SERVICE MANUAL

BK PRECISION®

MODEL 1403A & 1405

5MHz

OSCILLOSCOPE

BK PRECISION®

TEST INSTRUMENT SAFETY

WARNING

Normal use of test equipment and servicing of test equipment exposes you to a certain amount of danger from electrical shock because testing must often be performed where exposed high voltage is present. An electrical shock causing 10 milliamps of current to pass through the heart will stop most human heartbeats. Voltage as low as 35 volts dc or ac rms should be considered dangerous and hazardous since it can produce a lethal current under certain conditions. Higher voltage poses an even greater threat because such voltage can more easily produce a lethal current. Your normal work habits should include all accepted practices that will prevent contact with exposed high voltage, and that will steer current away from your heart in case of accidental contact with a high voltage. You will significantly reduce the risk factor if you know and observe the following safety precautions:

1. High voltage up to 1,400 volts is present when servicing this oscilloscope. Observe all high voltage precautions when the unit is operating with the case removed. Remember that a high voltage charge may be retained indefinitely, especially at the CRT socket and anode cap. Discharge high voltage capacitors with a grounded test lead after removing power.

2. Don't expose high voltage needlessly. Remove housings and covers only when necessary. Turn off equipment while making test connections in high-voltage circuits. Discharge high-voltage capacitors after removing power.

3. If possible, familiarize yourself with the equipment being tested and the location of its high voltage points. However, remember that high voltage may appear at unexpected points in defective equipment.

4. Use an insulated floor material or a large, insulated floor mat to stand on, and an insulated work surface on which to place equipment; and make certain such surfaces are not damp or wet.

5. Use the time-proven "one hand in the pocket" technique while handling an instrument probe. Be particularly careful to avoid contacting a nearby metal object that could provide a good ground return path.

6. When using the oscilloscope, the ground wire of the 3-wire ac power plug places the chassis and housing of the oscilloscope at earth ground. Do not attempt to defeat the ground wire connection or float the oscilloscope; to do so may pose a great safety hazard.

7. When using a probe, touch only the insulated portion. Never touch the exposed tip portion.

8. When testing ac powered equipment, remember that ac line voltage is usually present on some power input circuits such as the on-off switch, fuses, power transformer, etc. any time the equipment is connected to an ac outlet, even if the equipment is turned off.

continued on inside back cover

SERVICE MANUAL

for

B & K-PRECISION

MODEL 1403A and 1405

5MHz OSCILLOSCOPE

WARNING

This service manual is intended for use by qualified electronics technicians only. To avoid electric shock, do not perform servicing unless you are qualified to do so.

High voltage of approximately 1,400 volts dc is present when this instrument is operating. AC line voltage is present on the input power circuits whenever the ac power cord is connected to a live outlet, even if the scope is turned off. Observe all high voltage safety precautions when the housing is removed from the oscilloscope. Contacting exposed high voltage could result in fatal electric shock.

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use this address for technical inquiries and replacement parts orders

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Model 1405 Schematic Diagram & Parts List	499-164-9-001

INTRODUCTION

SCOPE OF MANUAL

This service manual covers B & K-Precision Model 1403A from the start of production through the end of production.

It also covers Model 1405 from the start of production until the printing of this service manual. Production changes which occur after the printing of this manual will be covered by loose "Addendum" sheets.

The "History of Production Changes" section, at the rear of the manual, itemizes all production changes which may affect servicing and repair of the instruments.

DESCRIPTION OF EQUIPMENT

The B & K-Precision Model 1403A and 1405 Oscilloscopes are compact, single trace, general purpose instruments for observing waveforms. These oscilloscopes use a 3-inch round CRT with a 12 x 12 division graticule which overlays the CRT. Waveforms can be viewed on about 8 x 10 divisions. The graticule also featues a dB scale, referenced to six divisions amplitude equals 0 dB.

The vertical channel has a bandwidth of dc to 5 MHz, and sensitivity of 10 mV/division. Input impedance is 1 Megohm, the standard value for oscilloscopes. A three-step attenuator offers 1:1, 10:1 and 100:1 steps, plus a variable gain control offers fully adjustable waveform amplitude. Terminals are also provided to allow external signals to be applied directly to the vertical deflection plates of the CRT.

The horizontal channel uses recurrent type sweep, with four ranges and a variable control to span the 10 Hz to 100 kHz band. The sweep can be synchronized to the waveform being observed (internal sync) with a trigger sensitivity of 1 division. External sync is also available, with a sensitivity of 2 volts peak-to-peak.

In X-Y operation, the horizontal channel becomes a variable gain X-axis amplifier with maximum sensitivity of 300 mV per division. Bandwidth is up to 250 kHz. A Z-axis input is provided for intensity modulation, if desired.

DIFFERENCES BETWEEN MODELS 1403A AND 1405

Electrically, the Model 1403A and 1405 are nearly identical. However, almost all external hardware and mechanical parts are different. The Model 1405 became a replacement for the Model 1403A in 1979, and featured a different case color, and many cosmetic differences on the front panel. All differences are itemized in the "Parts List" section of this service manual.

EXCLUSION OF MODEL 1403

This service manual does **not** cover Model 1403. Although the Model 1403 has a similarity in function to Model 1403A, there are several major differences in circuit design and specifications.

SPECIFICATIONS

CATHODE RAY TUBE

C312P31B or 75AVB31.

VERTICAL AMPLIFIER

Deflection Sensitivity:
10 mV/div or better.

Frequency Response:
DC: dc to 5 MHz (-3 dB).
AC: 2 Hz to 5 MHz (-3 dB).

Input Impedance:
1 MΩ shunted by 35 pF max.

Overshoot:
5% or less.

Attenuator:
1, 1/10, 1/100 multiplier within ±5%.

Gain Control Range:
Continuously variable, range greater than 22 dB.

Rated Maximum Input Voltage:
300 V (dc + ac peak) or 600 V p-p.

HORIZONTAL AMPLIFIER

Deflection Sensitivity:
300 mV/div or better.

Frequency Response:
DC to 250 kHz with EXT. GAIN control set at maximum. DC to approx. 40 kHz with EXT. GAIN control set at mid-range.

Input Impedance:
1 MΩ (±20%) shunted by 30 pF max (SYNC switch set to INT).

Attenuator (EXT GAIN):
Continuously variable to zero.

Rated Maximum Input Voltage:
100 V p-p.

SWEEP CHARACTERISTICS

Sweep Frequency:
10 Hz to 100 kHz continuously variable in 4 ranges.

Sweep Linearity:
Within 5%.

Synchronization:
Internal or external, negative slope.

Signal Amplitude Required For Synchronization:
Internal: More than 1 div deflection on cathode ray tube screen.
External: More than 2 V p-p.

INTENSITY MODULATION

Required Signal: 25 V p-p.

DIRECT DEFLECTION TERMINALS

Deflection Sensitivity:
10 V/div or better.

Input Impedance:
2.2 MΩ shunted by 25 pF or less.

POWER REQUIREMENTS

117/230 VAC, 50/60 Hz, 16 watts (Unit delivered for use on 117 VAC, 50/60 Hz).

DIMENSIONS, OVERALL

Width: 7-1/2" (190 mm).
Height: 6" (154 mm).
Depth: 11-27/32" (300 mm).

WEIGHT

8.36 lbs (3.8 kg).

ACCESSORIES SUPPLIED

Test Leads.
Spare Fuse.
Instruction Manual.
Schematic Diagram & Parts List.

CONTROLS AND INDICATORS

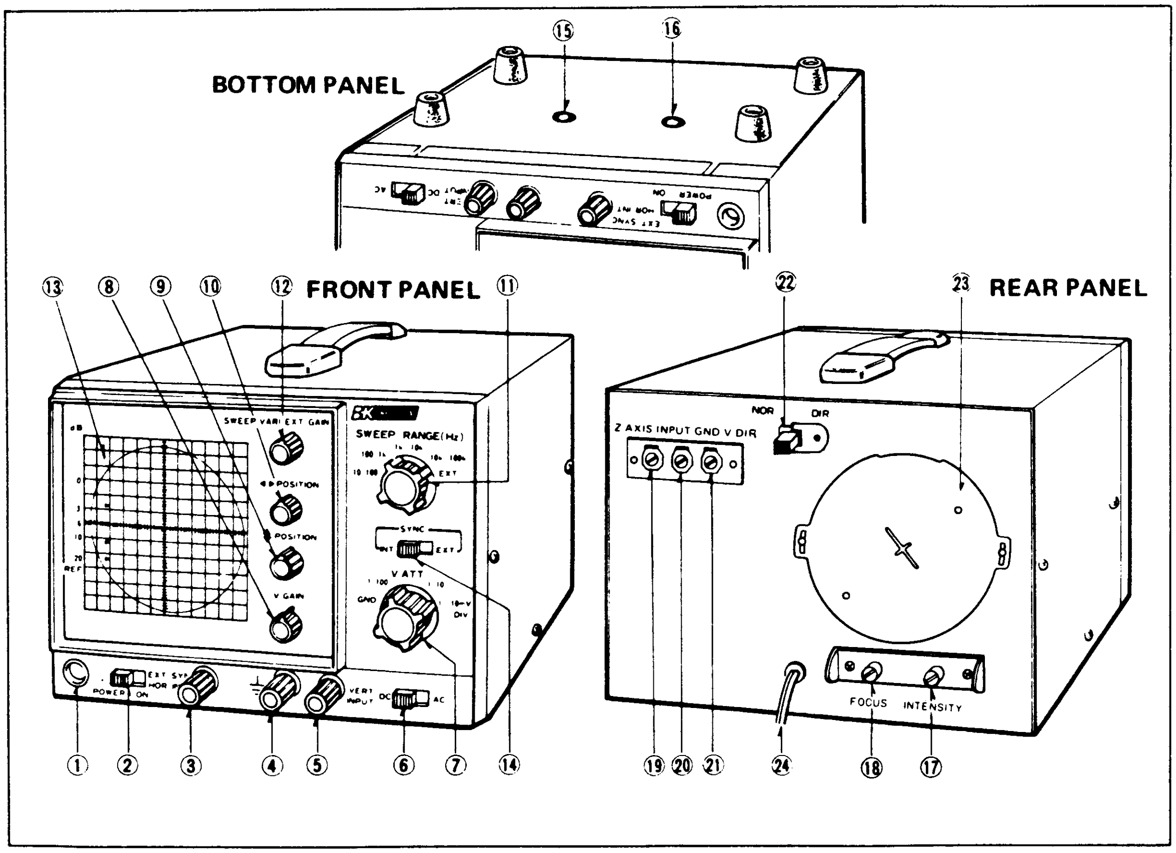


Fig. 1. Model 1405 Controls And Indicators.

FRONT PANEL CONTROLS AND INDICATORS

1. **Neon Pilot Lamp.** Lights when scope is operating.

2. **POWER Switch.** Power ON-OFF switch.

3. **EXT SYNC/HOR INPUT Jack.** Input for external sync or external horizontal signal. Connect signal common to the adjacent ground terminal.

4. **⏚ Jack.** Earth and chassis ground.

5. **VERT INPUT Jack.** Input for vertical signal. Connect signal common to the adjacent ground jack.

6. **AC-DC Switch.** Selector switch for vertical input coupling. In AC position, vertical input is capacitively coupled and, therefore, dc component of signal is blocked, permitting observation of ac component only. In DC position, vertical input is directly coupled and, therefore, allows both dc and ac components of signal to cause vertical deflection.

7. **V ATT Switch.** Vertical attenuator. Coarse vertical amplitude range selector switch. Attenuates high amplitude signals applied to VERT INPUT terminal before connection to vertical amplifier, providing suitable level for waveform display on CRT screen. "1" (10 mV/div) position is most sensitive range; signal applied to vertical amplifier is unattenuated. In 1/10 position, input to vertical amplifier is attenuated to 1/10 of input signal level. 1/100 position attenuates vertical amplifier input to 1/100 of input value. V GAIN control provides fine adjustment within each range. In GND position, VERT INPUT jack is disconnected from vertical amplifier and input of amplifier is grounded. This provides trace at 0 volts reference for dc coupled input, and is correct position for making dc balance adjustments.

Signal Voltage To Be Measured (ranges overlap)	**Vertical Attenuator Position**
Below 0.8 V p-p (0.3 V rms)	1
0.2 to 8 V p-p (0.07 to 3 Vrms)	1/10
Above 2 V p-p (0.7 V rms)	1/100

8. **V GAIN Control.** Vertical gain control. Fine adjustment of waveform amplitude. This control must be fully clockwise for maximum sensitivity; e.g. 10 mV/div in "1" range of V ATTenuator.

