

INSTRUCTION MANUAL

Serial Number B010189

4701

**EIGHT - CHANNEL
MULTIPLEXER**



WARRANTY

All Tektronix instruments are warranted against defective materials and workmanship for one year.

Any questions with respect to the warranty, mentioned above, should be taken up with your Tektronix Field Engineer or representative.

All requests for repairs and replacement parts should be directed to the Tektronix Field Office or representative in your area. This procedure will assure you the fastest possible service. Please include the instrument Type (or Part Number) and Serial or Model Number with all requests for parts or service.

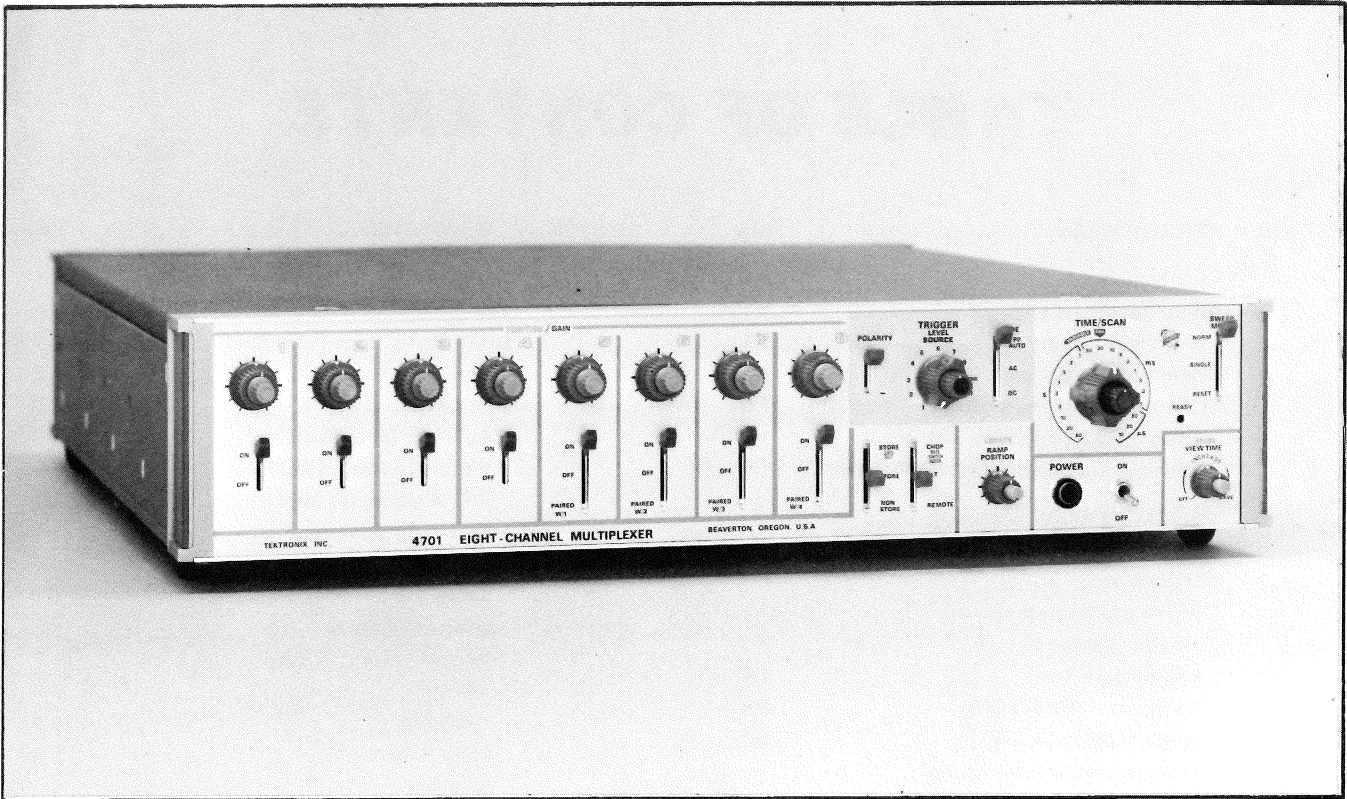
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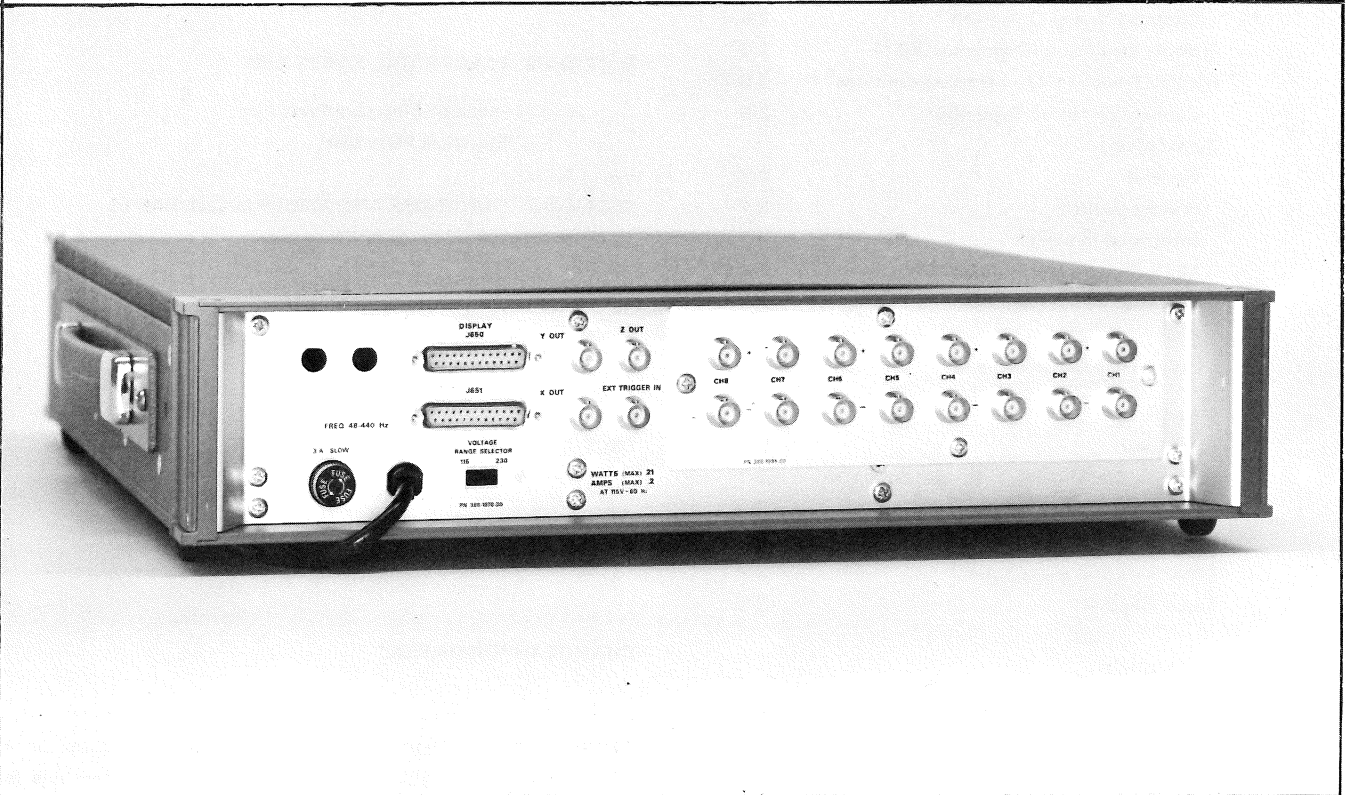
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(A) Front view of instrument.



(B) Rear view of instrument.

Fig. 1-1. 4701 Eight-Channel Multiplexer.

SECTION 1

SPECIFICATION

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

Introduction

The 4701 Eight-Channel Multiplexer provides eight differential input channels and a calibrated time base for use with any XYZ display monitor, including scan converters. The 4701 allows selection of as many as eight Y-T displays or four X-Y displays, or any combination of Y-T and X-Y displays.

The 4701 contains automatic erase circuitry for storage oscilloscopes, and circuitry to control the Write Only mode of a 4501 Scan Converter. The calibrated time base in the 4701 includes full triggering facilities.

Input to the eight channels is obtained by connectors on the rear of the 4701. The multiplexed output, together with display unit control signals, is available via a standard 25 pin connector, thus requiring only one interconnecting cable between the 4701 and Tektronix display units such as Tektronix Types 601, 602, 611 or a display device such as the Tektronix Type 4501 Scan Converter. Compatibility of the 4701 with display devices not manufactured by Tektronix can usually be determined by consulting the specifications of the 4701 and the display device.

