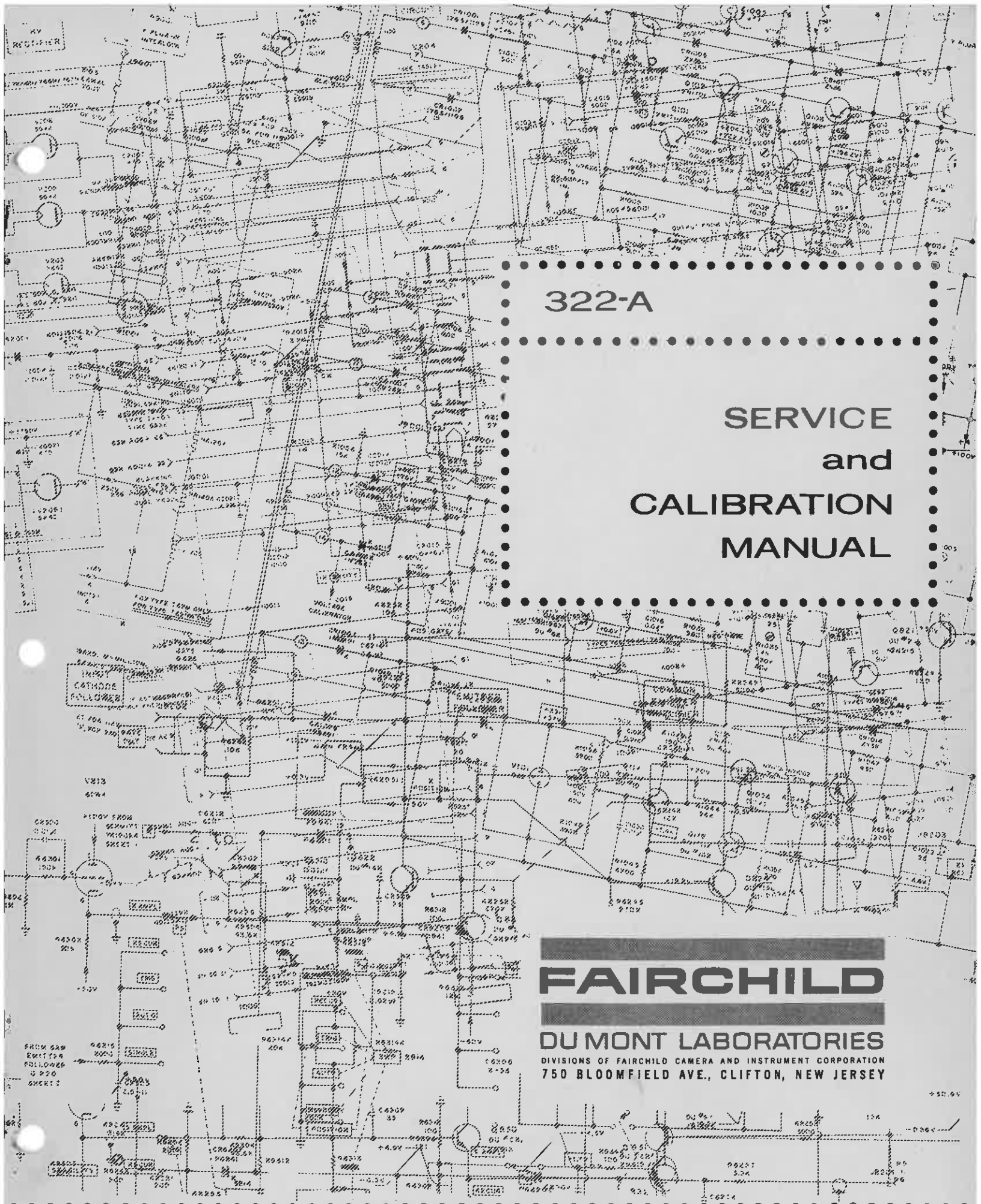

322-A

SERVICE and CALIBRATION MANUAL

FAIRCHILD

DU MONT LABORATORIES

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Scientific Instrument Service Department

SECTION 1

INTRODUCTION

1. GENERAL

Modern, general-purpose oscillography frequently requires the simultaneous comparison of various waveforms in complex circuits. In many cases these waveforms are generated on common time bases, but often simultaneous comparison of waveforms on different time bases is also required. Accurate comparison of two waveforms by alternately presenting them on a single-beam oscillograph is extremely difficult, as one must rely entirely on memory. Photographic recording of the phenomena is valuable in this instance; however, such recording, though excellent for obtaining permanent records, is not too satisfactory for making "on the spot" comparisons of waveforms. A dual-beam oscillograph readily fills this requirement by presenting two waveforms simultaneously for ready comparison. It makes possible the viewing of two separate waveforms at the same instant or the viewing of an expandad horizontal or vertical portion of a given wave simultaneously with the complete waveform.

The Du Mont Type 322-A Dual-beam Cathode-ray Oscillograph has been designed with the foregoing requirements in mind. It will display two waveforms separately or simultaneously, on separate or common time bases. It will display waveforms having amplitudes within the approximate range of 5 millivolts to 1,000 volts peak-to-peak. Through use of the Type 5AFP- dual-beam, tight tolerance cathode-ray tube and the employment of a precision source of voltage built into the instrument, rapid and accurate vertical amplitude calibration of the cathode-ray tube screen may be obtained. Thus, the Type 322-A becomes a true two channel electronic voltmeter from which accurate amplitude readings may be obtained of signals applied to either channel. Extremely close tolerances are maintained in the Type 5AFP- cathode-ray tube on deflection factors, deflection-plate alignment, tracking error, interaction factor, line resolution, undeflected spot position, and other related characteristics.

The Type 322-A has many obvious advantages over the time sharing limitations of electronically switching a single-beam oscillograph, optical difficulties present with beam splitting tubes and the inconvenience of viewing adjacent, single-beam oscillographs simultaneously.

2. PURPOSE

The Du Mont Type 322-A Cathode-ray Oscillograph will meet most exacting requirements for a modern, general-purpose laboratory instrument. Its field of application is extremely broad and includes such special uses as the study of input-output waveforms; the observation of an "unknown" waveform with respect to a reference waveform, the simultaneous display of a complete waveform and any selected portion of this waveform expanded up to five times full screen, etc.

3. FEATURES

Direct-coupled amplifiers having high sensitivity and a high degree of stability are provided for vertical and horizontal deflection. The sweep circuits allow the display of two waveforms on individual time bases or a common time base, as desired. The use of concentric front-panel control knobs assures ready access to related controls, reduced complexity of adjustment, compact design, and relatively low weight.

Both "recurrent" and "driven" sweep operations are incorporated. Synchronization or triggering of sweeps is accomplished by the Y INPUT signal through internal connection, by a variable, internally-available source of line-frequency voltage or by an external signal connected to appropriate front-panel terminals. Other features include return sweep-trace blanking, intensity-modulation facility, and beam control (both beams on separately or simultaneously). Conveniently accessible side-panel terminals facilitate connection of signals direct to deflection plates (through capacitators).

4. OPERATION

Before attempting operation of the oscillograph, read the sections on "Operation" and "Theory of Operation" carefully for familiarization with the equipment.

