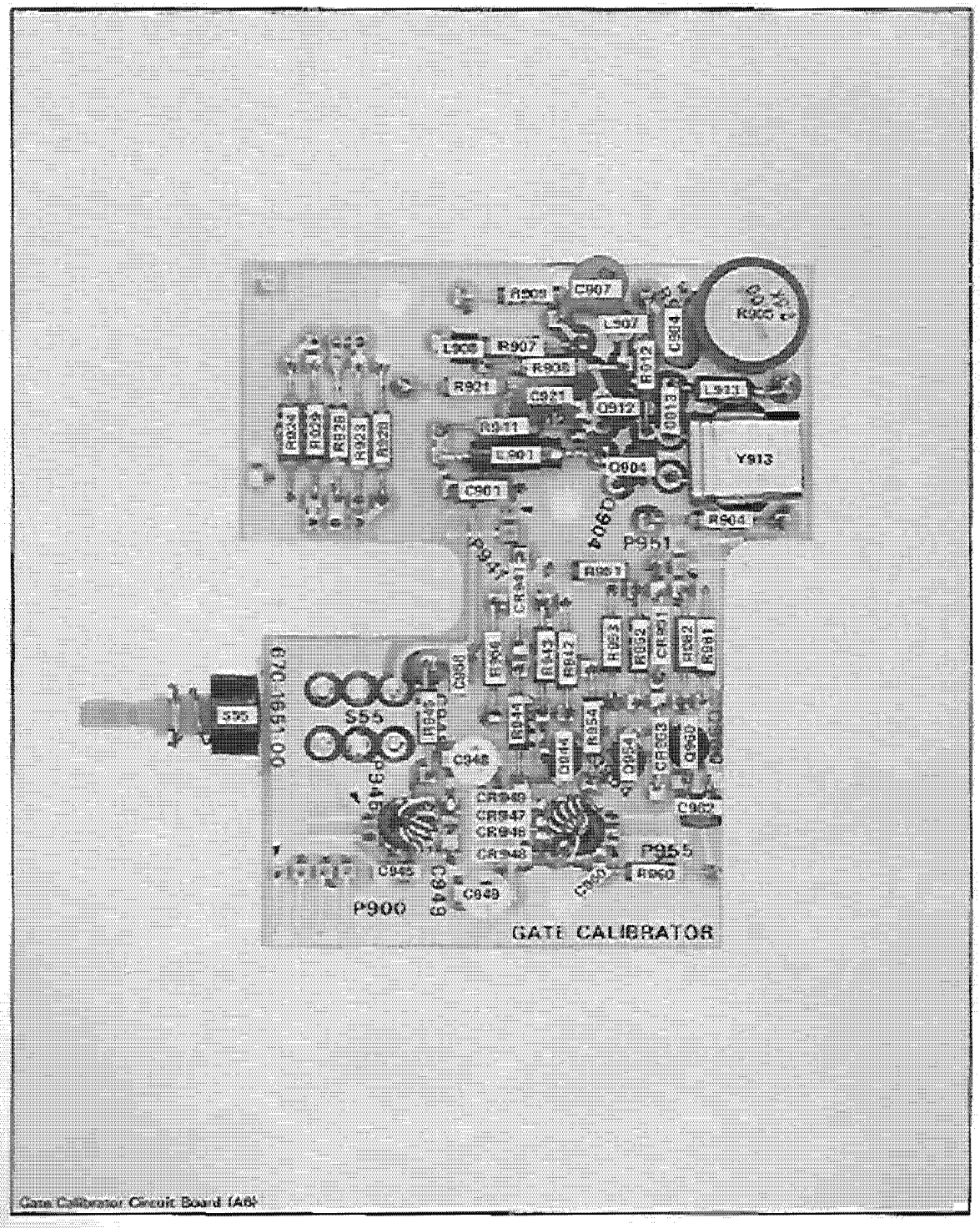
NOTE:
SEE PARTS LIST FOR TRANSISTOR AND DIODE TYPES

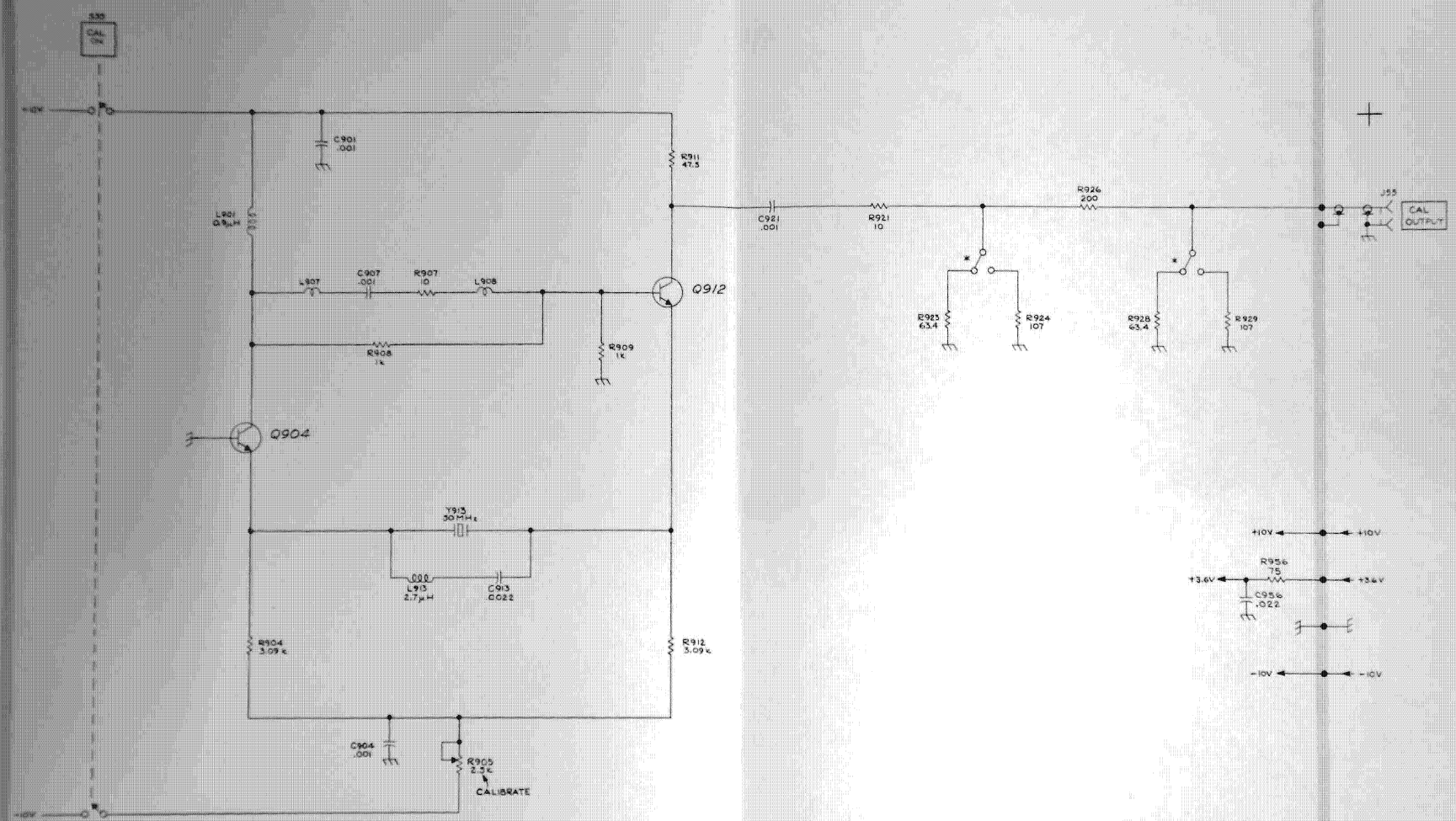
REFERENCE DIAGRAM
1 R F CIRCUIT
4 SWEEP GENERATOR

SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS OUTLINED OR DEPICTED IN BLUE.