The 4701, when used in conjunction with a storage or non-storage display unit, may be used to display signals on the display unit. The 4701 may also be used as an eight-channel time division multiplexer, with the time divisions controlled either internally or externally.

Safety Considerations

The instrument is intended to be operated from a single-phase power source which has one of its current-carrying conductors (the neutral conductor) at or near ground (earth) potential. Operation from other power sources where both current-carrying conductors are live with respect to ground (such as phase-to-phase on a multi-phase system, or across the legs of a 117-234 V single-phase system) is not recommended, as only the Line Conductor has over-current (fuse) protection within the instrument.

The instrument is provided with a three-wire power cord with a three-terminal, polarized plug for connection to the power source. The grounding terminal of the plug is directly connected to the instrument frame as recommended by national and international safety codes. Color coding of cord conductors follows the National Electrical Code (ANSI C1-1968) which specifies Line, Black; Neutral, White; Safety Earth or Ground, green with yellow stripe (or solid green).

Performance Conditions

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

The instrument must have been calibrated at an ambient temperature between +20°C and +30°C.

The instrument must be operated at an ambient temperature between 0°C and +50°C at an altitude of 15,000 feet or less.

**ELECTRICAL CHARACTERISTICS
AMPLIFIERS**

Characteristic	Performance Requirements	Supplemental Information
Input R and C (all channels)		1 M Ω within 5%, paralleled by approximately 20 pF
Channel Input to X or Y Output		Eight identical differential amplifiers (one for each input channel) and separate X and Y output amplifiers
Bandwidth	DC to 1 MHz	
Gain	Adjustable using front panel GAIN control for 1 V at X or Y output with an input of 1 V to 10 volts.	
Common Mode Rejection Ratio	At least 100:1 for frequencies below 100 kHz	
Maximum Differential Input (BNC inputs)		10 volts (either polarity)
Outputs (X,Y) at BNC or J650		From -5 V to +5 V
Output Impedance (X and Y)		Approximately 50 Ω

INTERNAL TIME BASE AND BLANKING

Characteristic	Performance Requirements	Supplemental Information
Time/Scan	50 seconds to 10 μ s time base ramp duration in 21 calibrated steps (5, 2, 1 sequence)	
Accuracy	Within 3%	
Variable (uncalibrated)	Permits slowing the ramp from the calibrated value by any factor from 1 to 1 to 2.5 to 1.	
Ramp Amplitude	Nominally 1 V at X output for use with display devices	Internally adjustable from 1 to 1.5 volts
Blanking Levels	TTL Output	
Low	Blanked	
High	Unblanked	
		Internally adjustable to 1 V

TRIGGERING, CHOP RATE, AND VIEWTIME

Triggering	20 Hz to 1 MHz with AC or P-P selected. DC to 1 MHz with DC selected.	
Channel 1 through 8	With channel input signal and GAIN setting resulting in an X or Y output signal of at least 20 mV	
EXT	At least 50 mV at rear-panel BNC connector	
Chop Rate	Any one of three frequencies selectable using an internal switch	Normally adjusted at HIGH rate using an internal adjustment. Tektronix Display Unit
	LOW	For Type 611 (rate ≈2.5 kHz)
	MED	For Type 601 and 602 (rate ≈33 kHz)
	HIGH	Type 4501 (rate ≈330 kHz)
View Time		100 ms to approximately 30 seconds

PROGRAMMABLE INPUTS (J651)¹

Characteristic	Performance Requirements	Supplemental Information																																							
Logic	Positive	"1" indicates that the pin is at its high level																																							
Remote Erase		Pin 18																																							
Channel Identify		Levels on three pins of J651 indicate to external equipment which channel is presently displayed.																																							
		<table border="1"> <thead> <tr> <th rowspan="2">Channel Displayed</th> <th colspan="3">J651 pin number</th> </tr> <tr> <th>4</th> <th>15</th> <th>1</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>0</td> <td>0</td> <td>0</td> </tr> <tr> <td>2</td> <td>0</td> <td>0</td> <td>1</td> </tr> <tr> <td>3</td> <td>0</td> <td>1</td> <td>0</td> </tr> <tr> <td>4</td> <td>0</td> <td>1</td> <td>1</td> </tr> <tr> <td>5</td> <td>1</td> <td>0</td> <td>0</td> </tr> <tr> <td>6</td> <td>1</td> <td>0</td> <td>1</td> </tr> <tr> <td>7</td> <td>1</td> <td>1</td> <td>0</td> </tr> <tr> <td>8</td> <td>1</td> <td>1</td> <td>1</td> </tr> </tbody> </table>	Channel Displayed	J651 pin number			4	15	1	1	0	0	0	2	0	0	1	3	0	1	0	4	0	1	1	5	1	0	0	6	1	0	1	7	1	1	0	8	1	1	1
		Channel Displayed		J651 pin number																																					
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		5	1	0	0																																				
		6	1	0	1																																				
7	1	1	0																																						
8	1	1	1																																						

PROGRAMMABLE INPUTS (J651)¹ cont.

Characteristic	Performance Requirements	Supplemental Information																																							
Clear		Pin 10 (pulls 4701 into channel 1)																																							
Channel Select	Permits selecting channel from a remote location using a binary code applied to three pins of J651.	4701 switch must be set to REMOTE. <table border="1"> <thead> <tr> <th rowspan="2">Channel Desired</th> <th colspan="3">J651 pin number</th> </tr> <tr> <th>8</th> <th>7</th> <th>6</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>1</td> <td>1</td> <td>1</td> </tr> <tr> <td>2</td> <td>1</td> <td>1</td> <td>0</td> </tr> <tr> <td>3</td> <td>1</td> <td>0</td> <td>1</td> </tr> <tr> <td>4</td> <td>1</td> <td>0</td> <td>0</td> </tr> <tr> <td>5</td> <td>0</td> <td>1</td> <td>1</td> </tr> <tr> <td>6</td> <td>0</td> <td>1</td> <td>0</td> </tr> <tr> <td>7</td> <td>0</td> <td>0</td> <td>1</td> </tr> <tr> <td>8</td> <td>0</td> <td>0</td> <td>0</td> </tr> </tbody> </table>	Channel Desired	J651 pin number			8	7	6	1	1	1	1	2	1	1	0	3	1	0	1	4	1	0	0	5	0	1	1	6	0	1	0	7	0	0	1	8	0	0	0
Channel Desired	J651 pin number																																								
	8	7	6																																						
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3	1	0	1																																						
4	1	0	0																																						
5	0	1	1																																						
6	0	1	0																																						
7	0	0	1																																						
8	0	0	0																																						

INPUT POWER AND REGULATED SUPPLIES

Line Voltage Range		
115 VAC	90 to 136 VAC	Selected by rear-panel slide switch
230 VAC	180 to 272 VAC	
Line Frequency Range		48 Hz to 440 Hz
Maximum Power Consumption (High Line, 60 Hz)	21 W	

¹See Table 1-1 for pin functions of rear panel connectors J650 and J651. The pin locations on connectors J650 and J651 are shown in Fig. 1-2.

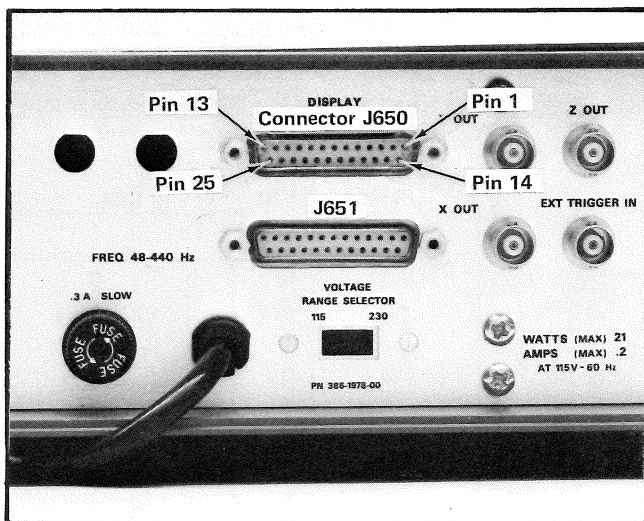


Fig. 1-2. Rear panel 25 pin connectors.

ENVIRONMENTAL CHARACTERISTICS

Storage	
Temperature	-40°C to +65°C.
Altitude	To 50,000 feet.
Operating	
Operating Temperature	0°C to +50°C.
Operating Altitude	To 15,000 feet.