TABLE 1-1

PERFORMANCE SPECIFICATIONS

CATHODE-RAY TUBE	
Type	5AFP- Dual-beam
Total Accelerating Potential	3,000 Volts (with respect to cathode)
Illuminated Scale	Engraved illuminated scale with front panel dimmer control
VERTICAL AXIS	
Deflection Factor	
Amplifier (at full gain)	0.1 volt peak-to-peak full scale; or 0.025 peak-to-peak volt/inch (.009 rms volt/inch)
Direct	36-45 peak-to-peak volts/inch; 13-16 rms volts/inch
Undistorted Deflection	At least 4 inches
Sinusoidal Frequency Response (Through Ampl)	
Direct coupling	Flat to dc. Down not more than 10% at 100 kilocycles or 50% at 350 kilocycles
Capacitive Coupling	Down not more than 10% at 10 cycles and 100 kilocycles or 50% at 350 kilocycles
Transient Response	
Rise Time (10% to 90%)	2 μs max.
Overshoot	2% max.
Decay	
Direct coupling	None
Capacitive Coupling	10% or less in 45 milliseconds
Input Voltage (To Ampl)—Maximum	
Single-ended	
Capacitive Coupling	1,000 (dc plus peak ac)
Direct Coupling	1,000 (dc plus peak ac) on all ranges of VOLTS FULL SCALE except 0.1 where it is 100 volts (dc plus peak ac)
Balanced	0.4 volt peak-to-peak between grids, with a mean dc level between 0 and +1 volt (VOLTS FULL SCALE switch) at 0.1 DC only and (MULTIPLIER fully clockwise)
Input Impedance	
Method	Capacitive or direct
Attenuation	By factors of 1, 10, 100, 1,000 ±2% as selected by the VOLTS FULL SCALE switch (0.1, 1, 10, or 100 positions respectively)
Input Impedance	
Amplifier	
Single-ended	2 megohms, 50 μμf
Balanced	4 megohms, 40 μμf
Direct	
Single-ended	1.5 megohms, 20 μμf
Balanced	3 megohms, 20 μμf
Positioning	Permits examination on screen of any portion of signal expanded to five-times full scale diameter

TABLE 1-1

PERFORMANCE SPECIFICATIONS (Continued)

HORIZONTAL AXIS

Deflection Factor

Amplifier (at full gain) ..... 0.3 peak-to-peak volt/inch; 0.1 rms volt/inch

Direct ..... 40-50 peak-to-peak volts/inch; 14-18 rms volts/inch

Sinusoidal Frequency Response

Individual Channel

Direct Coupling ..... Flat to dc. Down not more than 10% at 100 kilocycles or 50% at 300 kilocycles

Capacitive Coupling ..... Down not more than 10% at 10 cycles and 100 kilocycles or 50% at 300 kilocycles

Common Channel

Direct Coupling ..... Down not more than 10% at 70 kilocycles or 50% at 200 kilocycles

Capacitive Coupling ..... Down not more than 10% at 10 cycles and 70 kilocycles or 50% at 200 kilocycles

Transient Response

Individual

Rise Time (10% to 90%) ..... 2 μs max.

Overshoot ..... 1% max.

Decay

Direct Coupling ..... None

Capacitive Coupling ..... 20% or less in 45 milliseconds

Common

Rise Time ..... 2.5 μs

Overshoot ..... 1% max.

Decay

Direct Coupling ..... None

Capacitive Coupling ..... 20% or less in 45 milliseconds

Input Voltage

Capacitive Coupling ..... 1,000 volts (dc plus peak ac)

Direct Coupling .....

Attenuator Setting	*Peak-to-Peak Volts*
1:1	18
10:1	180

Input Coupling (To Ampl) ..... Capacitive or direct

Attenuation (Ampl Connection) ..... By factors of 1 or 10, ±10%

Input Impedance

Amplifier ..... 2 megohms, 40 μμf

Direct

Single-ended ..... 1.5 megohms, 20 μμf

Balanced ..... 3 megohms, 20 μμf

Linear-sweep Time Base

Circuit ..... A gas triode is used for both driven and recurrent sweeps. Return trace is automatically blanked. With common sweep, built-in compensation equalizes horizontal deflection and position for both beams

TABLE 1-1
PERFORMANCE SPECIFICATIONS (Continued)

HORIZONTAL AXIS (Continued)

Frequency (Recurrent Sweep)	2 to 30,000 sawtooth cps. Sweep frequencies lower than 2 cps may be obtained by connecting an external capacitor between the SAWTOOTH terminal and ground (SWEEP at EXT CAP), giving 0.5 second per microfarad. SWEEP at EXT CAP with no capacitor connected gives approximately 50,000 sawtooth cps.
Time Duration (Driven Sweep)	0.5 second to 33 microseconds for 4-inch deflection
Positioning	Permits examination on screen of any portion of sweep expanded to six-times full screen diameter
Synchronization	INTernal, EXternal, or LINE frequency as selected
Common Sweep	Provision for Channel A sweep to deflect both beams simultaneously thus providing a common time base for vertical inputs to Channels A and B
Individual Sweep	Provision for independent sweep operation of Channels A and B

INTENSITY MODULATION (Z AXIS)

Input Impedance	0.2 megohms, 30 μμf
Sensitivity	2 to 56 volts peak (negative), depending on the intensity setting, are required to blank the beam

DUAL CHANNEL CONTROLS

Beam Control	Permits selection of either beam separately or simultaneously
Sweep Selector	Permits selection of common or individual sweep operation

CALIBRATION VOLTAGE

Availability	To input of Vertical Ampl of each channel (following the attenuator) by means of individual front-panel switches
Amplitude	0.1 volt peak-to-peak. Independent of VOLTS FULL SCALE setting
Waveshape and Frequency	Square wave at power-line frequency
Accuracy (Amplitude) Over-all	±5% or better

TABLE 1-1

PERFORMANCE SPECIFICATIONS (Continued)

SAWTOOTH TEST SIGNAL

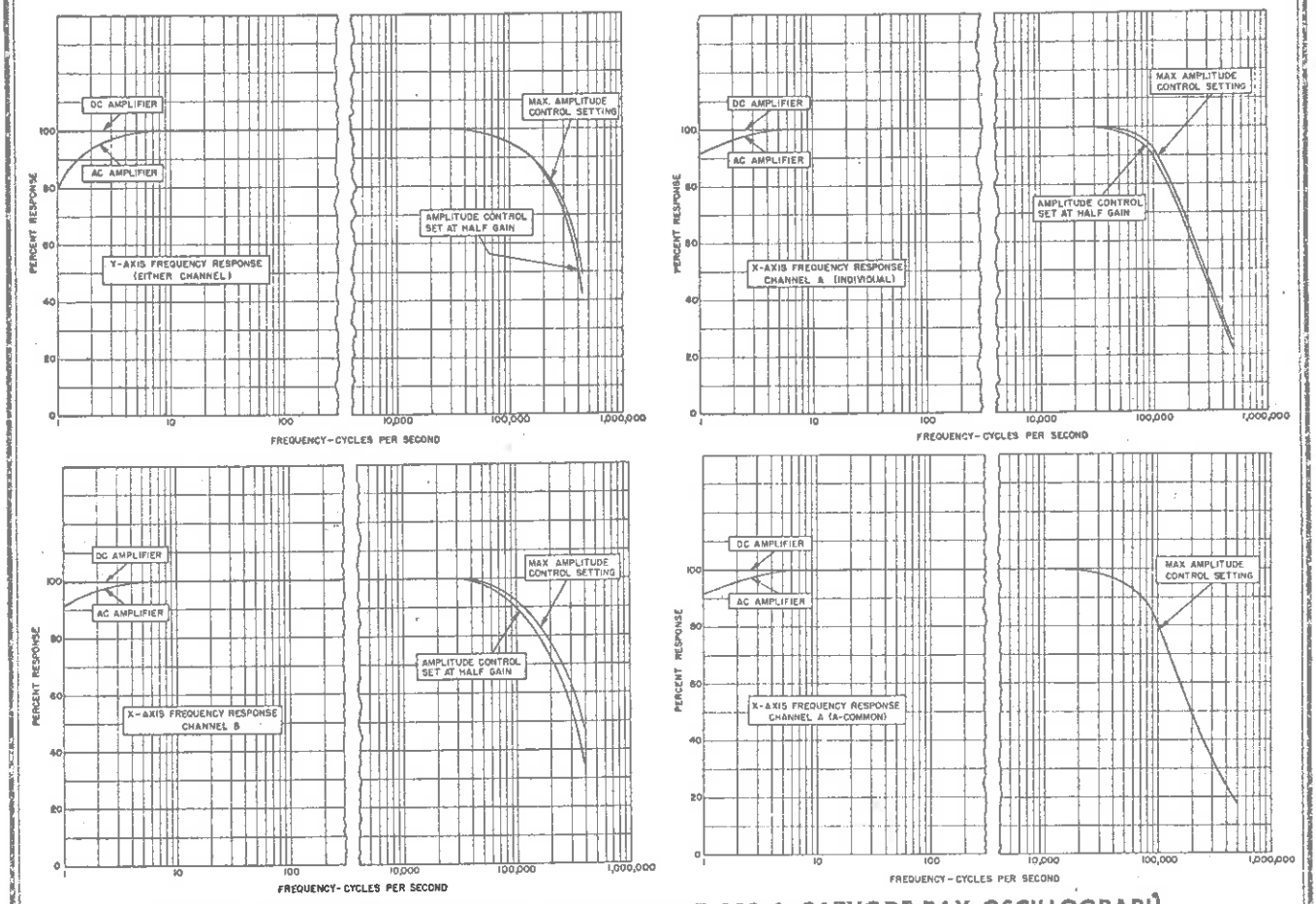
Availability	At front panel for each channel
Voltage	5 volts peak-to-peak, nominal
Impedance	50,000 ohms
Frequency	2 to 30,000 sawtooth cps