REV DEC 1982

Tab6 50MHz Calibrator

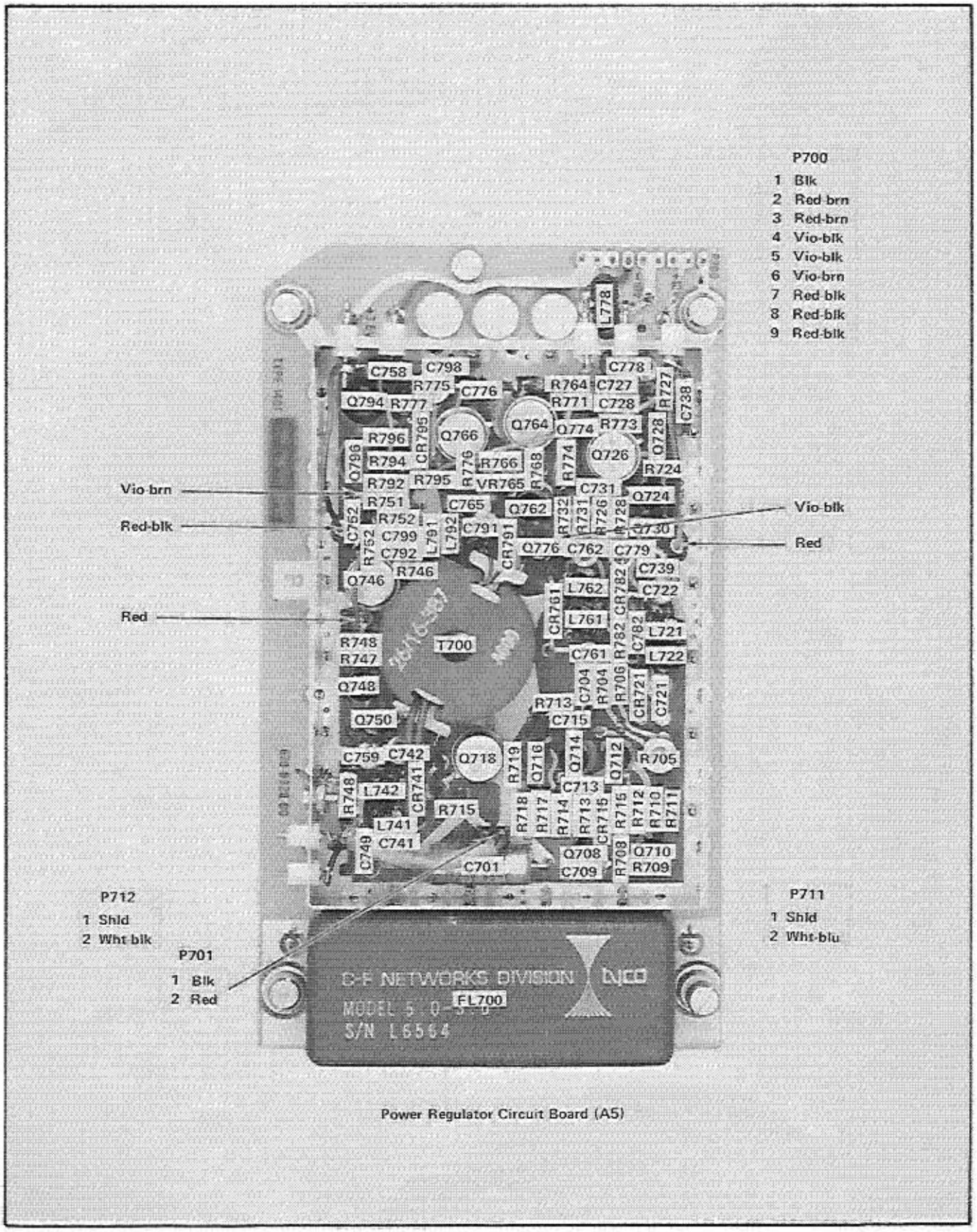




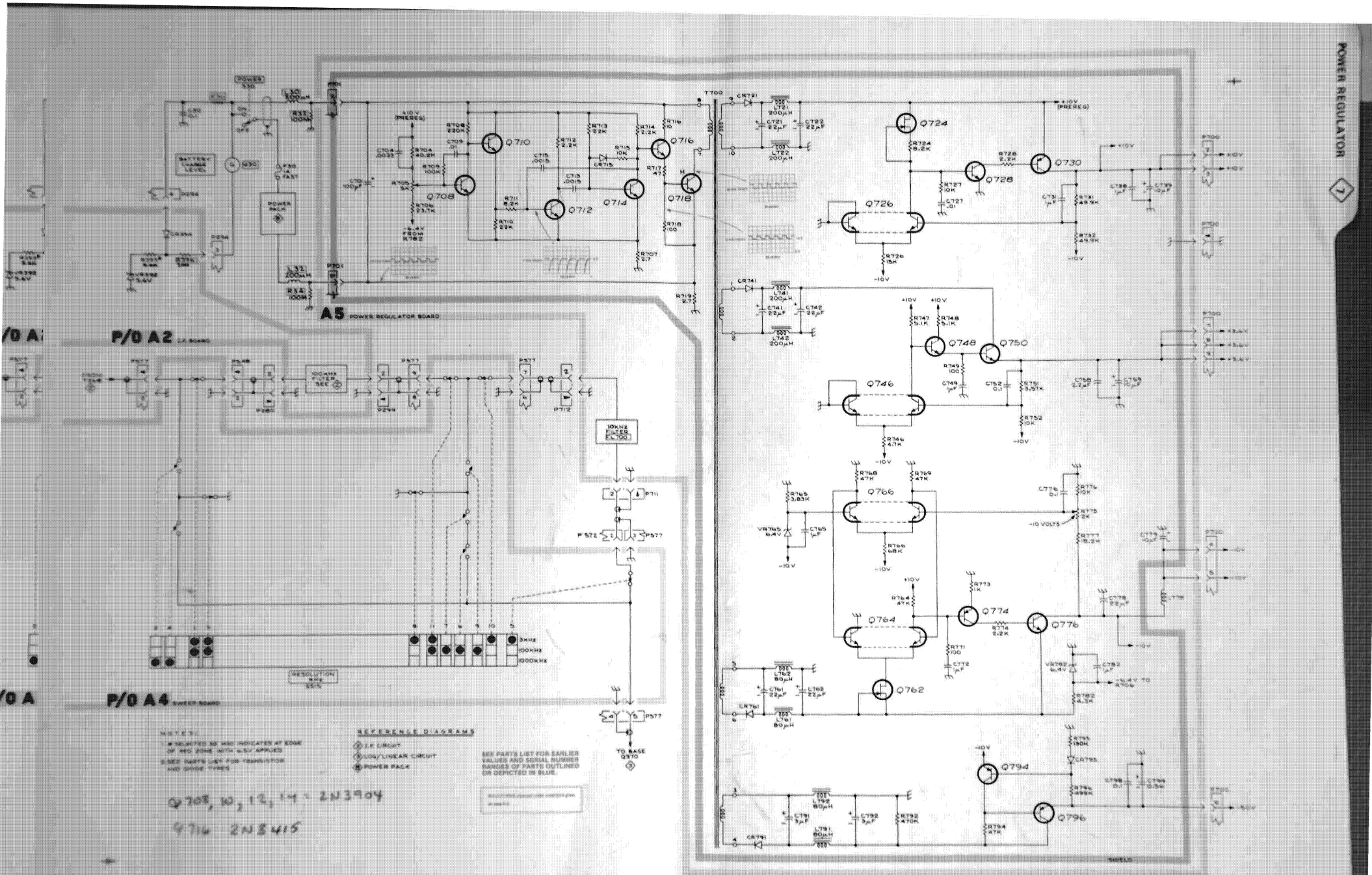
P/O A6 GATE CALIBRATOR BOARD

NOTES:
1. ✱ JUMPER SHOWN FOR 140A
2. SEE PARTS LIST FOR SEMICONDUCTOR TYPES

Tab Power Regulator



Power Regulator Circuit Board (A5)



NOTES:
1. ✱SELECTED SO MDC INDICATES AT EDGE OF RED ZONE WITH +5V APPLIED
2. SEE PARTS LIST FOR TRANSISTOR AND DIODE TYPES

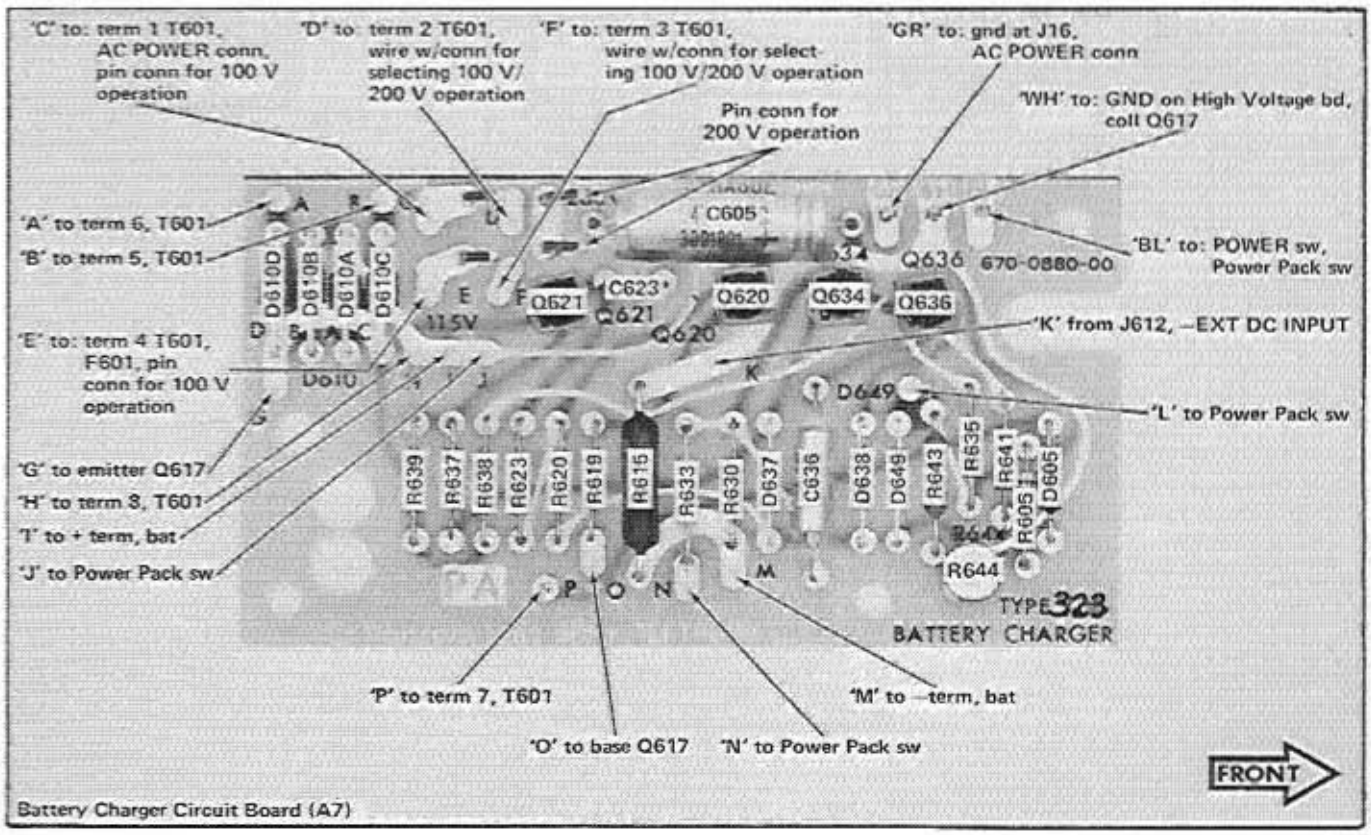
REFERENCE DIAGRAMS
- ① I.F. CIRCUIT
- ② LOG/LINEAR CIRCUIT
- ③ POWER PACK

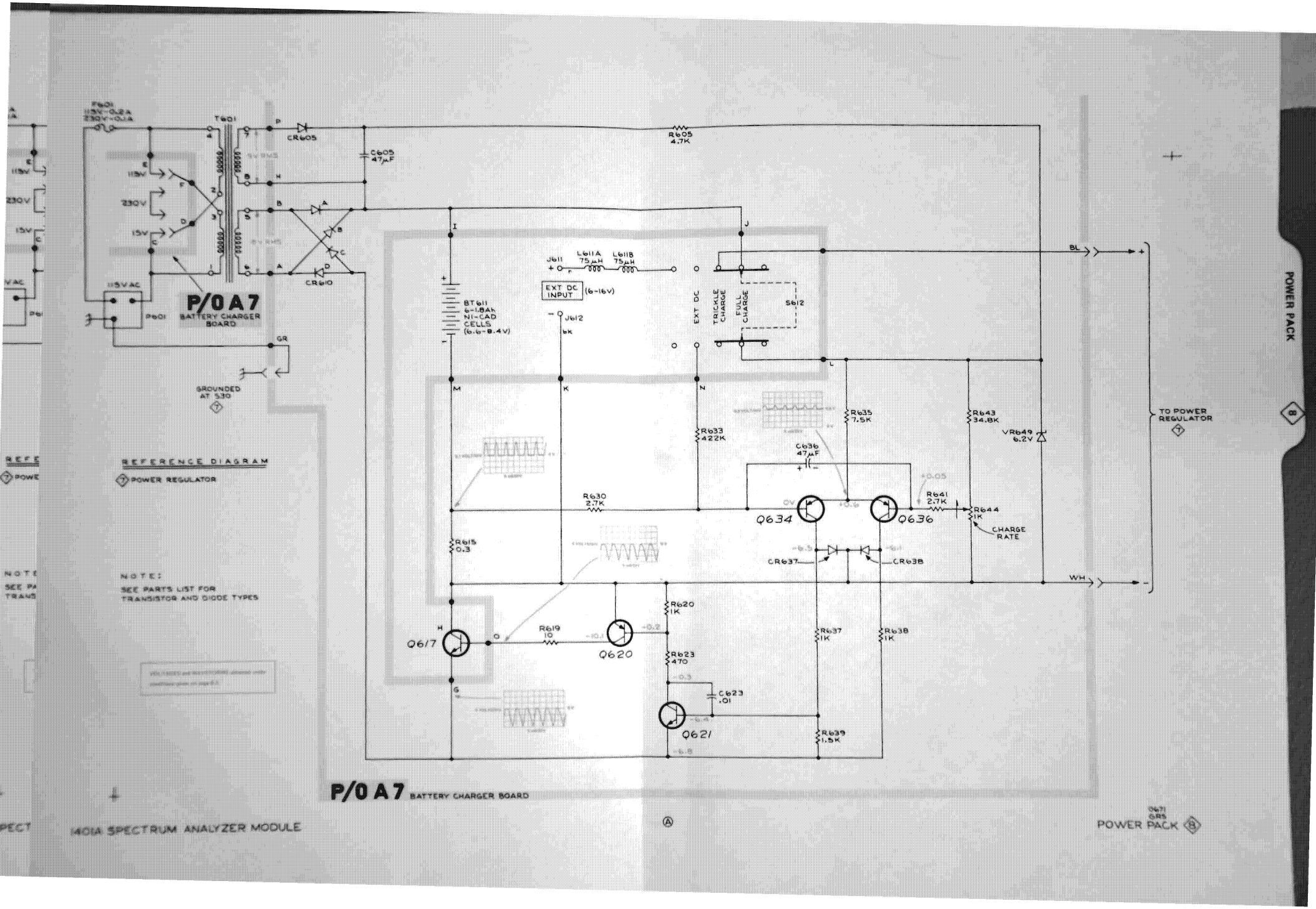
SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS OUTLINED OR DEPICTED IN BLUE.