MECHANICAL CHARACTERISTICS

Dimensions	Height \approx 3 1/2 inches	
	Width \approx 19 inches	
	Length \approx 19 inches	
Standard Accessories Included		
1	6 ft Interconnecting Cable	012-0258-00
1	25 Pin Connector (Male)	131-0570-00
1	Instruction Manual	070-1164-00

TABLE 1-1
PIN ASSIGNMENTS

Pin No.	Upper 25-Pin Connector (J650)	Lower 25-Pin Connector (J651)
1	X Output	"1" Identify (output)
2	X Ground	
3	Y Ground	
4	Blanking (Z output)	"4" Identify (output)
5	Z Ground	Ground
6	Non-Store (output)	"1" Channel Selection (input)
7	Erase Interval (input)	"2" Channel Selection (input)
8		"4" Channel Selection (input)
9		
10		Clear (input)
11	Switching Signal (input)	
12		
13		
14	X Ground	
15	Y Output	"2" Identify (output)
16	Y Ground	
17	Z Ground	Ground
18	Erase (output)	Remote Erase (input)
19	Program Ground	
20		
21		
22	WRITE ONLY (output)	
23		
24		
25		

SECTION 2

OPERATING INSTRUCTIONS

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

Introduction

The 4701 Eight-Channel Multiplexer is intended for use with Display Instruments such as Tektronix Types 601, 602, 611, and 4501. The 4701 permits simultaneous display on the display device of signals from as many as eight different sources. This is accomplished by time-sharing (switching) between "ON" channels. No time is allotted to an "OFF" channel. Simultaneous display of as many as eight Y-T or four X-Y displays can be selected. If desired, a combination of Y-T and X-Y displays may be used (i.e. six Y-T and one X-Y).

Channels 1, 2, 3 and 4 can be individually turned ON or OFF, channels 5, 6, 7 and 8 can be individually turned ON or OFF or can be PAIRED with channels 1, 2, 3 and 4 respectively to provide X-Y displays. Signals delivered to "ON" channels appear at the "Y" output of the 4701 sequentially (1, 2, 3, 4, 5, 6, 7, and 8). If the PAIRED position (available for channels 5 through 8) is selected, the input signal of these channels is delivered to the "X" (horizontal) output of the 4701 during the time allotted to the channel with which it is paired.

Input to the eight channels is through eight pairs of BNC connectors. Differential input is provided by a plus (+) and minus (-) connector for each channel. Three BNC connectors on the rear panel provide X, Y, and Z output signals. The X, Y, and Z outputs of the 4701 are also connected to the upper 25 pin connector (J650) on the instrument rear panel. This connector also provides control signals, such as Erase or Write Only commands to display devices that can utilize these signals. Another 25 pin connector (J651) is provided on the rear panel. This connector may be connected to a remote programming device. Pin assignment for both rear panel 25 pin connectors is given in Section 1 (Table 1-1) of this manual.

Front panel controls, for each of the eight channels, are provided for GAIN and POSITION. See Fig. 2-1A. The POSITION control provides independent vertical movement of the displays of "ON" channels. The POSITION control for a channel switched to PAIRED causes horizontal movement of the paired channel display.

The calibrated time base in the 4701 includes full triggering facilities. See Fig. 2-1B. Peak-to-peak auto triggering

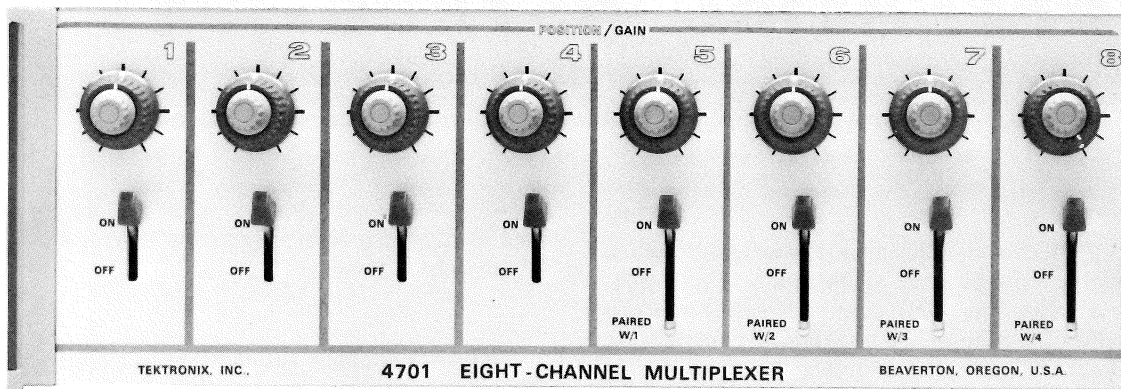
is available. Trigger slope and amplitude can be selected, as well as triggering from an external source, the line, or any of the eight channels.

The 4701 contains automatic erase circuitry for controlling storage display devices. The display device may be erased and the 4701 channel or channels selected manually at the 4701 front panel, or by signals from a remote programming device. An automatic erase feature controls the time-base and erase function so that the unit will step through the "ON" channels to create the display and hold this display for a time determined by the setting of the VIEW TIME control.

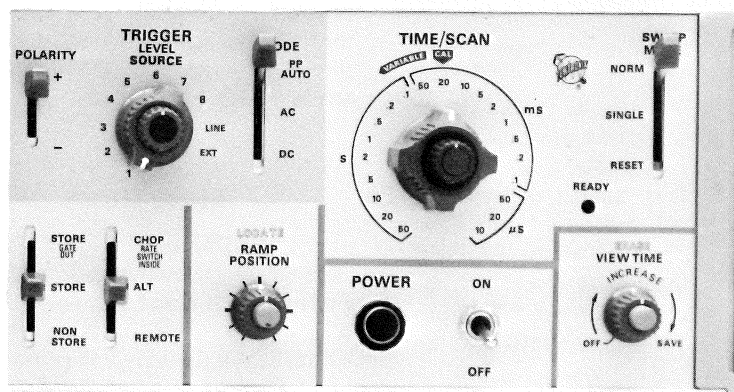
FUNCTIONS OF CONTROLS, CONNECTORS AND INDICATORS

Front Panel Controls and Indicators

TIME/SCAN Switch	Permits selection of calibrated TIME/SCAN ranges from 50 seconds to 10 μ s in a 5, 2, 1 sequence (21 calibrated switch positions).
VARIABLE Control	With the VARIABLE control, any time per scan between that selected by the TIME/SCAN control and the next slowest TIME/SCAN position can be obtained. The VARIABLE control permits increasing the selected TIME/SCAN (slowing the ramp) by any factor from 1 to 1, to at least 2.5 to 1. The variable control is not calibrated.
SWEEP MODE Switch	
NORM	The channels are displayed in sequence each time triggering from the selected triggering source occurs.
SINGLE	A single sweep results, if the READY light is "ON", when triggering from the selected triggering source occurs. In alternate (ALT) mode, only one channel will



(A) Individual channel controls (left portion of 4701 front panel).



(B) Controls located on right portion of 4701 front panel.

Fig. 2-1. 4701 Front panel controls. (A) shows controls located on left portion of front panel and (B) shows controls located on right portion.

be displayed and another reset is necessary to display the next successive channel. In CHOP mode, all "ON" and "PAIRED" channels will be displayed in one sweep.

SWITCHING MODE
Switch (CHOP, ALT, REMOTE)

Permits selecting the mode of channel switching. Switching between "ON" channels can be controlled in CHOP and ALT mode.

RESET

Pushing the switch to RESET and releasing it resets the sweep and causes the READY light to come on.

In CHOP MODE an internal oscillator, providing a choice of three switching frequencies, controls channel switching.

READY Indicator

When light is "ON" during Single sweep operation, the instrument is waiting for a trigger signal from the selected trigger source. Arrival of a trigger starts the sweep and shuts off the light.

In ALT MODE the channel switching rate is determined by the setting of the TIME/SCAN control.

STORE (Gate Out), STORE, NON STORE Switch

Permits programming (from the 4701 front panel) of display device modes.

In REMOTE the channel selected is determined by the level on three input lines assigned for this purpose. A binary code is used (CH 1 = 111, CH 8 = 000). With REMOTE selected, both the "ON" and "OFF"

positions of all eight of the front panel switches are ignored. If a front panel switch (assume CH 5) is in the "PAIRED" position and the channel it is paired with (CH 1) is remotely selected, an X-Y display results.