POWER SOURCE

Voltage	115/230 volts rms ±10%
Frequency	50 to 400 cycles per second
Power Consumption	225 watts
Fuses	3 amp (115 volts); 1.5 amp (230 volts). In addition, power supply for each channel is fused separately

PHYSICAL CHARACTERISTICS

Size	Height: 15-3/4"; width: 12-1/2"; depth: 22-7/8"
Weight	75 lbs.



TYPICAL FREQUENCY-RESPONSE CURVES—TYPE 322-A CATHODE-RAY OSCILLOGRAPH

SECTION II

OPERATION

1. UNPACKING AND INSPECTING THE INSTRUMENT

The Du Mont Type 322-A Dual-beam Cathode-ray Oscillograph is shipped with all tubes in place and ready to operate. The two Y-amplifier sub-chassis are pre-loaded for shipment to prevent possible damage to tubes or components. The screws holding these sub-chassis down should be loosened (but not removed) to allow the sub-chassis to float free. For location of these sub-chassis, see Figures 4-1 and 4-2. To slide the instrument out of its cabinet, first remove the two screws at the back of the cabinet.

2. LOCATION AND INSTALLATION

a. GENERAL

Since the Type 322-A is a portable test instrument, no special installation procedure is required. Normally, the oscillograph may be placed where most convenient for viewing the screen. However, it is always desirable to employ the shortest possible signal leads to avoid stray pickup.

b. MAGNETIC AND ELECTRIC FIELDS

Although magnetic and electrostatic-shielding has been provided in the design of the instrument, operation in strong fields such as are found near transmitters, transformers, and power-generating equipment, etc., may introduce spurious deflections, and should be avoided.

Electrostatic pickup may be minimized by the use of shielded input cables and connections and with a good electrical ground on the chassis of the instrument. Spurious magnetic deflections may be eliminated or reduced to an unobjectionable point by removing the instrument from the immediate vicinity of the disturbance; orienting the instrument in the field so that spurious deflection is at a minimum; or in extreme cases, by adding additional magnetic shielding in the form of a large iron or steel container in which the entire instrument may be placed.

c. LINE VOLTAGE AND FREQUENCY

This oscillograph will operate from a source of 115 or 230 volts rms at any frequency between 50 and 400 cycles. Normally, the instrument is connected for 115-volt operation. A tag on the handle will specify the proper line voltage. To change from 115-volt to 230-volt line operation or vice versa, see Section IV on Maintenance and the schematic diagram in the back of this manual.

d. POWER REGULATION

The Type 322-A will operate satisfactorily with steady line-voltage variations of ±10% from the specified value, because of the regulator circuits employed in the instrument. However, greater than 10% variation may cause the power supply to operate erratically with consequent unsatisfactory performance of the oscillograph. Where line-voltage variations are excessive, it is recommended that a constant-voltage transformer be employed in the power line to the instrument. If such a regulator is used, precautions should be taken to avoid the effects of stray magnetic fields as discussed in paragraph 2b.

— WARNING —

Potentials as high as *3,000* volts are employed in this instrument. Such voltages are extremely dangerous; and every possible safety precaution should be taken to avoid contact. The instrument is safe when enclosed in its cabinet and should not be operated with the chassis withdrawn except for purposes of adjustment or repair. When necessary to energize the oscillograph with the chassis outside its cabinet, refer to the precautions given in paragraph 2 of Section IV, Maintenance.

3. TURNING ON THE INSTRUMENT

To place the instrument in operation, plug the power cord into the line outlet, and throw the POWER switch to the "up" position. Switch the BEAM CONTROL to ON, and allow approximately thirty seconds for the instrument to warm up. Adjust the INTENSITY and POSITION controls as required until both beams appear on screen.

CAUTION—AVOID HIGH INTENSITY, SHARPLY FOCUSED TRACES. A sharply focused line or spot of high intensity, having short length or small area, respectively, should not be permitted to remain stationary on the screen for any considerable length of time. Under such conditions, the entire energy of the beam is concentrated over a small area, thus subjecting the screen material to burning and discoloration.

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4. CONTROLS AND TERMINALS

a. GENERAL

Some simplification in understanding the Type 322-A may be obtained by considering the instrument as essentially two completely separate oscillographs, enclosed in one cabinet with individual controls for each oscillograph. For convenience, these controls are so positioned that those associated with one oscillograph (Channel A) are left of center while those associated with the other oscillograph (Channel B) are located to the right of center. Two controls (BEAM CONTROL and SWEEP SELECTOR), common to both channels, are located on the center line of the panel.

