Beckman Industrial™

CIRCUITMATE™ 9020
20 MHz Oscilloscope

OPERATOR'S MANUAL

ADDENDUM No. 1

PARA. 4.2.1.

GENERAL Please allow your oscilloscope to warm up for at least 30 minutes before performing the initial setup procedure.

ITEM 6. Set CH1-POS control to display the CAL waveform centred on the screen as shown in figure 4-1. The resultant deflection should be four divisions (+/–5%).

NOTE: Initial component drift may cause this parameter to be slightly off. This may be easily corrected by adjusting the "Y GAIN" control accessed from the underside of the oscilloscope cabinet. There is a control for channel 1 & one for channel 2.

NOTE: THIS ADJUSTMENT SHOULD BE MADE WITH A NON-CONDUCTIVE ALIGNMENT TOOL.

ITEM 11. Set VOLT/DIV to 5mV/DIV and the DC-GND-AC Switch to the GND position. Centre the trace with the CH1-POS control and rotate the amplitude VAR to the CAL position. The trace should remain in the centre. This is the "DC BALANCE" and there should be no more than .2 divisions shift.

NOTE: Initial component drift may cause this parameter to be slightly off. This may be easily corrected by adjusting the "DC BALANCE" control accessed from the underside of the oscilloscope cabinet. There is a control for channel 1 & channel 2.

If adjustment is necessary,centre the trace with the position control, rotate the amplitude VAR again to the full clockwise position. Adjust the DC BALANCE control to return the trace to the centre of the graticule. Due to interaction between controls, it may be necessary to repeat the procedure one or more times.

NOTE: THIS ADJUSTMENT SHOULD BE MADE WITH A NON-CONDUCTIVE ALIGNMENT TOOL.

ONE YEAR LIMITED WARRANTY

Each Beckman Industrial Corporation oscilloscope, excluding probes, is warranted against any defects of material or workmanship which develop within a period of one (1) year following the date of purchase of the oscilloscope by the original purchaser. This warranty is extended by Beckman Industrial Corporation only to the original purchaser of the oscilloscope, who must, as a CONDITION PRECEDENT TO WARRANTY COVERAGE AND PERFORMANCE THEREUNDER BY BECKMAN INDUSTRIAL CORPORATION, complete and return the Warranty Registration Card, received on purchase of the oscilloscope.

In the event a defect develops during the warranty period, Beckman Industrial Corporation will, at Beckman Industrial Corporation's election, repair or replace the oscilloscope with a new or reconditioned equivalent model, without charge for parts or labor. In order to obtain performance of any obligation of Beckman Industrial Corporation under the warranty, the original purchaser must notify Beckman Industrial Corporation Customer Service Department at (714) 773-6886 of the defect, obtain a Return Authorization Number and receive instructions on where to return the defective product for the performance of service. In the event the oscilloscope must be returned, it must be sent postage prepaid, along with a handling charge of $10 to an authorized Beckman Industrial Corporation Service Center.

In the event of replacement with a new or reconditioned model, the replacement unit will continue the warranty period of the original oscilloscope for six (6) months after the date of repair, whichever is longer.

This warranty shall not apply to any defect, failure or damage caused by improper use or improper or inadequate maintenance or care. Beckman Industrial Corporation shall not be obligated to furnish service under this warranty a) to repair damage resulting from attempts by personnel other than Beckman Industrial Corporation representatives to install, repair or service the product; b) to repair damage resulting from improper use; c) to service a product that has been modified or integrated with other products when the effect of such modification or integration increases the time or difficulty of servicing the product.

ANY IMPLIED WARRANTIES ARISING OUT OF THE SALE OF THE BECKMAN INDUSTRIAL CORPORATION OSCILLOSCOPE, INCLUDING BUT NOT LIMITED TO IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, ARE LIMITED IN DURATION TO THE ABOVE-STATED ONE (1) YEAR PERIOD. BECKMAN INDUSTRIAL CORPORATION SHALL NOT BE LIABLE FOR LOSS OF USE OF THE OSCILLOSCOPE OR OTHER INCIDENTAL OR CONSEQUENTIAL DAMAGES, EXPENSES, OR ECONOMIC LOSS OR FOR ANY CLAIM OR CLAIMS FOR SUCH DAMAGES, EXPENSES, OR ECONOMIC LOSS.

Some states do not allow limitations on how long implied warranties last or the exclusion or limitation of incidental or consequential damages, so the above limitations or exclusions may not apply to you.

Operator's Manual 3000-940-189A
November 1985

OPERATOR'S MANUAL

CIRCUITMATE™ 9020

20 MHz Oscilloscope

BECKMAN INDUSTRIAL CORPORATION
A subsidiary of Emerson Electric Company

Instrumentation Products Division
Brea, CA 92621

SPECIAL SAFETY PRECAUTIONS

Observe the following safety precautions during oscilloscope operation. BECKMAN INDUSTRIAL CORPORATION assumes no responsibility for the operator's failure to either comply with instructions given in this manual or in the following special precautions.

INSTRUMENT GROUNDING

To minimize shock hazard, the instrument must be connected to a three-wire electrical power system. This instrument is equipped with a three-conductor AC power cord. DO NOT connect the instrument to or operate the instrument from an electrical outlet that is not grounded. It is advisable not to use power cord adapter plugs. If this is necessary, plug power cord into a three-contact to two-contact adapter with the ground wire (green) firmly connected to an electrical ground (safety ground) at the power outlet. The power cord and AC outlet of this instrument meet International Electrotechnical Commission (IEC) safety standards.

To avoid any ELECTRICAL HAZARDS, it is recommended for safety that an isolation transformer be connected between the AC power source and the oscilloscope.

OPERATING IN AN EXPLOSIVE ATMOSPHERE

DO NOT operate instrument in the presence of flammable materials -- possible explosion hazard. Operation of this instrument in such as environment represents a definite safety hazard.

KEEPING AWAY FROM LIVE CIRCUITS

Operating personnel should not remove instrument covers. Component replacement and internal adjustments are best accomplished by an authorized Beckman Industrial Service Center.

For service personnel: DO NOT replace components with power cord connected. Dangerous high voltages may exist even with the power cord disconnected. To avoid injuries, always disconnect power and discharge circuits before attempting to perform any servicing other than live circuit testing or calibration.

Do not attempt oscilloscope adjustments or alignment while alone. Instead, insist on the presence of another person with the capability of administering first aid, if needed.

SUBSTITUTING PARTS OR MODIFYING INSTRUMENT

Because of the danger of introducing additional hazards, do not use substitute parts. Instead, use only factory-approved parts and procedures to service this equipment. Of special importance -- NEVER make any unauthorized modifications to the internal or external areas of the oscilloscope.

X-RAY RADIATION NOTICE

X-ray radiation emitted by the Model 9020 Oscilloscope is less than 0.5mR/hr at a distance of five (5) centimeters (12.7 inches) from the cathode-ray tube surface. The instrument is well shielded and meets the safety and health requirements of IEC 348.

X-ray radiation primarily depends on the cathode-ray tube characteristics and associated low voltage and high voltage circuits. Continued safe operation is ensured by periodic adjustment of both low voltage and high voltage power supplies. This is best handled by an authorized Beckman Industrial Service Center. Also be sure that when the cathode-ray tube needs to be replaced, only an identical CRT (Toshiba 150BTB31) is installed.

Notes:

If the 9020 is turned on while the component test button is depressed, it will appear to be "dead." To restore normal operation, press and release the component test button.

CONTENTS

CONTENTS (continued)

1.1 DESCRIPTION

The BECKMAN INDUSTRIAL™ CIRCUITMATE™ 9020 Oscilloscope is rugged, easy-to-operate, highly-reliable, and provides dual-channel operation within the frequency bandwidth of DC to 20MHz at -3db with a maximum sweep time of up to 50 ns/div. Waveforms are accurately presented on the oscilloscope's 150mm rectangular CRT screen with internal graticule.

The instrument provides a multitude of operating features including waveform triggering, sweep delay, single sweep, hold off, and component testing. These plus its ease of operation make the Model 9020 an ideal instrument for diversified types of research, education, production, and development of electronic circuits and equipment.

1.2 MODES OF OPERATION

The Model 9020 Oscilloscope provides operating modes in either single or dual trace. In the single trace mode, it can produce waveforms on either channel (CH1 or CH2).

While in dual trace mode, the ALT, CHOP, or ADD modes of operation can be selected. In the ALT mode, the trigger signal is derived from both channels alternately. In the CHOP mode, the trigger signal is derived from one channel. Finally the ADD mode is used for adding or subtracting the signals on CH 1 and 2 providing differential measurement waveform analysis.

The CH1 (Vertical) and CH2 (Horizontal) have the same input impedance and sensitivity ranges. X-Y waveform analysis is achieved by switching the CH1 signal into vertical deflection circuits and the CH2 signal into the horizontal deflection circuits.

1.3 VERTICAL DEFLECTION

Both vertical input preamplifiers (CH 1 and CH 2) have Dual FET and monolithic integrated circuits to minimize drift caused by environmental conditions. Input attenuators provide 10 steps frequency-compensated RC networks for achieving accurate measurements of displayed waveforms.

Each preamplifier has diode-protected FET input circuits. Input signals are individually switched by diode gates and alternately presented to the final vertical amplifier in either the CHOP mode of operation or the ALT mode of operation. Control for the CHOP mode is achieved by a bistable multivibrator-produced 500KHz square wave. Control in the ALT mode is derived from a sweep generator produced blanking pulses. These pulses are frequency divided in two and applied to switching diode gates.

1.4 TIME BASE

The time base of the oscilloscope has 20 calibrated sweep speeds from 0.1us to 0.2s with a variable control for continuously adjustable sweep rates. The X-POS magnifier control is capable of increasing the displayed sweep rate by a factor of 10.

The HOLD-OFF control alters the hold-off time between sweeps. This is used for triggering aperiodic signals where stable triggering of these complex waveforms cannot be attained with the TRIG LEVEL control alone.

The instrument triggering circuits are highly reliable with sensitivity enough to allow reliable triggering of signals up to 30MHz in frequency and with extremely small amplitudes. The TRIGGER mode can be selected from AUTOmatic Peak-to-Peak Level or NORMal Triggering. TRIGGER COUPLING and SOURCE are multi-function selector switches providing a wide range of options to achieve stable waveforms of very complex signals. A TRIG LEVEL lamp on the front panel flashes to indicate that the trigger circuit has received a trigger signal and the sweep is running.

Single sweep and reset function are used to display non re-occuring events. The TRIG LEVEL lamp indicates in this case that the sweep is awaiting a trigger signal. A simple sweep DELAY selector has 6 decade ranges from 100ns to 0.1s for 100 times expansion of the signal interval.

A NORMAL/SEARCH/DELAY switch selects the sweep mode. The DELAY position allows selection of the proper delay time. A MULTIPLIER control provides precise fine adjustment of time delay interval expansion for continuously shifting starting points. IF the delay function is adjusted properly, it is possible to increase the sweep rate for expanding the desired signal interval.

1.5 AC POWER SOURCE

A power source selector fuse switch is provided on the rear panel. The correct fuse to match primary power source combined with a unique primary power selector arrangement is used to modify the power input circuit to accept a multitude power input ac voltages (refer to paragraph 2.2.1).

1.6 PERFORMANCE INSTRUMENT CHARACTERISTICS AND SPECIFICATIONS

Table 1-1 lists the performance characteristics and specifications for the Model 9020 Oscilloscope.

TABLE 1-1. PERFORMANCE CHARACTERISTICS AND SPECIFICATIONS

GENERAL:

Cathode Ray Tube:	150mm Rectangular with 8x10 division internal graticule; Approx. 2KV acceleration potential; Phosphor P31
Trace Rotation:	Corrects trace tilt; adjustment is made on right side of instrument.
Beam Finder:	Returns trace to view regardless of control settings
Z-MOD(EXT BlanKing input)	DC-Coupling, All TTL low level (⩽0.2V)input Signal can blank any intensity trace on CRT display. BlanK Range: 0.2~30V, unblanking Voltage: ⩾0.5V Maximan inpnt Voltage: ±30V (DC+peak AC)Blanking Bandwidth ⩽ 2MHZ
Ramp Output:	Sawtooth wave approx. 5Vp-p
Calibrator:	1KHz (5%), 0.2Vp-p (2%) Square Wave

VERTICAL DEFLECTION

Bandwidth:	DC to 20MHz (-3db)
Risetime:	17.5ns (about)
Overshoot:	< 3%
Calib. Deflection Factor:	10 steps; 5mV/div to 5V/div, 1-2-5 Sequence
Accuracy:	± 3% (10°C to 35°C)
Variable Control:	5:1; max clockwise increases sensitivity five times to 1mv/div, 10MHz(-3dB) approx. 5% error
Input impedance:	1M ohm, 35pf ±5pf, (2%)
Input Max. Voltage:	400V (DC or pos peak AC); 500Vp-p AC at 1KHz or less

TABLE 1-1. PERFORMANCE CHARACTERISTICS AND SPECIFICATIONS (continued)

VERTICAL DEFLECTION (cont.)		
	Operating Modes:	CH1, CH2, CH1 & CH2, ALTernate, CHOPped (Approx. 500KHz)
	Algebraic Addition:	CH1 + CH2; or -CH1 + CH2
	Inverter:	CH1 only
TIMEBASE		
	Deflection Factor:	20 calibrated steps; 0.1us/div to 0.2s/div (1-2-5 sequence); uncalibrated VAR control extends deflection factor to 0.5s/div.
	Accuracy:	Less than 3% (10°C to 35°C)
	Expansion:	X10, Accuracy Less then 5% (0.2us, 0.1us Uncalibrated)
	Single Sweep:	SINGLE - RESET switches with LED
	Holdoff:	10:1, HOLD-OFF variable control increases holdoff time
TRIGGER		
	Triggering Modes:	AUTO (peak) or NORM
	Source:	CH1, CH2, ALT (CH1/CH2), EXT.
	Coupling:	AC, DC, LF, HF
	Slope:	+ or -
	Sensitivity:	Internal 0.5div (20Hz - 20MHz), External 0.5Volts (min)
	Bandwith:	DC - 30MHz
	Trigger Level:	Variable control; level indicated by LED

TABLE 1-1. PERFORMANCE CHARACTERISTICS AND SPECIFICATIONS (continued)

SWEEP DELAY:		
	Ranges:	10, 1, 0.1ms; 10, 1, 0.1us.
	Mode:	Normal, Search, Delay.
	Multiplier:	10 turn variable (X1 to X10)
X - Y OPERATION:		
	X-Y Mode:	Selected by X-Y switch
	Bandwidth:	DC - 2MHz (3dB), Y, CH1; X, CH2
	Phase Shift:	Less than 3^{o}(100KHz)
COMPONENT TESTER:		
	Test Voltage:	8.6Vac (rms) (Max., Open circuit)
	Test Current:	Max. 28mA (shorted)
	Test Frequency:	50Hz/60Hz
	Components:	Capacitor, Inductor, Diode, Transistor, Zener, etc.
AMBIENT OPERATIONAL CONDITIONS:		
	Normal Range:	10^{o} to 35^{o}C; R.Humidity 80% max.
	Limited Range:	0^{o} to 50^{o}C; R.Humidity 80% max.
POWER CONSUMPTION:		Approx. 35 watts
DIMENSIONS:		310 mm (wide); 160 mm (high); 400 mm (deep).
WEIGHT:		9Kg
ACCESSORIES:		Power cord, Operator's Manual Probe (10:1/1:1).

2.1 UNPACKING NEW OSCILLOSCOPE

When the new Model 9020 Oscilloscope is received, carefully inspect unopened shipping container for any signs of damage. If damage has occurred during transit, immediately notify the carrier or dealer of this damage and file a claim. It is usually advisable not to proceed with unpacking the instrument until the carrier and/or dealer are present to view any possible damage to the shipping container. If the oscilloscope is already unpacked, save the original shipping container, so it is available for inspection, if a claim is filed.

If no damage to the shipping containers is found, open the container and remove the oscilloscope and accessories. Check shipping container contents using the inventory list packed with the equipment.

2.2 POWER REQUIREMENTS

The instrument operates on power sources of 110, 120, 220, 240 Vac(rms) $\pm 10\%$; at a frequency of 50/60 Hz single phase.

To minimize shock hazard, the instrument must be connected to a three-wire electrical power system. This instrument is equipped with a three-conductor AC power cord. DO NOT connect the instrument to or operate the instrument from an electrical outlet that is not grounded.

It is advisable not to use power cord adapter plugs. If this is necessary, plug power cord into a three-contact to two-contact adapter with the ground wire (green) firmly connected to an electrical ground (safety ground) at the power outlet.

2.2.1 Selecting Proper Power Input Plug

The power cord and AC outlet of this instrument meet International Electrotechnical Commission (IEC) safety standards. Various configurations used for three-pole power cords are illustrated in Figure 2-1. The number directly above each drawing is the international part code for that power cord. One of the illustrated types is equipped with the instrument. Other plug type (not illustrated) are available as options. Contact your local dealer or Beckman Industrial Corporation for more information.