RAMP POSITION Control Permits horizontal movement of the sweep start position. Sweep start of all channels (except paired) is moved to the left or right by rotating the RAMP POSITION control.

LOCATE Pushbutton When this button is pushed in, the horizontal and vertical gain of all channels is reduced to about 1/3 of the previous value. This control is provided as an aid in locating and positioning the traces.

POWER ON-OFF Switch and Indicator Switch used to apply or remove input power to the instrument. The indicator lamp lights when power is applied.

VIEW TIME Controls (for Storage Monitors)

VIEW TIME in OFF No auto erase, manual erase with ERASE pushbutton.

VIEW TIME in SAVE No auto erase. The ERASE pushbutton erases the screen and a single display of "ON" channels is initiated by the trailing edge of the Erase Interval pulse from storage units. In CHOP this will require only one sweep, in ALT this will require one sweep for each ON channel.

VIEW TIME between OFF and SAVE The sequence of operation is as follows:

- a. Display erases.
- b. The end of the erase interval initiates a single display of ON channels. In CHOP this will require only one sweep, in ALT this will require one sweep for each ON channel.
- c. The display remains static for from <100 ms to about 30 seconds as selected by the VIEW TIME control, or until the ERASE pushbutton is pushed.
- d. Display erases and sequence continues once again.

Rear Panel Connectors and Switches

Connector J650 (Upper 25-Pin Connector) Same type connector as used on Tektronix display devices. X, Y, and Z outputs and signals for control of the display device are available at this connector.

Connector J651 (Lower 25-Pin Connector) May be connected to a remote programming device. Provides three binary lines for ON channel selection, three binary lines for ON channel indication, a line for remote erase, and a clear line that resets instrument to Channel 1. See Table 1-1.

115 V/230 V Switch Permits powering the 4701 from a nominal 115 V or 230 V line voltage source.

X, Y, Z Output Connectors Three BNC connectors for the 4701 X, Y, and Z outputs.

TRIG IN Connector A BNC connector for applying a triggering signal from an external source.

Differential Input Connectors 16 BNC connectors (+ and - for each of the eight channels).



A slide type switch is provided on the 4701 rear panel to permit instrument operation from 115 V or 230 V line power. Be sure that this switch is set to the position corresponding to your line voltage before applying power to this instrument.

FIRST TIME OPERATION

Set 4701 front panel controls as given below:

Channel selecting switches	
for all channels	OFF
Channel POSITION controls	
for all channels	fully ccw
GAIN Controls for	approximate
all channels	midposition
POLARITY	+
MODE	P-P AUTO
TIME/SCAN	5 ms
TIME/SCAN Variable	
(outer knob)	fully cw to CAL
SWEEP MODE	NORM
Store/Non Store	
Switch	NON STORE
Chop/Alternate/Remote	
Switch	ALT
RAMP POSITION	approximate
Control	mid-position
POWER Switch	OFF

Operating Instructions—4701

NOTE

Be sure that your display unit is set for a no signal beam position at the center of the display. If in doubt disconnect any interconnecting cabling between the 4701 and your display unit and turn up the display unit Intensity until a spot is visible. Front panel controls, internal positioning switches, or internal X and Y adjustments are provided by various display units for centering the beam along the X and Y axis.

Positioning a Trace

1. Connect the X, Y, and Z outputs on the 4701 rear panel to the X, Y, and Z inputs of the display device (three coaxial cables are required with BNC connectors).

NOTE

If a Tektronix Display Device such as the Type 601, 602, 611, or 4501 is used, the 6 foot interconnecting cable supplied with your 4701 may be substituted for the three coaxial cables specified in Step 1. This cable is connected from the upper 25 pin connector (J650) on the 4701 rear panel to the same type connector on the display device. Additional capability provided by this cable is discussed following First Time Operation.

2. Turn on the power switch of the 4701 and the display device, and permit warm-up time if required by the display device.

3. Move the channel selecting switch for channel 1 to ON.

4. Turn channel 1 POSITION control (outer knob) slowly clockwise and watch for a trace.

5. Position the trace near top of the display area.

6. Adjust the RAMP POSITION control so that the trace starts near the left edge of the display area.

7. Turn the channel 1 POSITION control clockwise until the channel 1 trace is deflected off-screen.

8. Push in the LOCATE pushbutton and note that the trace is now visible, although it is shorter in length. The LOCATE switch is provided as an aid in locating and positioning channel displays.

9. Release the LOCATE pushbutton and again position the channel 1 trace near the top of the display.

10. Move the channel selecting switch for channel 2 to ON.

11. Turn the channel 2 POSITION control slowly clockwise and position the channel 2 trace slightly below the channel 1 trace.

12. Repeat steps 10 and 11 for the remaining channels.

13. Turn off all channels except channels 1, 4, and 8 and note that only these three channels are displayed.

14. Set the TIME/SCAN control to 2 second position and note that ON channels are displayed in numerical order.

15. Return the TIME/SCAN switch to the 5 ms position.

16. Move the TRIGGER MODE switch to the AC or DC position and note that no traces are displayed. A free running trace is possible only in the P-P AUTO position.

17. Return the TRIGGER MODE switch to P-P AUTO position.

18. Set channel 4 and 8 switches to OFF.

Observing an Input Signal

1. Vertically position the channel 1 trace to the approximate center of the display area.

2. Connect a 0.4 V amplitude, 1 kHz square wave to the (+) input for channel 1 (rear panel BNC connector).

NOTE

Signal amplitudes from approximately 20 mV to 10 volts are usable. For signals smaller than specified in step 2, turn the channel 1 GAIN control clockwise, and for larger signals turn the control counterclockwise. If the period of the signal differs from the 1 ms given in step 2, change the 4701 TIME/SCAN setting accordingly.

3. Set TRIGGER SOURCE to channel 1.

4. Adjust TRIGGER LEVEL, and observe that triggering is occurring on the positive slope of the displayed signal. Set GAIN for desired amplitude.

5. Switch POLARITY to (-) and check for triggering on the negative slope of the input signal (TRIGGER LEVEL may require readjustment).

6. Check triggering in the AC and DC positions of the TRIGGER MODE switch. Note that no display is present unless the TRIGGER LEVEL control is set to a position that results in triggering.

7. Return the TRIGGER MODE switch to P-P AUTO.

Single Scan Operation

1. Rotate the TRIGGER LEVEL control fully clockwise so that the sweep is free-running instead of triggered.

2. Slowly rotate the TRIGGER LEVEL control ccw just enough to obtain a stable triggered display.

3. Disconnect the input signal to channel 1 at the rear panel, or turn off the signal source.

4. Switch the SWEEP MODE switch to SINGLE. Note that no signal is displayed, and that the READY light is lit.

5. While observing the display device, return the signal to the channel 1 input and note that a single scan is displayed. The READY light goes out when the sweep is triggered.

6. Push the SWEEP MODE switch to the RESET position and release it. Each time this switch is pushed to RESET, a single sweep is displayed. Since the 1 kHz input signal provides suitable triggering signals at intervals of 1 ms, the READY light hasn't time to come on before the sweep is triggered and power is removed from the READY light.

7. Return the SWEEP MODE switch to NORM.

GENERAL OPERATING INFORMATION

PAIRED Operation

Switching to "PAIRED" provides an X-Y display of the paired channels. With channel 1 "ON" and channel 5 switched to "PAIRED", the internal time base will not be used during the time allotted for display of the channel signal. The channel 1 signal, after passing through its pre-amplifier, is delivered to the Y (vertical) Amplifier, and the channel 5 signal supplies input to the X (horizontal) Amplifier during the same time interval.

Determining the phase angle between signals, or the ratio of two frequencies, or presenting graphic displays are some of the applications of X-Y displays.

Another application of "PAIRED" operation is supplying time base ramps of various durations. This permits simultaneous display of signals requiring two, three, or four different time bases.

ALT (Alternate) Sweep Operation

The sequential selection of "ON" channels is illustrated by the photos of Fig. 2-2. Signals are being delivered to channels 1, 2, and 4 of the 4701 and these channels are switched "ON". Fig. 2-2A shows the display on a Type 601 Display Unit, while Fig. 2-2B shows the display of the 4701 "Y" output on the test oscilloscope.