Q708, 10, 12, 14 = 2N3904

Q716 2N3415

Tab 8 Power Pack




F601
115V-0.2A
230V-0.1A
T601
CR605
C605
47μF
R605
4.7K
115V
230V
15V
115VAC
P601
P/O A7
BATTERY CHARGER
BOARD
CR610
GR
GROUNDED
AT 530
BT611
6-1.8Ah
NI-CAD
CELLS
(6.6-8.4V)
J611
L611A
75μH
L611B
75μH
EXT DC
INPUT
(6-16V)
J612
EXT DC
TRICKLE
CHARGE
FULL
CHARGE
S612
BL
WH
TO POWER
REGULATOR
R633
422K
R635
7.5K
R643
34.8K
VR649
6.2V
C636
47μF
R630
2.7K
Q634
Q636
R641
2.7K
R644
1K
CHARGE
RATE
R615
0.3
CR637
CR638
R620
1K
Q617
R619
10
Q620
R623
470
C623
.01
Q621
R637
1K
R638
1K
R639
1.5K
REFERENCE DIAGRAM
7 POWER REGULATOR
NOTE:
SEE PARTS LIST FOR
TRANSISTOR AND DIODE TYPES
P/O A7 BATTERY CHARGER BOARD
140A SPECTRUM ANALYZER MODULE
A
0471
GRS
POWER PACK 8
POWER PACK
8

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
#	NUMBER SIZE
ACTR	ACTUATOR
ADPTR	ADAPTER
ALIGN	ALIGNMENT
AL	ALUMINUM
ASSEM	ASSEMBLED
ASSY	ASSEMBLY
ATTEN	ATTENUATOR
AWG	AMERICAN WIRE GAGE
BD	BOARD
BRKT	BRACKET
BRS	BRASS
BRZ	BRONZE
BSHG	BUSHING
CAB	CABINET
CAP	CAPACITOR
CER	CERAMIC
CHAS	CHASSIS
CKT	CIRCUIT
COMP	COMPOSITION
CONN	CONNECTOR
COV	COVER
CPLG	COUPLING
CRT	CATHODE RAY TUBE
DEG	DEGREE
DWR	DRAWER
ELCTRN	ELECTRON
ELEC	ELECTRICAL
ELCTLT	ELECTROLYTIC
ELEM	ELEMENT
EPL	ELECTRICAL PARTS LIST
EQPT	EQUIPMENT
EXT	EXTERNAL
FIL	FILLISTER HEAD
FLEX	FLEXIBLE
FLH	FLAT HEAD
FLTR	FILTER
FR	FRAME or FRONT
FSTNR	FASTENER
FT	FOOT
FXD	FIXED
GSKT	GASKET
HDL	HANDLE
HEX	HEXAGON
HEX HD	HEXAGONAL HEAD
HEX SOC	HEXAGONAL SOCKET
HLCPS	HELICAL COMPRESSION
HLEXT	HELICAL EXTENSION
HV	HIGH VOLTAGE
IC	INTEGRATED CIRCUIT
ID	INSIDE DIAMETER
IDENT	IDENTIFICATION
IMPLR	IMPELLER
IN	INCH
INCAND	INCANDESCENT
INSUL	INSULATOR
INTL	INTERNAL
LPHLDR	LAMPHOLDER
MACH	MACHINE
MECH	MECHANICAL
MTG	MOUNTING
NIP	NIPPLE
NON WIRE	NOT WIRE WOUND
OBD	ORDER BY DESCRIPTION
OD	OUTSIDE DIAMETER
OVH	OVAL HEAD
PH BRZ	PHOSPHOR BRONZE
PL	PLAIN or PLATE
PLSTC	PLASTIC
PN	PART NUMBER
PNH	PAN HEAD
PWR	POWER
RCPT	RECEPTACLE
RES	RESISTOR
RGD	RIGID
RLF	RELIEF
RTNR	RETAINER
SCH	SOCKET HEAD
SCOPE	OSCILLOSCOPE
SCR	SCREW
SE	SINGLE END
SECT	SECTION
SEMICOND	SEMICONDUCTOR
SHLD	SHIELD
SHLDR	SHOULDERED
SKT	SOCKET
SL	SLIDE
SLFLKG	SELF-LOCKING
SLVG	SLEEVING
SPR	SPRING
SQ	SQUARE
SST	STAINLESS STEEL
STL	STEEL
SW	SWITCH
T	TUBE
TERM	TERMINAL
THD	THREAD
THK	THICK
TNSN	TENSION
TPG	TAPPING
TRH	TRUSS HEAD
V	VOLTAGE
VAR	VARIABLE
W/	WITH
WSHR	WASHER
XFMR	TRANSFORMER
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
0000C	GETTIG ENGINEERING AND MFG CO.		SPRINGMILL, PA 16875
0000M	SONY/TEKTRONIX CORPORATION	P O BOX 14, HANEDA AIRPORT	TOKYO 149, JAPAN
00779	AMP, INC.	P O BOX 3608	HARRISBURG, PA 17105
01295	TEXAS INSTRUMENTS, INC., SEMICONDUCTOR GROUP	P O BOX 5012, 13500 N CENTRAL EXPRESSWAY	DALLAS, TX 75222
02768	ILLINOIS TOOL WORKS, INC., FASTEX DIV.	195 ALGONQUIN ROAD	DES PLAINES, IL 60016
04423	TELONIC INDUSTRIES, INC.	21282 LAGUNA CANYON ROAD	LAGUNA BEACH, CA 92652
05091	TRI-ONDINATE CORPORATION	343 SNYDER AVENUE	BERKELEY HEIGHTS, NJ 07922
10369	CHICAGO SWITCH, INC.	2035 WABANSIA AVE.	CHICAGO, IL 60647
12327	FREEWAY CORPORATION	9301 ALLEN DRIVE	CLEVELAND, OH 44125
14140	EDISON ELECTRONICS DIV., MCGRAW EDISON CO.	GRENIER FIELD-MUNICIPAL AIRPORT	MANCHESTER, NH 03130
16179	OMNI SPECTRA, INC.	24600 HALLWOOD CT.	FARMINGTON, MI 48024
19209	GENERAL ELECTRIC CO., ELECTRONIC CAPACITOR AND BATTERY PRODUCTS DEPT. BATTERY PRODUCTS SEC.	P. O. BOX 114	GAINESVILLE, FL 32601
22526	BERG ELECTRONICS, INC.	YOUK EXPRESSWAY	NEW CUMBERLAND, PA 17070
27264	MOLEX PRODUCTS CO.	5224 KATRINE AVE.	DOWNERS GROVE, IL 60515
60418	TORSION BALANCE COMPANY	125 ELLSWORTH P O BOX 535	CLIFTON, NJ 07012
70276	ALLEN MFG. CO.	P. O. DRAWER 570	HARTFORD, CT 06101
71279	CAMBRIDGE THERMIONIC CORP.	445 CONCORD AVE.	CAMBRIDGE, MA 02138
71286	REXNORD, INC., SPECIALTY FASTENER DIV.	22 SPRING VALLEY RD.	PARAMUS, NJ 07652
71785	TRW, CINCH CONNECTORS	1501 MORSE AVENUE	ELK GROVE VILLAGE, IL 60007
72228	CONTINENTAL SCREW CO., DIV. OF AMTEL, INC.	459 MT. PLEASANT	NEW BEDFORD, MA 02742
73743	FISCHER SPECIAL MFG. CO.	446 MORGAN ST.	CINCINNATI, OH 45206
73803	TEXAS INSTRUMENTS, INC., METALLURGICAL MATERIALS DIV.	34 FOREST STREET	ATTLEBORO, MA 02703
74445	HOLO-KROME CO.	31 BROOK ST. WEST	HARTFORD, CT 06110
77250	PHEOLL MANUFACTURING CO., DIVISION OF ALLIED PRODUCTS CORP.	5700 W. ROOSEVELT RD.	CHICAGO, IL 60650
78189	ILLINOIS TOOL WORKS, INC. SHAKEPROOF DIVISION	ST. CHARLES ROAD	ELGIN, IL 60120
78471	TILLEY MFG. CO.	900 INDUSTRIAL RD.	SAN CARLOS, CA 94070
79136	WALDES, KOHINOOR, INC.	47-16 AUSTEL PLACE	LONG ISLAND CITY, NY 11101
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 SPECIALTY CO., SUBSIDIARY OF BELDEN CORPORATION	213 E HARRIS AVENUE	SAN FRANCISCO, CA 94080
83385	CENTRAL SCREW COMPANY	2530 CRESCENT DRIVE	BROADVIEW, IL 60153
83903	ACCURATE DIE AND STAMPING DIV., ALLIED PRODUCTS CORPORATION	1947 N MAUD AVENUE	CHICAGO, IL 60614
86928	SEASTROM MFG. COMPANY, INC.	701 SONORA AVENUE	GLENDALE, CA 91201
91836	KINGS ELECTRONICS CO., INC.	40 MARBLEDALE ROAD	TUCKAHOE, NY 10707
95987	WECKESSER CO., INC.	4444 WEST IRVING PARK ROAD	CHICAGO, IL 60641
98278	MALCO A MICRODOT COMPANY, INC. CONNECTOR AND CABLE DIVISION	220 PASADENA AVENUE	SOUTH PASADENA, CA 91030
98291	SEALECTRO CORPORATION	225 HOYT	MAMARONECK, NY 10544
98978	INTERNATIONAL ELECTRONIC RESEARCH CORP.	135 W MAGNOLIA BLVD.	BURBANK, CA 91502

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	366-1269-00	B010100	B059999	1	KNOB:GRAY,1-500	80009	366-1269-00
	366-1269-02	B060000		1	SHELL,KNOB:W/LENS	80009	366-1269-02
-2	366-1234-00			1	KNOB:GRAY,FINE	80009	366-1234-00
-3	366-1146-00			1	KNOB:GRAY,IF GAIN	80009	366-1146-00
	213-0153-00			1	. SETSCREW:5-40 X 0.125,STL BK OXD,HEX	000CY	OBD
-4	366-1001-00			1	KNOB:GRAY,RF ATTENDB	80009	366-1001-00
	213-0153-00			2	. SETSCREW:5-40 X 0.125,STL BK OXD,HEX	000CY	OBD
-5	366-1168-00			1	KNOB:BLACK CAP AND RED BODY	80009	366-1168-00
	213-0153-00			1	. SETSCREW:5-40 X 0.125,STL BK OXD,HEX	000CY	OBD
-6	366-1258-00			1	KNOB:GRAY,MHZ/DIV	80009	366-1258-00
	213-0153-00			2	. SETSCREW:5-40 X 0.125,STL BK OXD,HEX	000CY	OBD
	358-0414-00			1	BUSHING,SLEEVE:0.25 OD X 0.21 INCH LONG	80009	358-0414-00
-7	200-1011-04	B010100	B049999	1	CAP.,KNOB:DIAL WINDOW	80009	200-1011-04
	200-1011-05	B050000		1	CAP.,KNOB:DIAL WINDOW	80009	200-1011-05
-8	366-1150-00			1	KNOB:GRAY,FREQ SPAN	80009	366-1150-00
	213-0153-00			2	. SETSCREW:5-40 X 0.125,STL BK OXD,HEX	000CY	OBD
-9	331-0267-00			1	. DIAL,SCALE:	80009	331-0267-00
-10	366-0494-00			1	KNOBGRAY,W/SETSCREW	80009	366-0494-00
	213-0153-00			1	. SETSCREW:5-40 X 0.125,STL BK OXD,HEX	000CY	OBD
-11	366-0379-00			1	KNOB:GRAY,MODE	80009	366-0379-00
	213-0153-00			1	. SETSCREW:5-40 X 0.125,STL BK OXD,HEX	000CY	OBD
-12	----- -----			1	RESISTOR,VAR:(SEE R25 EPL)		
					(ATTACHING PARTS)		
-13	210-0413-00			1	NUT,PLAIN,HEX.:0.375-32 X 0.50 INCH,STL	73743	3145-402
	210-0021-00			1	WASHER,LOCK:INTL,0.476 ID X 0.60"OD STL	78189	1222-01-00-0541C
-14	220-0459-00			1	NUT,PLAIN,DODEC:	73743	2XX-64066-101
-15	210-0047-00			1	WASHER,LOCK:0.88 ID X 1.110 OD	78189	1234-04-00-0541C
-16	201-0015-00			1	CUP,COMPONENT M:	80009	201-0015-00
					- - - * - - -		
-17	----- -----			1	RESISTOR,VAR:(SEE R26 EPL)		
					(ATTACHING PARTS)		
-18	210-0413-00			1	NUT,PLAIN,HEX.:0.375-32 X 0.50 INCH,STL	73743	3145-402
-19	210-0255-00			1	TERMINAL,LUG:0.391" ID INT TOOTH	80009	210-0255-00
-20	220-0459-00			1	NUT,PLAIN,DODEC:	73743	2XX-64066-101
-21	210-0047-00			1	WASHER,LOCK:0.88 ID X 1.110 OD	78189	1234-04-00-0541C
-22	201-0016-00			1	CUP,COMPONENT M:	80009	201-0016-00
					- - - * - - -		
-23	----- -----			1	RESISTOR,VAR:(SEE R20 EPL)		
					(ATTACHING PARTS)		
-24	210-0583-00			1	NUT,PLAIN,HEX.:0.25-32 X 0.312 INCH,BRS	73743	2X20224-402
-25	210-0940-00			1	WASHER,FLAT:0.25 ID X 0.375 INCH OD,STL	79807	OBD
					- - - * - - -		
-26	----- -----			1	METER,ELEC FREQ:(SEE M30 EPL)		
					(ATTACHING PARTS)		
-27	352-0243-00			1	HOLDER,INDICATR:BATTERY LEVEL,PLASTIC	80009	352-0243-00
					- - - * - - -		
	175-1162-00			1	CABLE ASSY,SP:5.5 INCH LONG	80009	175-1162-00
	131-0888-00			1	. CONNECTOR,PLUG,:MALE	26805	2031-5006-95
-28	131-0818-00			1	. CONNECTOR,RCPT,:BNC,FEMALE	91836	KC19-153BNC
-29	333-1323-02			1	PANEL,FRONT:	80009	333-1323-02
-30	260-1139-00			1	SWITCH,ROTARY:DPDT,PUSH-PUSH	14140	28KM3C500N
					(ATTACHING PARTS)		
	213-0020-00			1	SETSCREW:6-32 X 0.125 INCH,HEX.SOC STL	70276	OBD
					- - - * - - -		
-31	260-1116-00			1	SWITCH,SLIDE:SPDT	10389	23-021-144
					(ATTACHING PARTS)		
-32	211-0069-00			2	SCREW,MACHINE:2-56 X 0.125 INCH,PNH STL	77250	OBD
-33	210-0259-00			1	TERMINAL,LUG:0.099"ID INT TOOTH,SE	80009	210-0259-00
					- - - * - - -		
-34	214-0992-00			1	IND ASSY,SW POS:	80009	214-0992-00
-35	260-0903-00			1	SWITCH,SLIDE:DPDT,0.5A,125V	0000M	260-0903-00
					(ATTACHING PARTS)		
-36	210-0586-00			1	NUT,PLAIN,EXT W:4-40 X 0.25 INCH,STL	78189	211-041800-00
					- - - * - - -		