2.2.2 Checking and Adjusting Instrument for AC Line Voltage

The oscilloscope can operate on any one of the line voltages shown in Table 2-1. To select proper voltage on voltage selector plug proceed as follows:

1. Locate voltage selector plug (Figure 2-2) on rear panel of instrument.

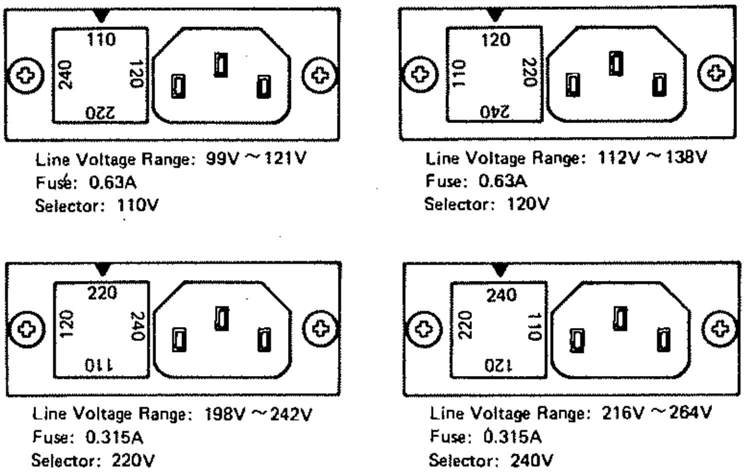


Figure 2-1. Power Plug Types Available for Use with the Instrument

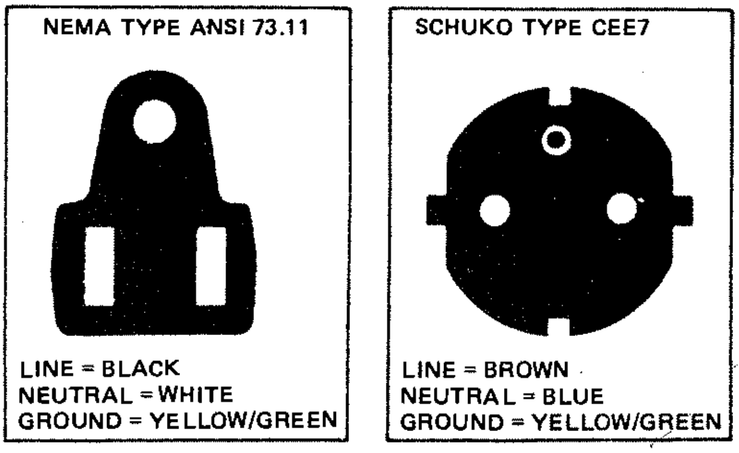


Figure 2-2. Select Proper Line Voltage as Indicated on Voltage Selector Plug

2. Remove ac power cord from receptacle.

3. Locate a small screwdriver insert slot between the power receptacle and the voltage selector plug.

4. Insert blade of small screwdriver into the slot and carefully pry outward until selector plug can be removed with your fingers.

5. Note fuse rating and check it with Table 2-1 for correct rating necessary with the source input power value.

   For example, if you had a source power rating of 125 Vac, 60Hz, then you would select a 630mA fuse and install this fuse in the selector plug. You would then insert selector plug into fuse selector plug receptacle with the "125" located on top and press carefully but firmly until selector plug is flush with surface.

CAUTION

Oscilloscope may not operate or may appear to be defective if voltage selector plug is selected for value not matching ac power input. Be sure to check table on rear of instrument or Table 2-1 for correct fuse rating matching input ac line voltage.

TABLE 2-1. INSTRUMENT OPERATING VOLTAGES

VOLTAGE INDICATED ON SELECTOR PLUG	VOLTAGE TOLERANCE	FUSE
110V	110V - 120V	630mA
125V	112V - 135V	630mA
220V	220V - 240V	315mA
240V	220V - 260V	315mA

2.3 HINTS ON SELECTING OPERATING SITE

Before selecting an operating site, note the following precautions:

- Avoid locating oscilloscope next to air conditioning or heating vents. Sudden changes in cooling or heating can cause adverse temperature changes causing possible drift and unwanted changes in measurement results.
- Avoid locations that can block instrument air vents. Locate oscilloscope in a relatively dust free atmosphere without excessive moisture and corrosive chemicals. Performance may be affected by strong electromagnetic fields that exist near large electric motors, diathermy machines, or microwave sources.
- Do not place equipment next to or in a location that is experiencing excessive vibration that can damage circuit boards and other sensitive internal components.
- Operate instrument within 3-1/2 feet (1.07 meters) of power source so that extension cables are not necessary.

2.4 OPERATING ENVIRONMENT

The normal ambient temperature range of this oscilloscope is 10° to 35°C (50° to 95°F). Operation of the oscilloscope outside of this temperature range may damage sensitive measurement circuits.

2.5 CRT INTENSITY

To protect your eyes from excessive strain while viewing screen, adjust intensity until screen is comfortable to view. This usually prevents eye strain and extends CRT phosphor life. When the oscilloscope is not in use, be sure to turn down the intensity as this also extends life of the CRT phosphor and avoids burning spots on the CRT face.

2.6 OPERATING WITHIN MAXIMUM SIGNAL INPUT LIMITS

The maximum input voltage of each input connector and probe input is shown in Table 2-2. NEVER apply a voltage higher than specified.

TABLE 2-2. MAXIMUM ALLOWABLE SIGNAL INPUT VOLTAGES

INPUT CONNECTOR	MAXIMUM SIGNAL INPUT VOLTAGE
CH1, CH2 inputs	400Vp-p (DC+AC peak)
EXT TRIG input	100Vp-p (DC+AC peak)
Z - Modulation	30Vp-p (DC+AC peak)

2.7 HINTS FOR OPERATING OSCILLOSCOPE

Observe the following suggestions for successful instrument operation:

- NEVER place heavy objects on oscilloscope.
- NEVER operate with input voltages exceeding maximum limits.
- Do not insert wires, pins, or other metal objects into ventilation holes.
- NEVER place a hot soldering iron on or near the cabinet or especially near the CRT screen.
- Do not place a magnet or magnetic generating device near the cabinet.
- Do not move or pull oscilloscope with power cord or input probe cord. Especially never move instrument when power cord or signal input lead is connected to a circuit.

2.8 ADDITIONAL CUSHIONS

Additional instrument foot cushions are packed inside the manual bag. The cushions, if desired, can be permanently attached to the corners of the right side of the oscilloscope.

3.1 FRONT PANEL

Figure 3-1 shows the Model 9020 Oscilloscope front panel operating controls, indicators, and signal input connectors. Table 3-1 lists each of these and gives a brief functional description.

3.2 REAR PANEL

Figure 3-2 shows the rear panel signal input/output connectors and power receptacle. Table 3-2 lists each of these and gives a brief functional description.

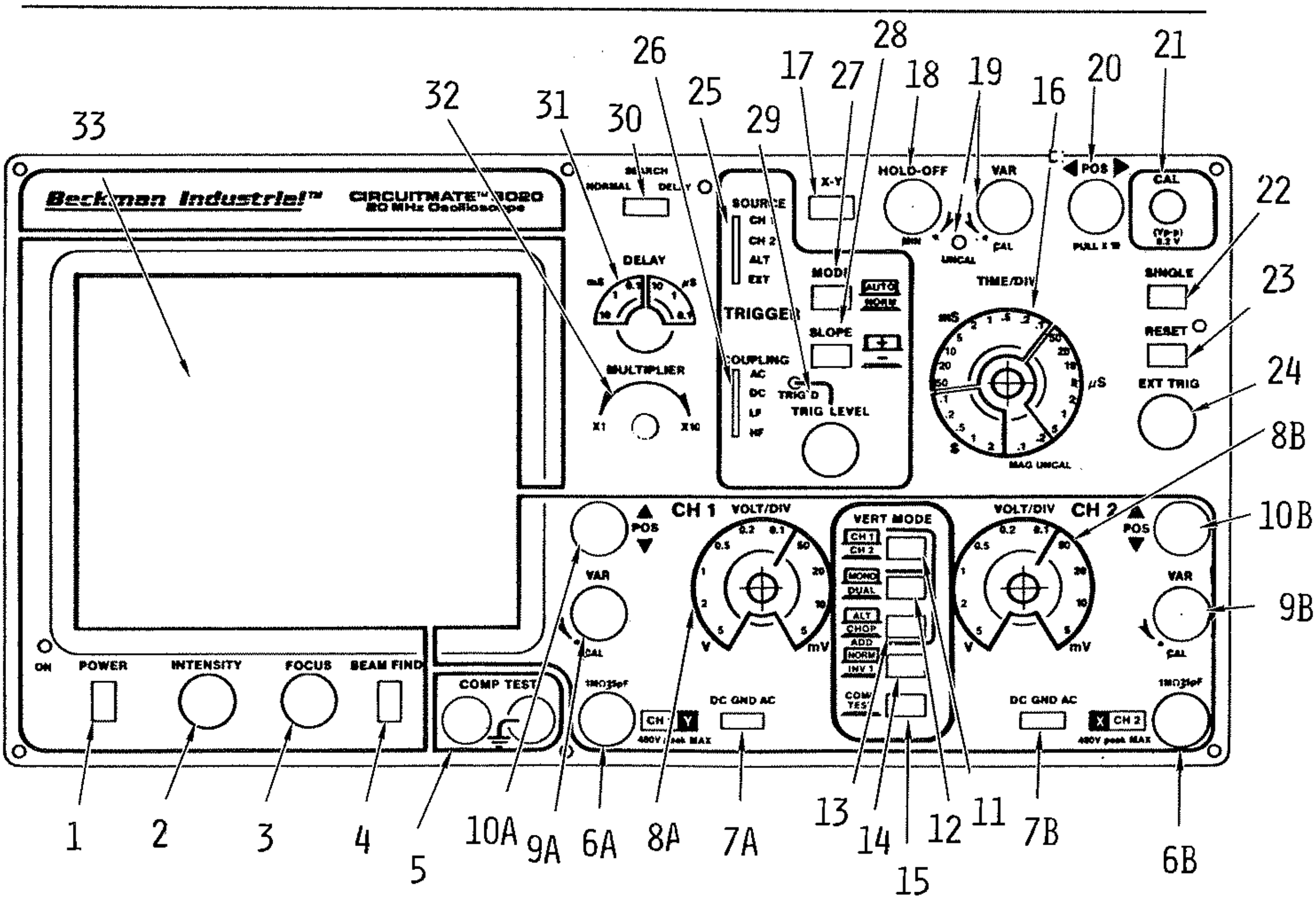


Figure 3-1. Model 9020 Oscilloscope Front Panel

TABLE 3-1. FRONT PANEL CONTROLS, INDICATORS, AND CONNECTORS

1	POWER pushbutton	Turns power on and off. Power ON lamp lights when power is on.
2	INTENSITY control	Controls brightness of display. Clockwise rotation increases brightness.
3	FOCUS control	After obtaining appropriate brightness with INTENSITY, adjust FOCUS for clearest line.
4	BEAM FIND pushbutton	Brings beam trace to center area of screen regardless of location.
5	COMP TEST jacks	Input banana jacks to test component function (refer to item 15).
6A/6B	CH1(Y) / CH2(X) inputs	Input BNC connector for CH1 or CH2 deflection signals. Also provides deflection signal inputs in the X-Y operating mode. Input impedance is 1 megohm paralleled with capacitance of 25 picofarads.
7A/7B	DC/GND/AC switches	Selects following input coupling options for CH1(7A), CH2(7B): DC: dc coupling, all signal are directly connected to attenuator. GND: input signal is switched off and attenuator is grounded. AC: blocks dc signal component allowing only AC signal to pass into attenuator.
8A/8B	CH1/CH2 VOLT/DIV switches	CH1(Y)/CH2(X) attenuator. Selects deflection factor from 5v/div to 5mv/div (1-2-5 sequence, 10 positions). Calibrated deflection with VAR control (9A/9B) in CAL position.

TABLE 3-1. FRONT PANEL CONTROLS, INDICATORS, AND CONNECTORS (continued)

9A/9B VAR controls	Provides continuously variable uncalibrated deflection between calibrated setting of VOLT/DIV switch. In counter-clockwise CAL position, to maximum clockwise increase sensitivity five times.
10A/10B CH1/CH2 POS controls	Sweep position adjustment for CH1 or CH2. In X-Y mode of operation, CH1 POS controls y-axis (vertical), and POS controls x-axis (horizontal) positioning.
11 CH1,CH2 pushbutton	Selects CH1 or CH2 vertical operation, released pushbutton is CH1 operation and pressed is CH2.
12 MONO,DUAL pushbutton	Selects trace mode of operation. Released (MONO) single trace. Pressed (DUAL) both traces.
13 ALT,CHOP,ADD pushbutton	Provides three operating modes: Pressed (CHOP) mode (all other push buttons in VERT MODE released) derives trigger signal from only one channel. Released (ALT) mode, trigger signal is derived from both channels alternately. Pressed (CHOP) ADD mode; with CH1,CH2 in (CH1) and MONO,DUAL in (MONO) (all other push buttons in VERT MODE released). Used to add or subtract CH1 and CH2 signals providing differential measurement waveform analysis.
14 NORM,INV 1 pushbutton	Selects CH1 operation in normal (released mode) or INV 1 (inverted form). This combined with ALT/CHOP pushbutton (13) can add or subtract input signals.

TABLE 3-1. FRONT PANEL CONTROLS, INDICATORS, AND CONNECTORS (continued)

15 COMP TEST pushbutton	When pressed, tests: FETs, transistors, diodes, Zener diodes, inductors, transformers, capacitors, etc, connected between COMP TEST jacks (5). Characteristic traces of various components are listed in Section Four, Figure 4-4.
16 TIME/DIV switch	Twenty three positions ranging from: 2 sec/div to 0.1 us/div in 1-2-5 sequence.
17 X-Y pushbutton	Pressing applies vertical signal to the CH1(Y) input connector. Vertical screen positioning is controlled by CH1 POS control.
18 HOLD OFF control	Controls hold-off time between sweep signals to obtain stable display when triggering an aperiodic signal. The control hold off time ranges from 1 to 10 times timebase.
19 VAR control	Provides continuously variable sweep rate by a factor of 2.5. UNCAL lamp is turned on when VAR control is not in CAL position.
20 POS (PULL X 10) control	Positions the display horizontally. Pulling control out increases the displayed sweep rate by a factor of 10.
21 CAL output test signal	Provides a 1 KHz, 0.2Vp-p squarewave for testing oscilloscope and for calibrating voltage and probe freq. compensation.

TABLE 3-1. FRONT PANEL CONTROLS, INDICATORS, AND CONNECTORS (continued)

22	SINGLE pushbutton	Provides single sweep function after a sweep is displayed. Further sweeps can not be presented until RESET pushbutton is pressed. An LED lamp to the right of pushbutton comes on to indicate that single sweep is triggered.
23	RESET pushbutton	In SINGLE sweep mode (22), the sweep is triggered then pressing this pushbutton resets to single sweep operation, and LED lamp goes out.
24	EXT TRIG imput jack	For introducing an external signal for use as a trigger signal. TRIGGER SOURCE switch must be in EXT position for external trigger signal to work.
25	TRIGGER SOURCE switch	Four position switch: CH 1: A sample of signal derived from CH1 input connector is used as a trigger signal. CH 2: A sample of signal derived from CH2 input connector is used as a trigger signal. ALT: Alternative trigger which can trigger channels 1 and 2 alternately. Function is used in alternative dual trace, during vertical mode operation. EXT: Trigger signal is obtained from EXT TRIG connector.

TABLE 3-1. FRONT PANEL CONTROLS, INDICATORS, AND CONNECTORS (continued)

26 TRIGGER COUPLING switch	Four position switch: AC: Rejects dc and attenuates signals below 100Hz, accepts signals above 100Hz. DC: Accepts all trigger signals from DC to 20MHz or greater. LF: Accepts low frequency signals below about 10Hz. HF: Accepts signals above 10Hz.
27 TRIGGER MODE pushbutton	Chooses trigger type: AUTO: Automatically operates trigger action. Trigger level is obtained from trigger signal peak-to-peak value. TRIG LEVEL control is adjusted to a level within peak range of signal. NORM: Trigger level range is obtained from +5v to -5v by adjusting TRIG LEVEL control.
28 TRIGGER SLOPE pushbutton	Selects triggering slope: "+" Triggering occurs when trigger signal crosses trigger level in a positive-going direction. "-" Triggering occurs when trigger signal crosses trigger level in a negative-going direction.

TABLE 3-1. FRONT PANEL CONTROLS, INDICATORS, AND CONNECTORS (continued)

29 TRIG LEVEL control	Used to select a level within signal peak range from which the sweep can be triggered at a proper input signal starting edge. When sweep operates, TRIG'D lamp comes on.
30 NORMAL, SEARCH, DELAY switch	NORMAL: Selects main sweep functions. LED lamp (at right of switch) is off. SEARCH: Searches for a point at which the sweep will be delayed. LED lamp flashes. DELAY: - Used in conjunction with DELAY switch whereby delayed signal is displayed by increasing sweep rate of timebase. LED lamp stays on.
31 DELAY switch	Selected delay time after trigger point.
32 MULTIPLIER control	Provides continuously variable delay time after trigger point.
33 CRT display	150mm rectangular screen with internal graticule 8 x 10 div and blue filter placed in front of CRT.