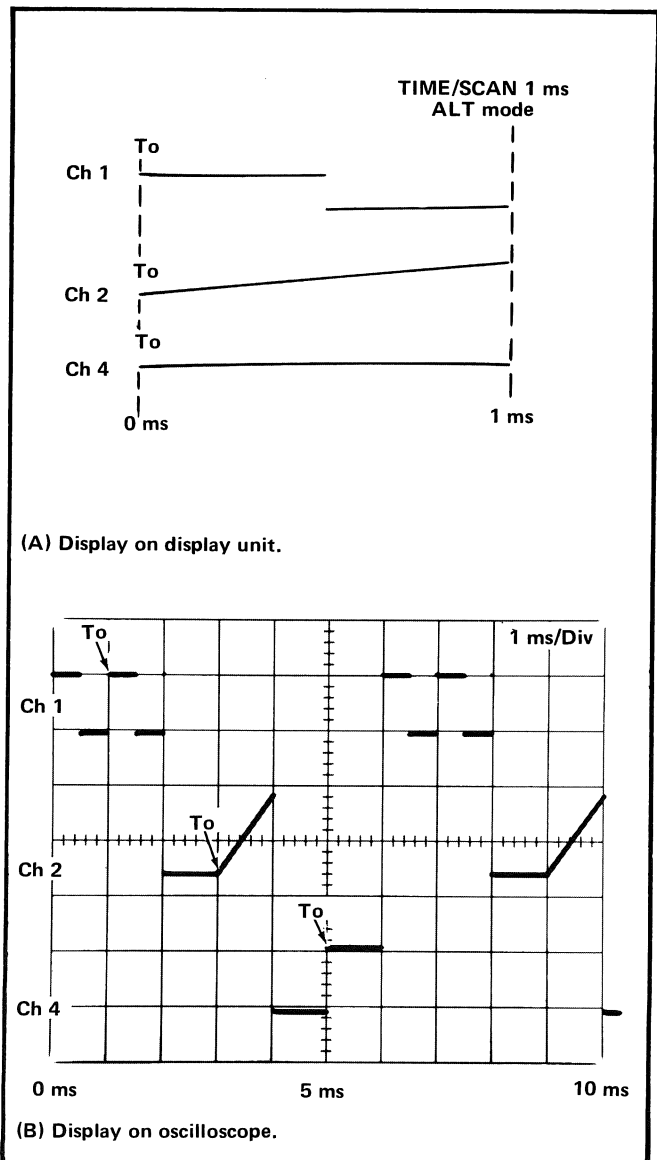


Fig. 2-2. Sequential selection of channels.

Operating Instructions—4701

The signal fed to the 4701 channel 1 input is a 1 kHz square-wave from the calibrator of the test oscilloscope. Although the 4701 channel 2 and channel 4 input signals are normally applied from an external source, the 4701 is providing these signals in the example illustrated in Fig. 2-2. The channel 2 input signal is applied through a probe connected to the circuit providing the 4701 time base ramp. The channel 4 input is connected to the 4701 "Z" output to show the blanking signal for the conditions given in Fig. 2-2.

The long blanking interval (1 ms) is the result of setting the 4701 TIME/SCAN equal to the period of the input signal used as the triggering source. If the TIME/SCAN is at 1 ms and the hold-off time is assumed to be 0.1 ms, sweeps cannot be triggered at intervals closer than 1.1 ms.

Fig. 2-2B shows that the "ON" channels (1, 2, and 4) are displayed in numerical order. A total of 6 ms is required to display all three signals once. The symbol T_O is used in Fig. 2-2 to indicate the time at which the 4701 sweep circuit is triggered.

CHOP (Chopped Sweep Operation)

The CHOP position of the channel selection mode switch is useful in reducing flicker of the display at the slower TIME/SCAN settings. In the example shown in Fig. 2-2, 2 ms is required for the display of each channel with ALT. mode selected. If the CHOP position is selected, only 2 ms is required for each display of all "ON" channels.

With CHOP selected, switching between "ON" channels occurs at a rate determined by the 4701 Chop Rate Oscillator. The maximum recommended chopping rate is dependent upon the bandwidth of the display device (see Section 1). Low, medium, or high chop rates are selectable using the Chop Rate switch mounted on the 4701 Counter Board.

If a Tektronix Type 4501 Scan Converter is used as the display device, the CHOP mode permits sampling of three of the 4701 input signals during each "Write" interval (in WRITE-READ mode) of the Type 4501.

NOTE

When using a Type 4501 having a serial number from B010000 to B999999 be sure that pin 11 of J1302 is connected to pin 1 of J1304. Soldering a wire between these pins makes the 4501 Read/Write Switching Signal available at 25 pin connector J1302.

This use is discussed later in this section under Applications.

REMOTE Operation (connector J651)

In REMOTE, the channel selected is determined by the level on three lines assigned for this purpose (see Fig. 2-3). A binary code is used for remote channel selection (Ch 1 = 111, Ch 8 = 000). With REMOTE selected, both the "ON" and "OFF" positions of all eight of the 4701 front panel switches are ignored. If a front panel switch (assume Ch 5) is in the "PAIRED" position and the channel it is paired with (Ch 1) is remotely selected, an X-Y display results. If REMOTE is selected and the cable to J651 is disconnected, channel 1 is displayed, since pins 8, 7, and 6 of J651 are "high".

If the remote programming device switches pin 10 of J651 to its low level, a "Clear" command is sent to the 4701. This causes the 4701 Counter output to select the channel 1 signal for display. Remote erasing of a display device connected to the 4701 through connector J650 may be accomplished by switching pin 18 of J651 to a low level.

The 4701 channel being displayed is indicated by the level on three pins of J651 (See Section 1 for pin numbers and coding used for "Identify").

Display Device to 4701 Interconnections (J650)

The functions provided by connector J650 can be placed in three groups: X, Y, and Z output signals to the display device, commands to the display device, and information from the display device (see Fig. 2-4). The X, Y, and Z output signals appear at pins 1, 15 and 4 respectively of J650. The 4701 commands available for use by the display device are: Non-store, Erase, and WRITE ONLY. The Non-store and Erase commands are for use by storage type display devices and the WRITE ONLY command can be used to control the operating mode of the Tektronix Type 4501 Scan Converter.

Connection to the Type 4501 Scan Converter. Fig. 2-4 shows the three output commands of the 4701 connected to the 25 pin remote control connector on the rear panel of the Type 4501 Scan Converter. Since PROGRAM GROUND (pin 19 of J650) of the 4701 is connected to CHASSIS GROUND (pin 19 of J1302) on the Type 4501, the commands from the 4701 can control the 4501 even if LOCAL control is selected at the Type 4501 front panel; provided that the 4501 front panel switches are in positions other than NON-STORE and WRITE ONLY. With the 4501 set to LOCAL the 4501 display may be erased from the 4501 or 4701 front panel. It should be noted that the 4701 can deliver a WRITE ONLY command only with STORE (GATE OUT) selected and during sweep time of the 4701.

The function of all pins of J650 is given in Table 1-1 in Section 1.