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
1-37	131-0809-00			1		TERMINAL,STUD:PNL MT,4-40 TAP I END	71279	570-1510-01-0519
-38	210-0201-00			1		TERMINAL,LUG:SE #4	86928	A373-157-2
-39	211-0005-00			2		SCREW,MACHINE:4-40 X 0.125 INCH,PNH STL	83385	OBD
-40	386-1768-00			1		PLATE,SW MTG:	80009	386-1768-00
						- - - * - - -		
-41	260-0643-00			1		SWITCH,TOGGLE:SPDT,50VDC	83332	SP3
						(ATTACHING PARTS)		
-42	210-0562-00			2		NUT,PLAIN,HEX.:0.25-40 X 0.312 INCH,BBS	73743	2X20224-402
-43	210-0940-00			1		WASHER,FLAT:0.25 ID X 0.375 INCH OD,STL	79807	OBD
-44	210-0046-00			1		WASHER,LOCK:INTL,0.26 ID X 0.40" OD,STL	78189	1214-05-00-0541C
						- - - * - - -		
-45	119-0231-01			1		ATTENUATOR,VAR:0-60 DB IN 10DB STEPS	04423	8181-S
						(ATTACHING PARTS)		
	210-0590-00			1		NUT,PLAIN,HEX.:0.375 X 0.438 INCH,STL	73743	2X28269-402
-46	210-0978-00			3		WASHER,FLAT:0.375 ID X 0.50 INCH OD,STL	78471	OBD
						- - - * - - -		
-47	----- -----			1		RESISTOR,VAR:(SEE R5 EPL)		
						(ATTACHING PARTS)		
	213-0022-00			2		SETSCREW:4-40 X 0.188 INCH,HEX SOC STL	74445	OBD
						- - - * - - -		
-48	384-1023-00			1		EXTENSION SHAFT:4.106 L X 0.125 OD SST	80009	384-1023-00
						(ATTACHING PARTS)		
-49	220-0483-00			1		NUT,PUSH ON:FOR 0.125 INCH SHAFT	02768	8064-12-00-0531
						- - - * - - -		
-50	386-1772-02			1		SUBPANEL,FRONT:	80009	386-1772-02
-51	407-0768-03			1		BRACKET,CONN:	80009	407-0768-03
						(ATTACHING PARTS)		
-52	213-0007-00			1		SCR,TPG,THD FOR:10-32 X 0.25 INCH,HEX SOC	74445	OBD
-53	355-0154-00			1		STUD,RETAINING:0.394 INCH LONG,STL	80009	355-0154-00
-54	211-0504-00			2		SCREW,MACHINE:6-32 X 0.25 INCH,PNH STL	83385	OBD
						- - - * - - -		
-55	131-0955-00			2		CONNECTOR,RCPT,:BNC,FEMALE,W/HARDWARE	05091	31-279
-56	200-0103-00			1		NUT,PLAIN,KNURL:0.25-28 X 0.375" OD,BRASS	80009	200-0103-00
-57	129-0077-00			1		STUD,SHOULDERED:0.938 INCH LONG,BRASS	80009	129-0077-00
						(ATTACHING PARTS)		
-58	210-0455-00			1		NUT,PLAIN,HEX.:0.25-28 X 0.375 INCH,BRASS	73743	3089-402
-59	210-0223-00			1		TERMINAL,LUG:0.25 INCH DIA,SE	86928	A313-136
						- - - * - - -		
-60	352-0266-00			1		FUSEHOLDER:	80009	352-0266-00
						(ATTACHING PARTS)		
-61	211-0112-00			1		SCREW,MACHINE:4-40 X 0.375"100DEG,FLH STL	83385	OBD
-62	210-0001-00			1		WASHER,LOCK:INTL,0.092 ID X 0.18"OD,STL	78189	1202-00-00-0541C
-63	210-0405-00			1		NUT,PLAIN,HEX.:2-56 X 0.188 INCH,BRS	73743	2X12157-402
						- - - * - - -		
-64	334-1547-01			1		PLATE,IDENT:	80009	334-1547-01
-65	----- -----[1]			2		CKT CARD ASSY:VARIABLE RESISTOR SOCKET		
	----- -----			-		. EACH CIRCUIT CARD ASSEMBLY INCLUDES:		
-66	136-0261-00			3		. SOCKET,PIN TERM:FOR 0.22 INCH PIN	00779	1-331677-6
-67	----- -----			1		CKT CARD ASSY:VERTICAL DISPLAY(SEE A3 EPL)		
-68	136-0350-00			4		. SOCKET,PLUG-IN:3 PIN,LOW PROFILE	80009	136-0350-00
-69	131-0608-00			19		. TERMINAL,PIN:0.365 L X 0.25 PH,BRZ,GOLD PL	22526	47357
-70	129-0106-00			1		. POST,ELEC-MECH:0.218 OD X 0.125 INCH L,BRS	80009	129-0106-00
						(ATTACHING PARTS FOR CKT CD)		
-71	211-0008-00			1		SCREW,MACHINE:4-40 X 0.25 INCH,PNH STL	83385	OBD
-72	211-0079-00			2		SCREW,MACHINE:2-56 X 0.188 INCH,PNH STL	77250	OBD
-73	352-0195-00			1		HOLDER,PUSH SW:	80009	352-0195-00
						- - - * - - -		
-74	----- -----			1		CKT CARD ASSY:IF(SEE A2 EPL)		
-75	131-0608-00			45		. TERMINAL,PIN:0.365 L X 0.25 PH,BRZ,GOLD PL	22526	47357
-76	136-0241-00			2		. SOCKET,PLUG-IN:10 CONTACT,ROUND	71785	133-99-12-064
-77	136-0219-00			7		. SOCKET,PLUG-IN:4 PIN	80009	136-0219-00
-78	136-0220-00			6		. SOCKET,PLUG-IN:3 PIN,SQUARE	71785	133-23-11-034
-79	211-0155-00			6		. SCREW,EXT,RLV B:4-40 X 0.375 INCH,SST	80009	211-0155-00

[1] Replaceable under 670-0364-XX in EPL.

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
1-80	361-0346-00			6		. SPCR,GUIDE POST:4-40 ID X 0.25 OD	80009	361-0346-00
-81	361-0301-00			6		. SPACER,SLEEVE:4-40 X 0.105 INCH LONG	80009	361-0301-00
-82	----- -----			1		RF MODULE ASSY:(SEE A1 EPL),(FIGURE 2 MPL)		
						(ATTACHING PARTS)		
-83	213-0007-00			2		SCR,TPG,THD FOR:10-32 X 0.25 INCH,HEX SOC	74445	OBD
-84	355-0154-00			2		STUD,RETAINING:0.394 INCH LONG,STL	80009	355-0154-00
-85	211-0504-00			2		SCREW,MACHINE:6-32 X 0.25 INCH,PNH STL	83385	OBD
						- - - * - - -		
-86	----- -----	B010100	B049999	1		CKT CARD ASSY:POWER REGULATOR(SEE A5 EPL)		
	----- -----	B050000		1		CKT CARD ASSY:POWER REGULATOR(SEE A5 EPL)		
-87	337-1390-00			1		. SHIELD,ELEC:POWER SUPPLY,LOWER	80009	337-1390-00
-88	337-1391-00			1		. SHIELD,ELEC:POWER SUPPLY,WRAPAROUND	80009	337-1391-00
-89	131-0158-00			7		. TERMINAL,FEEDTH:INSULATED,0.566 INCH LONG	98291	011103900479
-90	136-0366-00			4		. SOCKET,PLUG-IN:6 PIN	80009	136-0366-00
-91	136-0350-00			13		. SOCKET,PLUG-IN:3 PIN,LOW PROFILE	80009	136-0350-00
-92	136-0365-00			3		. SOCKET,PLUG-IN:3 PIN	80009	136-0365-00
-93	210-0259-00			2		. TERMINAL,LUG:0.099"ID INT TOOTH,SE	80009	210-0259-00
						(ATTACHING PARTS FOR EACH)		
	211-0022-00			1		. SCREW,MACHINE:2-56 X 0.188 INCH,PNH STL	83385	OBD
-94	210-0405-00			1		. NUT,PLAIN,HEX.:2-56 X 0.188 INCH,BRS	73743	2X12157-402
						- - - * - - -		
-95	131-0608-00			20		. TERMINAL,PIN:0.365 L X 0.25 PH,BRZ,GOLD PL	22526	47357
-96	136-0263-03	B010100	B051050	20		. SOCKET,PIN TERM:FOR 0.025 INCH SQUARE PIN	00779	86250-2
	136-0263-04	B051051		20		. SOCKET,PIN TERM:FOR 0.025 INCH SQUARE PIN	22526	48059
-97	214-0757-00			1		. HEAT SINK,ELEC:	98978	TXP0503B
-98	214-1519-00			1		. HEAT SINK,XSTR:	80009	214-1519-00
-99	337-1389-00			1		. SHIELD,ELEC:POWER SUPPLY,UPPER	80009	337-1389-00
-100	348-0102-00			FT		. PAD,CUSHIONING:13.76 INCH LONG(CUT TO FIT)	80009	348-0102-00
-101	211-0155-00			4		. SCREW,EXT,RLV B:4-40 X 0.375 INCH,SST	80009	211-0155-00
-102	361-0346-00			4		. SPCR,GUIDE POST:4-40 ID X 0.25 OD	80009	361-0346-00
-103	361-0301-00			4		. SPACER,SLEEVE:4-40 X 0.105 INCH LONG	80009	361-0301-00
-104	131-0707-00			5		. CONNECTOR,TERM.:0.48" L,22-26AWG WIRE	22526	75691-005
	131-0708-00			2		. CONTACT,ELEC:0.48"L,28-32 AWG WIRE	22526	47437
-105	352-0169-00			1		. CONN BODY,PL,EL:2 WIRE BLACK	80009	352-0169-00
	672-0490-00			1		CKT CARD ASSY:W/CAM SWITCH	80009	672-0490-00
-106	----- -----	B010100	B020409	1		. CKT CARD ASSY:SWEEP(SEE A4 EPL)		
	----- -----	B020410	B040979	1		. CKT CARD ASSY:SWEEP(SEE A4 EPL)		
	----- -----	B040980		1		. CKT CARD ASSY:SWEEP(SEE A4 EPL)		
-107	136-0269-02			3		. . SOCKET,PLUG-IN:14 CONTACT,LOW CLEARANCE	01295	C95140
-108	136-0241-00			1		. . SOCKET,PLUG-IN:10 CONTACT,ROUND	71785	133-99-12-064
-109	131-0608-00			45		. . TERMINAL,PIN:0.365 L X 0.25 PH,BRZ,GOLD PL	22526	47357
-110	131-0566-00			1		. . LINK,TERM.CONNE:0.086 DIA X 2.375 INCH L	55210	L-2007-1
-111	214-0579-00			5		. . TERM.,TEST PT:BRS CD PL	80009	214-0579-00
-112	136-0350-00			8		. . SOCKET,PLUG-IN:3 PIN,LOW PROFILE	80009	136-0350-00
-113	136-0399-00	B020410	B040979	40		. . SOCKET,PIN TERM:	27264	1938-48
	136-0514-00	B040980		5		. . SOCKET,PLUG IN:MICROCIRCUIT,8 CONTACT	82647	C93-08-18
	263-1100-00			1		. SW CAM ACTR AS:FREQUENCY	80009	263-1100-00
-114	384-1021-00			1		. . EXTENSION SHAFT:6.895 L X 0.081 OD SST	80009	384-1021-00
-115	354-0219-00			1		. . RING,RETAINING:FOR 0.25 INCH SHAFT	79136	5103-25-MD-R
-116	200-1107-00			1		. . COVER,CAM SW:	80009	200-1107-00
						(ATTACHING PARTS)		
-117	211-0022-00			3		. . SCREW,MACHINE:2-56 X 0.188 INCH,PNH STL	83385	OBD
-118	210-0001-00			3		. . WASHER,LOCK:INTL,0.092 ID X 0.18"OD,STL	78189	1202-00-00-0541C
-119	210-0405-00			3		. . NUT,PLAIN,HEX.:2-56 X 0.188 INCH,BRS	73743	2X12157-402
						- - - * - - -		
-120	401-0054-00			1		. . BEARING,CAM SW:FRONT	80009	401-0054-00
						(ATTACHING PARTS)		
-121	211-0116-00			1		. . SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH BRS	83385	OBD
-122	211-0148-01			1		. . SCREW,MACHINE:4-40 X 0.312 INCH,PNH,SST	83385	OBD
-123	210-1002-00			1		. . WASHER,FLAT:0.125 ID X 0.25 INCH OD,BRS	12327	OBD
-124	210-0406-00			2		. . NUT,PLAIN,HEX.:4-40 X 0.188 INCH,BRS	73743	2X12161-402
						- - - * - - -		