9. **↕ POSITION Control.** Vertical position control. Moves entire waveform up and down on CRT screen.

10. **◄► POSITION Control.** Horizontal position control. Moves entire waveform left or right on CRT screen.

11. **SWEEP RANGE Control.** Coarse sweep frequency selector switch. The 10-100, 100-1k, 1k-10 k, and 10 k-100 k positions represent the range of sweep frequencies that are possible with the fine sweep frequency control (SWEEP VARI/EXT GAIN control) within each range. EXT position selects external horizontal deflection. In this mode, sweep generator is disabled and HOR INPUT jack is connected to horizontal amplifier. Signal applied at HOR INPUT jack produces horizontal (X-axis) deflection.

12. **SWEEP VARI/EXT GAIN Control.** Fine sweep frequency adjustment and external signal gain control. When SWEEP RANGE switch is set to EXT, this control adjusts gain of horizontal channel. Note that horizontal frequency response varies with position of this control (refer to specifications).

13. **CRT Graticule.** Graticule is made of acrylic resin and has engraved markings, both coarse and fine, to aid in measuring waveform on CRT screen. There is also a dB scale on the graticule, indexed at 0, -3, -6, -10, and -20 dB and REF. Amplitude from REF to 0 dB is 6 divisions. These graduations are convenient for frequency response measurements.

14. **SYNC INT-EXT Switch.** In INTernal sync position, sweep is synchronized to output of vertical amplifier, which is also the waveform being observed on CRT screen. In EXT position, sweep is synchronized to signal applied to EXT SYNC jack. For synchronized waveform display, this signal must have a time relationship to signal being observed.

BOTTOM PANEL CONTROLS

15. **DC BALANCE Control.** DC balance adjustment for vertical amplifier. This adjustment should be set for zero or minimum vertical movement of trace as V GAIN control is rotated from full clockwise to full counterclockwise (with V ATT set to GND).

16. **HOR GAIN Control.** Horizontal amplifier calibration adjustment.

REAR PANEL CONTROLS

17. **INTENSITY Control.** Adjusts brightness of trace.

18. **FOCUS Control.** Adjusts clarity of trace.

19. **Z AXIS Terminal.** Input terminal for intensity modulation. This jack requires an ac voltage or pulse of approximately 25 V p-p to blank the screen. Positive portion of signal increases intensity, and negative portion reduces intensity or blanks screen.

20. **GND Terminal.** Earth and chassis ground.

21. **V DIR Terminal.** Direct deflection input terminal. An external signal can be routed directly to CRT vertical deflection plates by connection to this terminal (connect signal common to the adjacent GND terminal), and setting DIR-NOR switch to DIR. Sensitivity is 10 volts per division.

22. **DIR-NOR Switch.** Selects input to CRT vertical deflection plates. In NORmal position, output of vertical amplifier is connected to vertical deflection plates for normal oscilloscope operation using VERT INPUT jack. In DIRect position, V DIR and GND input terminals are connected to vertical deflection plates.

23. **CRT ADJ.** Trace rotation adjustment. Loosen and rotate CRT to correct trace tilt.

24. **Power Cord.**

CIRCUIT DESCRIPTION

BLOCK DIAGRAM ANALYSIS

Refer to Fig. 2, which is a block diagram of the oscilloscope.

The vertical channel circuits include the vertical attenuator and vertical amplifier. The VERT INPUT signal is applied through the AC-DC switch, which selects capacitive or direct coupling, and through the V ATT (vertical attenuator) to the vertical amplifier. The vertical amplifier is a highly stable, direct-coupled differential amplifier with a gain of approximately 61 dB, giving a maximum sensitivity of approximately 10 mV per division. The vertical attenuator and vertical gain control reduce the signal when less output is required. The output of the vertical amplifier is applied to the vertical deflection plates of the CRT when the NOR-DIR switch is set to NOR. When the NOR-DIR switch is set to DIR, the output of the vertical amplifier is disconnected and a signal from the V DIR and GND terminals is applied directly to the vertical deflection plates.

The horizontal channel circuits include a sweep generator for a time base and a horizontal amplifier. The recurrent type sweep generator is a free running sawtooth oscillator which produces the sweep waveform. Its frequency range is selected by the SWEEP RANGE switch, and fine frequency control is provided by the SWEEP VAR control. The INT-EXT switch selects the sync signal for the sweep generator from the vertical channel, or the EXT SYNC input.

The sawtooth wave is amplified by the horizontal amplifier and applied to the horizontal deflection plates of the CRT. The horizontal amplifier is a stable, direct coupled differential amplifier with a gain of approximately 35 dB. The horizontal amplifier may also be used to amplify an external signal applied at the HOR INPUT jack. In this mode, the EXT GAIN control allows the gain to be varied by about 10 dB.

The power supply provides operating voltages for all circuits. The regulated +15 V, -15 V, and -6 V sources are used in the vertical preamplifier and sweep generator circuits. The +170 V source is used in the vertical and horizontal final amplifier stages. The high voltage source provides about -1400 volts acceleration voltage for the CRT beam. The Z-axis input is applied to the control grid, where it may be used as intensity modulation of the CRT beam.

VERTICAL CHANNEL CIRCUITS

Refer to Fig. 3 for a simplified diagram of the vertical channel circuits and to the schematic diagram in the rear of the manual for full circuit detaills.

Input Circuit

The vertical input signal is first routed to the AC-DC coupling switch, S3. Switch S3 selects or bypasses capacitor C1. In the AC position, C1 is connected in series with the input. In the DC coupling position, capacitor C1 is bypassed and the input signal is coupled directly to the attenuator switch.

Vertical Attenuator

The basic sensitivity of the vertical channel is 10 mV/division. The vertical attenuator expands the input range by offering three sensitivity steps of 10 mV/div, 0.1 V/div, and 1 V/div. This is achieved by voltage divider networks, selected by S1a and S1b, which attenuate the input to the vertical preamplifier by X1 (direct), X10, or X100. Trimmer capacitors TC101 and TC102 provide frequency compensation for the X10 and X100 steps, to match the X1 step. A constant input impedance of 1 Megohm is maintained in all steps. A fourth step of switch S1 opens the VERT INPUT path and grounds the input of the vertical preamplifier. This establishes a convenient 0-volt reference.

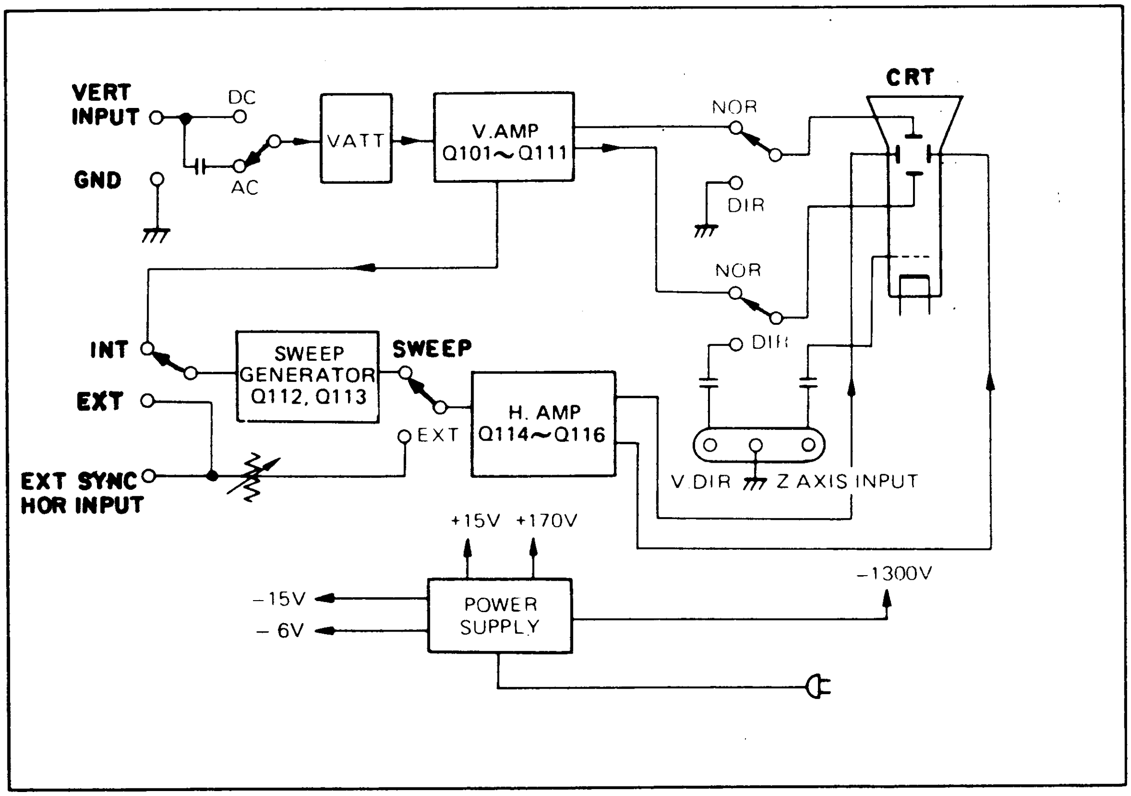


Fig. 2. Block Diagram.

Vertical Preamplifier

The vertical preamplifier is a direct-coupled differential amplifier made up of three stages, an FET input amplifier Q101-Q103, a buffer stage Q104-Q105, and a transistor amplifier stage Q106-Q109.

The first stage is an FET input amplifier, Q101-Q103, which presents a very high input impedance. It has negligible shunting effect on the 1 Megohm input resistance. The signal side of Q102 establishes the internal dc balance for the entire vertical amplifier board. VR101 (DC BAL) allows adjustment of dc balance. FET Q101 provides input voltage overload protection and FET Q103 establishes signal ground for Q102 and succeeding amplifier stages. Q102 and Q103 are source coupled in a differential amplifier configuration; the input signal applied to Q102 is coupled to the source of common gate FET Q103.

In the second stage of the vertical preamplifier, Q104 and Q105 are emitter-followers to Q102 and Q103. These transistors act as impedance converters, converting from the very high impedance of the FET's to a low impedance drive signal for the transistor amplifier.

Q106-Q109 form the third stage of the vertical preamplifier. Vertical gain (V GAIN) is controlled by front panel potentiometer VR1 which limits the current fed to the bases of Q108 and Q109. Stability of Q106-Q109 is maintained through the use of negative feedback provided by C132 and R178. Signal output voltage is developed across resistors R122 and R123 from emitter currents of Q108 and Q109 and fed to the final amplifier, Q110 and Q111.

Vertical Final Amplifier

The vertical final amplifier stage includes differential amplifier Q110 and Q111. A high frequency compensation network may be trimmed by adjustment TC103 to achieve the

5 MHz bandwidth. Front panel vertical positioning is accomplished by potentiometer VR2, ⧫ POS, as it shifts the dc bias of Q110 and Q111. The vertical deflection plates of the CRT are fed from the collectors of Q110 and Q111, when NOR-DIR switch S5 is set to NOR. At this point, the waveform is about 10 volts per division.

With NOR-DIR switch S5 set to DIR, the vertical deflection plates of the CRT are connected directly to the V DIR terminal and ground.

A sample of the vertical final amplifier output is available to the horizontal channel circuits for internal sync.

HORIZONTAL CHANNEL CIRCUITS

Refer to Fig. 4 for a simplified diagram of the horizontal channel circuits and to the schematic diagram at the rear of the manual for full circuit details.

Sweep Generator

The sweep generator circuit consists of a recurrent sweep sawtooth oscillator built around transistors Q112 and Q113.

The frequency at which the sawtooth oscillator operates is determined by the RC time constant of the components in the emitter circuit of Q113 (C3, C4, C5, VR4 and R141). SWEEP RANGE switch, S2, selects the capacitance component of the RC circuit: when set to the 10-100 position, C3 is selected, providing a capacitance of 0.47 µF; when set to the 100-1 k position, C4 is selected, providing a capacitance of 0.047 µF; when set to the 1 k-10 k position, C5 is selected, providing a capacitance of 390 pF; and, when set to the 10 k-100 k position, the stray capacitance of the circuit is selected. In each case, the SWEEP VARI/EXT GAIN control, VR4, and its series resistor R141, are selected as the resistance component of the RC circuit. The RC time constant is greatest when VR4 is fully counterclockwise and its resistance is highest. The RC time constant is reduced and the sweep frequency is increased as VR4 is turned clockwise.

Fig. 5 is a partial schematic diagram of the sweep generator circuit with waveforms to help illustrate operation of the circuit.