TABLE 2-1

TABLE OF OPERATING CONTROLS AND TERMINALS

Name of Control or Terminal	*Reference Symbol*	*FUNCTION*
INTENSITY	R707 R719	Varies trace intensity.
FOCUS	R709 R720	Adjusts trace focus.
BEAM CONTROL	S701	Turns cathode-ray beams on or off independently or simultaneously.
(Y) POSITION	R117 R617	Positions trace vertically.
(X) POSITION	R314 R414	Positions trace horizontally.
Y D-C BAL	R110 R610	When properly adjusted, prevents vertical movement of the trace when the MULTIPLIER control is varied.
X D-C BAL	R316 R416	When properly adjusted, prevents horizontal movement of the trace when the X AMPLITUDE control is varied.
VOLTS FULL SCALE (RANGE)	S101 S601	Selects input voltage range for full scale deflection.
VOLTS FULL SCALE (MULTIPLIER)	R112 R612	Selects full scale value multiplier.
X SELECTOR	S301 S401	Selects internal sweep or external signal for horizontal deflection.
X (AMPLITUDE)	R308 R408	Controls amplitude of horizontal deflection.
SWEEP SELECTOR	S402	Selects individual or A-common sweep.
SWEEP (RANGE)	S202 S502	Selects range of sweep frequencies.
SWEEP (VERNIER)	R213 R513	Provides continuous variation of sweep frequencies within the limits of the SWEEP (RANGE) control setting.
SYNC (SELECTOR)	S201 S501	Selects synchronizing signals (INT, EXT, LINE).
SYNC (AMPLITUDE)	R208 R508	Selects phase and varies amplitude of sync voltage.
SCALE ILLUMINATION	R815	Varies the illumination intensity of the illuminated scale.
CALIBRATOR	S102 S602	Provides 0.1 volt peak-to-peak calibration signal to vertical amplifier input.
Y INPUT	J101, J102 J601, J602	Connections for external signals to the vertical amplifiers, either balanced or single ended.
X INPUT	J301 J401	Connections for external signals to the horizontal amplifiers.
EXT SYNC	J201 J501	Connections for external sync signals.
SAWTOOTH	J202 J502	Provides for sweep sawtooth voltage at front panel and a connection for external capacitors for low-frequency sweeps.
	J103 J204 J503 J603	Provide connections to chassis ground.

Y INPUT, EXTernal SYNC, X INPUT, and SAW-TOOTH output terminals are duplicated for the two channels. Signals connected to the Y INPUT terminals may be either ac or dc and are attenuated by means of the VOLTS FULL SCALE (RANGE) switch when necessary to limit full screen deflections to 100 volts, 10 volts. 1 volt or 0.1 volt peak-to-peak when using the instrument as a peak-reading voltmeter. Signals connected to the X INPUT terminal may be either ac or dc also, and attenuation ratios of 1 or 10 may be selected.

The markings on the front panel adjacent to each control (See Figure 2-1) are essentially self explanatory, and the operator should find it possible to master the controls with a minimum of experimentation. For clarification of the functions of the dual controls, refer to Table 2-1.

Terminals for the connection of signals directly (through capacitors) to both sets of the cathode-ray-tube horizontal and vertical deflection plates are accessible through doors at each side of the instrument—those for Channel A at the left side, those for Channel B at right. For a view of these terminals, see Figure 2-3. To make side-panel connections, refer to paragraph 4e, (DIRECT CONNECTION TO DEFLECTION PLATES), paragraph 4f, (INTENSITY MODULATION), and to paragraph 5b, (VERTICAL AXIS "SWEEP" CONNECTION).

b. VERTICAL AXIS INPUT

(1) GENERAL

In normal operation, the signal or waveform to be studied is applied to the appropriate Y INPUT terminals to provide vertical deflection of the beam concerned. The instrument is shipped with a jumper connected from one of the two Y INPUT terminals to a ground (GND) terminal to accomodate unbalanced input signals. For observance of balance input signals the jumper must be removed. For such operation, refer to paragraph 5a.

(2) UNBALANCED INPUT

When the Type 322-A is adjusted for maximum vertical amplification (most sensitive setting of VOLTS FULL SCALE controls) an unbalanced input signal of only 0.1 volt peak-to-peak will produce full-screen (4 inches) vertical deflection. At the other extreme, a signal of 1,000 volts peak-to-peak can be observed on screen when the VOLTS FULL SCALE controls are set for maximum possible attenuation. UNDER NO CIRCUMSTANCES MUST A SIGNAL GREATER IN AMPLITUDE THAN 1,000 VOLTS (dc plus peak ac) BE APPLIED TO THE INPUT TERMINALS; as damage to the instrument may result.

(3) BALANCED INPUT (Also see paragraph 5a)

A balanced input signal of up to 0.4 volt peak-to-peak, having a dc level of no greater than +1 volt, may be applied to the Y INPUT front-panel terminals. If a signal larger than this is to be viewed, either external attenuation must be provided, or connection made directly to the deflection plates where 36-45 volts peak-to-peak will be required to produce one inch of deflection. With a balanced input signal at the Y INPUT terminal, the VOLTS FULL SCALE (RANGE) control must be set to 0.1 DC only.

c. AMPLITUDE CALIBRATION—MEASUREMENT OF SIGNAL VOLTAGE

Amplitude calibration on the Type 322-A Cathode-ray Oscillograph is accomplished by the substitution method. A voltage of known amplitude is available at the input to the Vertical Amplifier at the touch of a finger on the CALIBRATOR button. This calibrator signal is substituted for the signal under test. A few moments of actual experimentation with this calibrator signal will demonstrate the ease with which amplitude measurements may be made. To become familiar with the measurement of amplitudes by means of the built-in calibrator, the following procedure is suggested.

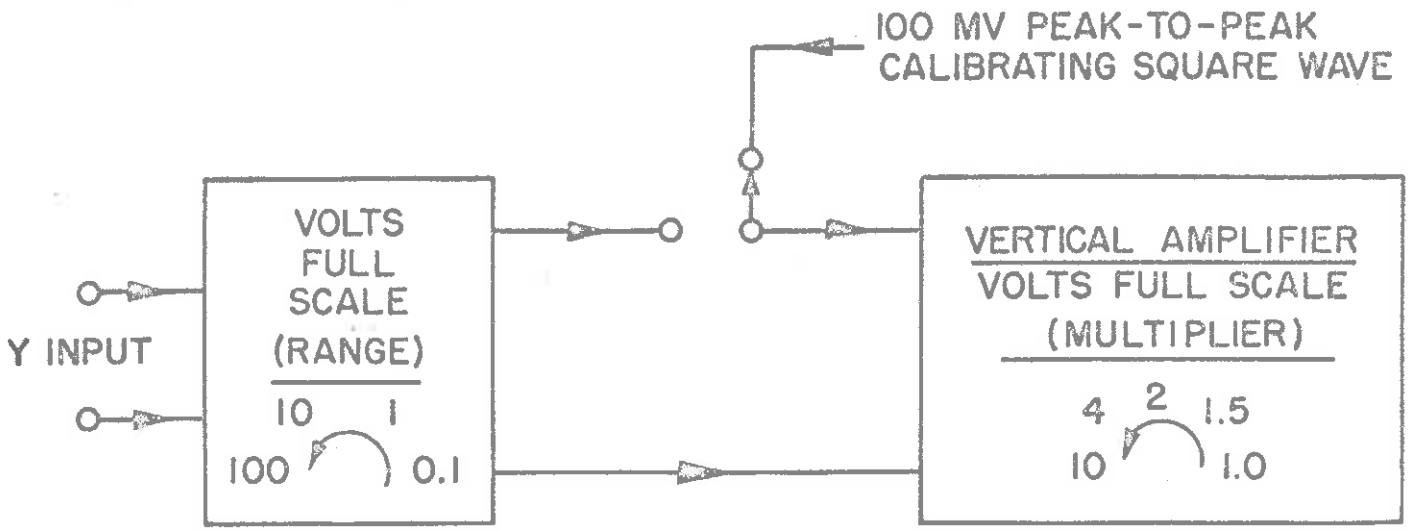
(1) FOR SIGNALS UP TO 100 VOLTS PEAK-TO-PEAK

Step 1: Apply the calibrator voltage to the Y INPUT of either channel by depressing the appropriate CALIBRATOR button. Adjust the appropriate (MULTIPLIER) gain control for a peak-to-peak beam deflection of four inches. This is best established by adjusting the vertical position control along with the (MULTIPLIER) control to cause the negative and positive peaks of the calibrator signal to appear at 0 and 100 on the left hand scale, respectively. Note that the (MULTIPLIER) knob pointer is in the general vicinity of the 1.0 on the scale.