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
1-125	131-0604-00			31		. . CONTACT,ELEC:CKT BD SW,SPR,CU BE	80009	131-0604-00
-126	214-1127-00			2		. . ROLLER,DETENT:0.125 DIA X 0.125 INCH L	80009	214-1127-00
-127	214-1139-00[1]			1		. . SPRING,FLAT:0.885 X 0.156CU BE GLD CLR	80009	214-1139-00
	214-1139-02[1]			1		. . SPRING,FLAT:GREEN COLORED	80009	214-1139-02
	214-1139-03[1]			1		. . SPRING,FLAT:RED COLORED	80009	214-1139-03
-128	105-0181-00			1		. . ACTUATOR,CAM SW:RESOLUTION	80009	105-0181-00
-129	401-0082-01			1		. . BEARING,CAM SW:FRONT	80009	401-0082-01
						(ATTACHING PARTS)		
	211-0116-00			1		. . SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH BRS	83385	OBD
	211-0148-01			1		. . SCREW,MACHINE:4-40 X 0.312 INCH,PNH,SST	83385	OBD
	210-1002-00			1		. . WASHER,FLAT:0.125 ID X 0.25 INCH OD,BRS	12327	OBD
	210-0406-00			2		. . NUT,PLAIN,HEX.:4-40 X 0.188 INCH,BRS	73743	2X12161-402
						- - - * - - -		
-130	384-0765-00			1		. . SHAFT,CAM SW:2.87 L X 0.156 OD,SST	80009	384-0765-00
-131	384-0766-00			1		. . SHAFT,CAM SW:6.024 L X 0.125 OD,SST	80009	384-0766-00
-132	105-0179-01			1		. . ACTUATOR,CAM SW:DISPERSION	80009	105-0179-01
-133	401-0065-00			1		. . BEARING,CAM SW:FRONT	80009	401-0065-00
						(ATTACHING PARTS)		
	211-0116-00			1		. . SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH BRS	83385	OBD
	211-0148-01			1		. . SCREW,MACHINE:4-40 X 0.312 INCH,PNH,SST	83385	OBD
	210-1002-00			1		. . WASHER,FLAT:0.125 ID X 0.25 INCH OD,BRS	12327	OBD
	210-0406-00			2		. . NUT,PLAIN,HEX.:4-40 X 0.188 INCH,BRS	73743	2X12161-402
						- - - * - - -		
	213-0048-00			1		. . SETSCREW:4-40 X 0.125 INCH,HEX SOC STL	74445	OBD
-135	376-0039-00	B020400	B029999	1		. . ADPT,SHAFT,CPLG:0.128 AND 0.082"DIA SHAFT	80009	376-0039-00
-134	354-0390-00			1		. . RING,RETAINING:0.338 ID X 0.025" THK,STL	79136	5100-37MD
	213-0075-00			2		. . . SETSCREW:4-40 X 0.094 INCH,HEX SOC STL	000BK	OBD
	376-0050-00	B030000		1		. . CPLG,SHAFT,FLEX:FOR 0.081/0.125 INCH SHAFTS	80009	376-0050-00
	213-0022-00			4		. . SETSCREW:4-40 X 0.188 INCH,HEX SOC STL	74445	OBD
	354-0251-00			2		. . RING,COUPLING:0.251 ID X 0.375 INCH OD,AL	80009	354-0251-00
	376-0046-00			1		. . CPLG,SHAFT,FLEX:PLASTIC	80009	376-0046-00
-136	----- -----			1		. RESISTOR,VAR:(SEE R15 EPL)		
						(ATTACHING PARTS)		
-137	210-0583-00			1		. NUT,PLAIN,HEX.:0.25-32 X 0.312 INCH,BRS	73743	2X20224-402
-138	210-0223-01			1		. TERMINAL,LUG:0.25 INCH DIA,SE,60 DEG BEND	86928	OBD
-139	407-0803-00			1		. BRACKET,CMPNT:	80009	407-0803-00
						- - - * - - -		
						(ATTACHING PARTS FOR CKT CD)		
-140	211-0116-00			2		SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH BRS	83385	OBD
-141	220-0455-00			2		NUT,BLOCK:0.281"SQ,THREE 4-40 THRU THDS	80009	220-0455-00
-142	211-0008-00			2		SCREW,MACHINE:4-40 X 0.25 INCH,PNH STL	83385	OBD
-143	220-0589-00			1		NUT,SLEEVE:0.375-32 X 0.50 INCH,HEX,BRS	80009	220-0589-00
-144	210-1096-00			1		WASHER,KEY:	80009	210-1096-00
						- - - * - - -		
-145	407-0769-01			1		BRACKET,LATCH:	80009	407-0769-01
						(ATTACHING PARTS)		
-146	211-0008-00			3		SCREW,MACHINE:4-40 X 0.25 INCH,PNH STL	83385	OBD
						- - - * - - -		
-147	344-0176-00			1		CLIP,GROUND:	80009	344-0176-00
						(ATTACHING PARTS)		
-148	210-0586-00			1		NUT,PLAIN,EXT W:4-40 X 0.25 INCH,STL	78189	211-041800-00
						- - - * - - -		
-149	105-0062-02			1		LATCH,THUMB:	80009	105-0062-02
						(ATTACHING PARTS)		
-150	211-0192-00			1		SCREW,SHOULDER:4-40 X 0.341 INCH,SLOT STL	80009	211-0192-00
-151	210-0907-00			1		WASHER,RING:0.25 INCH OD	71286	583-1
-152	210-0948-00			1		WASHER,NONMETAL:0.166 ID X 0.216 OD,TEFLON	83903	OBD
-153	210-0994-00			1		WASHER,FLAT:0.125 ID X 0.25" OD,STL	86928	5714-147-20N
						- - - * - - -		
-154	386-1769-00			1		SUPPORT,CHASSIS:	80009	386-1769-00
-155	352-0135-00			1		FUSEHOLDER:	80009	352-0135-00
						(ATTACHING PARTS)		
-156	361-0007-00			2		SPACER,SLEEVE:0.250 INCH DIA,PLASTIC	80009	361-0007-00
						- - - * - - -		

[1]Replace only with part bearing the same color code as the original part in your instrument.

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
1-157	179-1550-00			1		WIRING HARNESS,:	80009	179-1550-00
-158	131-0371-00			3		. CONTACT,ELEC:FOR NO.26 AWG WIRE	98278	122-0182-019
-159	131-0707-00			81		. CONNECTOR,TERM.:0.48" L,22-26AWG WIRE	22526	75691-005
	131-0708-00			27		. CONTACT,ELEC:0.48"L,28-32 AWG WIRE	22526	47437
-160	131-0818-00			2		. CONNECTOR,RCPT,:BNC,FEMALE	91836	KC19-153BNC
-161	352-0161-00			2		. CONN BODY,PL,EL:3 WIRE BLACK	80009	352-0161-00
-162	352-0162-00			4		. CONN BODY,PL,EL:4 WIRE BLACK	80009	352-0162-00
-163	352-0163-00			2		. CONN BODY,PL,EL:5 WIRE BLACK	80009	352-0163-00
-164	352-0165-00			5		. CONN BODY,PL,EL:7 WIRE BLACK	80009	352-0165-00
-165	352-0167-00			3		. CONN BODY,PL,EL:9 WIRE BLACK	80009	352-0167-00
-166	352-0169-00			11		. CONN BODY,PL,EL:2 WIRE BLACK	80009	352-0169-00
	179-1676-00			1		WIRING HARNESS,:GATE CALL	80009	179-1676-00
	131-0707-00			10		. CONNECTOR,TERM.:0.48" L,22-26AWG WIRE	22526	75691-005
	131-0708-00			6		. CONTACT,ELEC:0.48"L,28-32 AWG WIRE	22526	47437
	352-0169-00			1		. CONN BODY,PL,EL:2 WIRE BLACK	80009	352-0169-00
	352-0169-02			3		. CONN BODY,PL,EL:2 WIRE RED	80009	352-0169-00
	352-0162-00			1		. CONN BODY,PL,EL:4 WIRE BLACK	80009	352-0162-00
	352-0162-02			1		. CONN BODY,PL,EL:4 WIRE RED	80009	352-0162-02
	175-1161-00			1		CABLE ASSY,SP:4.75 INCH LONG	80009	175-1161-00
-167	131-0375-00			1		. CONNECTOR,PLUG,:RIGHT ANGLE	98291	051-028-0079-220
-168	131-0977-00			1		. CONNECTOR,PLUG,:RIGHT ANGLE,MALE	98291	050-028-0000-220
	175-1204-00			1		CABLE ASSY,RF:2.5 INCH LONG	80009	175-1204-00
	131-0375-00			1		. CONNECTOR,PLUG,:RIGHT ANGLE	98291	051-028-0079-220
	131-0707-00			1		. CONNECTOR,TERM.:0.48" L,22-26AWG WIRE	22526	75691-005
	131-0708-00			1		. CONTACT,ELEC:0.48"L,28-32 AWG WIRE	22526	47437
	352-0169-00			1		. CONN BODY,PL,EL:2 WIRE BLACK	80009	352-0169-00
	175-0358-05	XB040940		1		CABLE ASSY,RF:50 OHM COAX,3.25 INCH LONG	80009	175-0358-05
	131-0375-00	XB040940		2		. CONNECTOR,PLUG,:RIGHT ANGLE	98291	051-028-0079-220
	175-0358-06	XB040940		1		CABLE ASSY,RF:50 OHM COAX,3.25 INCH LONG	80009	175-0358-06
	131-0375-00	XB040940		2		. CONNECTOR,PLUG,:RIGHT ANGLE	98291	051-028-0079-220
	175-0358-07	XB040940		1		CABLE ASSY,RF:50 OHM COAX,2.925 INCH LONG	80009	175-0358-07
	131-0375-00	XB040940		2		. CONNECTOR,PLUG,:RIGHT ANGLE	98291	051-028-0079-220
	016-0119-02			1		CKT CARD ASSY:W/BATTERY SET	80009	016-0119-02
-169	343-0148-00			1		. BRACKET,CLAMP:	80009	343-0148-00
						(ATTACHING PARTS)		
-170	105-0063-00			1		. STRIKE,CATCH:	80009	105-0063-00
-171	211-0025-00			1		. SCREW,MACHINE:4-40 X 0.375 100 DEG,FLH STL	83385	OBD
						- - - * - - -		
-172	214-1013-01			2		. INSULATOR,PLATE:	80009	214-1013-01
-173	386-1328-00			1		. PLATE,PWR SPLY:	80009	386-1328-00
						(ATTACHING PARTS)		
-174	211-0008-00			5		. SCREW,MACHINE:4-40 X 0.25 INCH,PNH STL	83385	OBD
-175	210-0201-00			1		. TERMINAL,LUG:SE #4	86928	A373-157-2
						- - - * - - -		
-176	----- -----[1]			1		. CKT CARD ASSY:BATTERY CHARGER		
-177	136-0220-00			4		. . SOCKET,PLUG-IN:3 PIN,SQUARE	71785	133-23-11-034
-178	214-0506-00			3		. . CONTACT,ELEC:0.045 SQ X 0.375 INCH L	80009	214-0506-00
-179	214-0507-00			4		. . CONTACT,ELEC:0.45" SQ BRS,W/45 DEG BEND	80009	214-0507-00
						(ATTACHING PARTS FOR CKT CD)		
-180	210-0406-00			6		. NUT,PLAIN,HEX.:4-40 X 0.188 INCH,BRS	73743	2X12161-402
-181	210-0004-00			3		. WASHER,LOCK:#4 INTL,0.015THK,STL CD PL	78189	1204-00-00-0541C
-182	343-0119-00			1		. CLAMP,LOOP:0.094 INCH DIA	95987	3/32-2
-183	210-0994-00			3		. WASHER,FLAT:0.125 ID X 0.25" OD,STL	86928	5714-147-20N
-184	214-1059-00			1		. INSULATOR,PLATE:	80009	214-1059-00
						- - - * - - -		
	179-1207-00			1		. WIRING HARNESS,:BATTERY	80009	179-1207-00
	131-0371-00			3		. . CONTACT,ELEC:FOR NO.26 AWG WIRE	98278	122-0182-019
-185	348-0055-00			1		. GROMMET,PLASTIC:0.25 INCH DIA	80009	348-0055-00
	348-0031-00			1		. GROMMET,PLASTIC:0.156 INCH DIA	80009	348-0031-00
-186	----- -----			1		. TRANSFORMER:(SEE T601 EPL)		
						(ATTACHING PARTS)		
-187	211-0153-00			2		. SCREW,MACHINE:4-40 X 1 9/32INCH,RHS,STL	80009	211-0153-00
-188	210-0201-00			1		. TERMINAL,LUG:SE #4	86928	A373-157-2
-189	210-0906-00			3		. WASHER,NONMETAL:FIBER,0.125 ID X 0.203"OD	86928	OBD
-190	210-0406-00			2		. NUT,PLAIN,HEX.:4-40 X 0.188 INCH,BRS	73743	2X12161-402
						- - - * - - -		

[1] Replaceable under 670-0577-XX in EPL.