First, let us consider the free running manner of operation where no sync signal is applied. During the negative-going ramp portion of the sweep waveform (at Q113 emitter), Q112 conducts and establishes a dc voltage at the base of Q113, cutting it off. With Q113 cut off, the selected sweep range capacitor charges toward -15 volts through VR4 and R141. The rate of charge is determined by the RC time constant as previously described. As the capacitor charges, the voltage at the emitter of Q113 ramps negatively. The voltage continues to ramp negatively, which decreases the bias on Q113, until the threshold of conduction is reached.

The negative-going ramp ends when the threshold of conduction of Q113 is reached. Q113 conducts and quickly discharges the sweep range capacitor to the dc value established by the voltage divider of R138, Q113, VR4, and R141. This conduction of Q113 develops a negative pulse at the collector, which is fed back through C108 to the base of Q112, cutting it off. The RC time constant of C108 and R135 determine the cutoff period for Q112. This is the very short interval when the sawtooth waveform returns to its positive-most point. The negative pulse at the base of Q112 is inverted to a positive pulse at the collector, and is directly coupled to the base of Q113 to control the sweep capacitor discharge period. At the end of this pulse, Q113 is again cut off, and the next negative-going ramp begins. This cycle is continuously repeated. The sawtooth waveform ramps from approximately +2 volts to -2 volts, and is limited to the most linear portion of the sweep capacitor charge cycle.

Now let us consider circuit operation when a sync signal is applied. Refer again to the waveforms in Fig. 5. Sync signals are fed to Q112, superimposed on the sweep reset pulse, inverted and applied to the base of Q113. A negative-going edge of the sync input signal is inverted to a positive-going edge at the base of Q113. If this superimposed positive edge occurs just before the end of a free-running sweep, it will bias Q113 into conduction and

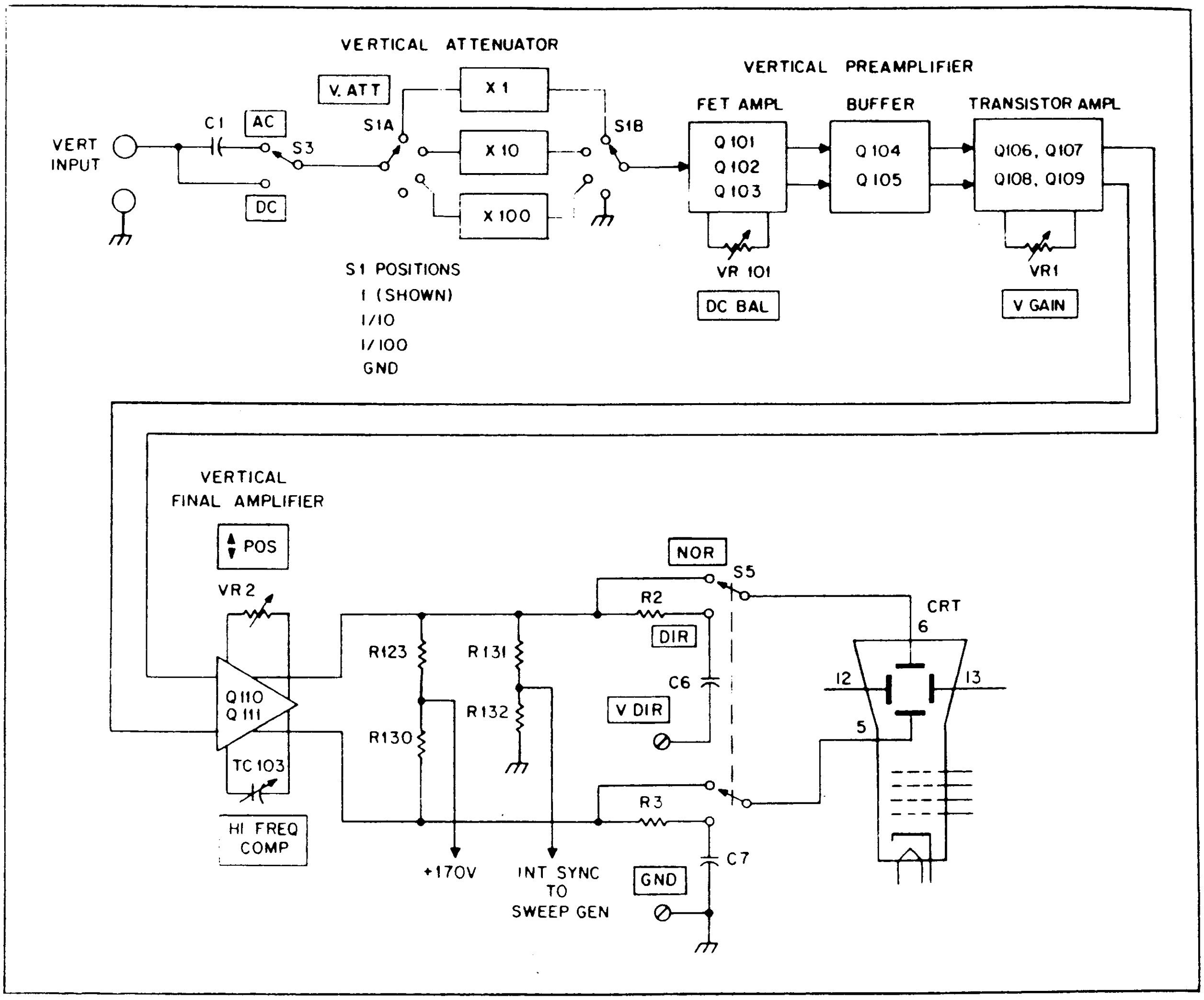


Fig. 3. Vertical Channel Circuits, Simplified Diagram.

end the sweep, thus locking the sweep into synchronization with the waveform being observed.

Fig. 5 shows how synchronization occurs with three cycles of square wave displayed and used for internal sync. The first two cycles have no effect, since the sweep is not yet approaching the threshold of conduction. However, the negative edge at the end of the third cycle of sync input (inverted to a positive edge at the base of Q113) causes Q113 to reach the threshold of conduction slightly sooner than in the free running state. The same principle applies for displaying and synchronizing more or less than three cycles, and for sine waves or other types of waveforms. The SWEEP RANGE selection and SWEEP VARI adjustment must first be set to a point near synchronization; then the sync signal locks the sweep into synchronization. Actually, for proper syncronization, the period of the sweep generator (in its free running state) must be a little longer than the time between sync pulses (or some multiple of sync pulses when more than one cycle is viewed).

Sync Circuit

The sync signal may originate from the vertical channel or an external sync signal applied at the EXT SYNC jack. One or the other may be selected by the INT-EXT switch, S4. The selected sync signal is capacitively coupled through C107 and clamped to the dc level of Q112 base by diode D101.

FET Buffer

FET buffer Q114 serves as a high input impedance, low output impedance stage between the sweep generator and the horizontal final amplifier. In sweep operation, FET Q114 prevents "loading" of the RC charge time constant ramp rate.

Horizontal Amplifier

The horizontal final amplifier is composed of a two transistor push-pull output stage, Q115 and Q116. Horizontal positioning of the trace is provided by VR3 (◀▶POS control on the front panel) as it changes the dc bias supplied to the base of Q116. The gain of the horizontal final amplifier is preset by internal adjustment VR102, as it sets the limit of emitter current available for Q115 and Q116. The voltage outputs of Q115 and Q116 are developed across R149 and R150 and applied to the horizontal deflection plates of the CRT.

EXTERNAL HORIZONTAL OPERATION

When SWEEP RANGE switch S2 is set fully clockwise to the EXT position, the sweep generator is disabled and an external signal applied at the EXT SYNC/HOR INPUT jack provides horizontal deflection of the CRT beam. This mode of operation is often called X-Y operation, as the horizontal input produces X-axis (horizontal) deflection, and the vertical input produces Y-axis (vertical) deflection.

Refer to Fig. 4 for a simplified circuit diagram, or to the schematic diagram for full circuit details. In this mode of operation, switch S2 entirely disconnects the sweep generator from Q114. The SWEEP VARI/EXT GAIN control, VR4, is connected between the HOR INPUT jack and FET buffer Q114. VR4 becomes the Horizontal Gain control, as it determines the level of signal applied to Q114. At maximum gain (no attenuation), the horizontal channel sensitivity is about 300 mV per division. VR4 is connected to provide a constant input impedance of 1 megohm. Q114 presents negligible shunting impedance, similar to Q102 in the vertical channel. The output of Q114 is amplified by the horizontal final amplifier, Q115 and Q116, just as in sweep operation, except that the external horizontal signal is being amplified instead of the sweep sawtooth signal.

LOW VOLTAGE POWER SUPPLY

Refer to the schematic diagram at the rear of the manual for circuit details.

The power transformer has two primaries which may be wired in parallel for 117 VAC operation, or in series for 230 VAC operation. Taps also permit wiring for 100 VAC operation. Neon lamp N1 and resistor R157 are connected across a 100-volt segment of the primary, causing the lamp to light whenever POWER switch S106 is ON.

A center-tapped secondary winding of the power transformer provides power supply source voltages of 25 volts and 160 volts rms.

Bridge rectifier D104 provides full wave rectification, and is connected to provide both positive and negative dc voltages. C116 and C117 provide filtering, and Zener diode D105 regulates the positive side of the bridge to +15 volts. C119 and C120 provide filtering, and Zener diode D106 regulates the negative side of the bridge to -15 volts. In addition, the raw dc from the negative side of the rectifier is also dropped through R155 and regulated to -6 volts by Zener diode D109. These regulated voltages are the "clean supplies", providing low noise operation of sensitive, high gain stages in the vertical and horizontal channels.

A +170 volt supply provides the operating voltage for the vertical and horizontal final amplifiers. Full wave rectifier diodes D102 and D103 convert the 160 volt rms output (225 volt peak) of the power transformer to dc, which is filtered by C114 and C115, providing approximately +170 volts.

HIGH VOLTAGE SUPPLY

The high voltage supply provides acceleration voltage for the CRT beam. The high voltage is derived from the 500 volt winding of

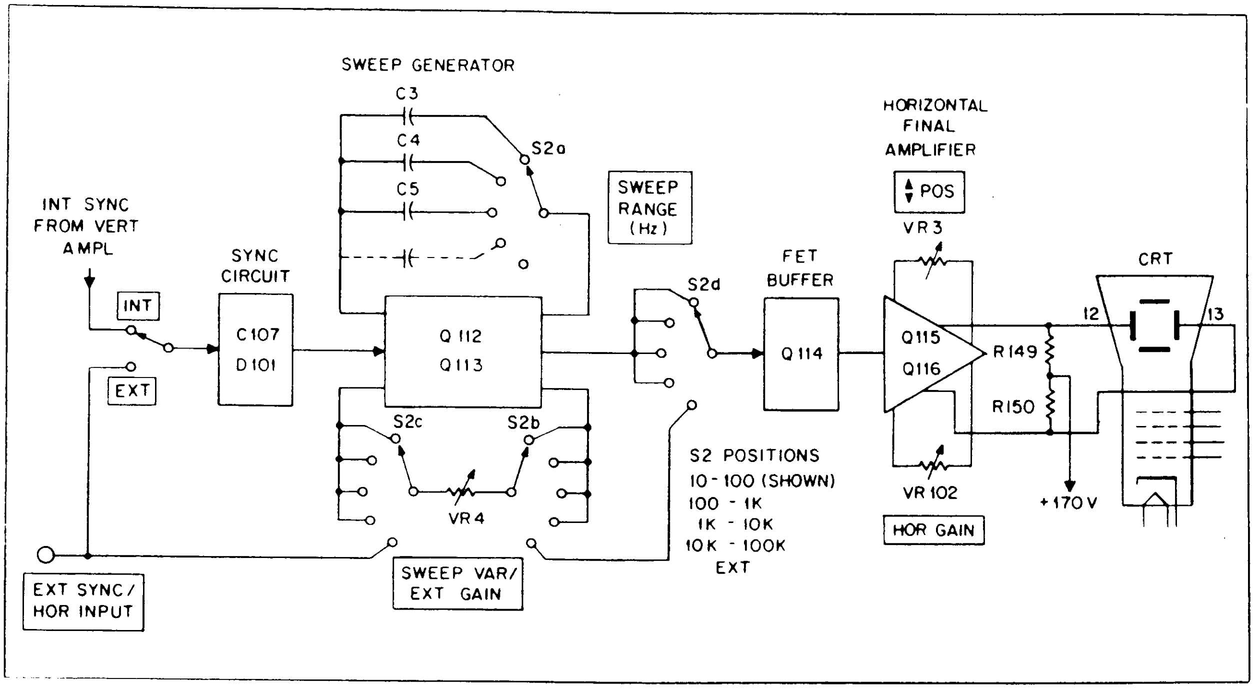


Fig. 4. Horizontal Channel Circuits, Simplified Diagram.