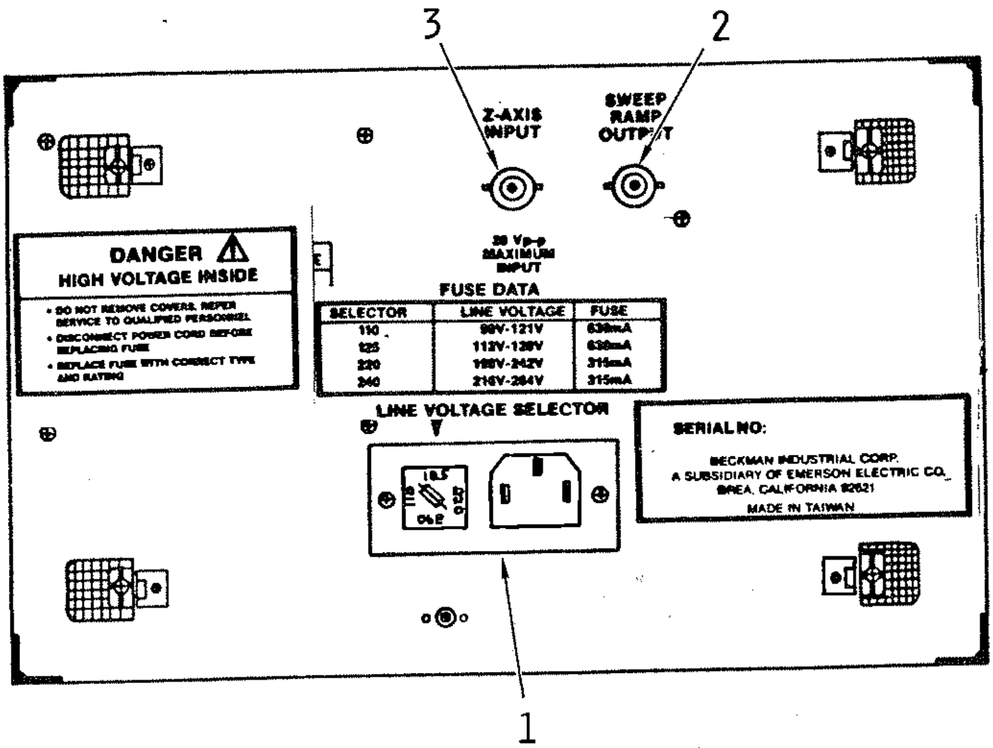


Figure 3-2 Model 9020 Oscilloscope Rear Panel Connectors

TABLE 3-2. REAR PANEL CONNECTORS

1	POWER RECEPTACLE AND FUSE HOLDER	Receptacle for AC power input. Fuse Holder is used as a power source selector.
2	S - output connector	Provides ramp (sawtooth wave) output about 5Vp-p, which is internal sweep signal.
3	Z - modulation connector	Input terminal for external intensity modulation signal.

4.1 INITIAL PREPARATION FOR USE

Before attempting to operate your new oscilloscope, perform the following procedure:

1. Verify that voltage selector block is in correct position with proper voltage displayed in top position on selector (refer to paragraph 2.2.2 in Section Two).

2. Insert power plug into receptacle on rear panel.

3. Place all pushbutton switches on front panel in out (released) position, except DUAL/MONO switch in VERT MODE pushbutton group to DUAL position (pushed in).

4. Set front panel controls to positions as indicated below:

   - INTENSITY fully counter-clockwise.
   - TRIGGER SOURCE to ALT.
   - CH1 and CH2 amplitude VAR to CAL.
   - DC/GND/AC to GND.
   - CH1-POS and CH2-POS to midrange.
   - TIME/DIV to .5ms/DIV.
   - NORMAL/SEARCH/DELAY to NORMAL.
   - Sweep VAR to CAL.
   - TRIGGER AUTO/NORM to AUTO.

5. Plug power cord into ac power outlet. Press red POWER on pushbutton in; power ON lamp comes on.

6. Adjust INTENSITY control for comfortable view of traces. If base lines are not found, press BEAM FIND button to locate traces and adjust CH1/CH2 POS controls and horizontal POS control to center traces on CRT display.

7. Now proceed to paragraph 4.2 to checkout the functional operation of the instrument.

4.2 CHECKING OSCILLOSCOPE OPERATION

Before using the new oscilloscope, be sure to go through the procedures in this paragraph to help familiarize yourself with the front panel controls and features of the Model 9020 Oscilloscope. Also any time that you wish to check instrument operation, it is a good idea to do this procedure because it functionally checks each display mode and operation of the front panel controls. The instrument can be operated in these procedures without the need of additional test equipment by using the front panel CAL (0.2V, 1KHz) output as a signal source.

4.2.1 Individual Channel Checkout Procedure

1. Adjust front panel controls as follows:

   CHANNEL 1
   - VOLT/DIV . . .50mV/DIV
   - DC-GND-AC . . .AC
   - VAR . . . . . .CAL
   - CH1-POS. . . . Center
   - VERT MODE. . . (all pushbuttons to out)

   TIME BASE
   - POS. . . . . Center (pushed in)
   - Sweep VAR. . . . . CAL
   - TIME/DIV 0.5ms/DIV
   - HOLDOFF. . . . . MIN
   - SINGLE . . . . OUT
   - NORMAL/SEARCH/DELAY . . .NORMAL

   TRIGGER
   - MODE . . . . . AUTO
   - SLOPE. . . . . + (PLUS)
   - TRIG LEVEL . . Center
   - SOURCE . . . . CH 1
   - COUPLING . . . AC

2. Press Power ON and set INTENSITY and FOCUS controls for desired baseline display.

3. Apply CAL voltage output directly to CH1 vertical input.

4. Adjust TRIG LEVEL for stable display. Also adjust X-POS for sweep baseline starting at first graticule line.

5. Verify six pulses with leading edge of first and sixth pulse on first and eleventh vertical graticule lines, respectively ($\pm$10%), as shown in Figure 4-1.

6. PLEASE REFER TO ADDENDUM No. 1

7. Rotate sweep VAR control clockwise to stop. Verify 12 or more pulses between first and eleventh graticule lines. Then move to CAL position.

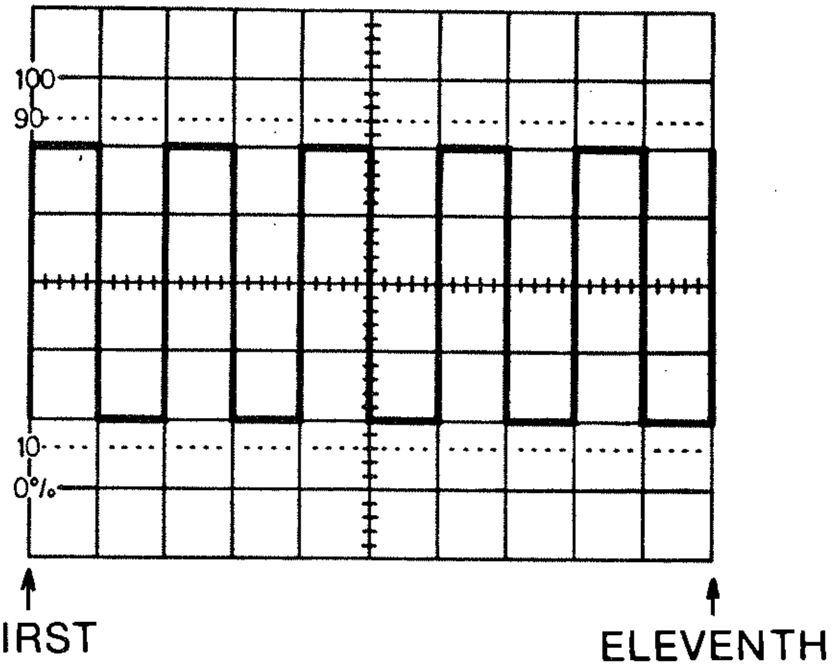


Figure 4-1. Six Leading Edges Shown with First and Eleventh on Graticule Lines

8. Set VOLT/DIV to 0.2V/DIV. Verify vertical amplitude in one division on screen.

9. Rotate amplitude VAR control clockwise to stop.

10. Verify amplitude of five divisions (±10%). The amplitude VAR control increases sensitivity five times.

11. PLEASE REFER TO ADDENDUM No. 1

12. Adjust TRIG LEVEL control fully clockwise. Then, press in AUTO/NORM switch to NORM (TRIG LED goes off) and verify no sweep.

13. Press in SINGLE pushbutton, RESET indicator goes on and stays on.

14. Press RESET pushbutton switch, Verify no sweep.

15. Rotate TRIG LEVEL fully counter-clockwise.

16. Verify one sweep, RESET indicator goes off after sweep.

17. Set AUTO/NORM switch to AUTO and TRIG LEVEL to center position.

18. Press RESET pushbutton. Verify one sweep.

19. Disable SINGLE sweep (SINGLE switch in out position).

20. Set NORMAL/SEARCH/DELAY switch to SEARCH position (LED lamp flashes).

21. Select DELAY time switch to lms.

22. Verify that portion of displayed trace on left screen is blanked, as shown in Figure 4-2.

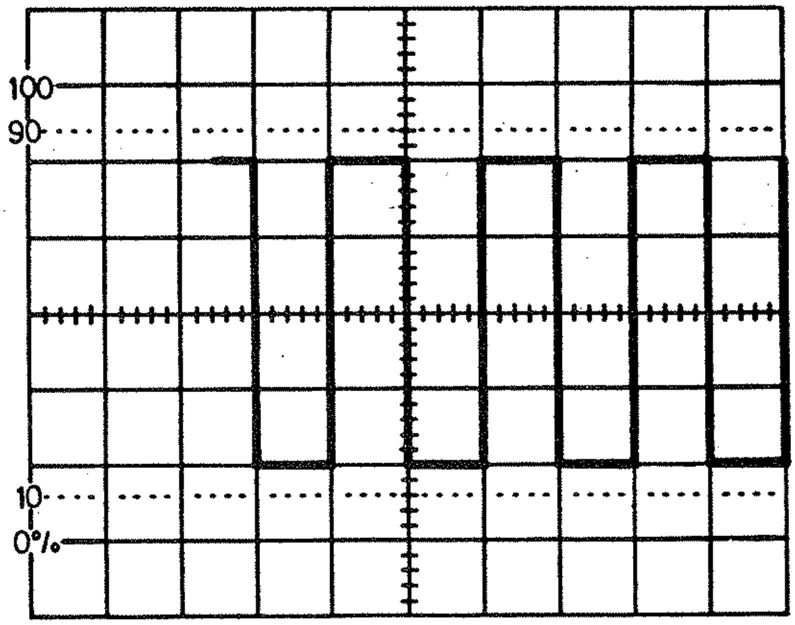


Figure 4-2. Left Portion of Waveform Blanked

23. Rotate MULTIPLIER (10 Turns) to increase (or decrease) the blanked portion about 2-5 divisions at a desired rising or falling edge. <u>If DELAY TIME is set too short, blanked portion will be very short. If DELAY TIME is set too long, waveform will be blanked.</u>

24. Set NORMAL/SEARCH/DELAY mode to DELAY position (LED lamp stays on fully).

25. Set TIME/DIV to 50us/DIV (or higher sweep rate).

26. Slightly adjust MULTIPLIER to position rise or fall edge in center of screen. Verify that waveform is expanded as shown in Figure 4-3.

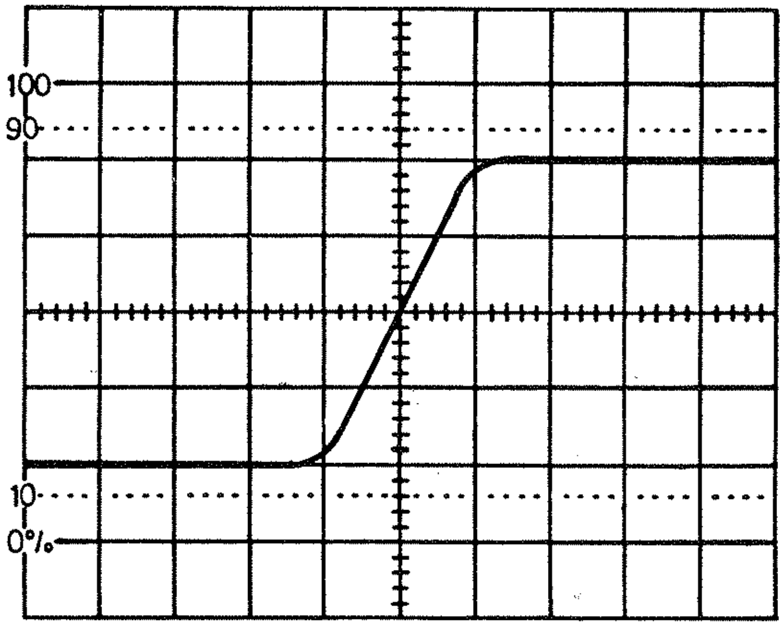


Figure 4-3. Sweep Delay Showing Expansion of Input Signal to Desired Interval

27. Set NORMAL/SEARCH/DELAY switch to NORMAL position and TIME/DIV to 1ms/DIV.

28. Pull out horizontal POS control (magnify 10 times). Verify that two pulses with leading edge of first and second pulse are on first and eleventh vertical graticule lines, respectively (±10%).

29. Push in horizontal POS control.

30. The checkout of Channel 2 is the same as Channel 1. To checkout Channel 2 repeat steps 1 through 29.

4.2.2. Dual trace, ALTernative Operating Mode Checkout

1. Connect 0.2V CAL output to both channel signal input connectors.

2. Press in on MONO/DUAL switch to obtain DUAL channel operation.

3. Move TRIGGER SOURCE switch to ALT position.

4. Perform operating timebase functions in the same way as described in paragraph 4.2.1, except in this case both channels are affected.

4.2.3. Dual Trace, CHOPped Operating Mode Checkout

1. Connect 0.2V CAL output to both channel signal input connectors.

2. Press in on MONO/DUAL switch to obtain DUAL channel operation.

3. Press in on ALT/CHOP switch to obtain CHOP operating mode.

4. Move TRIGGER SOURCE switch to CH1 or CH2.

5. Perform operating timebase functions in the same way as described in paragraph 4.2.1, except in this case both channels are affected.

4.2.4. Dual Trace, ADD Operating Mode Checkout

1. Connect 0.2V CAL output to both channel signal input connectors.

2. Actuate MONO/DUAL switch to obtain MONO position; ALT/CHOP switch to CHOP position; and CH1/CH2 switch to CH1.

3. Move TRIGGER SOURCE switch to ALT.

4. Perform operating timebase functions in the same way as described in paragraph 4.2.1, except in this case both channels are affected. Also ignore any instructions to change positions of VERT MODE pushbuttons and TRIG SOURCE switch, except as instructed above in this paragraph (4.2.4).

4.2.5. Component Tester Checkout

1. Press in COMP TEST pushbutton to place oscilloscope in component test operating mode.

2. Disconnect CH1 and CH2 input connectors.

3. Insert diode or zener diode, LED, capacitor, etc., between COMP TEST banana jacks.

4. Verify that displayed waveform are similar to the Test Patterns shown in Figure 4-4.

5. When you have finished component testing, press COMP TEST pushbutton to out position. This disables component test mode of operation.