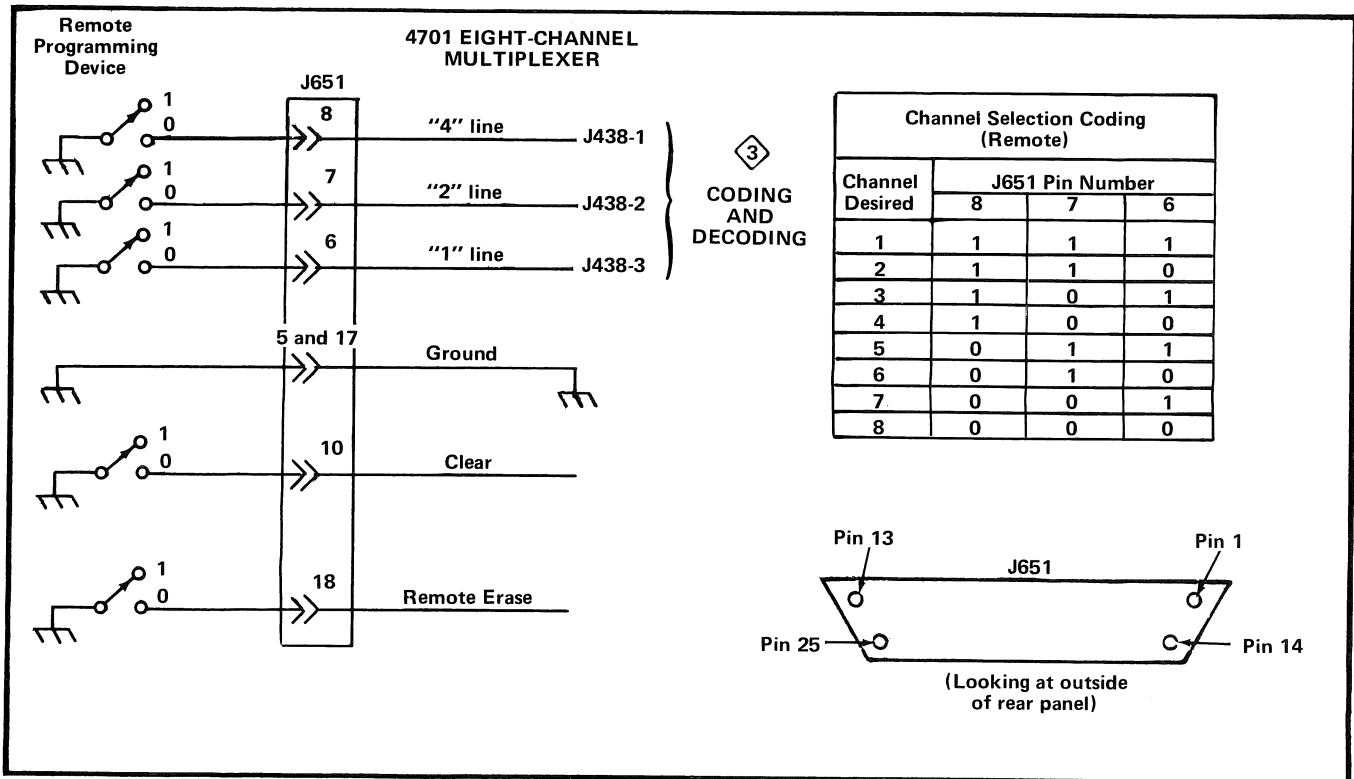


Fig. 2-3. REMOTE operation via connector J651.

APPLICATIONS

General

A few of the many possible applications of the 4701 are discussed below. Consult your Tektronix Field Engineer or Application Engineer if assistance is needed with your application.

Medical. Some medical applications in operating rooms and intensive care are monitoring the level of anesthesia, blood pressure, heart rate and ECG signals. In medical schools possible applications are monitoring actual or simulated ECG's, EDR's, EEG's, and EMG's. A system using the 4701, Type 611, and 4601 or a combination consisting of the 4701, Type 4501 and one or more TV receivers or large screen monitors should be useful in medical school applications. In medical clinics, the 4701 is useful for multi-signal tests performed on blood and other biophysical elements.

Education. The 4701 is useful in Engineering, Physics, Psychology, Veterinarian Departments and Technical Schools in lecture, labs, and research applications. The 4701, Type 4501, TV receiver combination is useful for lecture presentations to large groups. TV sets can be located remotely for optimized audience observations.

Petroleum/Chemical. The 4701 is useful to research groups and for process control applications. Monitoring pressure, temperature, and oxygen are some applications. The differential inputs of the 4701 channels permit location of the 4701 at a considerable distance from the points of data origin. The Auto Erase and REMOTE channel selection may be computer controlled. The 4701 together with a Type 611 Display Unit and a 4601 Hard Copy Unit provides a useful combination where permanent records of display information is necessary.

Recorders and Computers. The 4701 can record information faster than present recording systems, and is easier to use. The 4701, in combination with various oscilloscope systems and a 4601 Hard Copy Unit, is very useful in displaying and recording analog computer data.

Mechanical. Outputs from a number of transducers such as strain gauges may be displayed simultaneously for X-T or X-Y measurements.

Process Control

A practical hookup of the 4701 is shown in Fig. 2-5. On the 4701 the X, Y, and Z output pins of J650 are connected to the X, Y, and Z BNC connectors on the instrument rear panel. Connector J650 can be used to supply signals to

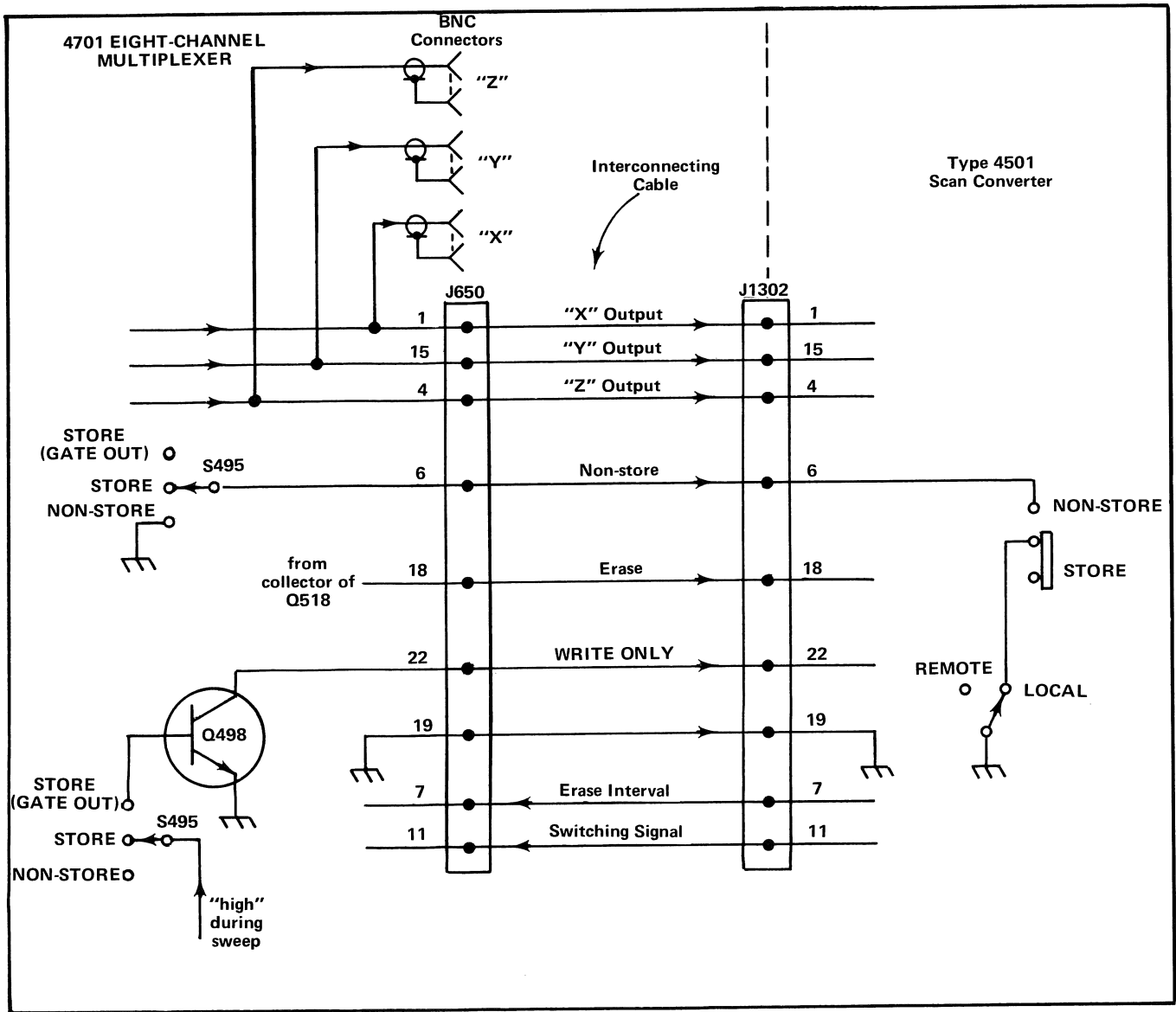


Fig. 2-4. Functions of connector J650.

a storage type display device, such as the Type 611, while the X, Y, and Z BNC connectors are supplying input signals to a non-storage type display device such as the Tektronix Type 602.

Signals from a number of locations can be applied to the inputs of the 4701 and displayed at a location remote from the 4701. The 4601 Hard Copy Unit, shown alongside the Type 611 Display Unit in Fig. 2-5, provides a permanent copy of the displayed signals when required. Selection of channels from the remote location is illustrated in Fig. 2-5.

An Integrated System

The 4701 is shown in Fig. 2-6 as part of a versatile system. A Tektronix 2601, with 26A1 and 26G2 plug-ins

permits amplification of weak signals and the use of different time bases for the various 4701 input signals.

Fig. 2-6 shows the 4701 rackmounted with the 2601 and 4501 Scan Converter. The 4501 provides a display at the rackmount location, and also provides a display at one or more remote locations on large screen TV receivers or monitors. Computer or manual programming of the channel displayed is also possible from a remote location. For further information on specific applications, consult your Tektronix Field Engineer.