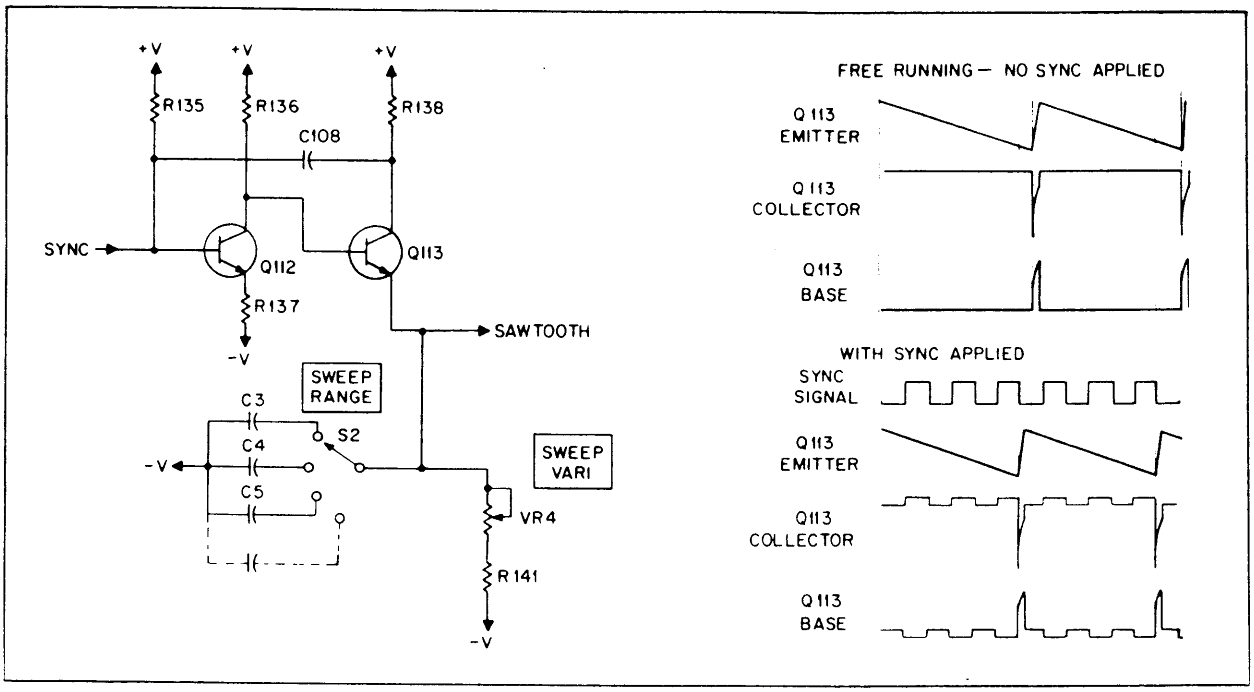


Fig. 5. Sweep Generator Circuit Diagram and Waveforms.

the power transformer. A voltage doubler, composed of high voltage diodes D107 and D108, and capacitors C124, C125 and C126, converts the 500 volt ac into -1400 volts dc. Filtering for the high voltage supply is provided by capacitor C123. The -1400 volts is applied across a voltage divider network consisting of R159-R161, VR103, R162, R163, R165, and R166. The control grid voltage is a fixed dc high voltage available from the voltage divider network. Part of the voltage divider network is paralleled by INTENSITY control VR104. VR104 adjusts the voltage at the cathode of the CRT with respect to the control grid voltage, thus varying brightness. Because the anode is grounded, a total accelerating potential of 1400 volts is used. The voltage divider network also includes FOCUS control VR103. It selects a somewhat lower voltage to be applied to the focus grid of the CRT.

A final winding of the power transformer provides 6.3 volts ac to the CRT filament. To prevent a high potential difference between the filament and cathode of the CRT, the 6.3 volt winding is floated to the high voltage supply.

A signal applied at the Z AXIS INPUT terminal is capacitively coupled through C121 to the control grid of the CRT. A signal of 25 volts amplitude or more will intensity modulate the CRT beam.

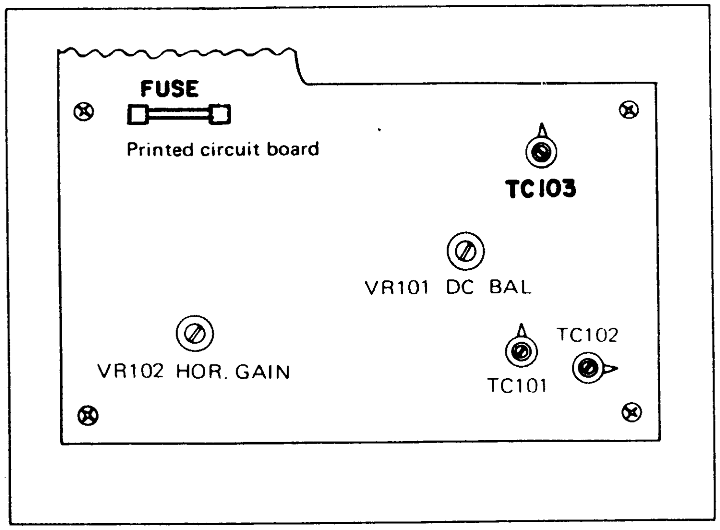


Fig. 6. Locations of Adjustments.

WARNING

The CRT socket and certain points on the circuit board carry high voltages of approximately -1400 V and +170 volts. Observe the high voltage safety precautions listed on the inside front cover.

ADJUSTMENT OF DC BALANCE

1. Allow at least 15 minutes of warm up time for the unit to stabilize before making this adjustment.
2. Set the operating controls as follows:

   SWEEP RANGE to any position except EXT.

   V ATT switch to GND.

   ↕ POSITION control to center trace vertically on CRT.
3. With no signal applied, a trace should be present on the CRT.
4. Rotate the V GAIN control back and forth from one extreme to the other, and observe if the trace shifts up and down.
5. If the trace shifts in step 4, adjust DC BAL trimmer VR101 for minimum shifting of the trace as the V GAIN control is rotated. For easiest adjustment, start with the V GAIN control fully counterclockwise. Repeat adjustment until shifting of the trace is minimized. VR101 is accessible through a hole in the bottom of the chassis as shown in Fig. 1 - or - the top case may be removed, and VR101 is located as shown in Fig. 6.

ADJUSTMENT OF HORIZONTAL GAIN

Preferred Method

This method of adjustment calibrates the external horizontal sensitivity to 300 mV/division.

1. Set oscilloscope controls as follows:

   SWEEP RANGE switch to EXT.

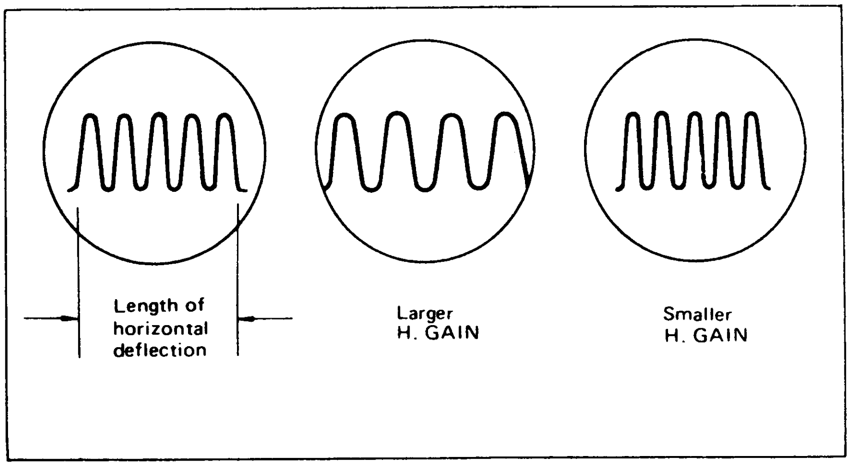


Fig. 7. Effects of HOR GAIN Adjustment VR104.

SWEEP VARI/EXT GAIN control fully clockwise.

V ATT switch to GND.

⬍ POS to center the trace vertically.

2. Apply a calibrated 3 V p-p sine wave or square wave at 1 kHz (with no dc offset) to the EXT SYNC/HOR INPUT jack. Connect the signal common to the ⏚ jack.
3. Adjust HOR GAIN trimmer VR102 for a horizontal deflection of 10 divisions. VR102 is accessible through a hole in the bottom of the chassis (see Fig. 1). If the case is removed, VR102 is located as shown in Fig. 6.

Alternate Method

This method of adjustment sets the sweep length for 10 divisions horizontal deflection, but external horizontal operation is uncalibrated. The effects of HOR GAIN adjustment are shown in Fig. 7.

1. Set oscilloscope controls as follows:

   SWEEP RANGE switch to any position except EXT.

   SWEEP VARI/EXT GAIN control fully clockwise.

   V ATT switch to GND.

   ⬍ POS to center the trace vertically.

2. A trace should be displayed on the CRT.
3. Adjust ◀▶POS control so the beginning of the trace is visible, and aligned with one of the graticule markers near the left edge of the CRT screen.
4. Adjust HOR GAIN trimmer VR104 for a trace length of 10 divisions. VR102 is accessible through a hole in the bottom of the chassis (see Fig. 1). If the case is removed, VR102 is located as shown in Fig. 6.

TRACE ROTATION ADJUSTMENT

The earth's magnetic field and other magnetic fields may cause the trace to tilt when the oscilloscope is moved from one location to another. This adjustment rotates the CRT to correct for trace tilt.

1. Set the operating controls as follows:

   SWEEP RANGE to any position except EXT.

   V ATT switch to GND.

2. With no signal applied, a trace should be present on the CRT. Adjust the POS control to center the trace vertically on the CRT. The trace should be parallel with the horizontal graticule line. If trace tilt is noted, make the following adjustment.
3. Refer to Fig. 8. Loosen the two screws

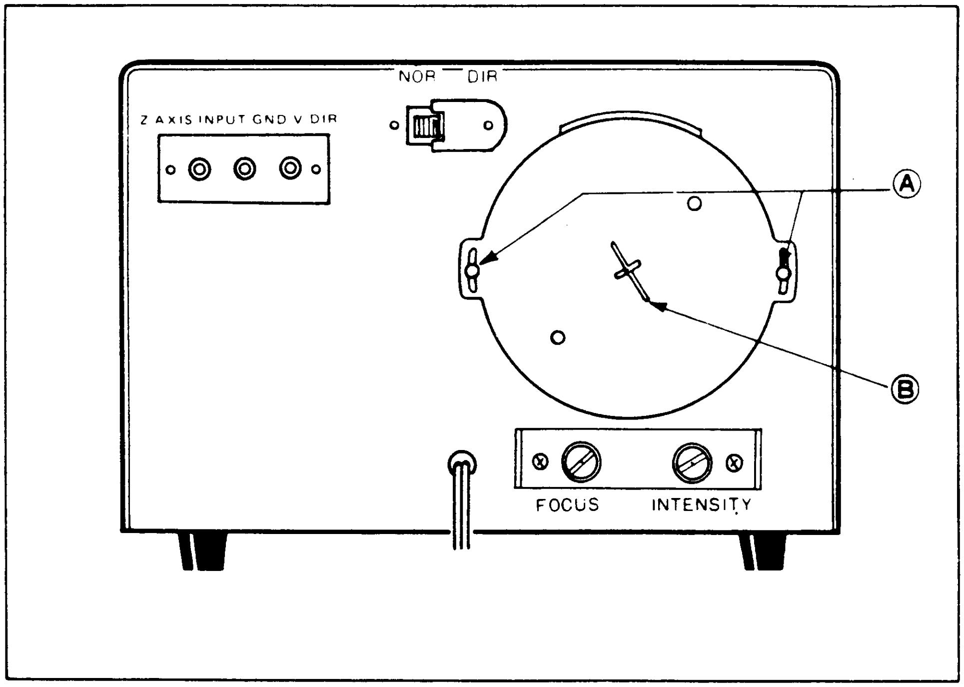


Fig. 8. Trace Rotation Adjustment.

(A) holding the CRT mounting plate at the rear.

4. Place a wide blade screwdriver into slit (B) to turn the CRT mounting plate, until the trace is parallel with the horizontal graticule line.

5. Carefully tighten screws (A), observing that the trace does not rotate when the screws are tightened.

FREQUENCY COMPENSATION ADJUSTMENTS

1. Remove the case from the unit.

2. Set oscilloscope controls as follows:

   V ATT switch to 1 (10 mV/DIV).