Step 2: Apply the signal under test to the Y INPUT terminal of the same channel. Again depress the CALIBRATOR button (removing the calibrator signal and applying the test signal). By means of the vertical-position control, position the signal under test ON SCREEN and set VOLTS FULL SCALE (RANGE) switch to the position which gives maximum deflection within the scale (four-inch) limits of the screen. *Do not touch or attempt to readjust the (MULTIPLIER) control knob.* If inadvertently moved, go back and reset according to Step 1.

SPECIAL NOTE:

Calibration of the vertical amplifier of the Type 322-A Cathode-ray Oscillograph is effected by the use of the CALIBRATOR push button which disconnects the applied signal and substitutes a line-frequency square wave of precisely 100 mv peak-to-peak. See Block Diagram, next page, showing that the calibrating signal is applied directly to the input of the amplifier, so that when the (MULTIPLIER) amplifier sensitivity control is set to produce 4 inches (full scale) deflection with the calibrating signal applied, the Y-axis amplifier functions as a volt-meter having a sensitivity of 100 mv full scale. The input attenuator provides alternative sensitivities of 1 volt, 10 volts and 100 volts full scale. Intermediate sensitivities may be obtained by making use of the (MULTIPLIER) control. For example, if it is adjusted so that the 100 mv signal gives half scale (2 inches) deflection, the basic sensitivity will be 200 mv full scale and the (MULTIPLIER) scale will read approximately 2. This gives an alternative way of using the instrument.



AMPLITUDE CALIBRATION SYSTEM—BLOCK DIAGRAM

Step 3: Now, position the trace so that the negative peak just touches the line at 0 on the left scale. Note the deflection in terms of units from 0 to 100 as read off the scale at the left. The peak-to-peak voltage is the reading from the scale divided by 100 and multiplied by the VOLTS FULL SCALE (RANGE) switch setting. As an example, suppose the scale reading is 65 and the VOLTS FULL SCALE (RANGE) switch is on position 10. The actual peak-to-peak voltage of the waveform would be 65/100 times 10 or 6.5 volts.

(2) FOR SIGNALS GREATER THAN 100 VOLTS PEAK-TO-PEAK

For signals of greater than 100 volts amplitude (peak-to-peak), it will be necessary to position the (MULTIPLIER) control knob in another position than 1.0. This will necessitate a somewhat different calibrating procedure, as follows:

Step 1: With the signal applied to the Y input terminal, set the VOLTS FULL SCALE (RANGE) switch at 100 and adjust the (MULTIPLIER) control for a suitable deflection on the screen—preferably near full scale.

Step 2: Depress the CALIBRATOR button, to apply the calibrator test signal and remove the signal under test. Note the scale marking nearest the pointer of the (MULTIPLIER) control knob. Take its reciprocal (i.e. 1/no.) and multiply by 100. Now readjust the multiplier control slightly, as required, until this screen deflection is obtained. As an example, suppose the (MULTIPLIER) knob points approximately to 1.5. It should be adjusted to give a vertical deflection on screen (using the left hand scale) of

$\frac{1}{1.5}$ x 100 or 66-2/3 units.

storing the signal under test to the screen. Position the

Step 3: Again depress the calibrator button, resignal as mentioned above in "Step 3" and read peak-to-peak amplitude directly from left hand scale. Divide reading obtained by 100 and multiply by the product of the VOLTS FULL SCALE (RANGE) switch position and the (MULTIPLIER) setting. This gives the actual voltage of the waveform under test.

With little practice, quick and accurate readings of signal voltages having amplitudes from approximately 0.005 volts (5 millivolts) to 1,000 volts may be obtained. It should be noted that an auxiliary scale is provided at the right side of the screen for measuring peak amplitudes of symmetrical signals. Use of this scale is self-evident.

d. SYNCHRONIZATION OF SWEEP

(1) RECURrent SWEEP

As a general rule, it is most satisfactory to employ INTernal SYNC. Low-amplitude signals applied to the Y INPUT terminals are thus amplified sufficiently before application to the sync circuits to produce stable synchronization of the sweep generators. Provision is also made for EXTernal sync, which is useful particularly in those cases where varying amplitudes of the same waveform are to be viewed in rapid succession. LINE-frequency sync is provided particularly as a convenience in synchronizing line-frequency signals applied direct to deflection plates, in noting phase shifts of line-frequency signals with respect to power line and as an aid in synchronizing line-frequency signals of low-amplitude or having a high noise content.

The proper manner of sync adjustment is as follows:

(a) Set the X-SELECTOR at RECUR SWEEP

(b) Set the SYNC (SELECTOR) at EXT, INT or LINE depending upon the signal to be synchronized as discussed above.

(c) Set the SYNC (AMPLITUDE) control at "O".

(d) Adjust the SWEEP (RANGE) switch and SWEEP (VERNIER) control to obtain the desired number of cycles of the signal on the screen and to stop the travel of the pattern as nearly as possible.

(e) Rotate the SYNC (AMPLITUDE) control either clockwise or counterclockwise to lock the pattern stationary depending upon whether it is desired to have

the beginning of the trace positive going or negative going, respectively.

(2) DRIVEN SWEEP

The DRIVEN SWEEP mode is generally employed for viewing random or aperiodic signals or periodic signals having a low-duty cycle. When operating the instrument in this manner, one excursion of the sweep occurs for each signal impulse or multiple thereof. To operate in this mode, proceed as follows:

(a) USING INTERNAL SYNC

1. Set SYNC (SELECTOR) at INT, SYNC (AMPLITUDE) at "0", X SELECTOR at OFF, and advance the X (AMPLITUDE) control approximately 1/4 turn. If necessary, position the beam to center of screen.

2. Apply signal to be observed to Y INPUT terminals, and adjust the (MULTIPLIER) control for at least 1 inch of vertical deflection.

3. Place the X SELECTOR in DRIVEN position, and rotate the SYNC (AMPLITUDE) control until a steady sweep is observed. The setting of the SYNC (AMPLITUDE) control may be critical.

4. Adjust SWEEP (RANGE) switch and SWEEP (VERNIER) control until, with periodic input signals, a steady pattern is obtained having the desired number of cycles appearing; or, with aperiodic or low-duty cycle signals, the complete waveform appears on the sweep.

5. Adjust the (X) POSITION AND X (AMPLITUDE) controls, if necessary, to obtain the desired portion of the trace on screen.

(b) USING EXTERNAL SYNC

When very high-frequency signals are to be observed, it may be helpful to resort to EXTernal SYNC to avoid erratic triggering of the sweeps. For EXTernal SYNC operation, proceed as follows:

1. Set SYNC Selector at EXT and all other controls as described under "Using Internal Sync."

2. Apply the EXT SYNC signal by connecting a test lead between the Y INPUT and EXT SYNC front-panel terminals; or, for most effective triggering from non-sinusoidal signals, apply the sync signal through a differentiating network having a time constant of approximately 10% of the period of the signal employed. For details of the differentiating circuit, see Figure 2-2.

NOTE

External synchronizing signals of approximately 5 volts or greater amplitude, when applied to the EXT SYNC terminals of one beam, may couple into the sync circuit of the other beam. Too large a sync signal should be avoided in such instances.