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
1-191	214-1639-00			1		. HEAT SINK,XSTR:	80009	214-1639-00
-192	----- -----			1		. TRANSISTOR:(SEE Q617 EPL)		
						(ATTACHING PARTS)		
-193	211-0510-00			2		. SCREW,MACHINE:6-32 X 0.375 INCH,PNH STL	83385	OBD
-194	214-1025-00			1		. INSULATOR,PLATE:	80009	214-1025-00
-195	210-0811-00			2		. WSHR,SHOULDERED:0.125 ID X 0.50 INCH OD	86928	5604-47
-196	210-0802-00			2		. WASHER,FLAT:0.15 ID X 0.312 INCH OD	12327	OBD
	210-0202-00			1		. TERMINAL,LUG:0.146 ID,LOCKING,BRZ TINNED	78189	2104-06-00-2520N
-197	210-0006-00			1		. WASHER,LOCK:INTL,0.146 IDX 0.288 OD,STL	78189	1206-00-00-0541C
-198	210-0407-00			2		. NUT,PLAIN,HEX.:6-32 X 0.25 INCH,BRS	73743	3038-0228-402
						- - - * - - -		
-199	260-0902-00			1		. SWITCH,SLIDE:DP3T,0.5A,125V	0000M	260-0902-00
						(ATTACHING PARTS)		
-200	211-0119-00			2		. SCREW,MACHINE:4-40X0.25" 100 DEG,FLH,STL	83385	OBD
						- - - * - - -		
-201	136-0140-00			1		. JACK,TIP:BANANA STYLE,CHARCOAL GRAY CA	80009	136-0140-00
						(ATTACHING PARTS)		
-202	210-0465-00			1		. NUT,PLAIN,HEX.:0.25-32 X 0.375 INCH BRS	73743	3095-402
-203	210-0223-00			1		. TERMINAL,LUG:0.25 INCH DIA,SE	86928	A313-136
						- - - * - - -		
-204	136-0139-00			1		. JACK,TIP:BANANA STYLE,W/RED CAP	80009	136-0139-00
						(ATTACHING PARTS)		
-205	210-0465-00			1		. NUT,PLAIN,HEX.:0.25-32 X 0.375 INCH BRS	73743	3095-402
-206	210-0223-00			1		. TERMINAL,LUG:0.25 INCH DIA,SE	86928	A313-136
						- - - * - - -		
-207	352-0132-00			1		. HOLDER,JACK TIP:BLACK PLASTIC	80009	352-0132-00
						(ATTACHING PARTS)		
-208	213-0107-00			1		. SCR,TPG,THD FOR:4-40 X 0.25 INCH,FLH STL	93907	OBD
						- - - * - - -		
-209	131-0552-00			1		. CONTACT,ELEC:SPL 3 PRONG MALE	0000M	131-0552-00
						(ATTACHING PARTS)		
-210	211-0101-00			2		. SCREW,MACHINE:4-40 X 0.25" 100 DEG,FLH STL	83385	OBD
						- - - * - - -		
-211	200-0813-00			1		. COVER,FUSE:	80009	200-0813-00
-212	386-1327-00			1		. PANEL,PWR SPLY:	80009	386-1327-00
						(ATTACHING PARTS)		
-213	211-0101-00			6		. SCREW,MACHINE:4-40 X 0.25" 100 DEG,FLH STL	83385	OBD
						- - - * - - -		
-214	343-0148-03			1		. BRACKET,CLAMP:	80009	343-0148-03
						(ATTACHING PARTS)		
-215	015-0063-00			1		. COMP,SUBASSY:	80009	015-0063-00
-216	211-0025-00			1		. SCREW,MACHINE:4-40 X 0.375 100 DEG,FLH STL	83385	OBD
						- - - * - - -		
	146-0012-01			1		. BATTERY,STORAGE:7.2V,1800 MAH	19209	418002HD13
-217	146-0011-01			6		. BATTERY,DRY:	19209	418002AA63
-218	----- -----			1		CKT CARD ASSY:GATE CALIBRATOR(SEE A6 EPL)		
-219	131-0589-00			12		. TERM,PIN:0.46 L X 0.025 SQ.PH BRZ GL	22526	47350
-220	136-0252-00			23		. SOCKET,PIN TERM:0.145 INCH LONG	00779	2-330808-7
-221	260-1308-00			1		. SWITCH,PUSH:MOMENTARY	80009	260-1308-00
-222	352-0096-00	B020400	B069999X	1		. CLIP,SPR,TNSN:CRYSTAL	80009	352-0096-00
						(ATTACHING PARTS FOR CKT CD)		
-223	211-0116-00			2		SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH BRS	83385	OBD
						- - - * - - -		
-224	131-1155-00			2		LINK,TERM.CONNE:	80009	131-1155-00

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty 1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
2-	119-0240-00			1	RF MODULE ASSY:	80009	119-0240-00
-1	441-0934-00			1	. CHAS,SHLD,RF:MAIN	80009	441-0934-00
-2	351-0253-00			9	. GUIDE-POST,LOCK:	80009	351-0253-00
-3	----- -----[1]			1	. CKT CARD ASSY:695 MHZ FILTER		
-4	131-0938-00			1	. . CONNECTOR,RCPT,:50 OHM MALE SNAP-ON	98291	051-043-0349
-5	----- -----[2]			1	. CKT CARD ASSY:SECOND CONVERTER		
-6	136-0252-00	B020410	B039999	4	. . SOCKET,PIN TERM:0.145 INCH LONG	00779	2-330808-7
	136-0252-04	B040000		3	. . SOCKET,PIN TERM:0.188 INCH LONG	22526	75060
-7	131-0938-00			1	. CONNECTOR,RCPT,:50 OHM MALE SNAP-ON	98291	051-043-0349
-8	----- -----			3	. . CAPACITOR:(SEE C173,C181,C184 EPL)		
					(ATTACHING PARTS FOR EACH)		
-9	210-0562-00			1	. . NUT,PLAIN,HEX.:0.25-40 X 0.312 INCH,BBS	73743	2X20224-402
-10	210-0046-00			1	. . WASHER,LOCK:INTL,0.26 ID X 0.40" OD,STL	78189	1214-05-00-0541C
					- - - * - - -		
-11	441-0936-00			1	. CHAS,SHLD,RF:REAR	80009	441-0936-00
					(ATTACHING PARTS)		
-12	211-0183-00			14	. SCREW,MACHINE:4-40 X 0.50 INCH,SOC HEX HD	000AH	OBD
					- - - * - - -		
-13	----- -----[3]			1	. CKT CARD ASSY:LOW PASS FILTER		
-14	131-0938-00			2	. . CONNECTOR,RCPT,:50 OHM MALE SNAP-ON	98291	051-043-0349
-15	----- -----[4]			1	. CKT CARD ASSY:WIDE BAND MIXER		
-16	131-0951-00			3	. . CONNECTOR,RCPT,:SNAP-ON MALE	98291	051-051-0159-220
-17	----- -----			2	. . CAPACITOR:(SEE C128,C129 EPL)		
					(ATTACHING PARTS FOR EACH)		
-18	210-0562-00			1	. . NUT,PLAIN,HEX.:0.25-40 X 0.312 INCH,BBS	73743	2X20224-402
-19	210-0046-00			1	. . WASHER,LOCK:INTL,0.26 ID X 0.40" OD,STL	78189	1214-05-00-0541C
					- - - * - - -		
-20	----- -----			1	. COIL:(SEE L151,L153 EPL)		
-21	----- -----			1	. CAPACITOR:W/HARDWARE(SEE C152 EPL)		
-22	131-0372-00			2	. CONNECTOR,RCPT,:COAXIAL	98291	51-043-4300
-23	210-0259-00			2	. TERMINAL,LUG:0.099"ID INT TOOTH,SE	80009	210-0259-00
					(ATTACHING PARTS)		
-24	211-0069-00			1	. SCREW,MACHINE:2-56 X 0.125 INCH,PNH STL	77250	OBD
					- - - * - - -		
-25	441-0935-00			1	. CHAS,SHLD,RF:FRONT	80009	441-0935-00
					(ATTACHING PARTS)		
-26	211-0183-00			12	. SCREW,MACHINE:4-40 X 0.50 INCH,SOC HEX HD	000AH	OBD
					- - - * - - -		
	119-0233-00			1	. OSCILLATOR,RF:	80009	119-0233-00
-27	155-0041-00			1	. . INTEGRATED CIR:	80009	155-0041-00
-28	346-0080-00			1	. . . STRAP,ELEC:	80009	346-0080-00
-29	131-0938-00			2	. . CONNECTOR,RCPT,:50 OHM MALE SNAP-ON	98291	051-043-0349
-30	----- -----			5	. . CAPACITOR:(SEE C111,C112,C115,C116,C117 EPL)		
					(ATTACHING PARTS FOR EACH)		
-31	210-0562-00			1	. . NUT,PLAIN,HEX.:0.25-40 X 0.312 INCH,BBS	73743	2X20224-402
-32	210-0046-00			1	. . WASHER,LOCK:INTL,0.26 ID X 0.40" OD,STL	78189	1214-05-00-0541C
					- - - * - - -		
-33	386-1771-00			1	. . PL,HYB CKT MTG:	80009	386-1771-00
					(ATTACHING PARTS)		
-34	211-0183-00			4	. . SCREW,MACHINE:4-40 X 0.50 INCH,SOC HEX HD	000AH	OBD
					- - - * - - -		
-35	----- -----[5]			1	. . CKT CARD ASSY:OSCILLATOR CURRENT		
-36	136-0350-00			1	. . SOCKET,PLUG-IN:3 PIN,LOW PROFILE	80009	136-0350-00
-37	131-0608-00			7	. . TERMINAL,PIN:0.365 L X 0.25 PH,BRZ,GOLD PL	22526	47357
-38	129-0322-00			2	. POST,ELEC-MECH:0.775" L X 0.188.HEX BRS	80009	129-0322-00
	437-0111-01			1	CABINET ASSY:	80009	437-0111-01
-39	334-1836-00			1	. PLATE,IDENT:	80009	334-1836-00
-40	376-0127-00			1	. COUPLER,SHAFT:PLASTIC	80009	376-0127-00
					(ATTACHING PARTS)		
-41	213-0179-02			2	. SCREW,CAP.:6-32 X 0.394 INCH,HEX HD STL	80009	213-0179-02
-42	132-0084-00			2	. INSULATOR,WSHR:	80009	132-0084-00
-43	200-0819-00			2	. COVER,HDL BRAKE:	80009	200-0819-00
-44	210-1053-00			4	. WASHER,SPR TNSN:	80009	210-1053-00

[1] Replaceable under 670-0331-XX in EPL.
[2] Replaceable under 670-0330-XX in EPL.
[3] Replaceable under 670-0332-XX in EPL.
[4] Replaceable under 670-0334-XX in EPL.
[5] Replaceable under 670-0950-XX in EPL.