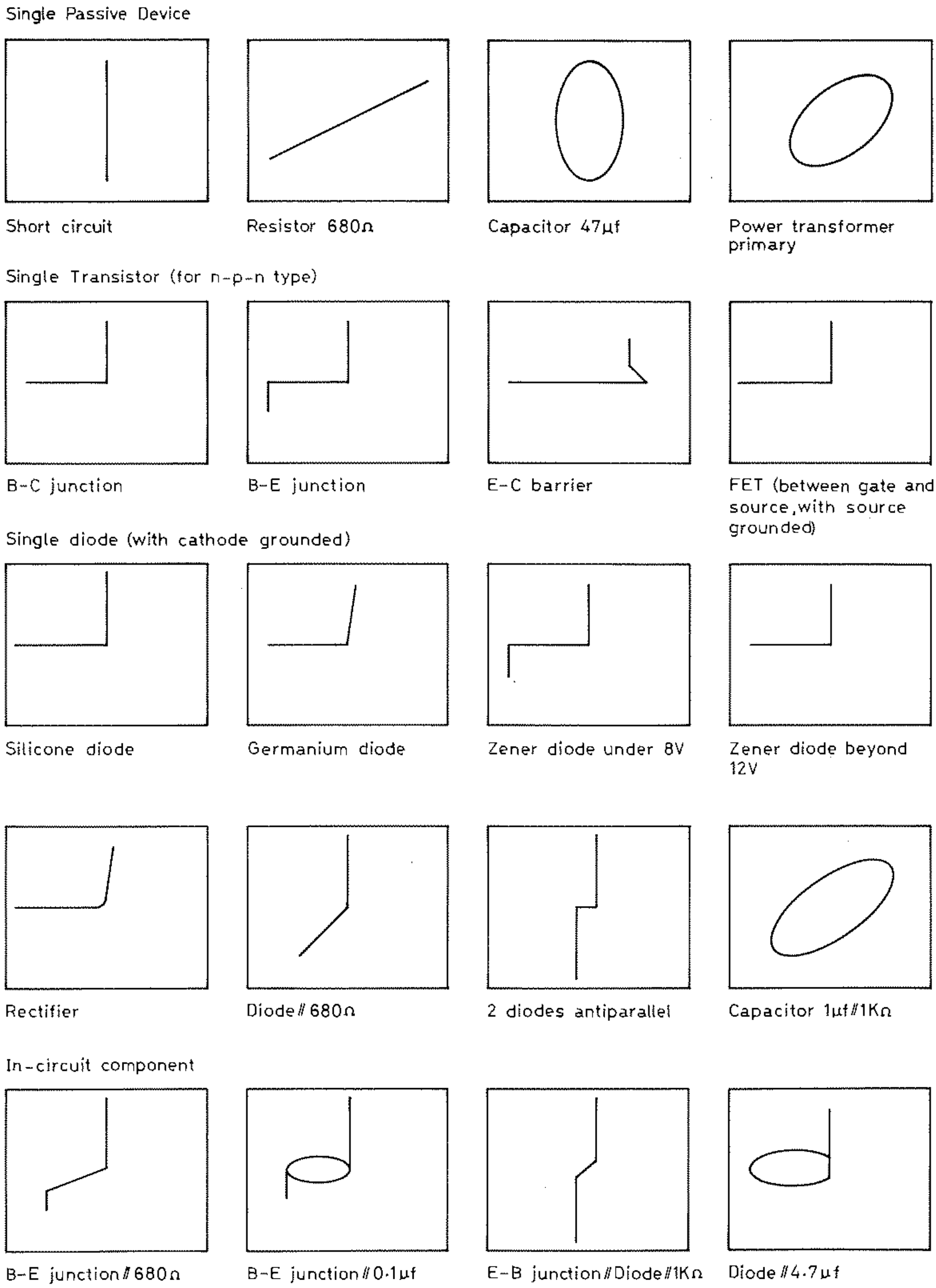


Figure 4-4. Component Test Patterns

4.3 OPERATING PROCEDURE INFORMATION

4.3.1 TRIGGER COUPLING Switch Function

The TRIGGER COUPLING slide switch has four positions: AC/DC/LF/HF. The correct position to use for coupling of the input signal for triggering depends upon the following information.

AC coupling removes the DC level from trigger signals and attenuates signals below 10Hz. In most cases this coupling selection works well. Only in some difficult cases where AC signals are highly complex do you need to use a different coupling position.

DC coupling connects input signals directly to the input amplifier. With DC coupling selected, a large DC voltage component in an input signal can offset the input signal outside the trigger level range of the instrument and cause the oscilloscope to lose trigger.

HF and LF positions both provide AC coupling functions. When AC signals are complex, and it is difficult to get stable waveforms by rotating TRIG LEVEL, either HF or LF can be selected to block low frequency (HF) or bypass high frequency (LF) signals providing a much more stable trigger function.

4.3.2 AUTO/NORM Pushbutton Function

In AUTO mode, the trig level is automatically set within the input signal peak-to-peak range. A bright baseline is displayed in the absence of a trigger signal. A trigger of 30Hz or higher overrides AUTO operation and produces a presentation. Adjustment of TRIG LEVEL control may be necessary to obtain a stable display. If the trigger is less than 30Hz, NORM operation must be used. A trigger signal is always needed in NORM operation to generate a sweep.

4.3.3 TRIG SOURCE Select Function

The trigger select SOURCE switch selects trigger sources from CH1, CH2, ALT or EXT. The ALT position selects a trigger source from both channels alternately. When dual trace ALT is selected, signals from both channels are required to obtain a stable display. In ALT trigger operation, if input frequency of Channel 1 differs much from Channel 2, the displayed waveforms may be dim and unstable.

4.3.4 HOLD-OFF Function

When the trigger signal is complex or is aperiodic, a stable waveform cannot be displayed by using the TRIG LEVEL control alone. It is necessary to rotate the HOLDOFF control to get more stable waveforms.

4.3.5 Sweep DELAY Function

By employing the sweep delay function, the start of the sweep can be selectively delayed from the trigger point 0.1us to a maximum of 10ms. It is therefore possible to start the sweep at nearly any point in a waveform. The interval, which follows the start of the sweep, can be greatly expanded by increasing the sweep speed. It can be expanded at least 100 times by using the DELAY switch and can be expanded to 1,000 times using the MULTIPLIER control; however, the display brightness decreases as sweep speed increases. Note that input signal jitters are somewhat increased with higher expansions of sweep speed.

Operation of the sweep delay is easy. Only three controls in the DELAY section are needed. The delay mode slide switch NORMAL/SEARCH/DELAY, the DELAY time rotary switch (selection of delay time range), and the MULTIPLIER variable control (10 Turns, fine control).

4.3.6 Component Test Function

With the built-in component tester: semiconductors, capacitors, inductors, resistors; R-L-C network or even combinations of R-L-C and semiconductors can be easily tested. Also, integrated circuits may be checked.

The tested result is displayed on the screen of the oscilloscope. The device under test can be either in or out of a circuit. When the device under test is situated in highly complex circuits, the test result may not be clear. This is due to the effects of the components and the stray capacitance in the test circuit. This problem may be overcome by comparing the result obtained from the circuit under test with the result obtained from a similar circuit which is known to be fully operative.

4.4 MEASURING INSTRUCTIONS

4.4.1 DC Voltage Measurement

1. Connect DC voltage directly to CH1 input.
2. Set AC-GND-DC to GND.
3. Adjust CH1-POS until baseline coincides with one horizontal graticule lines. This is used for the zero reference level.
4. Set VOLT/DIV to an appropriate range, and set AC-GND-DC switch to DC.
5. Baseline shifts by the amplitude of DC voltage. Multiply measurement of shift divisions by value indicated on VOLT/DIV switch. For example, in Figure 4-5, when VOLT/DIV is 50mV/DIV, the shift division is 4.2DIV, then the DC voltage (V_{dc}) is: 50mV/DIV x 4.2DIV:

$$\begin{aligned} V_{dc} &= 50 \times 10^{-3} \times 4.2 \\ &= 210 \times 10^{-3} \\ &= 210 \text{ mVdc} \end{aligned}$$

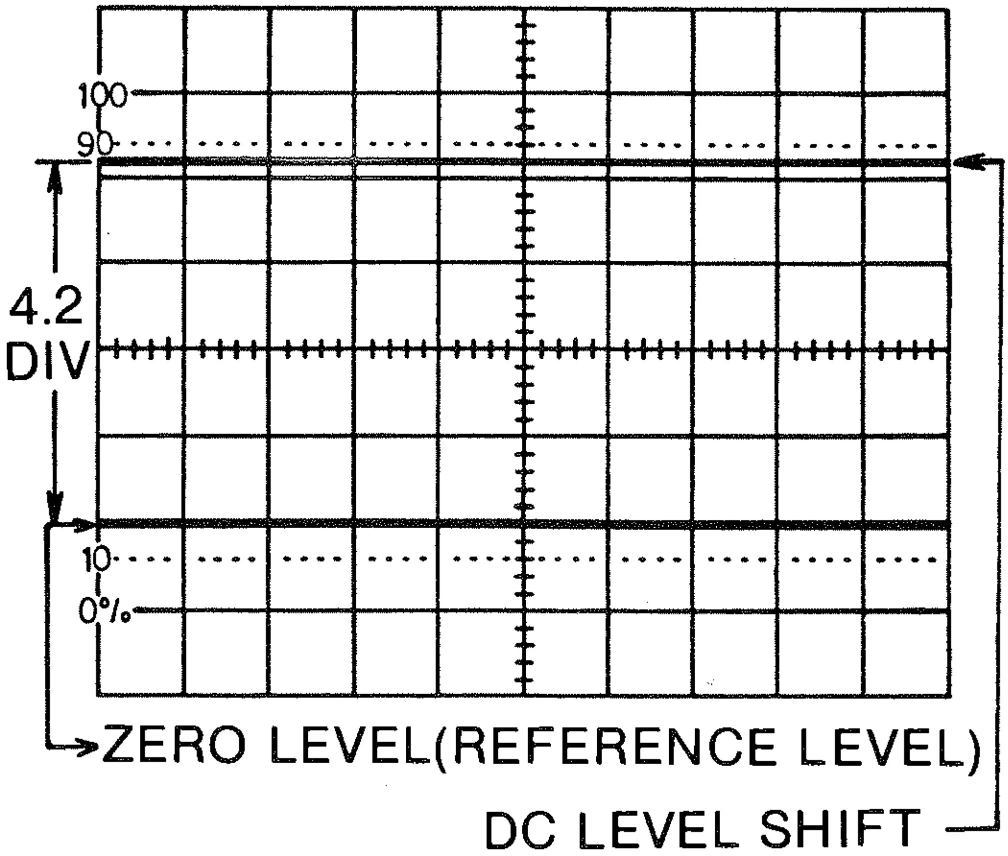


Figure 4-5 DC Voltage Measurement

6. If the X10 attenuation probe is in use, the true value of the signal becomes 10 times the calculated value, or 50mV/DIV x 4.2DIV x 10 = 2.10 Vdc.

4.4.2 AC Voltage Measurement

1. Connect signal directly to channel 1 input.

2. Set VOLT/DIV to an appropriate range, and set AC-GND-DC switch to AC.

3. Adjust CH1-POS control to position lowest portion of waveform to coincide with horizontal graticule lines between 10 and 90.

The peak-to-peak voltage (Vp-p) is measured as shown in Figure 4-6. If VOLT/DIV is adjusted to 0.1V/DIV, and waveform amplitude is 4.4 divisions, then Vp-p = 0.1V/DIV x 4.4Vp-p = 0.44Vp-p or 440mVp-p

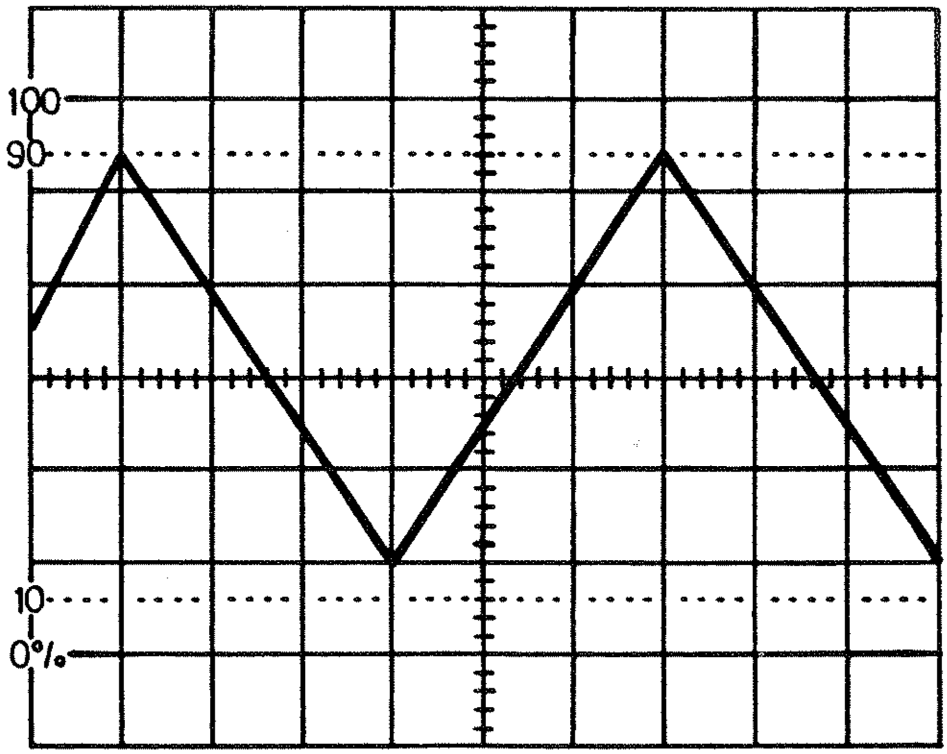


Figure 4-6. AC Voltage Measurement

4.4.3 Period Measurement

The duration of a signal period is determined by multiplying the horizontal distance in the signal period by the time coefficient selected on the TIME/DIV switch.

For example, as shown in Figure 4-7, the waveform which starts at point A and ends at point B is equal to one time period. The distance between A and B is equal to 2.0 division on the screen.

If, TIME/DIV is equal to 0.5ms/DIV, then the period (or A to B interval) is calculated as follows:

$$0.5\text{ms/DIV} \times 2.0\text{ DIV} = 1.0\text{ mS} = 1.0 \times 10^{-3}\text{ S}$$

Then, signal frequency (F) is

$$= 1/(1.0 \times 10^{-3})\text{ S} = 1 \times 10^{3}\text{ Hz} = 1\text{ KHz.}$$

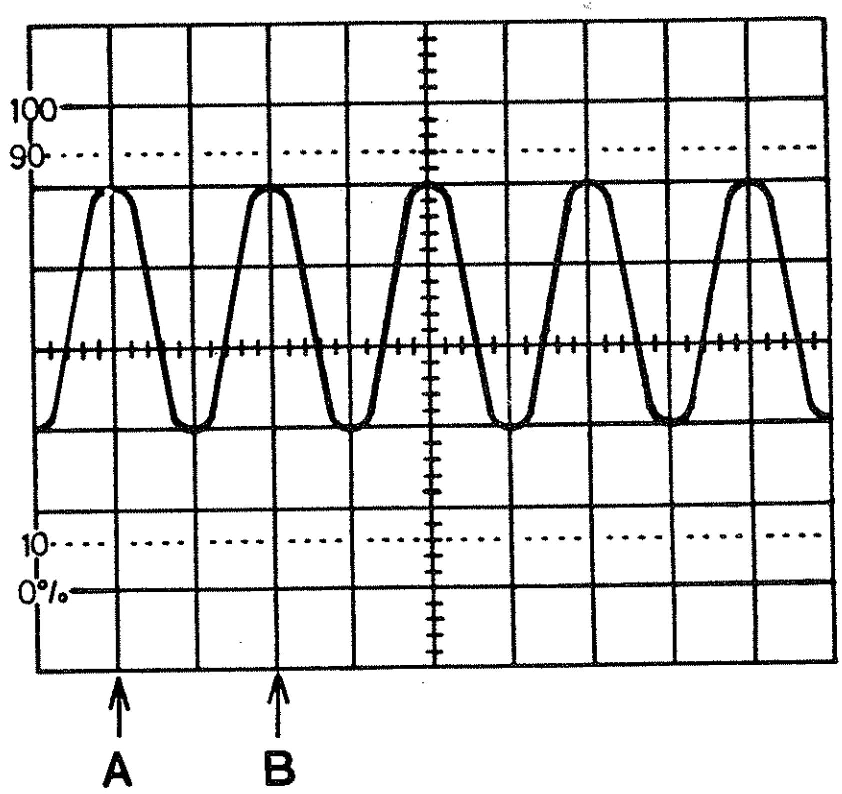


Figure 4-7. Period Measurement

4.4.4 Time Difference Measurement

Time difference measurements are accomplished in dual trace operation. When measuring the time difference between two signals, a position is selected on the TRIGGER SELECT switch as a source for the trigger reference signal. Two typical signals are displayed on the screen as shown in Figure 4-8.

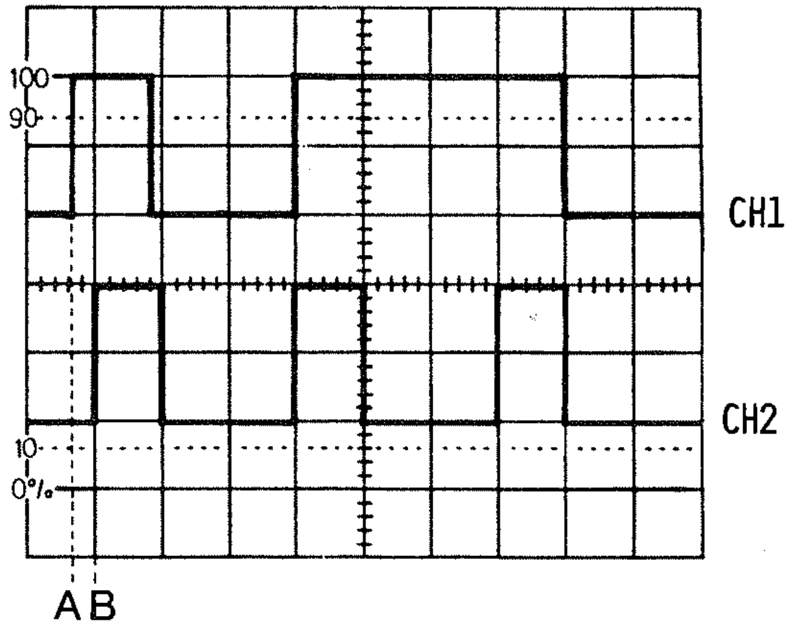


Figure 4-8. Waveforms for Time Difference Measurements

Figure 4-9 shows an expanded waveform of Figure 4-8, with trigger source as CH1. It is easier to measure the horizontal divisions from point A to point B point as shown in Figure 4-9. The time difference as for other measurements is obtained by multiplying the interval between A and B by sweep speed.