Multi Channel Oscilloscope Displays

The X, Y, and Z outputs of the 4701 can be connected to an oscilloscope having external X (horizontal) and Z

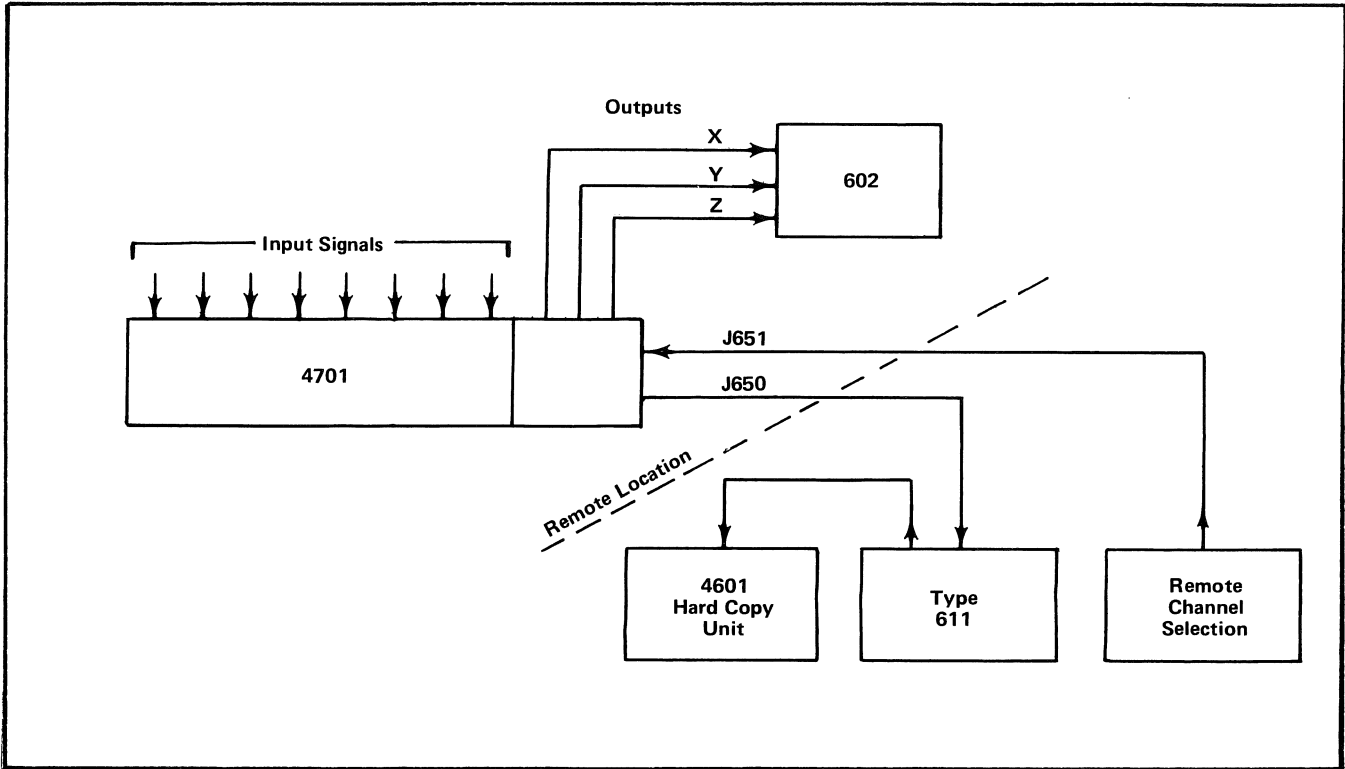


Fig. 2-5. Equipment set up suitable for a process control application.

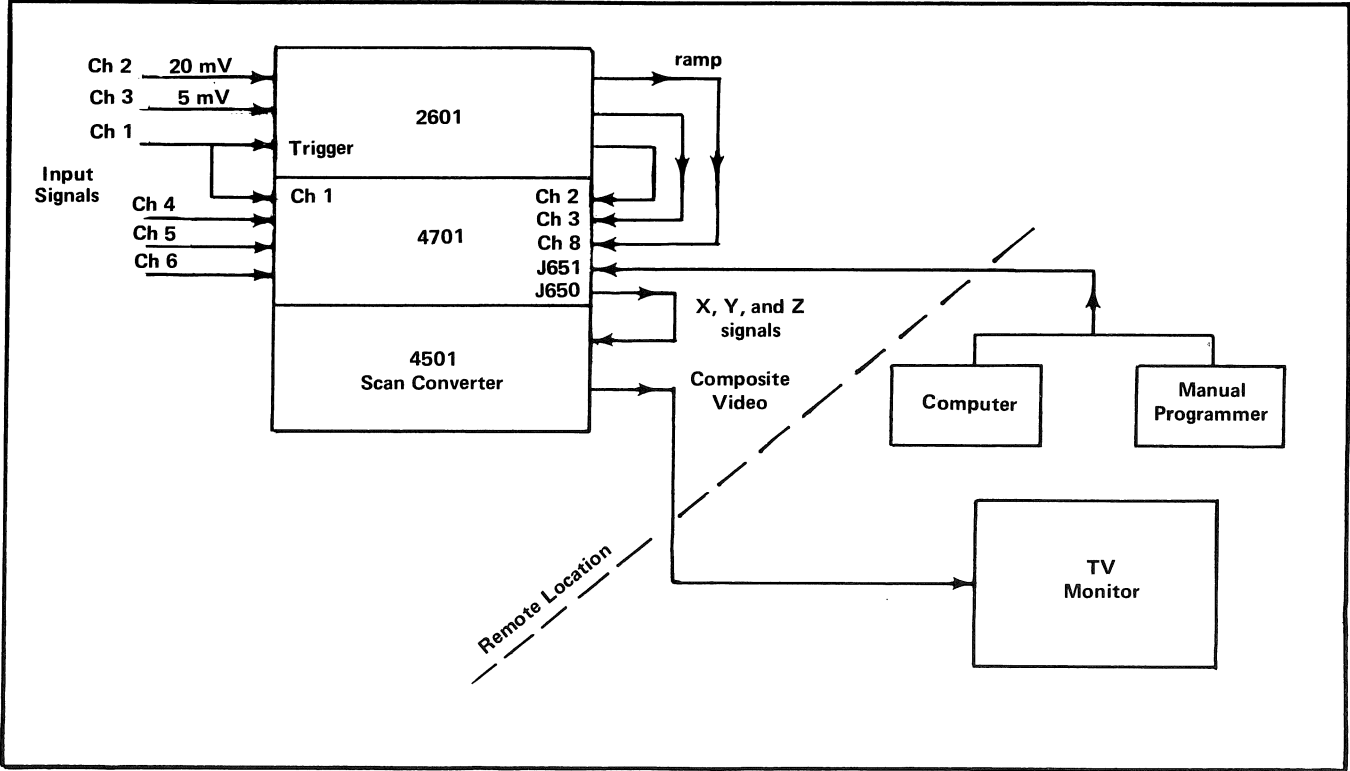


Fig. 2-6. A versatile integrated system for multichannel display.

Operating Instructions—4701

(blanking) connections, thereby permitting use of the oscilloscope as a storage or non-storage display device. The 4701 X, Y, and Z output signals can be delivered to the oscilloscope from the BNC connectors or from the proper pins of J650. Connections between pins of J650 assigned for storage use and the proper inputs and outputs of a suitable storage type oscilloscope permits storage of the multi-channel input signals of the 4701 on an oscilloscope.

The "Y" (vertical) output of the 4701 is fed to the oscilloscope vertical amplifier and the "X" (horizontal) output is fed to the oscilloscope External Horizontal input connector. The 4701 "Z" output signal is applied to the Blanking input connector provided on the rear panel of most oscilloscopes.

The 1 volt "X" and "Z" output signals of the 4701 will usually require amplification to meet the input require-

ments of the oscilloscope. In most applications, an amplifier such as the Tektronix 26A1 Operational Amplifier can be used to satisfy the requirements of the oscilloscope.

Use of External Blanking. The 4701 blanking signal duration is dependent on the setting of the TIME/SCAN control.

During PAIRED operation if an external ramp shorter in duration than that selected by the TIME/SCAN control is used the display remains unblanked during retrace of the external ramp. If the display resulting from the excessive unblanking time is considered undesirable a gating signal equal in duration to that of the external ramp can be introduced to the 4701 blanking circuit.