   V GAIN control fully clockwise.

   SYNC switch to INT.

   SWEEP RANGE switch to 100-1 k.

3. Apply a 1 kHz square wave to the VERT INPUT jack. Connect the signal common to the jack. Terminate the square wave generator into its characteristic impedance (i.e., for a square wave generator with an output impedance of 50 Ω, terminate into 50 Ω).

4. Adjust the output level of the square wave generator for a waveform amplitude of 6 divisions on the CRT screen.

5. Adjust the SWEEP VARI/EXT GAIN control to display two to four cycles of the square wave.

6. Adjust the ↕ POS and ↔ POS controls to position the display in the center of the CRT.

7. Adjust trimmer capacitor TC103 for the most ideal square wave waveshape, as shown in Fig. 9.

   If desired, an additional check for proper adjustment of high frequency compensation trimmer TC103 may be made as follows. Connect a sweep generator having a flat response from 1 kHz to at least 5 MHz to the vertical input. Adjust the sweep generator to sweep from 1 kHz to 5 MHz and externally synchronize the oscilloscope sweep to the trigger output of the sweep generator. The fre-

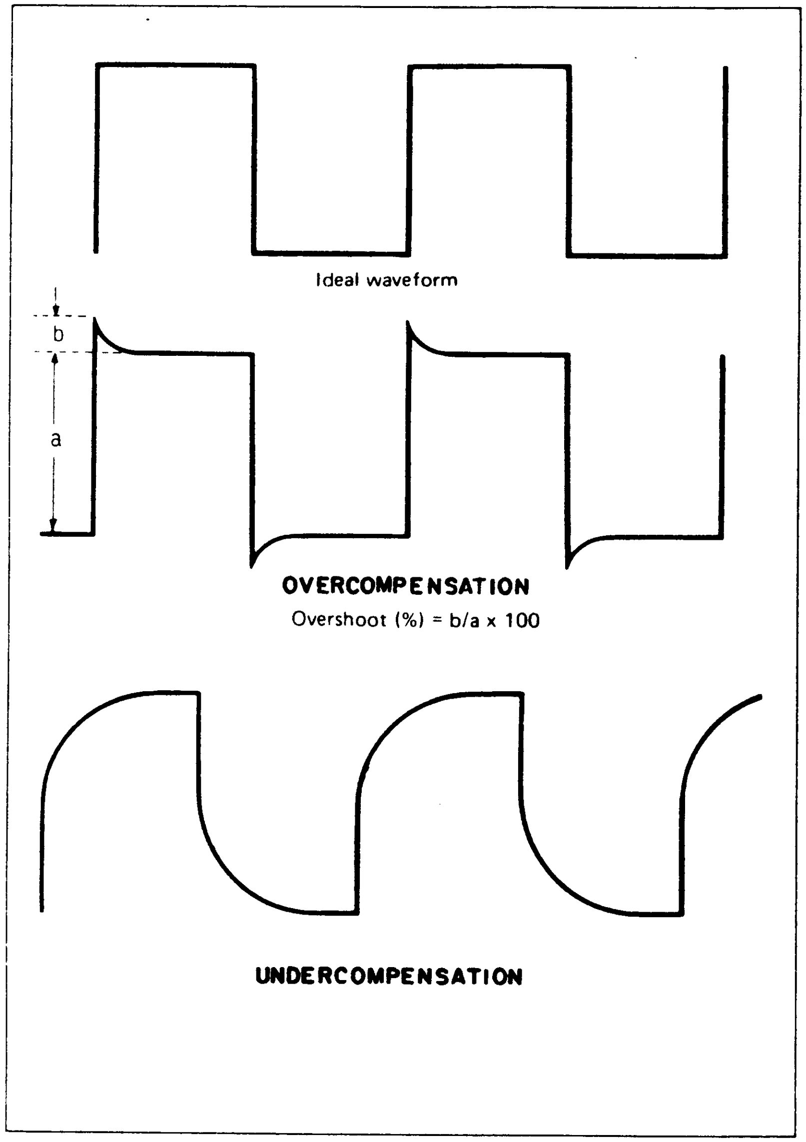


Fig. 9. Frequency Compensation Adjustments.

quency response curve will be displayed on the CRT. Adjust the sweep generator output level for 6 divisions amplitude on the CRT at the low frequency (1 kHz) reference. Adjust TC103 for the flattest frequency response, with no sharp dips or peaks, and so that amplitude at 5 MHz is at least 4.2 divisions (-3 dB).

8. Next, set the V ATT switch to 1/10 and increase the output of square wave generator to again obtain an amplitude of 6 divisions.

9. Adjust trimmer capacitor TC102 to match the waveform obtained in step 7.

10. Now, set the V ATT switch to 1/100 and again increase the output of the square wave generator for 6 divisions amplitude.

11. Adjust trimmer capacitor TC101 to match the waveform obtained in step 7.

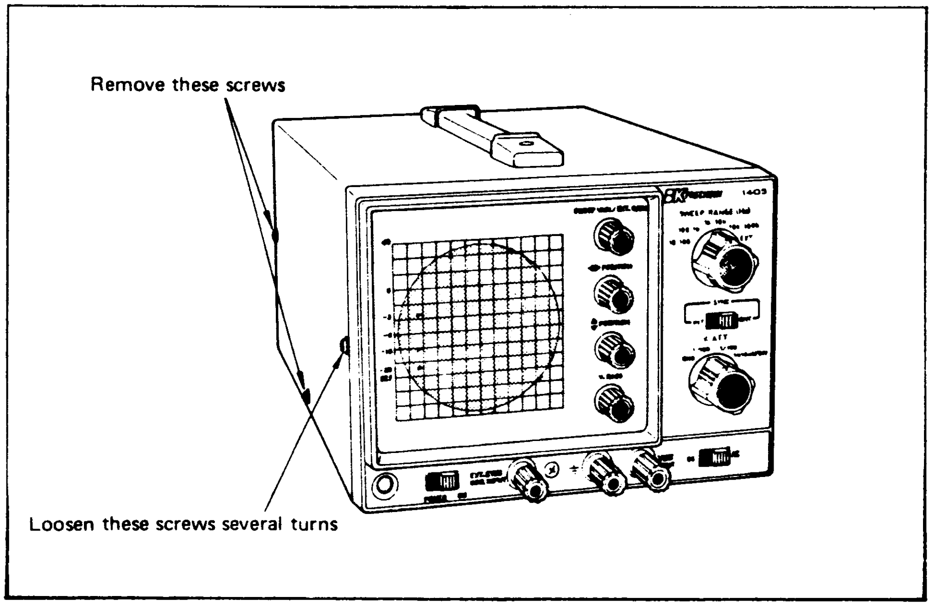


Fig. 10. Case Removal.

CASE REMOVAL

WARNING

High voltage up to -1400 volts is present when the case is removed and the oscilloscope is operating. AC line voltage is present on certain power input circuits any time the power plug is connected to a live outlet, even if the POWER switch is OFF. Observe the high voltage safety precautions listed on the inside front cover of this manual.

1. Refer to Fig. 10. Remove two screws from each side of the case as shown.
2. Loosen the remaining screw located at the center front section of each side several turns.
3. Grasp the carrying handle and slide case to rear, then lift case off.

FUSE REPLACEMENT

WARNING

Always disconnect scope from ac outlet before replacing a fuse. AC line voltage is present on the fuseholder whenever the power cord is connected to a live ac outlet, even if the scope's POWER switch is OFF.

1. Remove the case from the unit.
2. Remove the fuse from the fuse holder (located on the printed circuit board, refer to Fig. 6) and insert a new fuse of the proper value; 0.5 A for 117 volt operation, 0.3 A for 230 volt operation.

3. Troubleshoot the oscilloscope for the cause of the blown fuse and repair the malfunctioning circuit.

LINE VOLTAGE CONVERSION

WARNING

1. *Always disconnect scope from ac outlet before starting voltage conversion. AC line voltage may be present on the transformer whenever the power cord is connected to a live ac outlet, even if the POWER switch is OFF.*

2. *After conversion, replace the fuse with the correct value for the new line voltage:*
   0.5 A for 100 V or 117 V.
   0.3 A for 230 V.

The Model 1403A and 1405 Oscilloscopes are factory wired for 117 volt, 50/60 Hz ac line voltage. They may be rewired for 100 volt or 230 volt 50/60 Hz operation by rewiring the power transformer as shown in Fig. 11.

CRT REMOVAL AND REPLACEMENT

WARNING

1. *Always handle CRT's carefully. The CRT is under high vacuum. Careless handling may crack or weaken the glass, causing an "implosion". Resulting flying glass fragments could cause injury.*

2. *When replacing the tube, be careful to place the tube in the socket with the key positioned in the upper left direction (when viewed from the face).*

1. Remove the case from the unit.

2. Remove the socket from the CRT.

3. Completely remove the two screws which attach the CRT mounting plate to the rear of the chassis (Fig. 8).

4. Remove the entire CRT assembly from chassis, including the mounting plate and CRT shield (Fig. 12).

5. Loosen the two clamping screws from the CRT band (Fig. 12) and slide the CRT from the shield.

6. To replace the CRT, reverse the procedure. Adjust trace rotation when the new CRT is installed; see ADJUSTMENTS section.

FRONT PANEL REMOVAL

CAUTION

Handle the panel carefully. Rough handling may bend or crack the panel.

1. Remove the case.

2. Loosen set screws and remove all knobs.

3. Unscrew the mounting nut from the SWEEP RANGE selector switch shaft.

4. Remove the black screw from between the EXT SYNC/HOR INPUT terminal and ⏚ terminal.

5. Remove two screws from the lower section of the front panel (bottom of scope).

6. Carefully pull the panel forward.

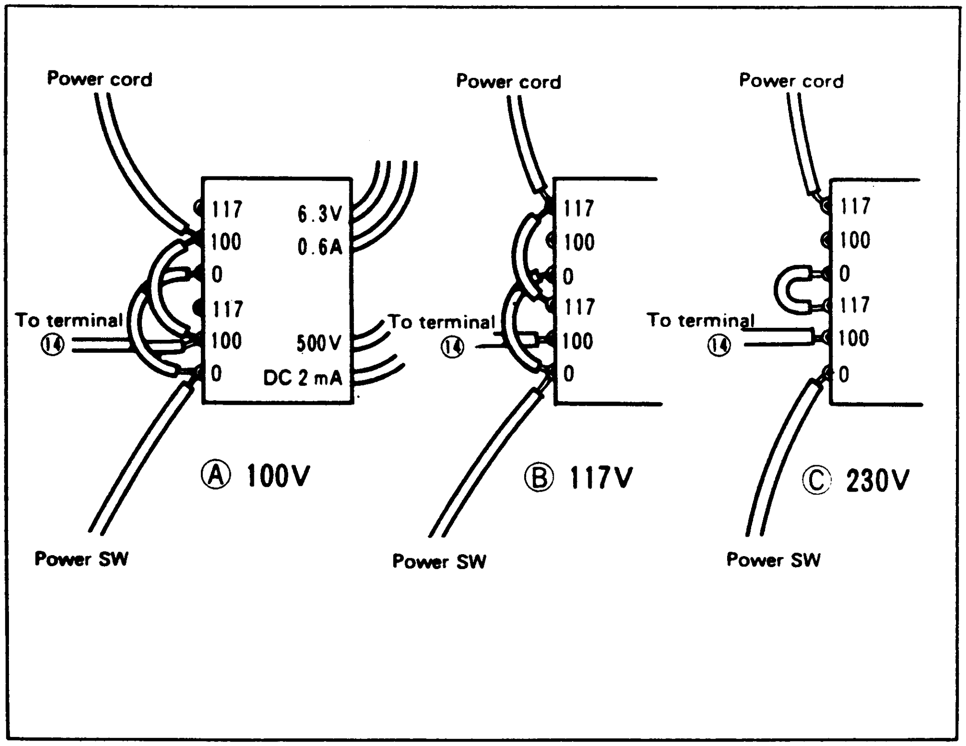


Fig. 11. Line Voltage Conversion.