Figure 4-10 is the waveform triggered by CH2 signal which is not a reference signal, and therefore impossible to measure time difference. A more precise measurement method is shown in Figure 4-11 and 4-12.

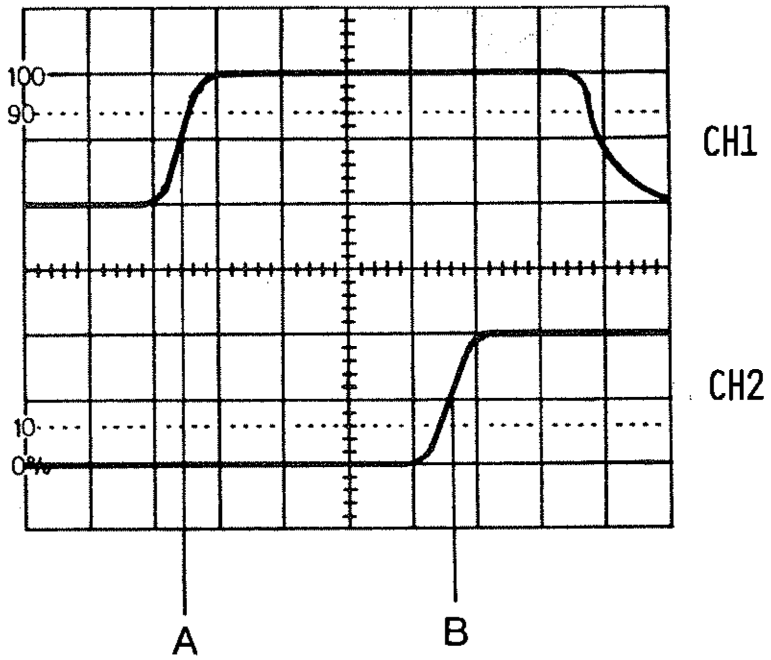


Figure 4-9. Expanded Waveforms Allow Easier Difference Measurements (TRIGGER SOURCE set to CH 1)

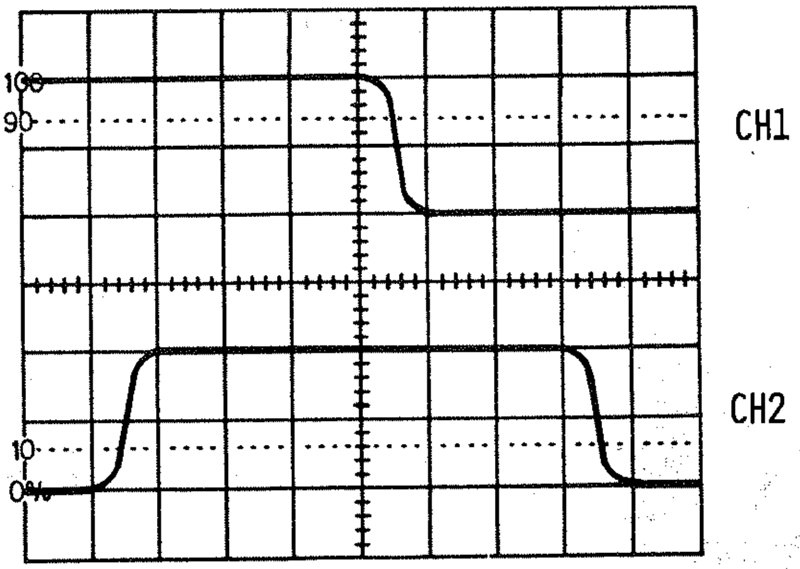


Figure 4-10. Improperly Expanded Waveform Making Measurement Impossible (TRIGGER SOURCE set to CH 2)

Figure 4-12 is the equal amplitude measuring method, and is achieved by rotating amplitude variable controls and CH1 POS control to equalize amplitudes for both channels.

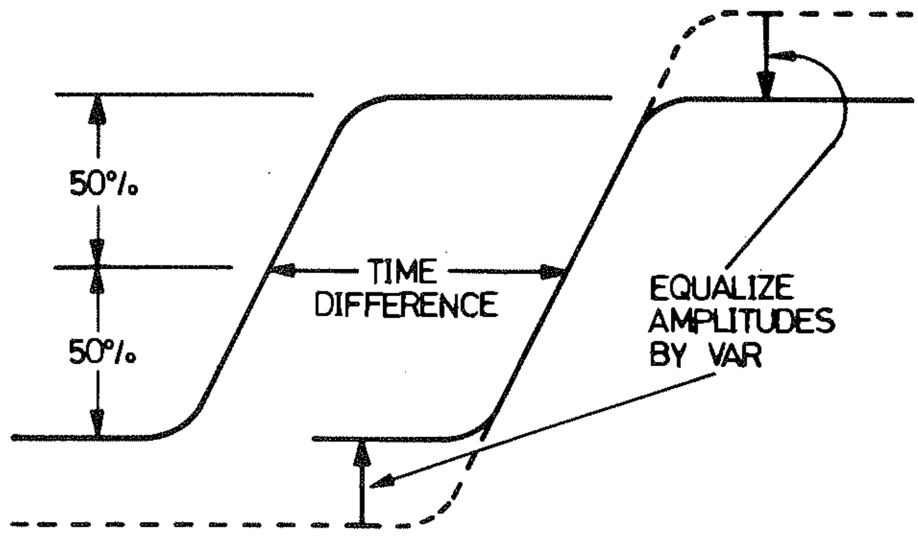


Figure 4-11. Equal Amplitude Measuring Method

Figure 4-12 is the superposition measuring method, and is achieved by adjusting the CH1-POS control to position the smaller amplitude waveform to the center of the larger amplitude waveform.

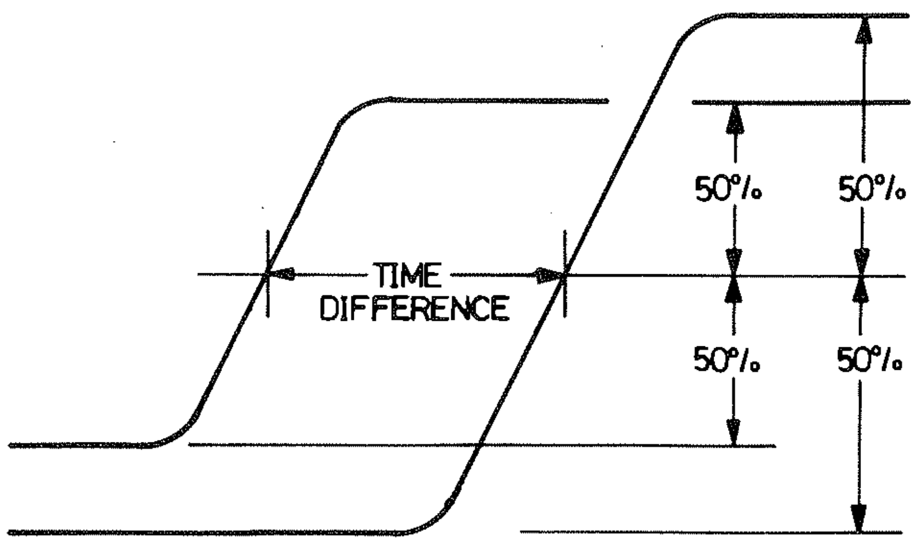


Figure 4-12. Superposition Measuring Method

4.4.5 Rise (Fall) Time Measurement

With pulse or square waveforms, the critical factor is the risetime of the voltage step. The rise time is generally measured between 10% and 90% of the vertical pulse height. Adjust signal peak-to-peak amplitude to fall within six divisions on the screen, and symmetrically adjust it to the horizontal center line. Match rise or fall line on the waveshape to the internal graticule of the two horizontal dotted lines and within ±2.4 divisions from screen center line. A properly adjusted waveform is shown in Figure 4-13.

To measure the rise time, adjust the VOLT/DIV switch with variable control and CH1 POS control so that the waveform amplitude precisely coincides with 0% and 100% lines on CRT graticule, as shown in Figure 4-13.

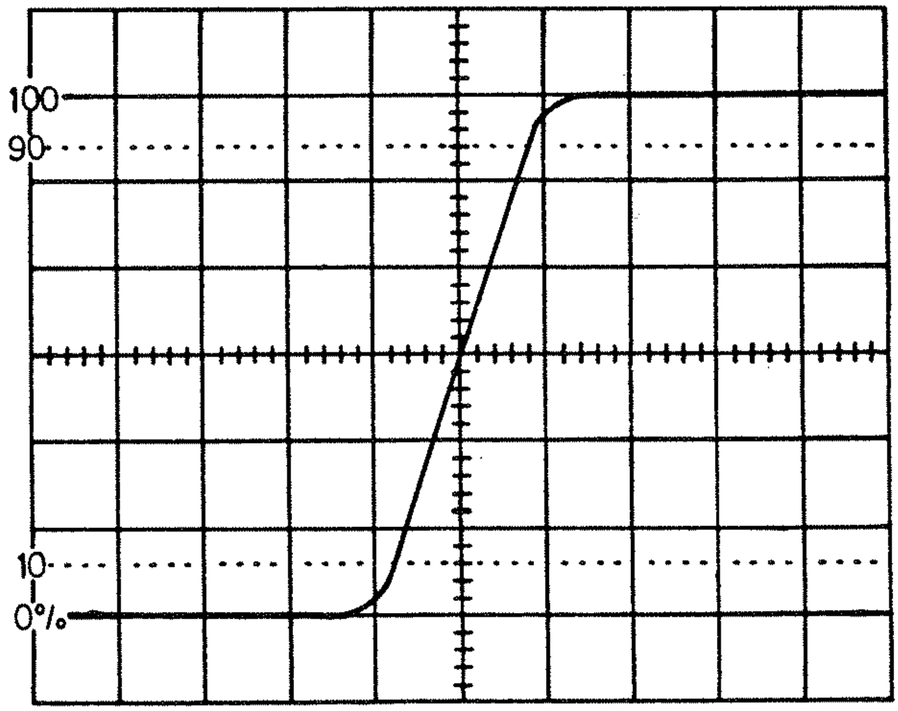


Figure 4-13. Rise or Fall Time Measurement

Risetime is defined by the product of the horizontal divisions between the waveform intersections to 10% and 90% dotted lines and the sweep time. If magnification is used, this product must be divided by 10. The falltime of a square wave can also be measured by using this method.

When risetime is measured directly from the displayed waveform on the screen, it contains two parameters. One parameters is the true risetime of the measured signal, the other is the risetime of the oscilloscope. For example,

T_s = measured risetime from CRT screen

T_o = oscilloscope risetime

T_{ms} = measured signal risetime

Risetime displayed in Figure 4-13, T_s has the following relationship,

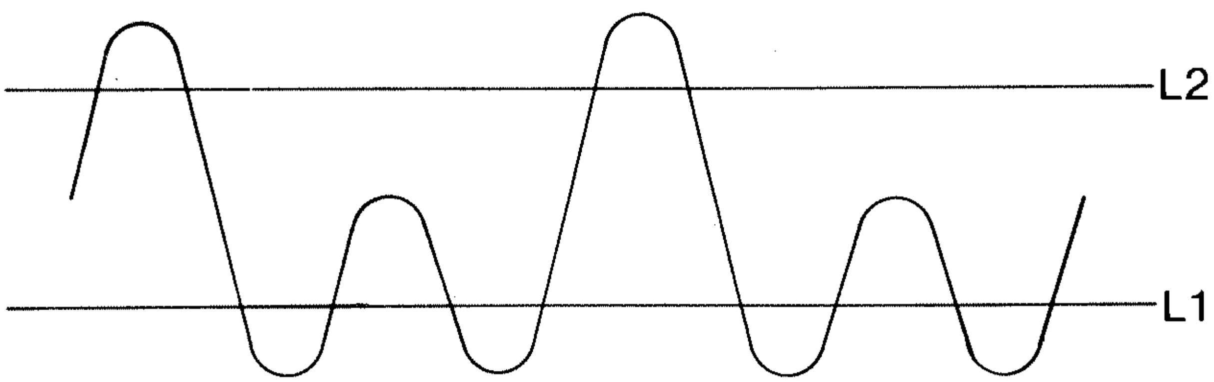
$$T_s = T_{ms}^2 + T_o^2$$

Actually, the true rise time is given by,

$$T_{ms} = T_s^2 - T_o^2$$

4.4.7 Synchronization of Complex Waveforms

In the case shown in Figure 4-14, the waveform contains two peaks that greatly differ in amplitude. This waveform will display double peaks of equal amplitude on the screen, if the trigger level is not set properly.



If trigger level is set at point L2 then both peaks will be displayed as shown here.

If trigger level is set at L1 then displayed waveform will display incorrectly with instability and with incorrect amplitude.

Figure 4-14. Waveform with Dual Peaks Displayed at Different Amplitudes

In Figure 4-14, if the TRIG LEVEL is set to L1, the waveform may be doubled, or even unstable. Operators should increase the TRIG LEVEL control until the display on the screen is synchronized.

4.4.7 Stabilizing Aperiodic Waveforms

In the case where waveforms greatly vary in pulse width, obtaining a stable display is difficult to adjust with TRIG LEVEL only. The HOLD OFF function will improve synchronization (Figure 4-15).

With an aperiodic waveform, adjusting HOLD-OFF control increases hold off time between two sweeps. If the hold-off time is increased to a proper range, an undesirable triggering level cannot generate sweep, thereby synchronizing the waveform. If adjustment of HOLDOFF and TRIG LEVEL controls do not produce a stable display, set TRIG COUPLING switch to HF position and readjust HOLD-OFF and TRIG LEVEL for improvement.

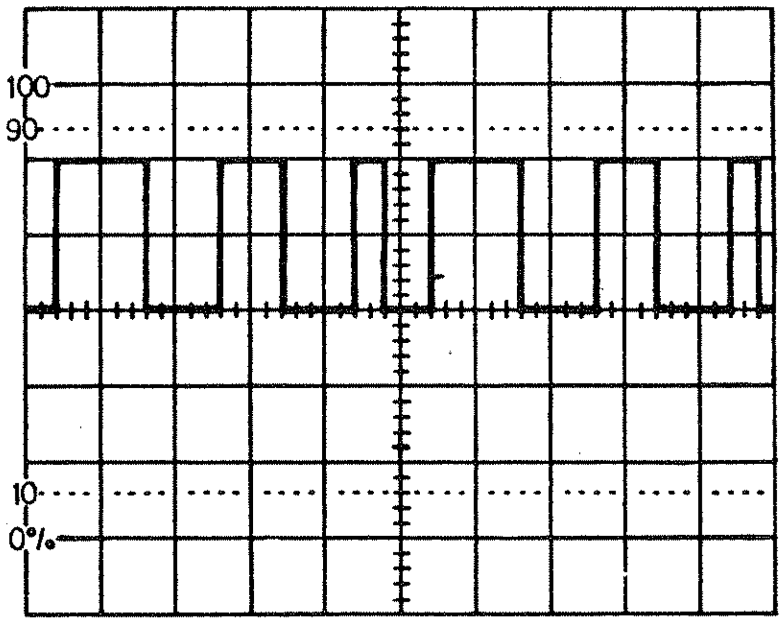


Figure 4-15. Aperiodic Square Wave

4.4.8 Selection of Trigger

As an aid to achieving easier operation and stable well-synchronized waveforms, recommended instructions are shown in Table 4-1.

TABLE 4-1. TRIGGER SELECTION GUIDE

Pushbutton Switch Positions					
VERT MODE GROUP	TRIGGER SOURCE	TRIGGER COUPLE	TRIGGER MODE	Use HOLD-OFF if waveshape is:	Use TRIG LEVEL if waveshape is:
CH1	CH1	AC	AUTO	Complex,Jitter	Complex
CH2	CH2	AC	AUTO	Complex,Jitter	Complex
DUAL,ALT	ALT	AC,HF	AUTO,NORM	If Unstable	Complex
DUAL,CHOP	CH1,CH1	AC,HF	NORM		
ADD	CH1,CH2	AC	AUTO		

5.1 DC BALANCE ADJUSTMENTS

Over long periods, the DC balance characteristics of the FET input of the vertical amplifier for each channel FET may drift.

If the vertical baseline position shifts greater than 1mm after a 30 minute warm-up of the instrument, then adjustment of the DC BALANCE potentiometer may be necessary. Access to this adjustment can be gained from the underside of the oscilloscope cabinet.

Before adjusting, set VOLT/DIV switch on the front panel to 5mV/DIV, and input coupling to GND. Also, use a non-metallic alignment tool to adjust the DC balance potentiometer.

The front panel VAR control should be continuously readjusted while the DC balance potentiometer is adjusted.