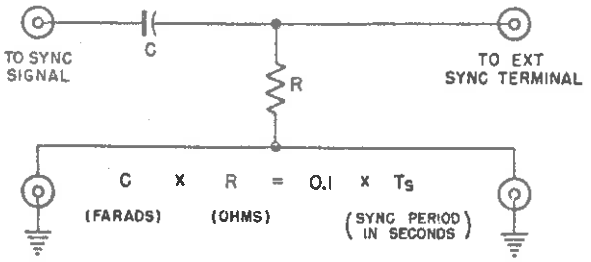


FIGURE 2-2. DIFFERENTIATING CIRCUIT FOR USE IN ESTABLISHING STABLE DRIVEN SWEEP

(3) OBTAINING LOW-FREQUENCY SWEEPS

Provision is made for connecting external capacitors to the SAWTOOTH terminals on the front panel to obtain lower-frequency sweeps than provided for in the instrument. In all positions of the SWEEP (RANGE) switch except EXT CAP a sawtooth waveform of approximately 5 volts amplitude is available at the SAWTOOTH terminal. The lowest sweep frequency obtainable without resorting to external capacitors is 2 cycles per second. For lower frequency sweeps, proceed as follows:

(a) Set the SWEEP (RANGE) switch (See Figure 2-1) to EXT CAP, and position the SWEEP (VERNIER) fully counterclockwise.

(b) Connect an external capacitor for the sweep duration desired (as determined from Table 2-2) between the SAWTOOTH and ground terminals. The SWEEP (VERNIER) may be employed to vary the sweep frequency over a limited range.

TABLE 2-2

EXTERNAL CAPACITORS FOR LOW-FREQUENCY SWEEPS

Sweep Frequency	*Sweep Duration*	*External Capacitance* Required*
1 cps	1 second	2 μf
0.5 cps	2 seconds	4 μf
0.25 cps	4 seconds	8 μf
0.1 cps	10 seconds	20 μf

* Capacitors having high leakage resistance (such as paper or plastic types) must be employed. 20 μf is highest capacitance value which can normally be used without experiencing erratic operation.

e. DIRECT CONNECTION TO DEFLECTION PLATES

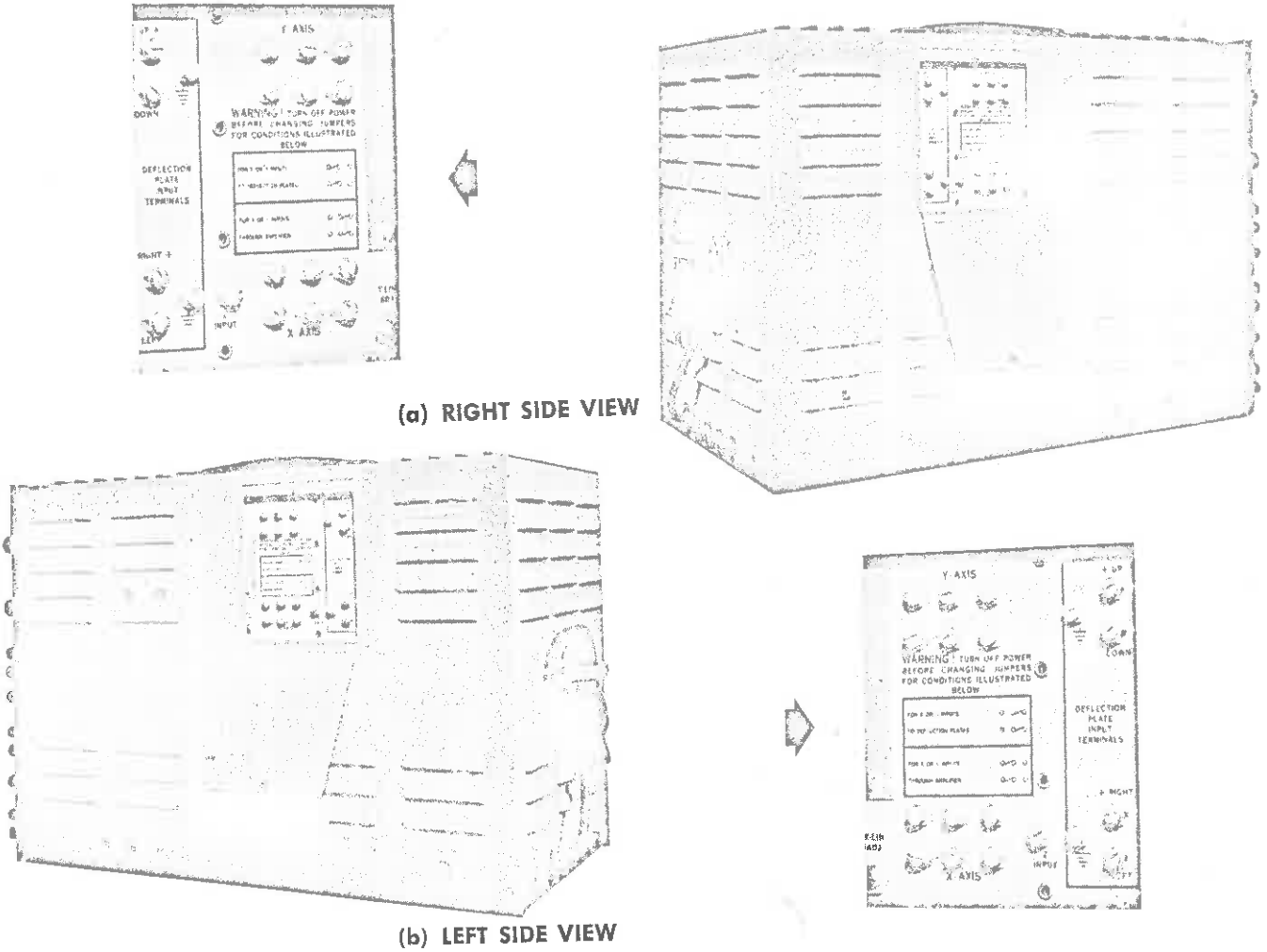
Figure 2-3 shows the location and identification of the terminals provided for making direct connection to the deflection plates. To make connections, follow the instructions given on the terminal boards. It will be necessary to move the jumpers from the "amplifier" position to the "direct input" position as indicated and to connect the signal to be observed to the appropriate UP, DOWN, LEFT or RIGHT terminals. Provision is made for balanced or single-ended inputs. For single-ended input, connect a jumper from input terminal to ground. The designations, UP, DOWN, LEFT and RIGHT denote for each terminal the direction of deflection resulting from the application of a positive-going signal thereto.

— WARNING —

Turn Power Off before making any connections to the side terminal boards. Some of these terminals are approximately 200 volts dc above ground.

To avoid any possibility of cross-coupling effects, it is suggested that, when connecting a signal direct to deflection plates, the corresponding channel controls (VOLTS FULL SCALE or X SELECTOR) be switched to OFF.

When applying signals direct to deflection plates as outlined above, the highest-frequency signal that can be observed is not limited by the response of the built-in amplifiers but is dependent only upon the input capacity to the deflection plate terminals and/or transit time of the electrons between the deflection plates. Provided the impedance of the signal source is kept low, transit time is the only consideration. It should be remembered, however that no amplification or attenuation is provided on "direct input" and that approximately 40 peak-to-peak volts are required to produce an inch of beam deflection vertically and approximately 45 peak-to-peak volts for one inch of deflection horizontally.



(a) RIGHT SIDE VIEW

(b) LEFT SIDE VIEW

FIGURE 2-3. LOCATION AND IDENTIFICATION OF SIDE-PANEL TERMINALS

Due to the continued improvement of this instrument, minor relocation of certain components may have occurred as this book went to press; thus, this photograph may not be representative of all models.