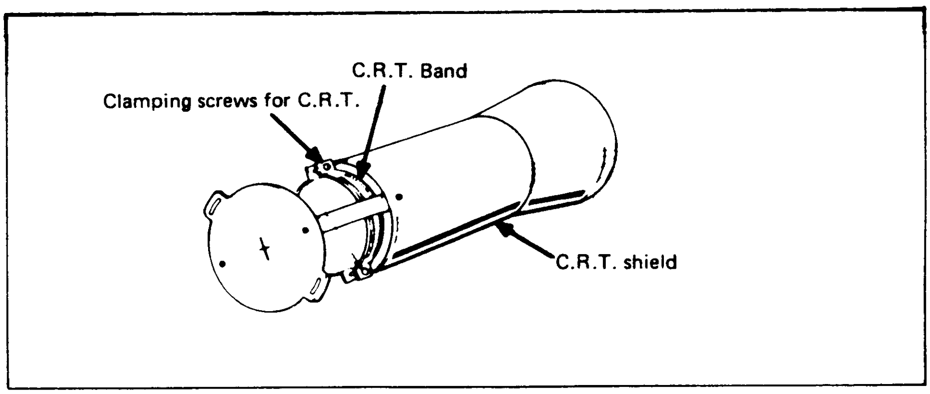


Fig. 12. CRT Removal and Replacement.

TROUBLESHOOTING

The following "Operational Checks" will completely check functional operation of the oscilloscope. They should be performed in the listed sequence. If the scope fails any step, refer to the corresponding "Troubleshooting" information to isolate the defective circuit. Refer to the VOLTAGE CHART section of this manual for normal voltages at all transistors and the CRT. After repairs are completed, the "Operational Checks" should be repeated to verify that the repair has fully restored proper operation, and to make sure that no additional problem exists.

OPERATIONAL CHECK	TROUBLESHOOTING
1. Connect power cord to live ac outlet. Turn on POWER switch. The neon pilot light should be lit.	No pilot light usually indicates a blown fuse or failure in the power input circuit. Check fuse, power transformer, POWER switch S106, neon lamp N1, R157. If unit blows fuses, disconnect power transformer secondary windings one at a time and check for shorted power supply. Especially check power supply filter capacitors C114, C115, C116, C117, C118, C119, C120.
2. Set V ATT switch to GND and SWEEP RANGE switch to EXT. Set ↕ POSITION and ↔ POSITION controls to mid-position and INTENSITY control to maximum. A dot should appear in the approximate center portion of the screen. **CAUTION** *Do not allow a bright dot to remain stationary for more than a few seconds. The CRT may become permanently burned. Reduce INTENSITY or go into sweep mode.*	No dot usually indicates a high voltage power supply or CRT failure. Check voltages at CRT pins. If high voltage abnormal, check 500 V winding of power transformer, D107, D108, C121-C126, R158-R167, VR103, VR104. If high voltage normal, check CRT filament voltage. Check CRT filament with ohmmeter (power removed).
3. Rotate ↕ POSITION control to both extremes. Dot should be adjustable beyond the top and bottom of screen. Adjust dot to vertical center of screen.	Non-centered or lack of adjustment range indicates vertical channel problem. Measure voltages at Q101-Q111.

OPERATIONAL CHECK	TROUBLESHOOTING
4. Rotate ◄► POSITION control to both extremes. Dot should be adjustable beyond the left and right edges of the screen. Adjust dot to horizontal center of screen.	Non-centered or lack of adjustment range indicates horizontal channel problem. Measure voltages at Q114, Q115, Q116.
5. Set SWEEP RANGE switch to 10 k-100 k position. A trace should be displayed on the CRT.	No trace indicates failure of low voltage power supply, sweep generator, or horizontal final amplifier. With another scope, check for sawtooth waveform at emitter of Q113. If no sawtooth, check voltages at Q112, Q113. If sawtooth present at Q113, check sawtooth waveform at Q115, Q116 collectors. Measure voltages at Q114, Q115, Q116.
6. A sharp, clear trace should be obtainable by adjusting the FOCUS and INTENSITY controls.	Improper operation indicates failure in FOCUS or INTENSITY circuit. Check VR103, VR104, R158-R166, C121, C122.
7. Rotate V GAIN control from one extreme to the other. The trace should not shift more than 1 division.	Shift of trace indicates need for DC BAL adjustment VR101.
8. Apply 40 mV p-p sine wave (14 mV rms) at 100 Hz to VERT INPUT jack. Set V ATT switch to "1" (10 mV/DIV), V GAIN control to maximum (fully clockwise), and AC-DC switch to AC. There should be approximately 4 divisions of vertical deflection. The waveform display may be unsynchronized.	No vertical deflection indicates failure in low voltage power supply or vertical channel. With another scope, check presence of sine wave signal at Q102-Q111. Measure voltages at Q101-Q111.
9. Set SWEEP RANGE switch to 10-100 position. Set SYNC switch to INT and adjust SWEEP VARI/EXT GAIN control. Synchronized display of waveform should be obtainable. Reduce vertical deflection to 1 division amplitude. Synchronized display should still be obtainable.	If display cannot be synchronized, first check sawtooth waveform at Q113 emitter with another scope. Make sure sawtooth is adjustable from about 10 Hz to 100 Hz with SWEEP VARI/EXT GAIN control. If not, check C3, VR104, and Q112, Q113 circuit. If sawtooth frequency is okay, check R131, R132, S4, C107, D101.

	OPERATIONAL CHECK	TROUBLESHOOTING
10.	Apply 0.4 V p-p sine wave (0.14 V rms) at 1 kHz to VERT INPUT jack. Set V ATT switch to 1/10. Again there should be about 4 division of vertical deflection.	If no or incorrect vertical deflection check 1/10 attenuator S1, R102, R106, C102, TC102.
11.	Synchronized waveform display should be obtainable on 100-1 k SWEEP RANGE.	Check C4, S2.
12.	Apply 4 V p-p sine wave (1.4 V rms) at 10 kHz to VERT INPUT. Set V ATT switch to 1/100. Again there should be about 4 division of vertical deflection.	If no or incorrect vertical deflection check 1/100 attenuator S1, R101, R105, C101, TC101.
13.	Synchronized waveform display should be obtainable on 1 k-10 k SWEEP RANGE.	Check C5, S2.
14.	Leave sine wave applied to the VERT INPUT jack and also apply it to the EXT SYNC/HOR INPUT jack. Set SYNC switch to EXT. Reduce signal to 2 V p-p. Synchronized waveform display should be obtainable.	Check R1, C2, S4.
15.	Set AC-DC switch to DC. Apply 4 V p-p square wave or sine wave with +2 V dc offset to VERT INPUT jack. Waveform display should be vertically centered about +2 divisions (extend from 0 to +4 divisions). Set AC-DC switch to AC. Waveform should be centered about 0.	Check S3, C1.
16.	Apply 3 V p-p sine wave (1.05 V rms) at 60 Hz to EXT SYNC/HOR INPUT jack. Return SWEEP RANGE switch to EXT position. Set SWEEP VARI/EXT GAIN control to maximum (fully clockwise). There should be approximately 10 divisions of horizontal deflection.	Incorrect amount of horizontal deflection indicates need for HOR GAIN adjustment VR102.
17.	Apply 10 V p-p signal between V DIR and GND terminals. Set NOR-DIR switch to DIR. A waveform of about 1 division amplitude should be displayed.	Check S5, C6, C7, R2, R3.

OPERATIONAL CHECK	TROUBLESHOOTING
18. Return NOR-DIR switch to NOR. Apply 60 Hz signal of at least 25 V p-p to both Z-AXIS INPUT terminal and VERT INPUT jack. Adjust for synchronized display of a few cycles. Displayed waveform should be intensity modulated.	Check R164, C121.

TROUBLESHOOTING NOTES

PARTS LIST

IMPORTANT

This parts list reflects the Model 1403A from the start of production to the end of production, and the Model 1405 at the start of production. When ordering parts for later version Model 1405, first check the HISTORY OF PRODUCTION CHANGES section at the end of this manual for possible differences.

U.S.A. PARTS ORDERING INFORMATION

There is a minimum charge for each invoice. Orders will be shipped C.O.D. unless previous open account arrangements have been made or remittance accompanies order. Advance remittance must cover handling and postage or express charges. Specify model and serial number when ordering replacement parts.

ORDER REPLACEMENT PARTS FROM:

B & K-Precision, Dynascan Corporation
Factory Service Operations
6460 West Cortland Street
Chicago, Illinois 60635
Telephone: (312) 889-8870
Telex: 25-3475

SCHEMATIC SYMBOL	DESCRIPTION	DYNASCAN PART NO.
	RESISTORS	
R1	100 kΩ ±5%, 1/4 W, Carbon	002-104-5-104
R2, 3	2.2 MΩ ±5%, 1/2 W, Carbon	002-102-5-225
R101	990 kΩ ±1%, 1/2 W, Carbon	002-102-3-994
R102	900 kΩ ±1%, 1/2 W, Carbon	002-102-3-904
R103	1 MΩ ±5%, 1/2 W, Carbon	002-102-5-105
R104	1 MΩ ±1%, 1/2 W, Carbon	002-102-3-105
R105	10.1 kΩ ±1%, 1/2 W, Carbon	002-001-9-024
R106	111 kΩ ±1%, 1/2 W, Carbon	002-001-9-021
R107, 108	1 kΩ ±5%, 1/4 W, Carbon	002-104-5-102
R109	5.6 kΩ ±5%, 1/4 W, Carbon	002-104-5-562
R110, 111	8.2 kΩ ±5%, 1/4 W, Carbon	002-104-5-822
R112	100 Ω ±5%, 1/4 W, Carbon	002-104-5-101
R113, 114	6.8 kΩ ±5%, 1/4 W, Carbon	002-104-5-682
R115, 116	100 Ω ±5%, 1/4 W, Carbon	002-104-5-101
R117	2.2 kΩ ±5%, 1/4 W, Carbon	002-104-5-222
R118, 119	3.3 kΩ ±5%, 1/4 W, Carbon	002-104-5-332
R120	2.2 kΩ ±5%, 1/4 W, Carbon	002-104-5-222
R121	47 Ω ±5%, 1/4 W, Carbon	002-104-5-470
R122, 1213	4.7 kΩ ±5%, 1/4 W, Carbon	002-104-5-472
R124	390 Ω ±5%, 1/4 W, Carbon	002-104-5-391
R125, 126	220 Ω ±5%, 1/4 W, Carbon	002-104-5-221
R127	680 Ω ±5%, 1/4 W, Carbon	002-104-5-681
R128	33 Ω ±5%, 1/4 W, Carbon	002-104-5-330
R129, 130	3.9 kΩ ±5%, 3 W, Metal Film	011-003-5-392
R131	120 kΩ ±5%, 1/4 W, Carbon	002-104-5-124
R132, 133	27 kΩ ±5%, 1/4 W, Carbon	002-104-5-273
R134	4.7 kΩ ±5%, 1/4 W, Carbon	002-104-5-472
R135	120 kΩ ±5%, 1/4 W, Carbon	002-104-5-124
R136	2.7 kΩ ±5%, 1/4 W, Carbon	002-104-5-272
R137	1.5 kΩ ±5%, 1/4 W, Carbon	002-104-5-152
R138	6.8 kΩ ±5%, 1/4 W, Carbon	002-104-5-682
R139	3.3 kΩ ±5%, 1/4 W, Carbon	002-104-5-332
R140	18 kΩ ±5%, 1/4 W, Carbon	002-104-5-183
R141	68 kΩ ±5%, 1/4 W, Carbon	002-104-5-683
R142	12 kΩ ±5%, 1/4 W, Carbon	002-104-5-123
R143	10 kΩ ±5%, 1/4 W, Carbon	002-104-5-103
R144, 145	12 kΩ ±5%, 1/4 W, Carbon	002-104-5-123
R146, 147	3.9 kΩ ±5%, 1/4 W, Carbon	002-104-5-392
R148	330 Ω ±5%, 1/4 W, Carbon	002-104-5-331
R149, 150	22 kΩ ±5%, 2 W, Metal Film	011-002-5-223
R151	33 kΩ ±5%, 1/4 W, Carbon	002-104-5-333
R152	120 kΩ ±5%, 1/4 W, Carbon	002-104-5-124
R153	820 Ω ±5%, 3 W, Metal Film	011-109-9-001
R154	680 Ω ±5%, 2 W, Metal Film	011-002-5-681
R155	470 Ω ±5%, 3 W, Metal Film	011-003-5-471
R156	1.2 kΩ ±5%, 1/2 W, Carbon	002-102-5-122
R157	100 kΩ ±5%, 1/4 W, Carbon	002-104-5-104
R158	47 kΩ ±5%, 1/2 W, Carbon	002-102-5-473
R159-161	1 MΩ ±5%, 1/2 W, Carbon	002-102-5-105
R162	270 kΩ ±5%, 1/2 W, Carbon	002-102-5-274