Correct DC balance is obtained when the vertical baseline position remains steady while the VAR control is varied. Use this same procedure for both Channel 1 and Channel 2.

5.2 TRACE ROTATION ADJUSTMENTS

The trace rotation adjustment compensates for external magnetic fields that may affect alignment of the horizontal baseline with respect to the CRT graticule. When the oscilloscope is moved to a new location, trace rotation adjustment should be checked and readjusted if necessary. To adjust the trace, proceed as follows:

1. Set DC-GNC-AC coupling switch to GND
2. Adjust CH1 POS control until baseline is on the center of the horizontal graticule line.
3. Using a non-metallic alignment tool, adjust TRACE ROTATION control (which is located on the Right Side of the cabinet) until baseline aligns with horizontal graticule line.

5.3 FOCUS AND ASTIGMATISM ADJUSTMENTS

Normally, the CRT has extremely good brightness and sharpness. Any reduction of the brightness or sharpness can be corrected by the FOCUS and ASTIGMATISM controls. Adjustments of focus and astigmatism can be performed as follows:

CAUTION

CRT brightness and sharpness will remain for very long intervals. Do not adjust ASTIGMATISM, except when necessary.

1. Turn INTENSITY control fully counter-clockwise.

2. Set vertical and timebase controls as follows:

VOLT/DIV. 10mV/DIV
AC-GND-DC . . . . . . .GND
VERT MODE . . . . . . .All push buttons out
VARiable. . . . . . . .CAL
TRIGGER . . . . SOURCE (CH 1); COUPLING (AC)
TRIG LEVEL. . . . . . .Center
X-Y deflection. . . .pushed in

3. Set INTENSITY to observe spot.

4. Adjust FOCUS and ASTIG controls for best defined spot. ASTIG control is located on the Power Supply Board as shown in Figure 5-1.

CAUTION

High Voltage exists near ASTIG control. Adjust carefully.

5.4 POWER SUPPLY ADJUSTMENTS

There are seven regulated DC operating voltages: +24V, +5V, -12V, +140V, +260V, including -1900V and 33V for the unblanking circuit. The +24V, +5V, -12V and 33V are fixed voltages $\pm 5\%$ tolerance.

It is not recommended that the operator attempt to readjust these voltages. Better to refer all alignment and servicing to an authorized Beckman Industrial Service Center.

5.5 CALIBRATION

To maintain oscilloscope accuracy, perform calibration at least every 1000 hours of operation, or every six months if used infrequently.

It is not recommended that the operator attempt to perform any calibration or any servicing of this oscilloscope. Instead refer this type of activity to an authorized Beckman Industrial Service Center.

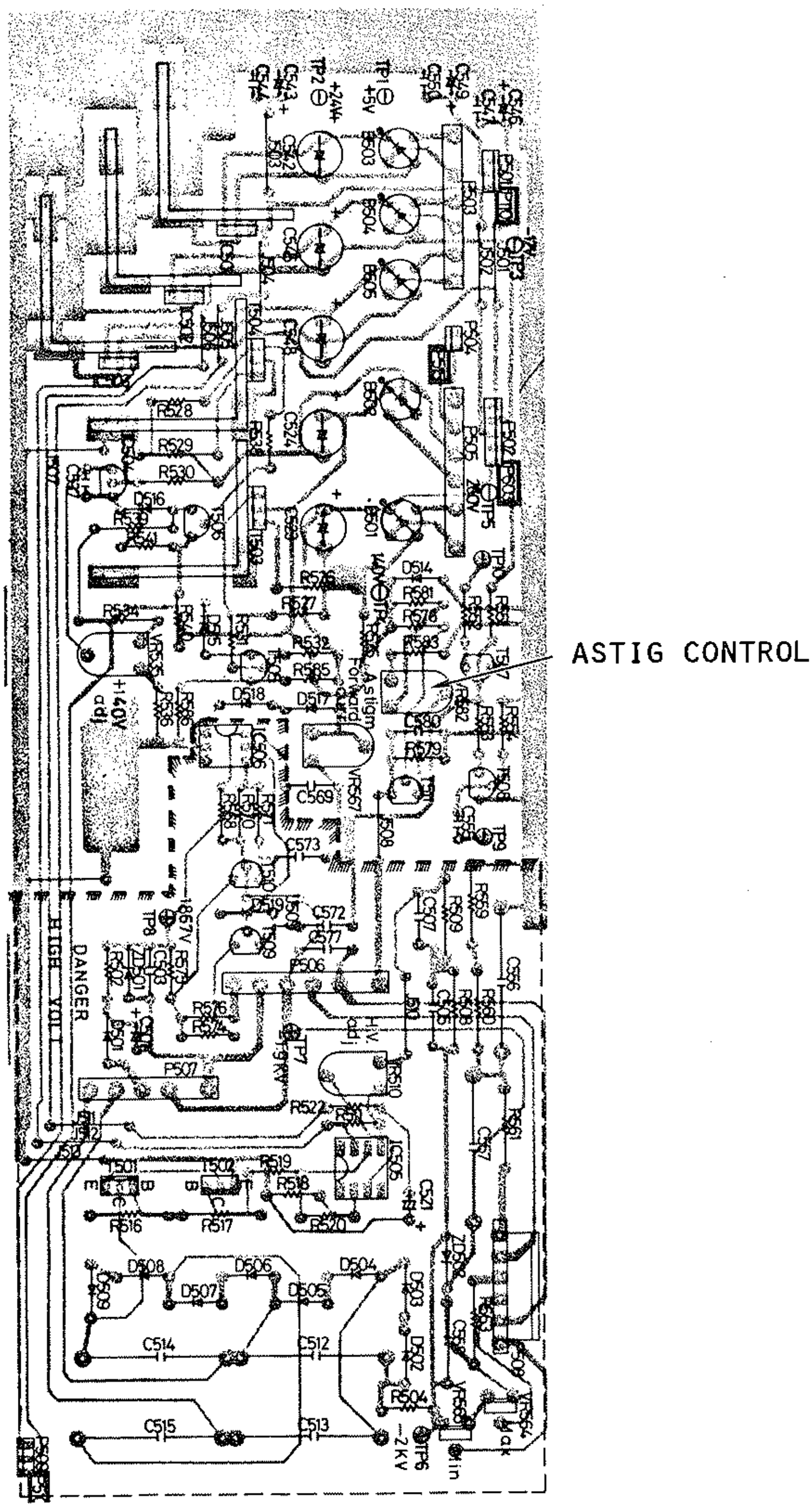


Figure 5-1. Power Supply Circuit Board

5.6 PROBE ADJUSTMENTS

Adjust probe frequency compensation by using following procedure (Probe is X1/X10 attenuator):

1. Set probe to X10 position, then connect probe tip to output of CAL 0.2V, 1KHz

2. Set VOLT/DIV to 5mV/DIV

3. Set AC-GND-DC to DC.

4. Adjust frequency compensating trimmer on the probe until the displayed square wave is in optimum state as shown in Figure 5-2. NOTE: When probe is in X1 position it does not require frequency compensation adjustment.

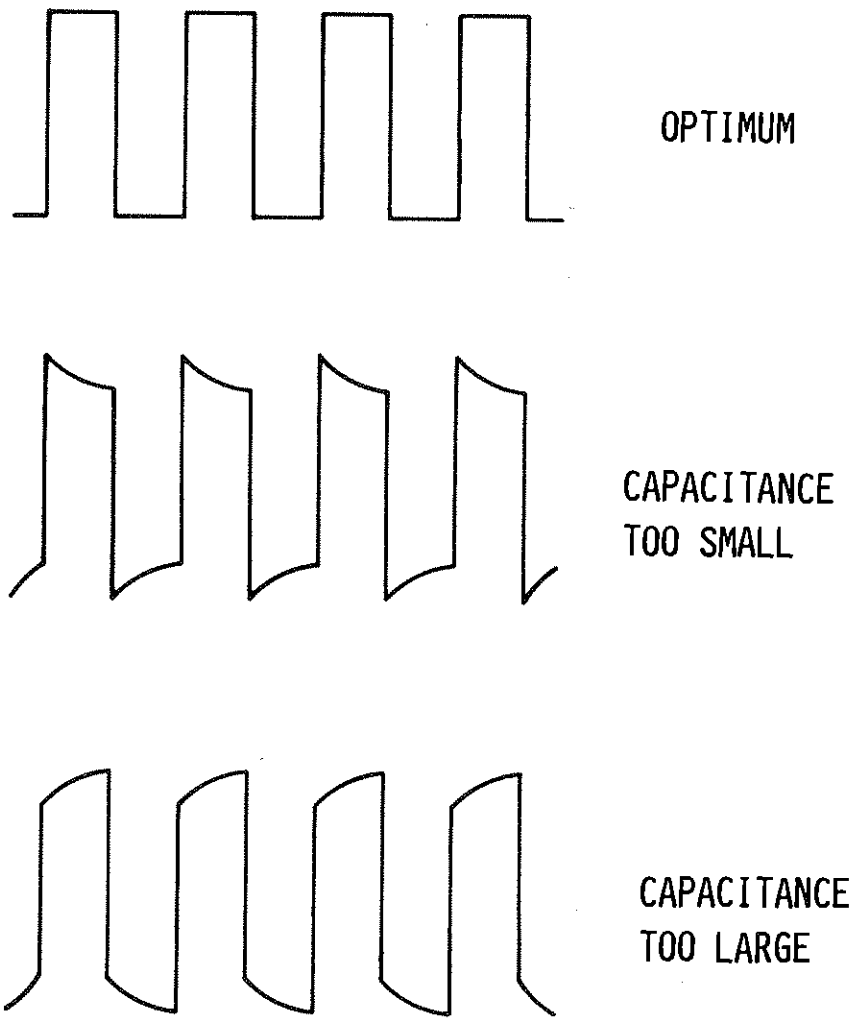


Figure 5-2. Probe Compensation

6.1 MAINTENANCE POLICY

6.1.1. Warranty Policy

The BECKMAN INDUSTRIAL™ Model 9020 Oscilloscope, excluding probes, is warranted against any defects of material or workmanship which develop within a period of one (1) year following the date of purchase by the original purchaser. This warranty is extended by Beckman Industrial Corporation only to the original purchaser of the oscilloscope, who must, as a CONDITION PRECEDENT TO WARRANTY COVERAGE AND PERFORMANCE THEREUNDER BY BECKMAN INDUSTRIAL CORPORATION, complete and return the Warranty Registration Card, received on purchase of the oscilloscope.

> ANY IMPLIED WARRANTIES ARISING OUT OF THE SALE OF THE BECKMAN INDUSTRIAL CORPORATION OSCILLOSCOPE, INCLUDING BUT NOT LIMITED TO IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, ARE LIMITED IN DURATION TO THE ABOVE-STATED ONE (1) YEAR PERIOD. BECKMAN INDUSTRIAL CORPORATION SHALL NOT BE LIABLE FOR LOSS OF USE OF THE OSCILLOSCOPE OR OTHER INCIDENTAL OR CONSEQUENTIAL DAMAGES, EXPENSES, OR ECONOMIC LOSS OR FOR ANY CLAIM OR CLAIMS FOR SUCH DAMAGES, EXPENSES, OR ECONOMIC LOSS.

Some states do not allow limitations on how long implied warranties last or the exclusion or limitation of incidental or consequential damages, so the above limitations or exclusions may not apply to you.

6.1.2 Warranty Repair Policy

In the event a defect develops during the warranty period, Beckman Industrial Corporation will, at Beckman Industrial Corporation's election, repair or replace the oscilloscope with a new or reconditioned equivalent model, without charge for parts or labor. In order to obtain performance of any obligation of Beckman Industrial Corporation under the warranty, the original purchaser must notify Beckman Industrial Corporation Customer Service Department at (714) 773-6886 of the defect, obtain a Return Authorization Number and receive instructions on where to return the defective product for the performance of service. In the event the oscilloscope must be returned, it must be sent postage prepaid, along with a handling charge of $10 to an authorized Beckman Industrial Corporation Service Center.

In the event of replacement with a new or reconditioned model, the replacement unit will continue the warranty period of the original oscilloscope for six (6) months after the date of repair, whichever is longer.

This warranty shall not apply to any defect, failure or damage caused by improper use or improper or inadequate maintenance or care. Beckman Industrial Corporation shall not be obligated to furnish service under this warranty:

a) to repair damage resulting from attempts by personnel other than Beckman Industrial Corporation representatives to install, repair or service the product;

b) to repair damage resulting from improper use;

c) to service a product that has been modified or integrated with other products when the effect of such modification or integration increases the time or difficulty of servicing the product.

6.2 PREVENTIVE MAINTENANCE

It is important that you follow the preventive maintenance items indicated below to insure years of reliable instrument performance and in certain cases extend the life of the instrument:

- Since semiconductors, precision components, static-sensitive devices, etc. are employed in this oscilloscope, use utmost care in operation and storage.

- Clean front surface of blue CRT filter every two weeks with soft tissue moistened in window cleaning fluid. If dust should accumulate on the CRT surface, the filter can be removed* for lightly dusting or blowing off the surface of the CRT only. Be especially sure not to wipe or even touch the inside surface of the blue filter as it is coated with a soft antistatic spray. This coating should remain on the inside surface of the blue filter to protect the CRT from nearby static charges.

- Every month wipe off entire oscilloscope cabinet with a cloth dampened in a anti-static electronic equipment cleaner.

- Be sure to retain the shipping box for storage of the instrument when it is not in use. Store in an ambient temperature from -10°C to +60°C, and keep away from moisture and dust.