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
2-45	386-1331-00			2		. PLATE,BRAKE:	80009	386-1331-00
-46	386-1339-00			2		. PLATE,BRAKE:	80009	386-1339-00
-47	129-0148-02			2		. POST,ELEC-MECH:0.455" L X 0.312 HEX STL	80009	129-0148-02
						- - - * - - -		
-48	386-1770-00			1		. PANEL,REAR:	80009	386-1770-00
-49	386-1315-01			1		. SUBPANEL,REAR:	80009	386-1315-01
-50	348-0187-00			8		. FOOT,CABINET:0.780 X 1.650 INCH LONG	80009	348-0187-00
-51	390-0181-00			1		. CABINET,SCOPE:	80009	390-0181-00
-52	213-0170-00			1		. THUMBSCREW:8-32 X 0.82 INCH L,STL	80009	213-0170-00
-53	210-1011-00			1		. WASHER,NONMETAL:0.13 ID X 0.375 " OD,PLSTC	83309	OBD
-54	354-0324-00			1		. RING,RETAINING:E SHAPE,0.102 ID X 0.270	79136	5133-14-MD

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MANUAL CHANGE INFORMATION

PRODUCT 1401A
070-1197-00

CHANGE REFERENCE M32550
DATE 4-4-78

CHANGE:	DESCRIPTION

EFF SN B071490

ELECTRICAL PARTS LIST AND SCHEMATIC CHANGES

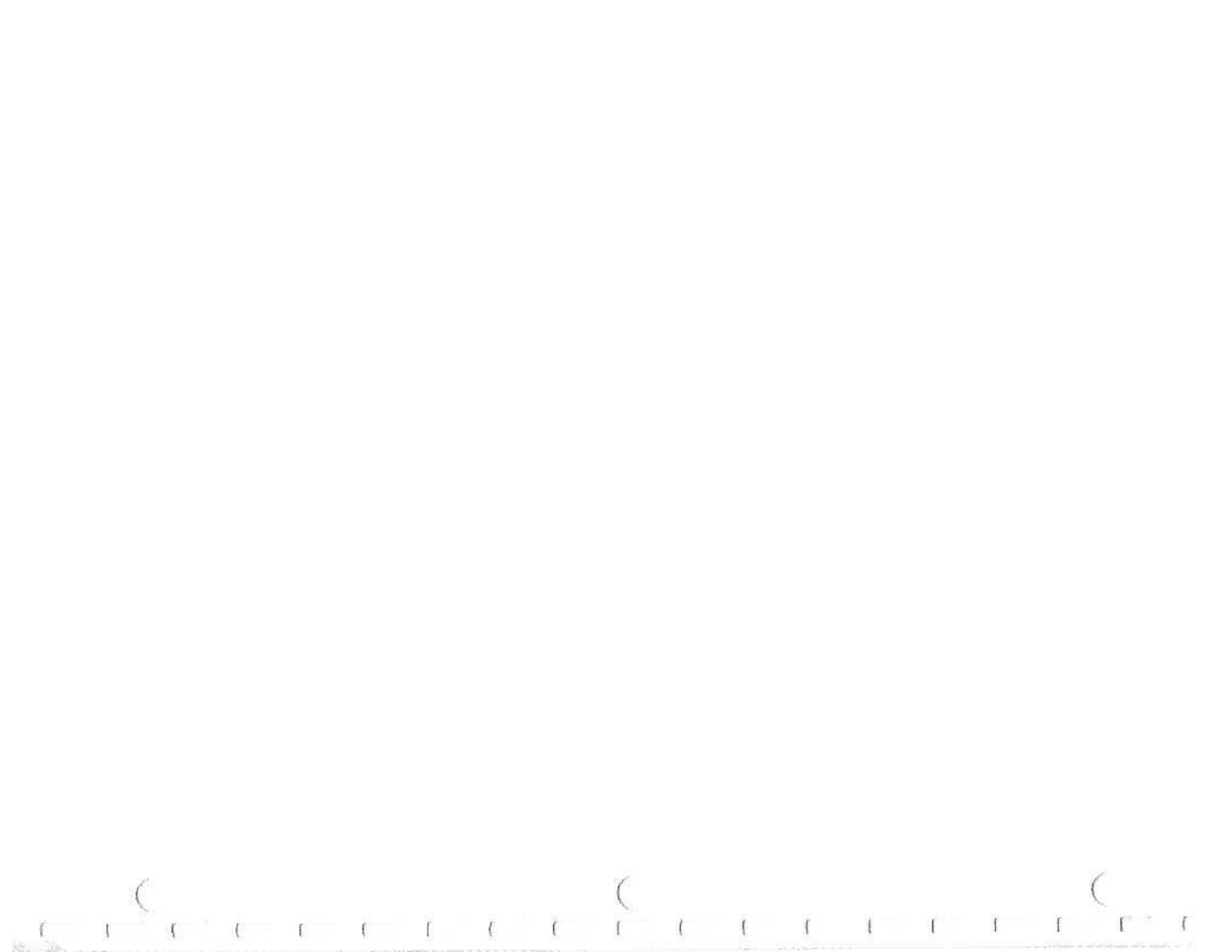
CHANGE TO:

A4	670-0333-04	CKT BOARD ASSY:SWEEP
L858	108-0691-00	COIL,RF:1.8MH
U520	155-0028-00	MICROCIRCUIT,DI:MILLER INTEGRATOR

ADD:

R858	315-0392-00	RES.,FXD,CMPSN:3.9K OHM,5%,0.25W

R858 is added in parallel with L858 located on the SWEEP circuit board assembly and shown on diagram 5 SWEEP SHAPER.



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MANUAL CHANGE INFORMATION

PRODUCT 1401A
070-1197-00

CHANGE REFERENCE M32731
DATE 10-31-77

CHANGE:	DESCRIPTION

EFF SN B070000

ELECTRICAL PARTS LIST AND SCHEMATIC CHANGES

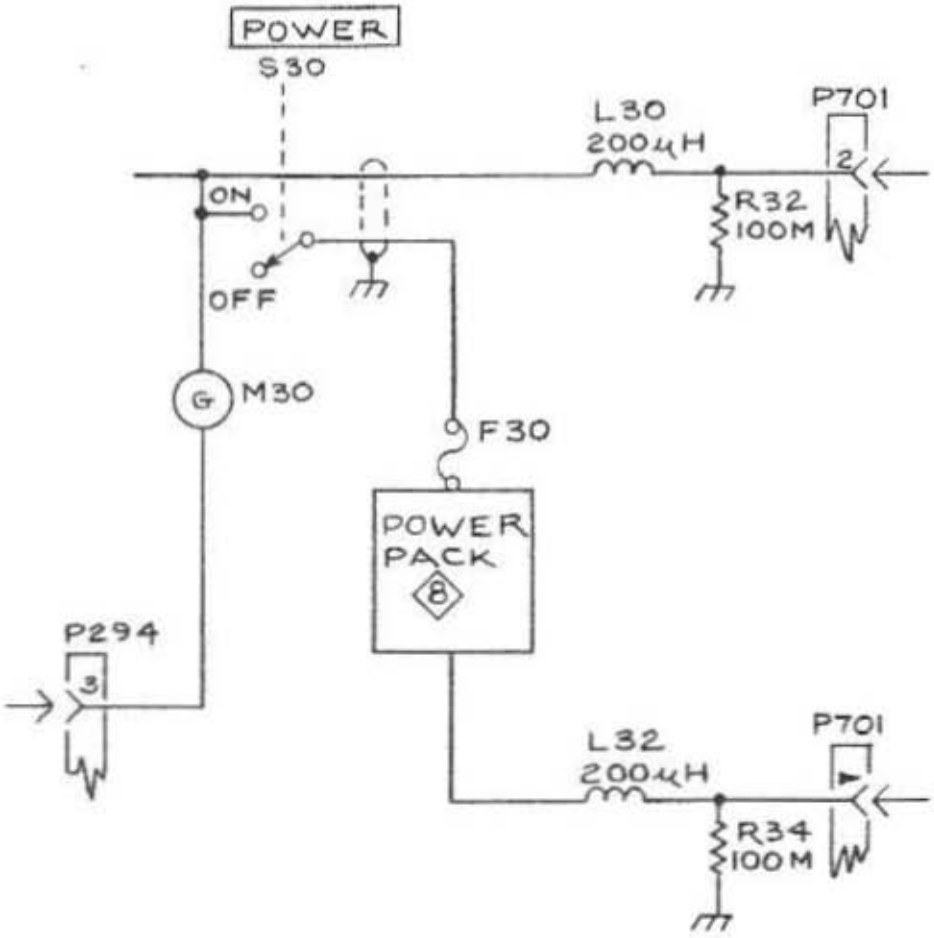
CHANGE TO:

A5	670-0328-02	CKT BOARD ASSY:POWER REGULATOR

ADD:

L30	108-0598-00	COIL RF: 200UH
L32	108-0598-00	COIL RF: 200UH
R32	315-0107-00	RES.,FXD,CMPSN:100 M OHM,5%,0.25W
R34	315-0107-00	RES.,FXD,CMPSN:100 M OHM,5%,0.25W

DIAGRAM <7> POWER REGULATOR



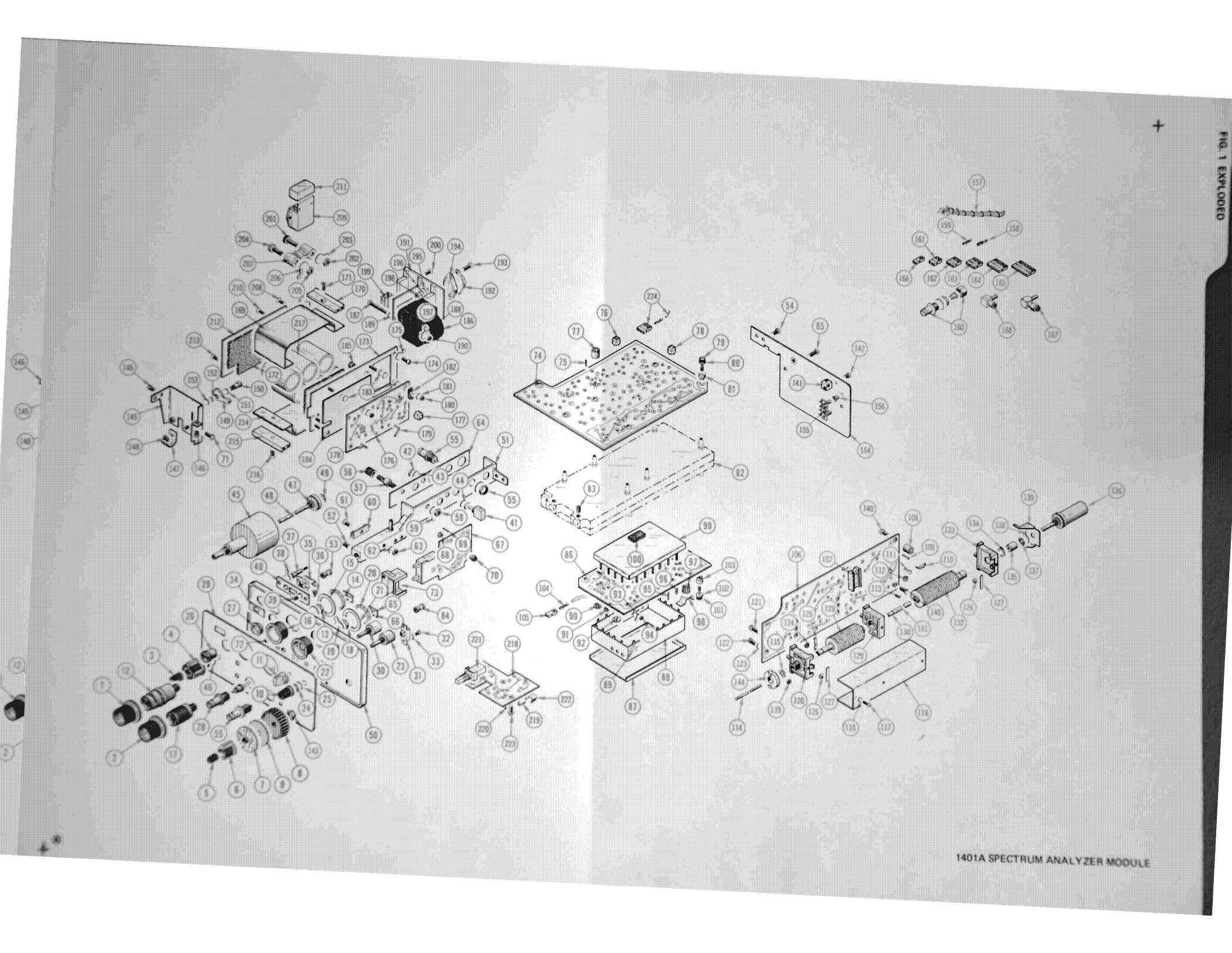
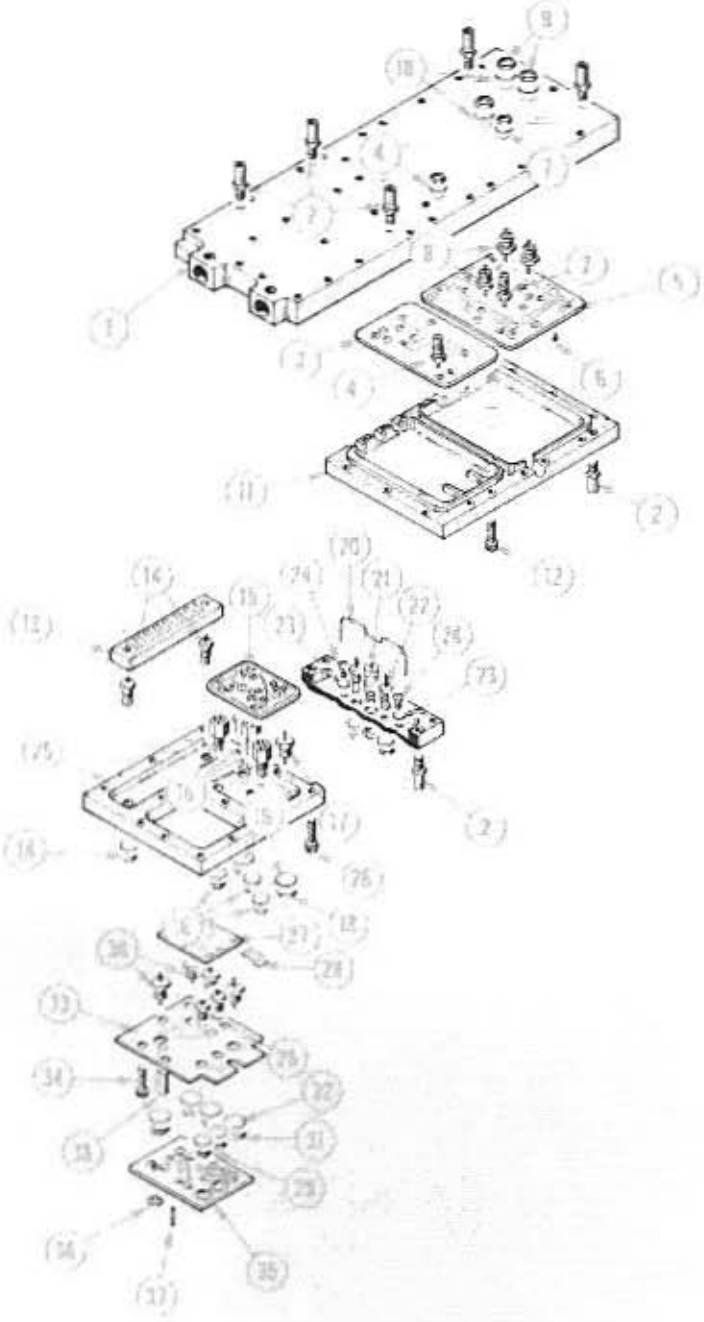