SCHEMATIC SYMBOL	DESCRIPTION	DYNASCAN PART NO.
R163	560 kΩ ±5%, 1/2 W, Carbon	002-102-5-564
R164	2.2 MΩ ±5%, 1/2 W, Carbon	002-102-5-225
R165	150 kΩ ±5%, 1/2 W, Carbon	002-102-5-154
R166	180 kΩ ±5%, 1/2 W, Carbon	002-102-5-184
R167	100 kΩ ±5%, 1/2 W, Carbon	002-102-5-104
R168, 169	100 Ω ±5%, 1/4 W, Carbon	002-104-5-101
R178	180 kΩ ±5%, 1/4 W, Carbon	002-104-5-184
VR1	2 kΩ Potentiometer (V GAIN Control)	008-267-9-001
VR2	500 Ω Potentiometer (V POS Control)	008-267-9-002
VR3	10 kΩ Potentiometer (H POS Control)	008-267-9-003
VR4	1 MΩ Potentiometer (SWEEP VAR/EXT GAIN Control)	008-194-9-002
VR101	4.7 kΩ Trimmer Pot (DC BAL Adj)	008-155-9-002
VR102	1 kΩ Trimmer Pot (HOR GAIN Adj)	008-155-9-005
VR103, 104	1 MΩ Trimmer Pot (FOCUS and INTENSITY Adj)	008-267-9-004
	CAPACITORS	
C1	0.1 µF, 630 V, Oil	024-009-9-002
C2	15 pF ±5%, 500 V, Titanium	020-158-9-001
C3	0.47 µF ±10%, Mylar	025-076-9-003
C4	0.047 µF ±10%, Mylar	025-104-9-001
C5	3900 µF ±10%, Mylar	025-076-9-001
C6, 7	0.47 µF, 630 V, Oil	024-009-9-001
C101	680 pF ±5%, Polystyrene	030-017-9-006
C102	68 pF ±5%, Polystyrene	030-017-9-003
C103	0.01 µF ±20%, 500 V, Ceramic Disc	020-111-9-002
C104	0.01 µF ±20%, Ceramic Disc	020-142-9-012
C105	180 pF ±5%, Ceramic Disc	020-158-9-002
C106	15 pF ±5%, Ceramic Disc	020-096-9-005
C107	1 µF, 50 V, Non-Polarized Electrolytic	034-006-9-001
C108	1 µF, 63 V, Electrolytic	022-140-9-001
C109	15 pF ±5%, Ceramic Disc	020-096-9-005
C110	390 pF ±5%, Polystyrene	030-038-9-001
C111	10 µF, 25 V, Electrolytic	022-130-9-002
C112	680 pF ±20%, Ceramic Disc	020-158-9-003
C113	330 pF ±5%, Ceramic Disc	020-158-9-004
C114, 115	47 µF, 250 V, Electrolytic	021-057-9-001
C116	220 µF, 25 V, Electrolytic	022-086-9-003
C117	220 µF, 50 V, Electrolytic	022-073-9-006
C118	220 µF, 25 V, Electrolytic	022-086-9-003
C119	220 µF, 50 V, Electrolytic	022-073-9-006
C120	100 µF, 25 V, Electrolytic	022-123-9-001
C121	0.01 µF +100/-0%, 2 kV, Ceramic Disc	020-158-9-005
C122	0.22 µF ±20%, Mylar	025-104-9-002
C123	0.1 µF ±10%, 1.6 kV, Oil	024-006-9-003
C124, 125	0.1 µF ±10%, 1 kV, Oil	024-003-9-001
C126	0.1 µF ±10%, 2 kV, Oil	024-006-9-004
C127	100 µF, 50 V, Electrolytic	022-073-9-007
C128	0.01 µF ±20%, Ceramic Disc	020-142-9-012

SCHEMATIC SYMBOL	DESCRIPTION	DYNASCAN PART NO.
C129-131	Not Used	
C132	68 pF ±5%, Ceramic Disc	020-144-9-005
TC101, 102	10 pF, Ceramic Trimmer	028-032-9-004
TC103	50 pF, Ceramic Trimmer	028-020-9-001
	DIODES	
D101	1N60, Germanium	150-001-9-005
D102, 103	VO8J, Silicon	151-028-9-006
D104	S1QB60, Bridge Rectifier	157-006-9-001
D105, 106	WZ-150, Zener, 15 V	152-070-9-001
D107, 108	HVT-22Z-3, High Voltage	151-041-9-001
D109	WZ-061, Zener, 6.1 V	152-070-9-002
D110	1S1555, Silicon (Model 1405 Only)	151-028-9-007
	TRANSISTORS	
Q101-103	2SK30A-O, FET	182-026-9-001
Q104-109	2SC535-B, NPN	176-036-9-001
Q110, 111	2SC1507, NPN	176-055-9-006
Q112, 113	2SC458-C, NPN	176-048-9-002
Q114	2SK30A-O, FET	182-026-9-001
Q115, 116	2SC1507, NPN	176-055-9-006
	SWITCHES	
S1	Rotary (V ATT)	083-199-9-001
S2	Rotary (SWEEP RANGE)	083-145-9-001
S3-6	Slide (INT-EXT, POWER, DC-AC, NOR-DIR)	084-022-9-002
	Switch Stop (for NOR-DIR Switch)	763-149-9-001
	MISCELLANEOUS ELECTRICAL PARTS	
	Test Leads	523-149-9-001
F101	Fuse, 0.5 A, 3AG (117 V Operation)	191-251-3-102
	Fuse, 0.3 A (230 V Operation)	191-010-9-001
N1	Neon Lamp, NE2PH1	401-014-9-001
	CRT, Type 312P31B or 75AVB31	230-011-9-001
	CRT Socket	749-080-9-001
	Power Transformer	065-122-9-001
	AC Power Cord, with 3-Prong Plug	420-013-9-001
	Binding Post/Banana Jack, Black (3 used)	345-054-9-001
	Terminal Strip, 3-Terminal (Z-AXIS, GND, V DIR)	345-031-9-001
	MECHANICAL PARTS	
	Case (1405)	272-156-9-001
	Case (1403A)	272-091-9-001
	Carrying Handle	746-039-9-001

SCHEMATIC SYMBOL	DESCRIPTION	DYNASCAN PART NO.
	Front Panel, Molded (1405)	255-195-9-001
	Front Panel, Molded (1403A)	255-139-9-001
	Decorative Panel (Front Panel Inlay)	
	#1 (1405)	260-228-9-001
	#2 (1405)	260-229-9-001
	#1 (1403A)	260-073-9-001
	#2 (1403A)	260-074-9-001
	Graticule (1405)	380-354-9-002
	Graticule (1403A)	380-255-9-001
	Knob, Small (V GAIN, SWEEP VARI/EXT GAIN, etc.)	751-120-9-004
	Knob, Large (V ATT, SWEEP RANGE)	751-124-9-002
	Chassis (1405)	257-124-9-001
	Chassis (1403A)	257-076-9-001
	Rubber Foot (4 used)	381-054-9-001
	Access Plate, Bottom (Model 1405 Only)	253-083-9-001
	Rubber Bushing (DC BAL, HOR GAIN)	381-049-9-003
	CRT Mounting Plate (Rear Panel)	251-463-9-001
	CRT Shield	256-121-9-001
	CRT Band	
	#1	251-461-9-001
	#2	251-462-9-001
	Mounting Bracket, for Power Transformer	251-312-9-001
	Mounting Plate, for Input Terminals	251-460-9-001
	Protection Plate, for FOCUS and INTENSITY Controls	763-149-9-002
	PC Board Support, Plastic (6 used)	380-256-9-002
	Power Cord Bushing (Strain Relief)	380-137-9-004
	PACKING PARTS	
	Carton (1405)	500-446-9-001
	Carton (1403A)	500-275-9-001
	Packing Material, Foamed Styrene	
	#1	502-091-9-001
	#2	502-107-9-001
	Protective Cover	502-070-9-005
	Polyethylene Bag	502-071-9-001
	Test Leads	523-149-9-001
	Instruction Manual (1405)	480-267-9-001
	Instruction Manual (1403A)	480-177-9-001
	Schematic Diagram & Parts List (1405)	499-164-9-001
	Schematic Diagram & Parts List (1403A)	499-085-9-001