TABLE 2-3

BACK-OF-PANEL TERMINALS

(Accessible Through Side-panel Doors)

Name of Terminal	*Reference Symbol*		*Function*
	Channel A	*Channel B*	
Z INPUT	J701	J720	Provides for connection of external signals to intensify modulate the trace.
DEFLECTION PLATE INPUT TERMINALS UP and DOWN	J107 J111	J607 J611	Provides for connection of signals to vertical deflection plates direct (through capacitor).
DEFLECTION PLATE TERMINALS RIGHT and LEFT	J306 J310	J406 J410	Provides for connection of signals to horizontal deflection plates direct (through capacitor).
Y AXIS	J104 J105 J106 J108 J109 J110	J604 J605 J606 J608 J609 J610	Provides "Direct" or "Through Amplifier" connection of vertical deflection voltages.
X AXIS	J302 J303 J304 J305 J307 J309	J402 J403 J404 J405 J407 J409	Provides for "Direct" or "Through Amplifier" connection of horizontal deflection voltages.

The direct connection to deflection plates in no way affects the beam positioning feature available when passing the signal through the built-in amplifiers. Since the deflection plates themselves are maintained at approximately 200 volts dc with respect to ground, it is generally impossible, if not undesirable, to make direct connection without the intervening isolation capacitors. If removal of a dc component in the signal under test is a disadvantage, any such signal may be applied through the built-in dc amplifiers by connection to the input terminals on the front panel; provided, of course, that the frequency components of the signal are in the frequency range of the amplifiers.

f. INTENSITY MODULATION

The Z INPUT terminals (See Figure 2-3) are provided for the connection of external signals to modulate the beams. Positive pulses at the Z INPUT terminal brighten the beam, negative pulses dim or blank it. A negative pulse of from 2 to 56 volts peak, depending on the INTENSITY setting, will be required to blank the beam.

5. SPECIAL TECHNIQUES

a. USE OF BALANCED INPUT

By removing the jumper between the Y INPUT terminals and ground, it is possible to feed a balanced-input signal to the respective vertical amplifier. No attenuation is provided on balanced input; however, the operator may find this feature extremely convenient for various applications. The following explanation of the balance-input feature may help the operator to determine when this type of operation may be useful or desirable.

If there is an in-phase signal applied to both inputs (known as a "common-mode" signal) superimposed on the balanced-input signal, the maximum input signal (dc plus peak signal ac) will be accordingly reduced.

One of the features of the balanced-input circuit is the differential action of the first stage in the Y amplifier. This circuit makes it possible to reject to a considerable degree

any common-mode signal while at the same time passing and amplifying the balanced-input signal. Thus, if there is any pickup of noise on test leads or in the equipment under test, such noise will be reduced materially on passing through the balanced-input circuit of the Type 322-A. The waveforms shown in Figure 2-4 illustrate the advantage of the balanced-input connection over the single-ended in such cases. In this figure, a test signal on which a "nuisance" signal is superimposed is shown on the cathode-ray tube screen when the signal is applied to the unbalanced input of the Type 322-A. Then, the same signal with the same "nuisance" voltage riding on it, is connected to the balanced-input connections of the Type 322-A. Note how much greater amplitude of the common-mode signal appears with the unbalanced-input connection.

To adjust for the best rejection of the unwanted common-mode signal, remove the jumper from the lower Y INPUT terminal of whichever channel is being adjusted. Jumper the two Y INPUT terminals, and connect a 1-volt signal between the Y INPUT terminals and ground. Set VOLT FULL SCALE (RANGE) switch at 0.1 DC and the (MULTIPLIER) control fully clockwise. Note the beam deflection produced. Vary the (MULTIPLIER) control for minimum deflection. If this does not reduce the amplitude of the trace to zero, set the (MULTIPLIER) control approximately mid-way and vary the Y D-C BAL screwdriver and adjustment for minimum deflection. (It will be necessary to adjust the (Y) POSITION control as the Y D-C BAL adjustment is being made to keep the beam centered vertically on the screen.) As now adjusted, it should be possible to go through the common-mode null with either the (MULTIPLIER) control or the Y D-C BAL adjustment. Remove the test signal and the jumper,

NOTE: OBSERVATION OF SINGLE-ENDED SIGNALS, AFTER HAVING MADE THESE BALANCED-INPUT ADJUSTMENTS, WILL REQUIRE RESETTING OF THE D-C BAL AND Y POSITION CONTROLS.

and apply signal to be observed between the two Y INPUT terminals.

An alternate method for optimum common-mode rejection, most suitable when setting the (MULTIPLIER) control at a specific point as desired, follows:

1. Adjust the (MULTIPLIER) control for the desired on-screen deflection of the balanced signal.

2. Adjust for common-mode rejection in the following manner:

a. Remove the jumper between the lower Y INPUT terminal of the appropriate channel and ground. Place jumper between the Y INPUT terminals and apply a 1 volt (or less) a-c signal between these terminals and ground.

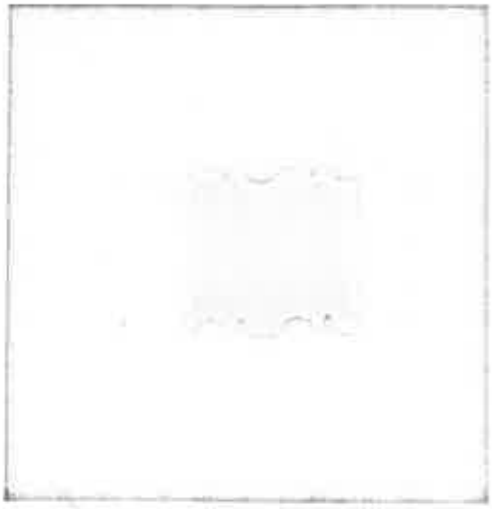
b. Adjust for minimum common-mode signal by means of the Y-DC BALance and (Y) POSITION controls (adjustment of the internal POSition CORRection control may also be necessary).

c. After adjustment for common-mode rejection has been completed, remove the jumper between the Y INPUT terminals and apply the balanced signal.

d. *The (MULTIPLIER) control must not be readjusted.* If a new setting is desired, readjustment for common-mode rejection, as described above, will be required.

When this procedure is followed, balanced signals of up

(a) Test Signal Applied to Balanced Input



(b) Test Signal Applied to Unbalanced Input

FIGURE 2-4. ILLUSTRATING EFFECTIVENESS OF BALANCED INPUT IN ELIMINATING "COMMON-MODE" SIGNALS

to 4 volts peak-to-peak may be applied with (MULTIPLIER) control set at 10 (maximum attenuation of signal). The common-mode signal must not exceed 1 volt for any setting of the (MULTIPLIER) control.

b. X INPUT

In some cases it may be desirable to apply a signal through the X- or horizontal-axis amplifier. If such is the case, connection may be made to the X INPUT terminals. Attenuation of a-c or d-c X INPUT signals by a ratio of 10 may be obtained, if desired. The X-amplifier sensitivity at full gain is 0.3 volt (300 d-c millivolts) per inch.

c. Y-AXIS "SWEEP" CONNECTION

For some applications it may be desirable to "sweep" the beam vertically and to apply the signal to be observed to the horizontal axis. This may readily be accomplished by first removing power to the instrument and then removing the X-AXIS jumpers shown in Figure 2-3. Make connections between the appropriate terminals as shown in Figure 2-5 at the side of the instrument. Reconnect power to the instrument. The signal is still connected to the Y-INPUT terminal but will appear as a horizontal deflection.

d. PHOTOGRAPHING OSCILLOGRAMS

Permanent photographic records of oscillograms, with or without the superposition of the calibrated scale, are readily obtainable from the Type 322-A. Since the calibrated scale may be illuminated, the oscillogram and scale can generally be photographed simultaneously. The P-11 screen is preferred for photographing oscillograms, although other screens may be used by allowing somewhat longer exposure times. When using a camera employing a dichroic beam-splitter such as in the Du Mont Recording Camera, the dichroic beam splitter mirror reflects actinic blue light only to the film; therefore, photo-recording from screens over which a yellow filter is superimposed becomes extremely difficult. Removing the yellow filter entirely in such instances is the best practice when recording.