FIG. 1 EXPLODED

1401A SPECTRUM ANALYZER MODULE



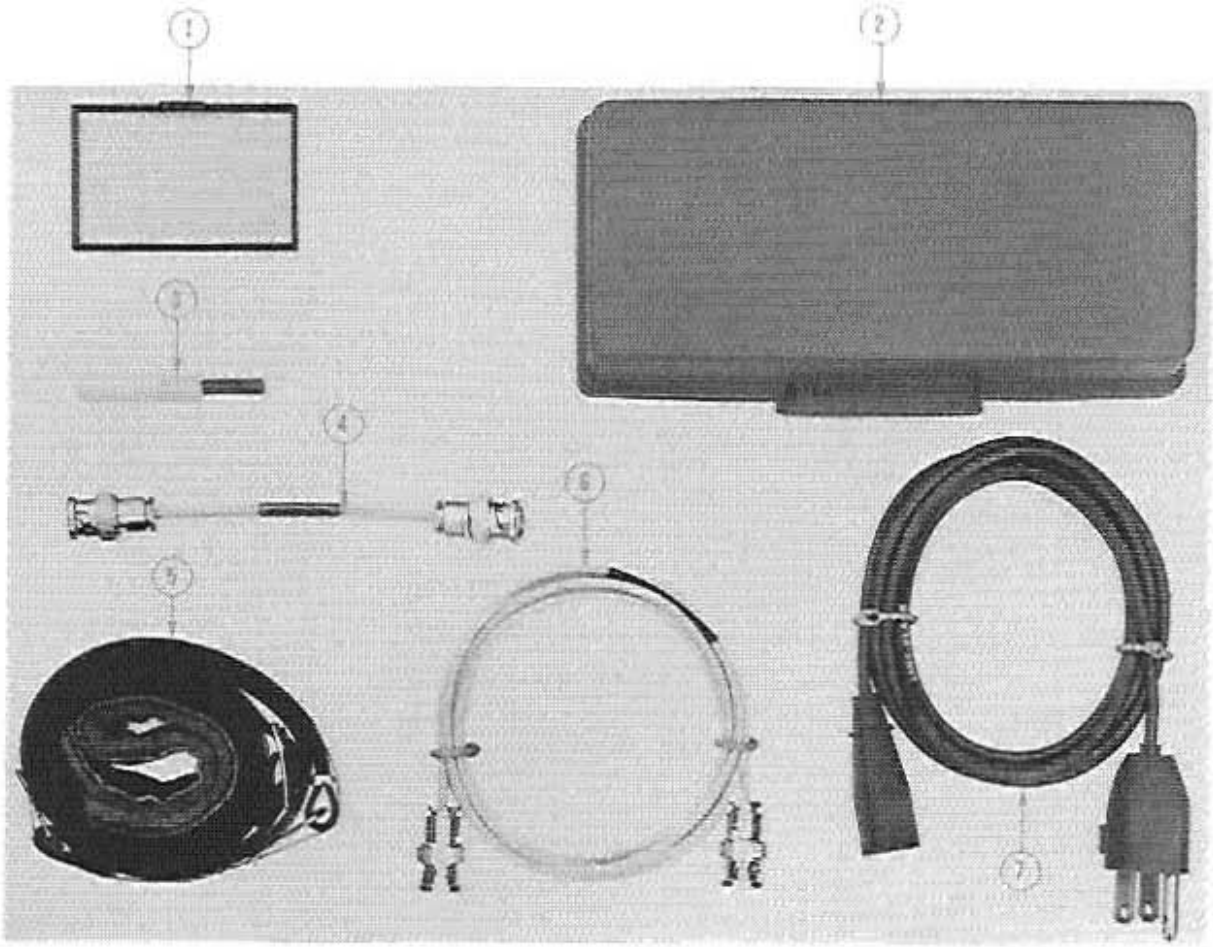


Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	1 2 3 4 5	Description
4-1	378-0670-02			1		FILTER, light, amber
	378-0670-01			1		FILTER, light, blue
-2	200-0812-00			1		COVER, front
-3	003-0672-00			1		SCREWDRIVER
-4	012-0214-00			3		CABLE, interconnecting, 5.50 inches long
-5	346-0051-00			1		STRAP ASSEMBLY, carrying
-6	012-0113-00			1		CABLE ASSEMBLY, RF, 72 inches long
-7	161-0043-02			1		CABLE ASSEMBLY, power
	016-0183-00	B020400	B030556	1		POUCH, accessory (not shown)
	016-0521-00	B030557		1		ACCESSORY BAG (not shown)
	016-0119-02			1		POWER PACK, with battery set
	070-1196-00			1		HANDBOOK, operator's
	070-1197-00			1		MANUAL, instruction

OPTIONAL ACCESSORIES (not shown)

011-0112-00	1	IMPEDANCE MATCHING NETWORK, 75 Ω to 50 Ω
016-0112-00	1	COVER, protective
040-0503-00	1	323/1401A CABINET MATING ASSEMBLY
146-0012-01	1	BATTERY SET

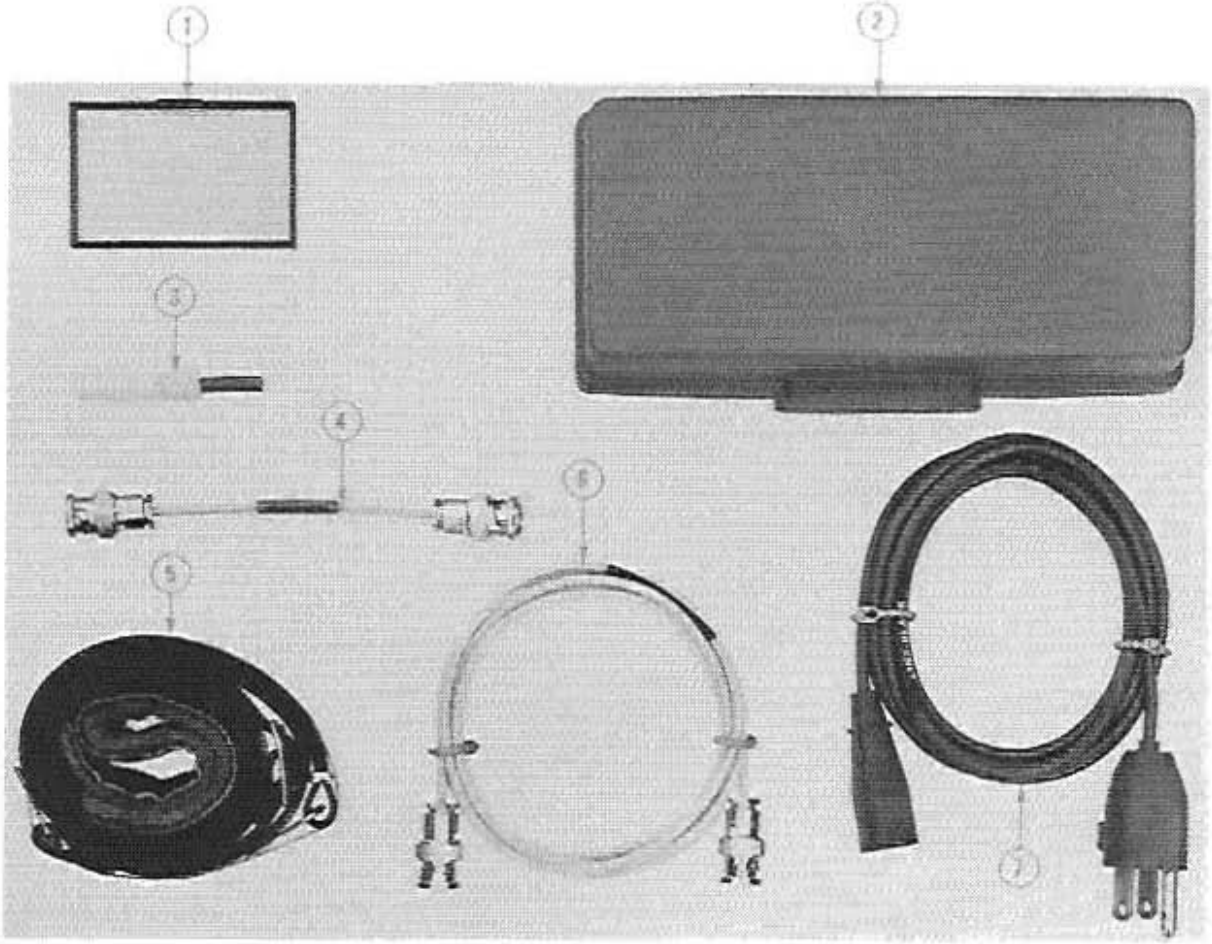


Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	1 2 3 4 5	Description
4-1	378-0670-02			1		FILTER, light, amber
	378-0670-01			1		FILTER, light, blue
-2	200-0812-00			1		COVER, front
-3	003-0672-00			1		SCREWDRIVER
-4	012-0214-00			3		CABLE, interconnecting, 5.50 inches long
-5	346-0051-00			1		STRAP ASSEMBLY, carrying
-6	012-0113-00			1		CABLE ASSEMBLY, RF, 72 inches long
-7	161-0043-02			1		CABLE ASSEMBLY, power
	016-0183-00	B020400	B030556	1		POUCH, accessory (not shown)
	016-0521-00	B030557		1		ACCESSORY BAG (not shown)
	016-0119-02			1		POWER PACK, with battery set
	070-1198-00			1		HANDBOOK, operator's
	070-1197-00			1		MANUAL, instruction

OPTIONAL ACCESSORIES (not shown)

011-0112-00	1	IMPEDANCE MATCHING NETWORK, 75 Ω to 50 Ω
016-0112-00	1	COVER, protective
040-0563-00	1	323/1401A CABINET MATING ASSEMBLY
146-0012-01	1	BATTERY SET