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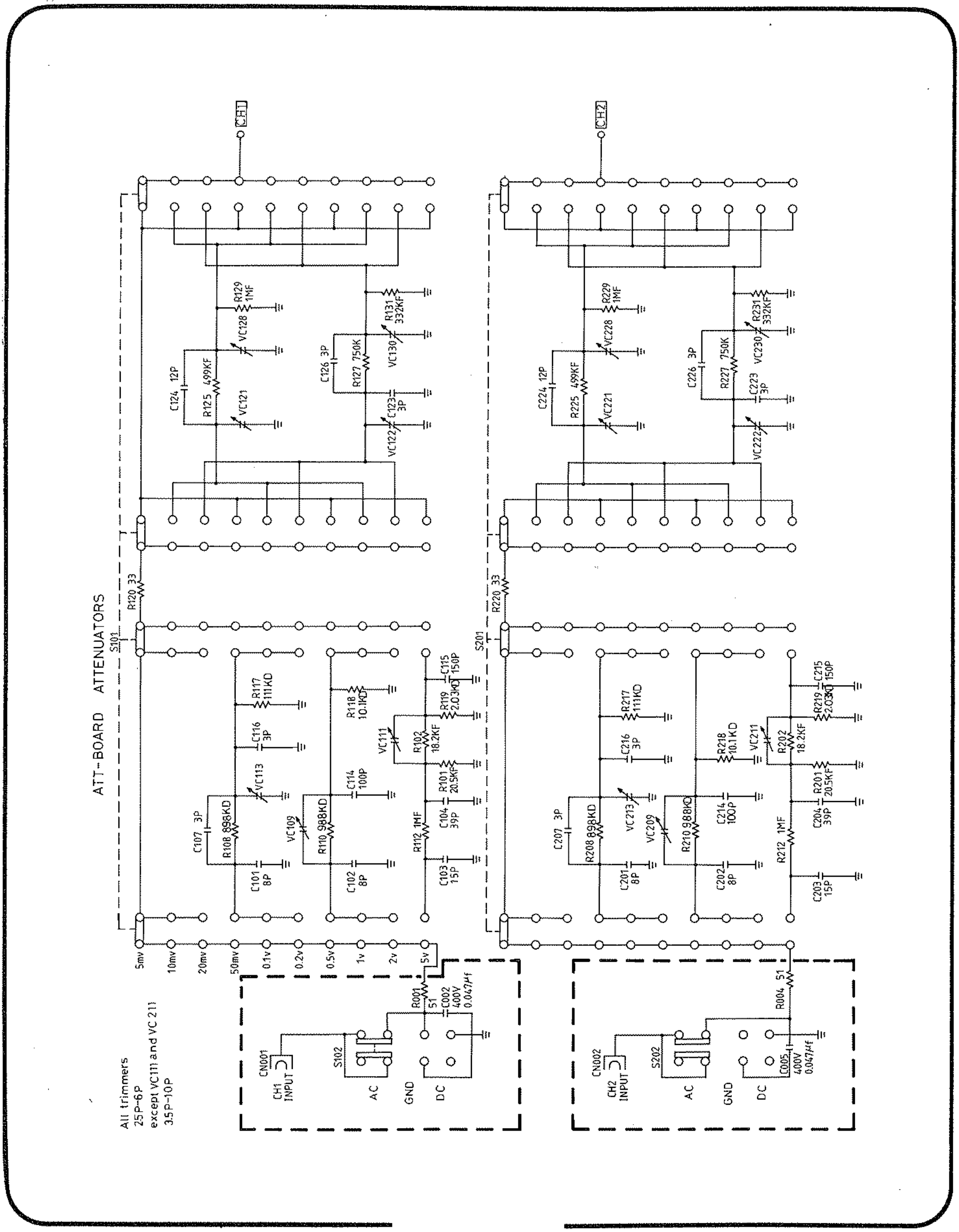
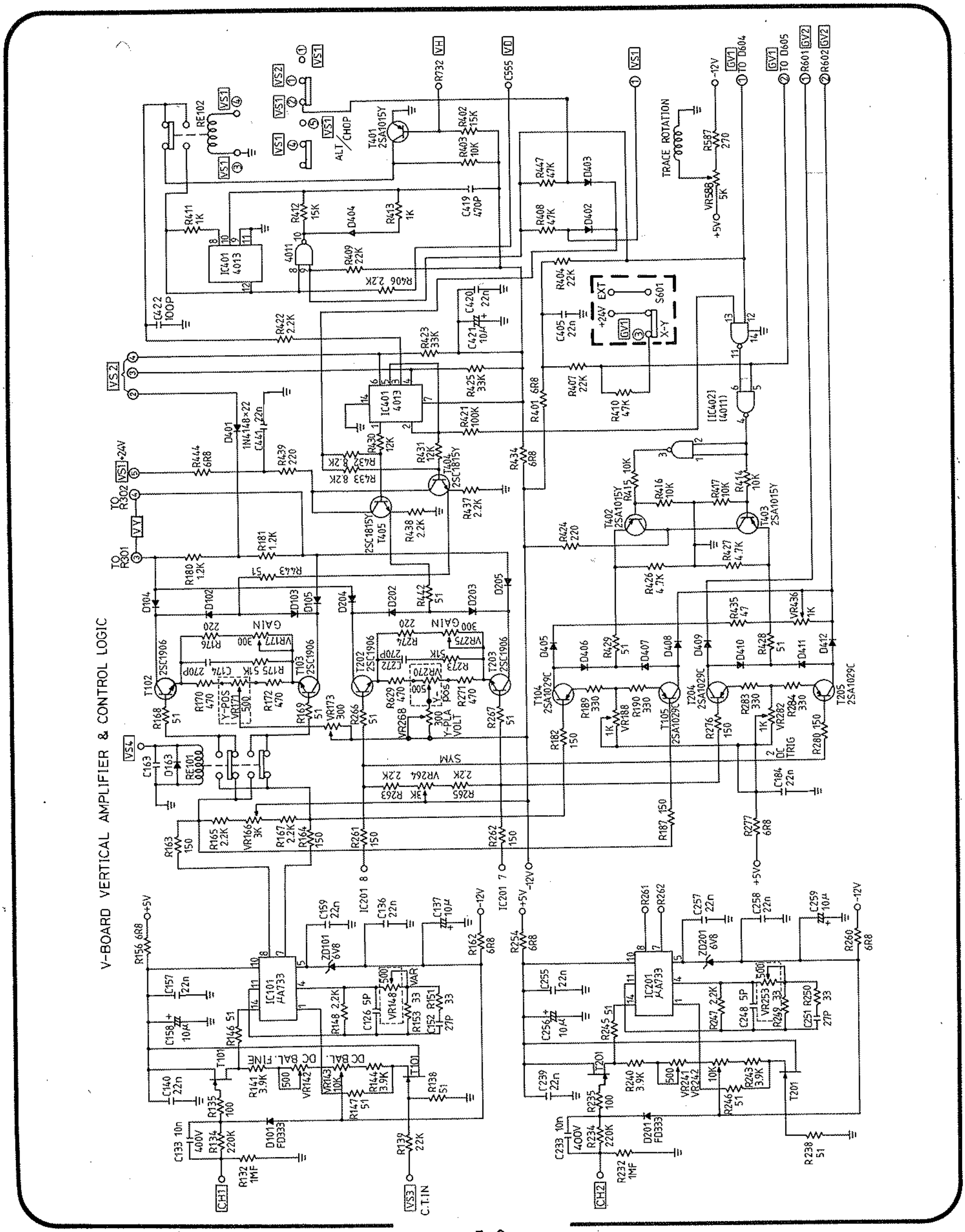
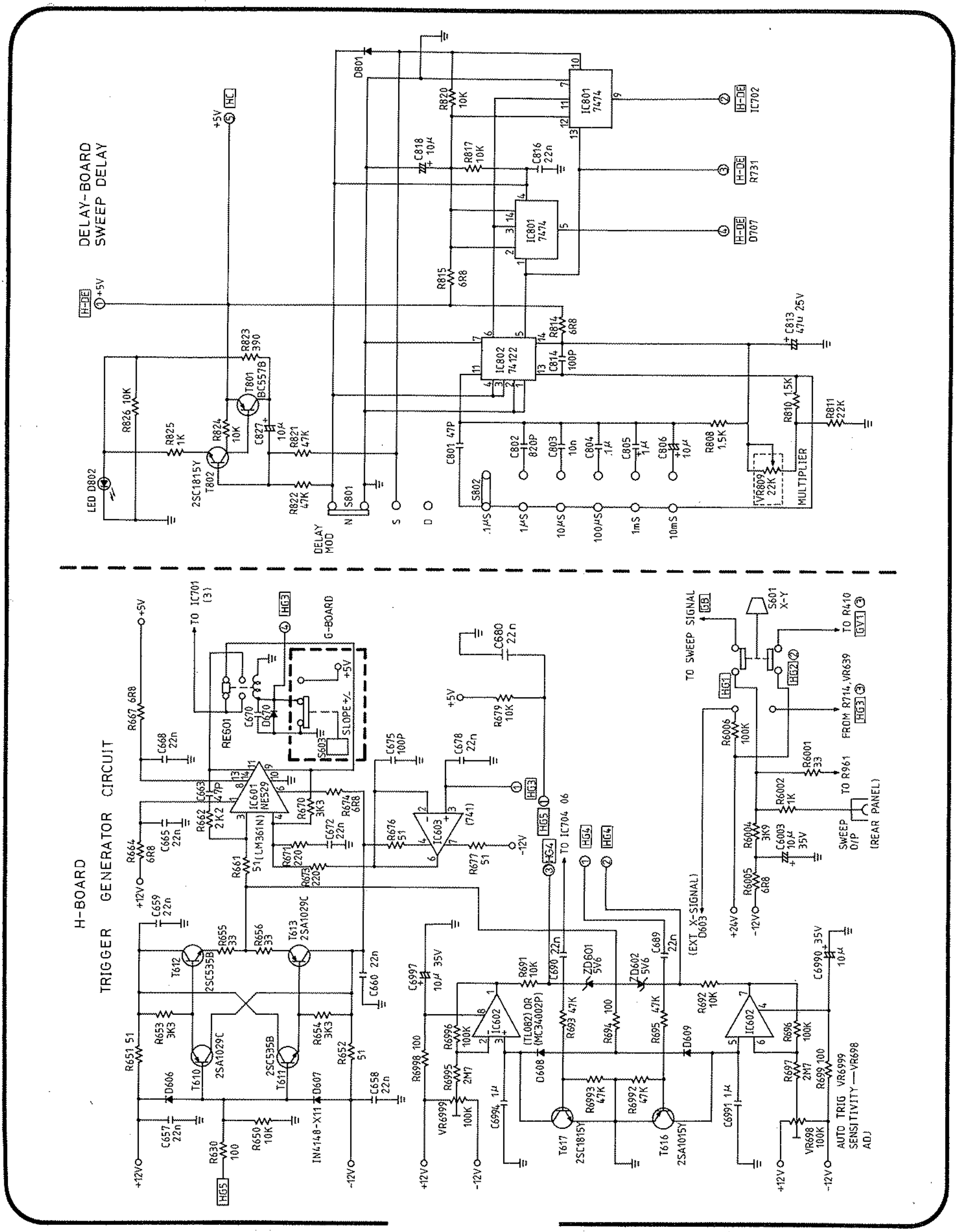
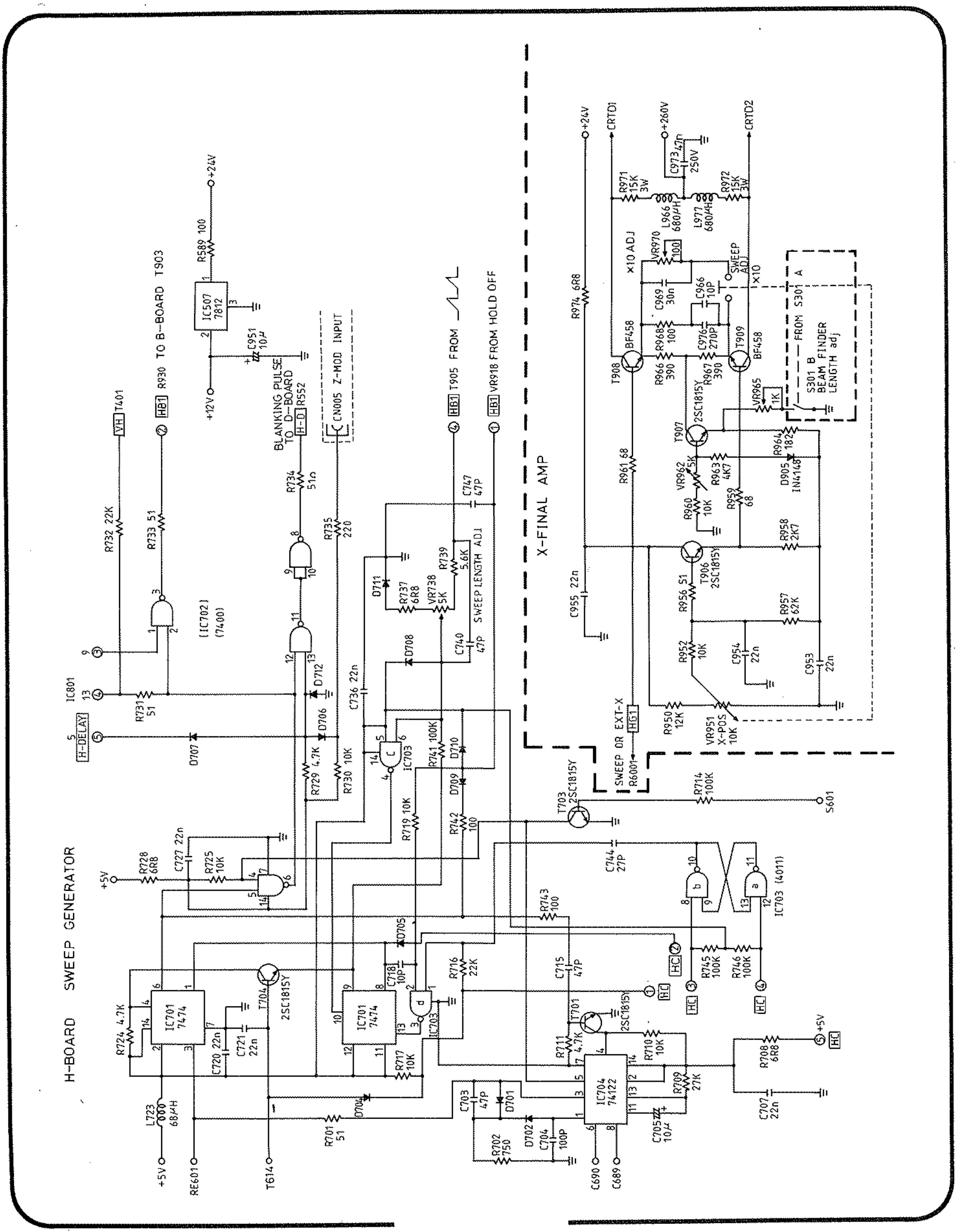
*CAUTION: DO NOT TOUCH OR WIPE the inside surface of the blue filter because it is coated with a soft antistatic spray. Because the coated side of the filter is unmarked, note this position when it is removed. Then when reinstalling ensure that the coated surface is again positioned to face the CRT.

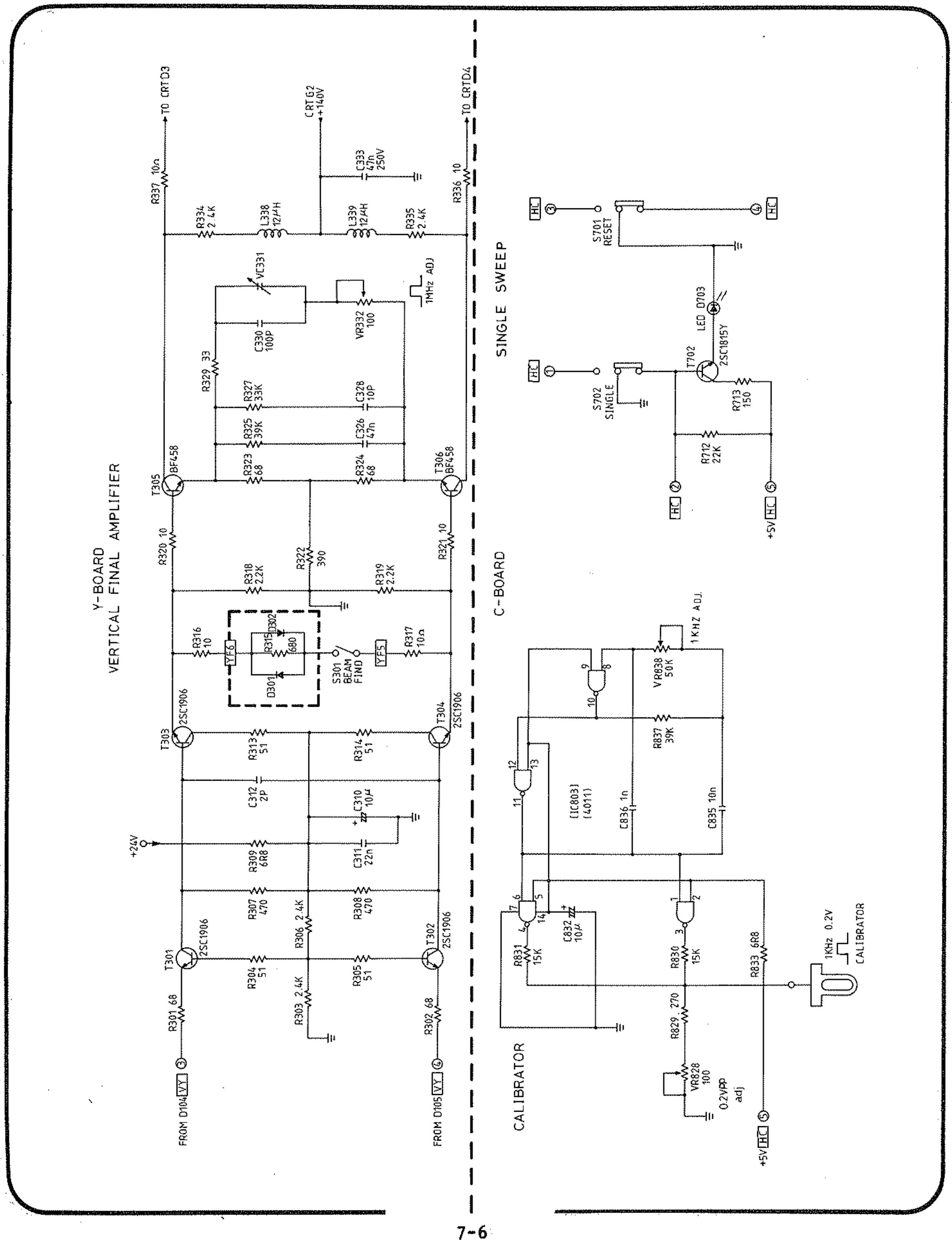
Schematic diagrams for the Model 9020 Oscilloscope are presented on the following pages:

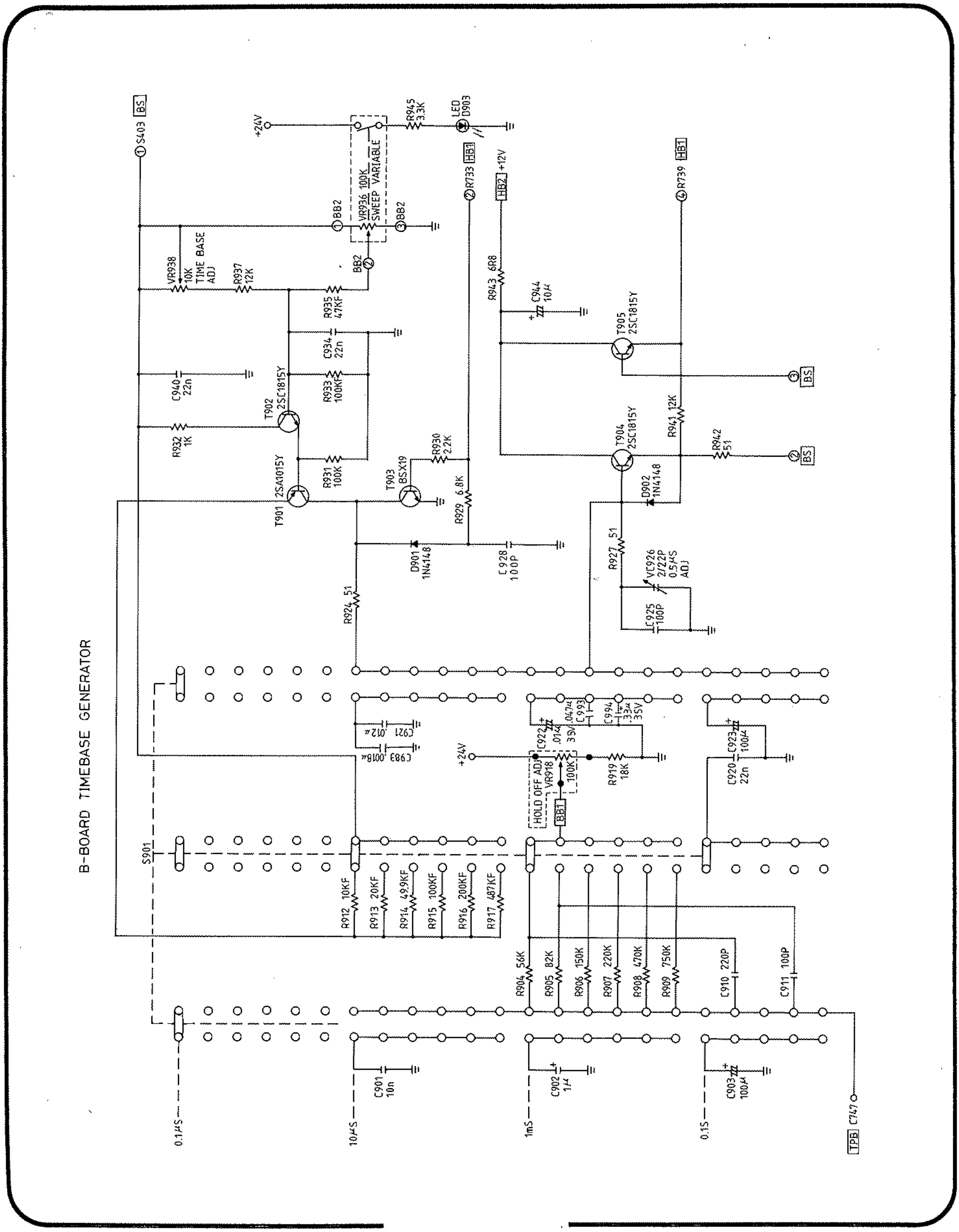

ATT-BOARD ATTENUATORS
CH1
CH2
S101
S201
R120 33
R220 33
R129 1MF
VC128
C124 12P
R125 499KF
VC121
C126 3P
R127 750K
VC130
R131 332KF
C123 3P
VC122
R229 1MF
VC228
C224 12P
R225 499KF
VC221
C226 3P
R227 750K
VC230
R231 332KF
C223 3P
VC222
R117 111KD
C116 3P
VC113
C107 3P
R108 898KD
C101 8P
R118 10.1KD
C114 100P
VC109
R110 988KD
C102 8P
C115 150P
R119 2.03KD
VC111
R102 18.2KF
R101 20.5KF
C104 39P
R112 1MF
C103 15P
R217 111KD
C216 3P
VC213
C207 3P
R208 898KD
C201 8P
R218 10.1KD
C214 100P
VC209
R210 988KD
C202 8P
C215 150P
R219 2.03KD
VC211
R202 18.2KF
R201 20.5KF
C204 39P
R212 1MF
C203 15P
5mv
10mv
20mv
50mv
0.1v
0.2v
0.5v
1v
2v
5v
R001 51
C002 400V 0.047μf
CN001
CH1 INPUT
S102
AC
GND
DC
R004 51
C005 400V 0.047μf
CN002
CH2 INPUT
S202
All trimmers
25P-6P
except VC111 and VC 211
3.5P-10P

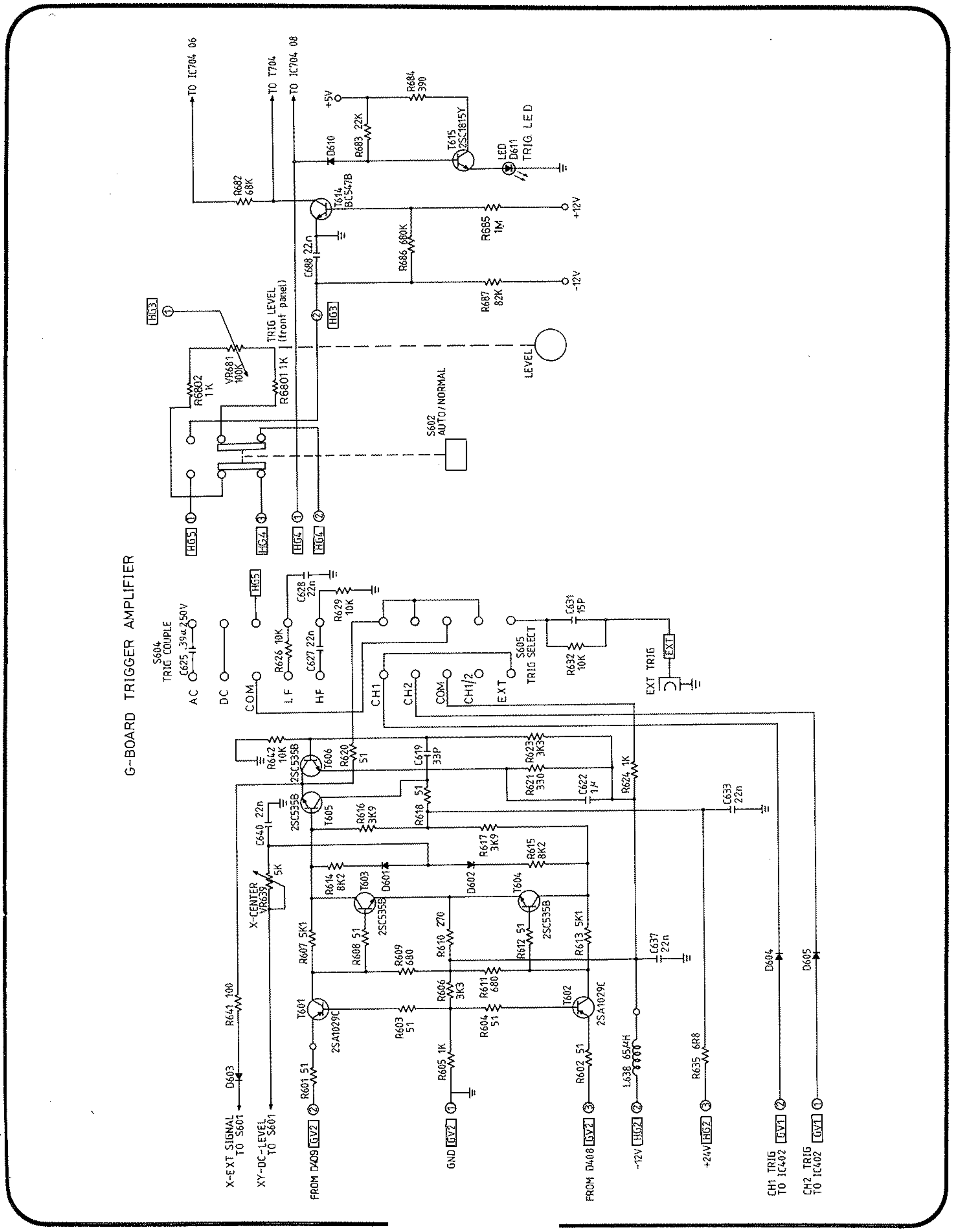

V-BOARD VERTICAL AMPLIFIER & CONTROL LOGIC

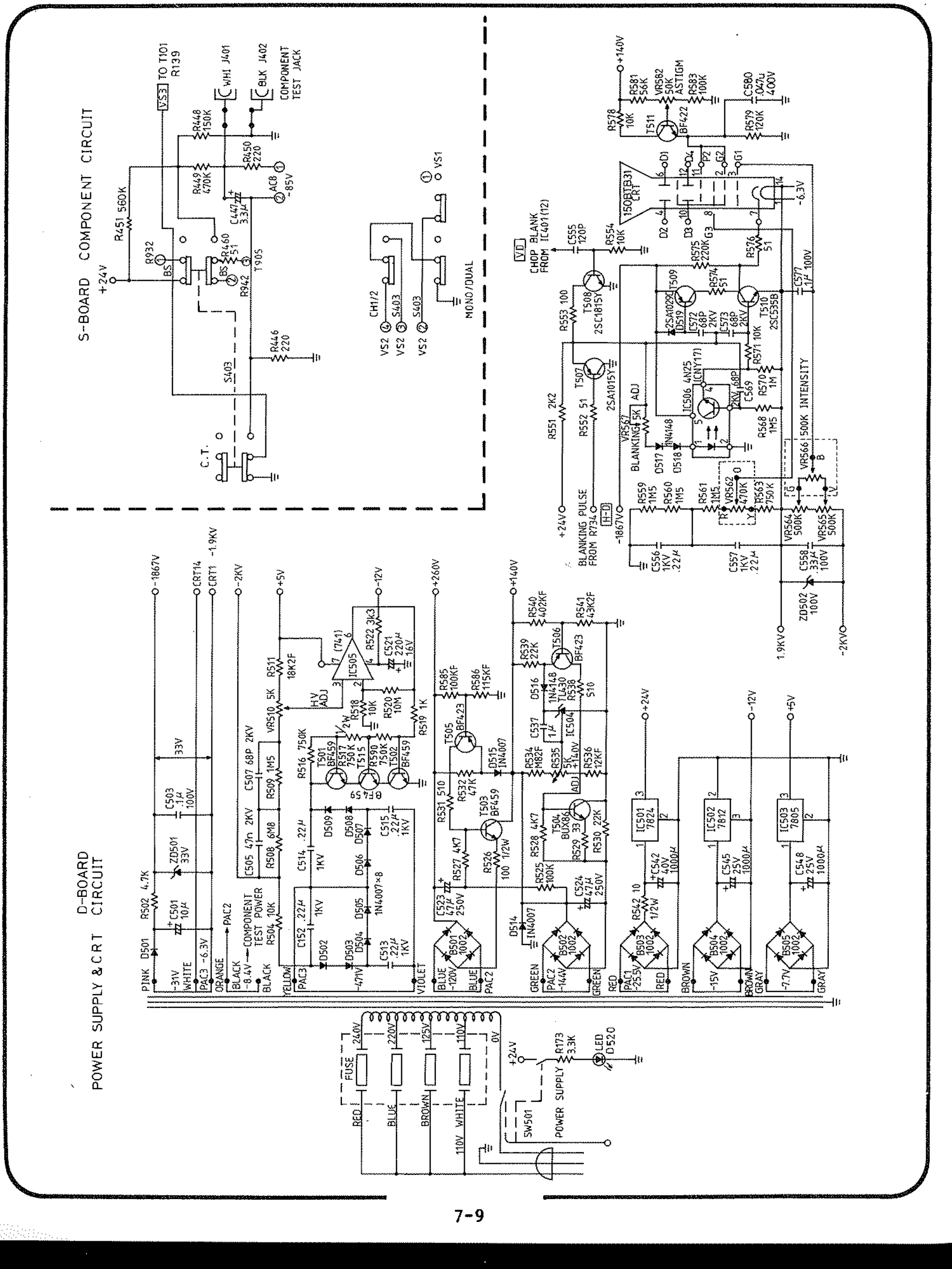

DELAY-BOARD
SWEEP DELAY
H-BOARD
TRIGGER GENERATOR CIRCUIT
G-BOARD
MULTIPLIER
AUTO TRIG SENSITIVITY ADJ
SWEEP O/P (REAR PANEL)
TO SWEEP SIGNAL
DELAY MOD


H-BOARD SWEEP GENERATOR
X-FINAL AMP
SWEEP LENGTH ADJ
BLANKING PULSE TO D-BOARD
CN005 Z-MOD INPUT
R930 TO B-BOARD T903
T905 FROM
VR918 FROM HOLD OFF
SWEEP OR EXT-X
FROM S301 A
S301 B BEAM FINDER LENGTH adj
x10 ADJ
SWEEP ADJ
X-POS
IC703 (4011)
IC702 (7400)
IC701 7474
IC704 74122
IC507 7812
+24V
+260V
+12V
+5V
CRTD1
CRTD2


Y-BOARD
VERTICAL FINAL AMPLIFIER
C-BOARD
SINGLE SWEEP
CALIBRATOR
TO CRTD3
TO CRTD4
CRT G2 +140V
R337 10Ω
R336 10
C333 47n 250V
R334 2.4K
L338 12μH
L339 12μH
R335 2.4K
VC331
VR332 100
1MHz ADJ
C330 100P
R329 33
R327 33K
C328 10P
R325 39K
C326 47n
R323 68
R324 68
T305 BF458
T306 BF458
R320 10
R321 10
R322 390
R318 2.2K
R319 2.2K
R316 10
YF6
D302
R315 680
D301
S301 BEAM FIND
YF5
R317 10Ω
T303 2SC1906
T304 2SC1906
R313 51
R314 51
C312 2P
C310 10μ
+24V
R309 6R8
C311 22n
R307 470
R306 2.4K
R308 470
T301 2SC1906
T302 2SC1906
R304 51
R305 51
R303 2.4K
R301 68
R302 68
FROM D104 VY 3
FROM D105 VY 4
HC 3
HC 4
S701 RESET
LED D703
HC 1
S702 SINGLE
T702 2SC1815Y
R713 150
R712 22K
HC 2
+5V HC 5
1KHZ ADJ.
VR838 50K
R837 39K
[IC803] (4011)
C836 1n
C835 10n
C832 10μ
R831 15K
R830 15K
R833 6R8
1KHz 0.2V
CALIBRATOR
R829 270
VR828 100
0.2VPP adj


B-BOARD TIMEBASE GENERATOR
S403
BS
+24V
R945 3.3K
LED D903
VR936 100K SWEEP VARIABLE
BB2
R733
HB1
HB2
+12V
R739
VR938 10K TIME BASE ADJ
R937 12K
R935 47KF
R943 6R8
C944 10µ
T905 2SC1815Y
C934 22n
C940 22n
R933 100KF
T902 2SC1815Y
R932 1K
R941 12K
R942 51
T904 2SC1815Y
R931 100K
R930 2.2K
T903 BSX19
T901 2SA1015Y
R929 6.8K
D902 1N4148
D901 1N4148
C928 100P
R927 51
VC926 2/22P 0.5µS ADJ
R924 51
C925 100P
C921 .012µ
C983 .0018µ
C922 .014
C993 .047µ 35V
C994 33µ 35V
VR918 100K
HOLD OFF ADJ
R919 18K
C923 100µ
C920 22n
BB1
S901
R912 10KF
R913 20KF
R914 49.9KF
R915 100KF
R916 200KF
R917 487KF
R904 56K
R905 82K
R906 150K
R907 220K
R908 470K
R909 750K
C910 220P
C911 100P
C901 10n
C902 1µ
C903 100µ
0.1µS
10µS
1mS
0.1S
TPB
C747


G-BOARD TRIGGER AMPLIFIER
TO IC704 06
TO T704
TO IC704 08
+5V
R684 390
R683 22K
D610
T615 2SC1815Y
LED D611 TRIG. LED
R682 68K
T614 BC547B
R685 1M
+12V
C688 22n
R686 680K
R687 82K
-12V
TRIG LEVEL (front panel)
VR681 100K
R6802 1K
R6801 1K
LEVEL
S602 AUTO/NORMAL
S604 TRIG COUPLE
C625 .39µ 250V
AC
DC
COM
LF
HF
R626 10K
C627 22n
C628 22n
R629 10K
C631 15P
R632 10K
S605 TRIG SELECT
CH1
CH2
COM
CH1/2
EXT
EXT TRIG
EXT
R642 10K
T606 2SC535B
R620 51
C619 33P
R623 3K3
R621 330
C622 1µ
R624 1K
T605 2SC535B
C640 22n
R616 3K9
R618 51
C633 22n
R617 3K9
R615 8K2
X-CENTER VR639 5K
R614 8K2
T603 2SC535B
D601
D602
T604 2SC535B
R607 5K1
R608 51
R609 680
R610 270
R612 51
R613 5K1
C637 22n
R606 3K3
R611 680
R641 100
T601 2SA1029C
R603 51
R604 51
T602 2SA1029C
R605 1K
R601 51
R602 51
L638 6.5µH
R635 6R8
D603
D604
D605
X-EXT SIGNAL TO S601
XY-DC-LEVEL TO S601
FROM D409 GV2
GND GV2
FROM D408 GV2
-12V HG2
+24V HG2
CH1 TRIG TO IC402 GV1
CH2 TRIG TO IC402 GV1
HG3
HG4
HG5


S-BOARD COMPONENT CIRCUIT
COMPONENT TEST JACK
MONO/DUAL
POWER SUPPLY & CRT
D-BOARD CIRCUIT
CHOP BLANK FROM IC401(12)
BLANKING PULSE FROM R734
BLANKING ADJ
500K INTENSITY
HV ADJ
COMPONENT TEST POWER
POWER SUPPLY
FUSE

MEMO

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BECKMAN INDUSTRIAL CORPORATION
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