VOLTAGE CHART

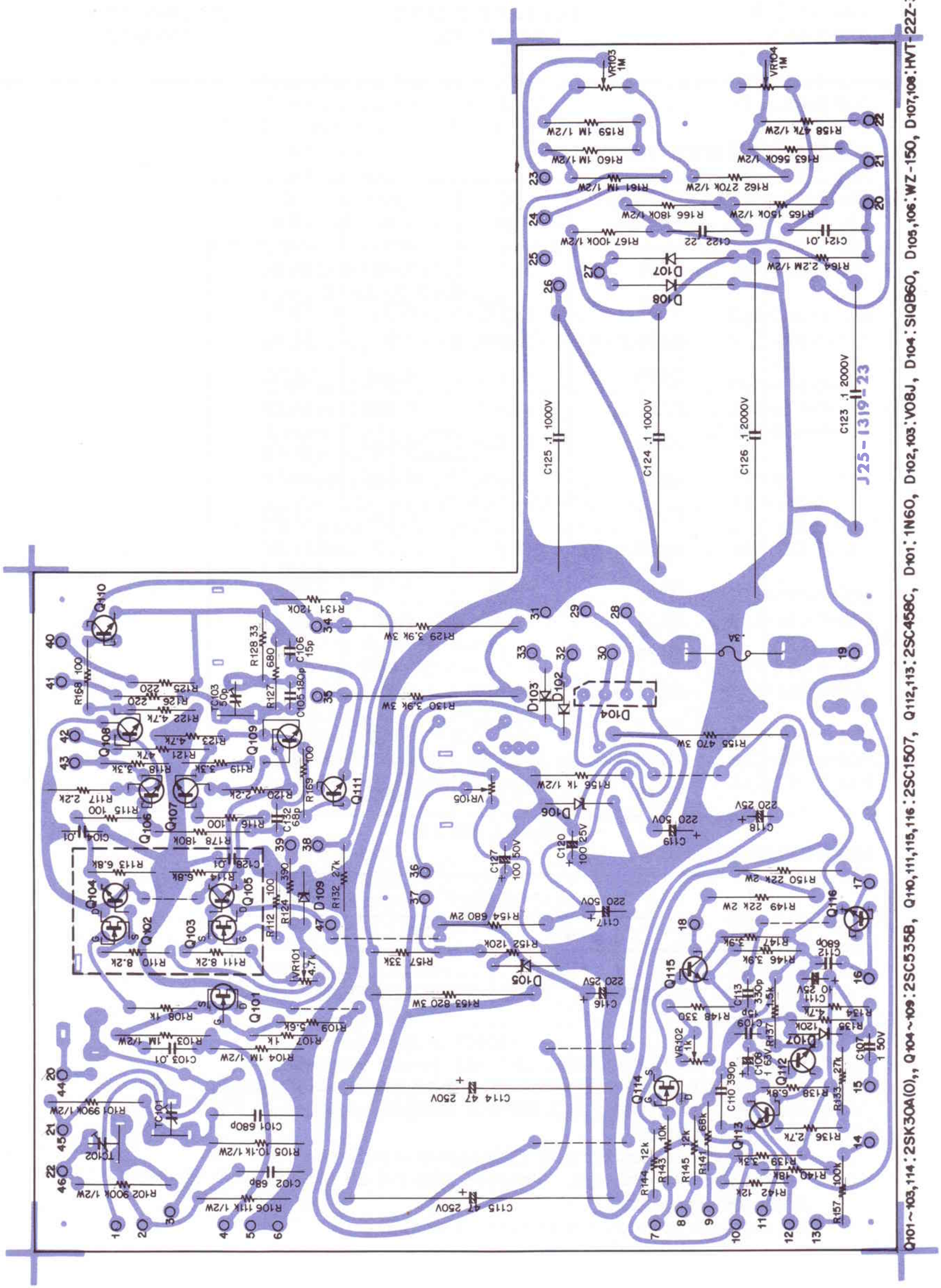
TRANSISTOR (FET) VOLTAGES

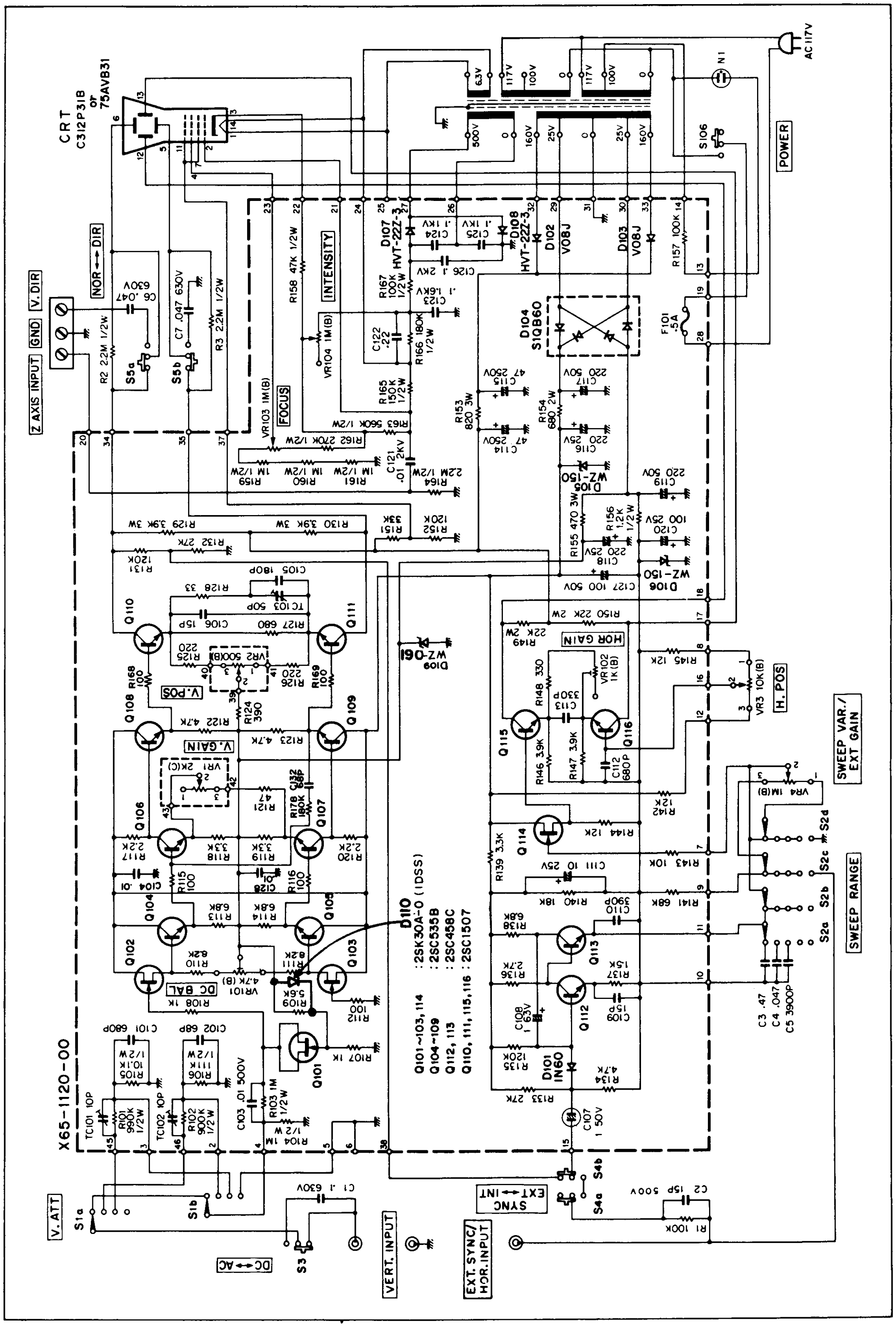
TRANSISTOR (FET)	E (S)	B (G)	C (D)
Q101	0.0	1.19	0.0
Q102	0.047	0.0	14.63
Q103	0.038	0.0	14.63
Q104	-0.643	0.047	14.63
Q105	-0.643	0.038	14.63
Q106	-1.344	-0.643	10.25
Q107	-1.344	-0.643	10.17
Q108	9.54	10.25	14.63
Q109	9.47	10.17	14.63
Q110	9.01	9.54	122.9
Q111	8.96	9.48	131.3
Q112	-12.12	-11.48	-1.22
Q113	-0.283	-1.22	3.31
Q114	-0.434	-0.280	14.63
Q115	-0.972	-0.434	104.2
Q116	-0.980	-0.448	104.8

CRT VOLTAGES

PIN			
11	4 *	3 *	2 *
139.7	-1167	-1393	-1438

NOTES:
1. Measurement Conditions:
   All front panel variable controls at center of rotation, V ATT at 1/100, coupling at DC, SWEEP RANGE at 100-1 k, SYNC at INT, no signal input.
2. All voltages measured with 10 Megohm multimeter.
3. * indicates high voltage. Measure with PR-28 High Voltage Multiplier Probe or equivalent.
4. All voltages measured with respect to chassis.


J25-1319-23
Q101~103,114: 2SK30A(O), Q104~109: 2SC535B, Q110,111,115,116: 2SC1507, Q112,113: 2SC458C, D101: 1N60, D102,103: V08J, D104: SIQB60, D105,106: WZ-150, D107,108: HVT-22Z-3


CRT
C312P31B
or
75AVB31
X65-1120-00
Q101~103, 114 : 2SK30A-0 (IDSS)
Q104~109 : 2SC535B
Q112, 113 : 2SC458C
Q110, 111, 115, 116 : 2SC1507
V. ATT
VERT. INPUT
EXT. SYNC/ HOR. INPUT
SWEEP RANGE
SWEEP VAR./ EXT GAIN
H. POS
POWER
INTENSITY
FOCUS
Z AXIS INPUT
AC 117V

488-162-9-001

HISTORY OF PRODUCTION CHANGES

MODEL 1403A

The schematic diagram in this manual reflects the Model 1405 at the start of production. It also applies to all production versions of Model 1403A, except that diode D110 is not used in Model 1403A. Mechanical parts differences between Model 1403A and 1405 are all itemized in the parts list.

MODEL 1405

The schematic diagram and parts list in this manual reflects the Model 1405 at the start of production. In addition to the production changes listed below, watch for any addenda that may be issued or inserted loose into the manual which cover production changes that may occur after this manual is printed.

SERIAL NO. 95-00001 TO 95-07000

Original production version, as reflected in the schematic diagram and parts list.

SERIAL NO. 95-07001 AND HIGHER

C109 changed from 15 pF ±5% to 27 pF ±5%.

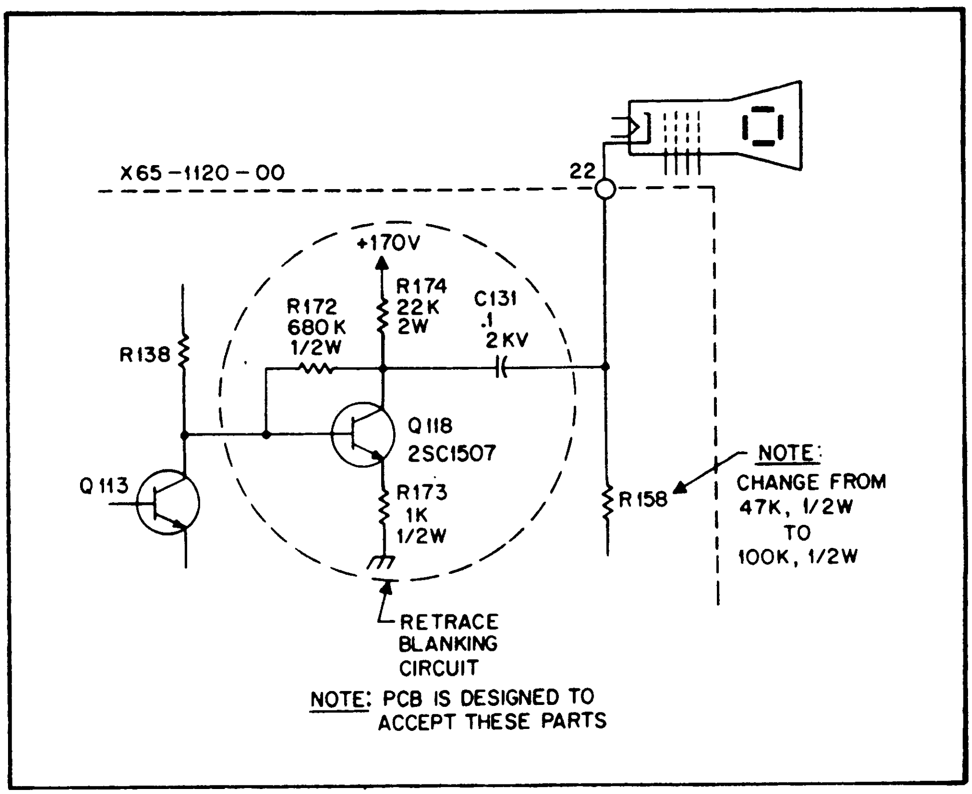
C109 27 pF ±5%, 50 V, Ceramic Disc 020-374-9-001

MODIFICATION TO ADD RETRACE BLANKING

The Model 1403A and 1405 Oscilloscopes do not include circuitry to blank the electron beam during retrace of the sweep. At brighter intensity settings, retrace may be visible. This is not objectionable to most users, and helps to reduce the cost of the instrument.

However, if visible retrace is considered objectionable, a retrace blanking circuit may be added. A schematic diagram of the circuit is shown below. The standard circuit board is designed to accept this circuit on a drop-in basis, and the circuit board legend identifies the proper location for each of the added parts. A parts list for the retrace blanking circuit follows:

SCHEMATIC SYMBOL	DESCRIPTION	DYNASCAN PART NO.
C131	0.1 µF, 2 kV Capacitor	024-006-9-004
Q118	2SC1507 NPN Transistor	176-055-9-006
R158	100 kΩ ±10%, 1/2 W Resistor	002-102-6-104
R172	680 kΩ ±10%, 1/2 W Resistor	002-102-9-684
R173	1 kΩ ±10%, 1/2 W Resistor	002-102-6-102
R174	22 kΩ ±10%, 2 W Resistor	011-003-5-223



Modification to Add Retrace Blanking.

ADAPTING 1403A OR 1405 TO USE STANDARD OSCILLOSCOPE PROBE

A standard oscilloscope probe, rather than the test leads supplied, is very handy for many measurements. A X10 probe attenuates the measured signal 10:1 and extends the voltage measurement range. It also offers the advantages of low capacitance and high resistance for less circuit loading when making measurements in high impedance or high frequency circuits. A X10/Direct probe offers all the advantages of a fixed X10 probe, plus the ability to switch to unattenuated (Direct) operation for low level signal measurements.

The Model 1403A and 1405 Oscilloscopes can be easily adapted to use a fixed X10 or X10/Direct oscilloscope probe. Standard oscilloscope probes use a BNC connector. A Pomona No. 1269 BNC-to-Dual Banana Adapter is all that is needed to convert this scope for use of a standard probe.

B & K-Precision offers a variety of oscilloscope probes. The Model PR-47 (fixed X10) or PR-40 (X10/Direct) is recommended for use with the Model 1403A or 1405 Oscilloscope.

All X10 and X10/Direct probes should have a probe compensation trimmer, which should be adjusted as follows:

1. Connect probe to scope.
2. Set X10-DIR switch on probe to X10, if so equipped.
3. Set V ATT switch on scope to "1" (10 mV/div).
4. Apply 1 kHz square wave to probe tip. Adjust scope controls for two to four cycles square wave display. Adjust square wave generator for four to six divisions amplitude.
5. Adjust for best square wave waveshape, as shown in Fig. 9 of this manual.

continued from inside front cover

9. Some equipment with a two-wire ac power cord, including some with polarized power plugs, is the "hot chassis" type. This includes most recent television receivers and audio equipment. A plastic or wooden cabinet insulates the chassis to protect the customer. When the cabinet is removed for servicing, a serious shock hazard exists if the chassis is touched. Not only does this present a dangerous shock hazard, but damage to test instruments or the equipment under test may result from connecting the ground lead of most test instruments (including this oscilloscope) to a "hot chassis". To make measurements in "hot chassis" equipment, always connect an isolation transformer between the ac outlet and the equipment under test. The **B & K-Precision** Model TR-110 Isolation Transformer, or Model 1653 or 1655 AC Power Supply is suitable for most applications. To be on the safe side, treat all two-wire ac powered equipment as "hot chassis" unless you are sure it has an isolated chassis or an earth ground chassis.

10. Special precautions are required to measure or observe line voltage waveforms with any oscilloscope. Use the following procedure:

    a. Do not connect the ground clip of the probe to either side of the line. The clip is already at earth ground and touching it to the hot side of the line may "weld" or "disintegrate" the probe tip and cause possible injury, plus possible damage to the scope or probe.

    b. Insert probe tip into one side of the line voltage receptacle, then the other. One side of the receptacle should be "hot" and produce the waveform. The other side of the receptacle is the ac return and no waveform should result.

11. Never work alone. Someone should be nearby to render aid if necessary. Training in CPR (cardio-pulmonary resuscitation) first aid is highly recommended.

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