6. AIDS TO OPERATION

a. GENERAL

Du Mont manufactures a number of accessories which increase the usefulness of the Type 322-A. For further information on these accessories refer to the latest Du Mont Catalog or contact the nearest Du Mont representative. A general description of some of the accessories applicable to the Type 322-A is given below.

b. VIEWING HOOD

Viewing hoods to fit the bezel of the Type 322-A are available from Du Mont. The hood excludes ambient light from the screen of the cathode-ray tube and permits the operator to see fast writing rate traces obscured by normal room light.

c. OSCILLOGRAPH-RECORD CAMERAS

Du Mont manufactures a line of oscillograph-record cameras that fall into three general categories: (1) moving film, (2) still, and (3) Polaroid-Land. The moving film cameras have variable speeds such that a signal may be connected to the Y- or vertical-axis amplifiers for display while the film moving across the plane of the cathode-ray tube screen will supply the X or sweep axis. This type of recording is particularly valuable in the study of aperiodic signals. The still cameras will make a permanent reproducible oscillogram of the complete cathode-ray tube screen with recurrent signal displays. This type of recording gives a 35 mm film record of waveforms for file or comparison. The Polaroid-Land cameras have the advantage of furnishing completed oscillograms within a minute of when they are taken. The camera is movable and indexed so that up to 6 or 8 waveforms may be photographed on a single frame for comparison. In conjunction with the above cameras, the standard illuminated scale of the Type 322-A gives a quantitative as well as a qualitative recorded oscillogram.

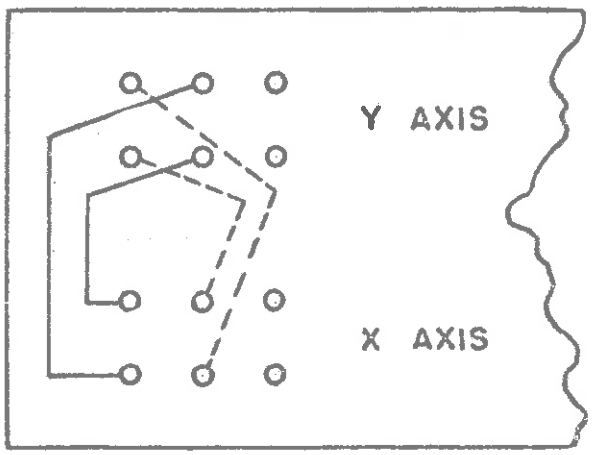


FIGURE 2-5

JUMPER CONNECTIONS FOR Y INPUT SIGNALS PRODUCING HORIZONTAL DEFLECTION (SOLID LINES) AND X INPUT OR SWEEP SIGNALS PRODUCING VERTICAL DEFLECTION (DOTTED LINES)

d. MOVABLE TABLE

Several models of movable tables which are designed for use with cathode-ray oscillographs can be supplied by Du Mont. Movable tables, with a cathode-ray oscillograph mounted thereon, provide a means of taking the oscillograph up to the source of the signal being measured to shorten lead lengths. The movable tables also add portability to the equipment so that it may be moved about more readily.

e. RACK MOUNT ADAPTER

Another accessory that increases the usefulness of the Type 322-A is the rack mount adapter which permits the cathode-ray oscillograph to be mounted semi-permanently in a standard relay rack. The instrument is readily installed or removed from the adapter in a few minutes.

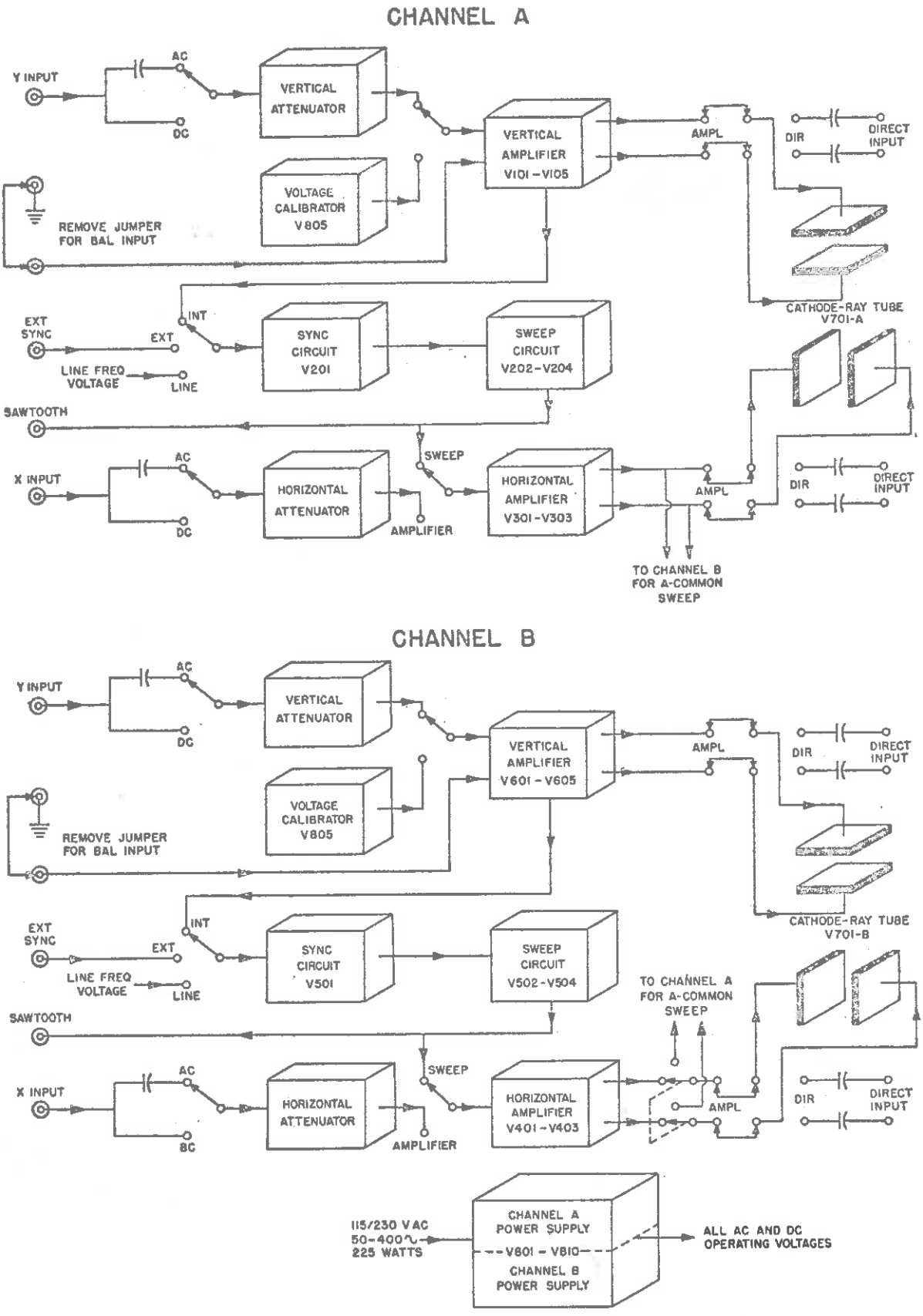


FIGURE 3-1. DU MONT TYPE 322-A, BLOCK DIAGRAM