SECTION 3

CIRCUIT DESCRIPTION

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

General

The circuit description combines a block diagram description with a discussion of the applicable schematic diagram. An understanding of the capabilities and use of the 4701 is an important aid to understanding the interrelation and functioning of the circuits shown on the schematic diagram. Therefore, it is recommended that the reader be familiar with information given in the Operating Section of this manual.

Headings used in this section correspond with those assigned to blocks on the Overall Block Diagram (see Diagrams section). On the block diagram, the number within a diamond indicates the schematic diagram on which circuits represented by the block are shown.

Introduction

Signals from as many as eight different sources may be fed into the differential inputs of the eight preamplifiers

through the eight pairs of BNC connectors on the 4701 rear panel. Channels switched to "ON" are directed, in numerical sequence, to the input of the Vertical Amplifier. The Decoder circuitry performs the job of switching each "ON" channel (in turn) to the input of the Vertical Amplifier.

The TIME/SCAN setting determines the duration of the ramp that is applied to the Horizontal Amplifier to provide a time base for "ON" channels. When channels are "paired" the internal ramp is not used as the time base source.

Preamps, Switching, and Output Amps 1

Preamplifiers. A separate preamplifier is provided for each of the eight channels. The overall gain from each of the preamplifier inputs to the "X" or "Y" output connectors, is dependent on the setting of the front panel GAIN control provided for each channel. Overall gain (preamplifier input to "X" or "Y" output connector) may be set to any value between 0.1 and 1.0 (unity). See Fig. 3-1.

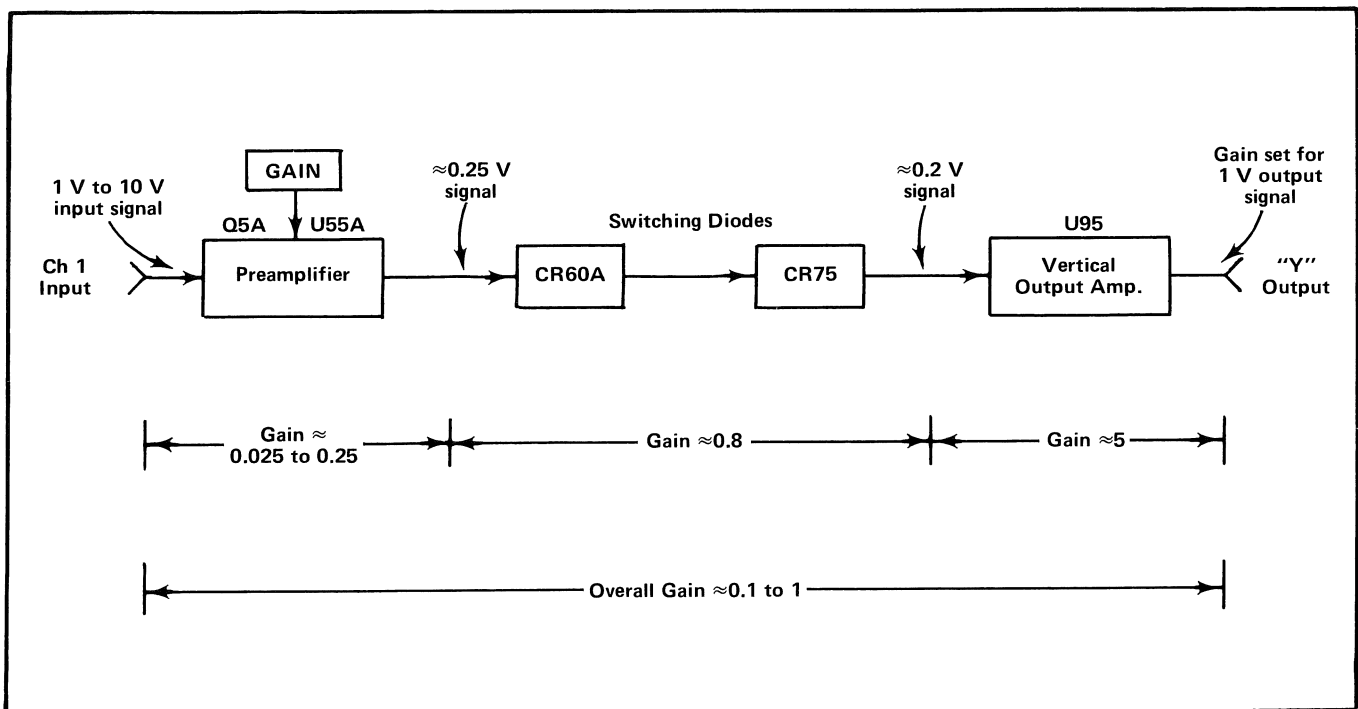


Fig. 3-1. Block diagram showing amplifier gain.

Circuit Description—4701

Since all eight preamplifiers are identical, components for only one channel are shown on the schematic diagram. Components and connectors for all eight channels are designated the same, except for the letter at the end. For example; channel 1 component designations end in A, channel 2 end in B, and channel 8 designations end with the letter H. Front panel controls for GAIN and POSITION, and internal adjustments for Balance and High Frequency Compensation, are provided for each channel (see Fig. 3-2). The output of each Preamplifier goes to the Trigger Selector switch and is also applied to a Diode Switch.

Diode Switch. When the front panel switch for a channel is set to "ON", or a channel is selected by remote programming, the Preamplifier output of the selected channel is coupled through its Diode Switch. Diode Switches for channels not selected (switched to "OFF") are open, and input signals to these channels cannot be displayed.

The diodes used as the channel 1 Diode Switch consist of the CR62A and dual-diode CR60A. If the line from the channel 1 output Gate (see Overall Block Diagram and schematic diagram 2) is at its "low" level, diode CR62A will conduct. Conduction of CR62A prevents coupling of the channel 1 Preamplifier output through CR60A. With the Channel 1 front panel switch set to "ON", CR62A will be shut off by a "high" from the Channel 1 Output Gate during the time allotted for display of Channel 1.

The Diode Switches connect or disconnect each preamplifier from one of two signal carrying lines (see Fig. 3-2). Outputs of the Diode Switches for channels 1, 2, 3, and 4 connect to one of these lines. Outputs of the Diode Switches for channels 5, 6, 7, and 8 connect to the other signal line.

Vertical Switching and Horizontal Switching. The block labeled Vertical Switching can connect the input of the Vertical Output Amplifier to either of the signal lines (line from channel 1 through 4 or the line from channel 5 through 8). No time is allotted to a channel if the front panel switch is at the "OFF" or "PAIRED" position, but "ON" channels are displayed in numerical sequence. A channel switched to "PAIRED" is displayed during the time allotted to the "ON" channel with which it is paired. If none of the front panel switches are at "ON", neither signal line is connected to the Vertical Output Amplifier.

With channel 1 and 7 front panel switches at "ON" a "low" is applied to the base of Q75 during the time allotted to channel 1, and the channel 1 signal is coupled through CR75 to the "Y" Output Amplifier. When the channel 1 display time ends, the Decoder (schematic 3) selects the next "ON" channel (channel 7 assumed) and CR85 is turned on by a "low" delivered to the base of Q85.

The block labeled Horizontal Switching connects either the internally generated ramp or the channel 5 through 8 signal line to the "X" Output Amplifier. A "high" will be delivered to the base of Q120 (from J436-1 on schematic 3) except during the time allotted to a "PAIRED" channel. With a "high" at the base of Q120, the internally generated ramp is connected to the "X" Output Amplifier via CR134. With a "low" at the base of Q120, the signal line from channels 5 through 8 is connected to the "X" Output Amplifier via CR130.

"X" and "Y" Output Amplifiers. The "X" (Horizontal) and "Y" (Vertical) Output Amplifiers circuits are identical. Each of these amplifiers provides an approximate X5 gain. An internal positioning adjustment (R91 for "Y", R141 for "X") is provided for each amplifier. These adjustments set the "X" and "Y" output levels to provide optimum positioning range for all front panel positioning controls. Pushing the LOCATE pushbutton reduces the amplifier gain to about one-third of normal, and thereby reduces the display device deflection caused by the "X" and "Y" outputs. Output impedance of the amplifiers is approximately 50 ohms.

Ramp Position. The circuit used to couple the internally generated ramp to the "X" Output Amplifier consists of Q170 and Q175. The ramp is applied to the base of Q175B via connector J66, pin 2. The RAMP POSITION control permits changing the DC level at the base of Q175B.

Except during display of a "PAIRED" channel, Q125 is shut off by a "high" at the base of Q120. With Q125 "off", CR127 is reverse-biased and both sections of CR134 conduct. The base-emitter current of Q175A affects the voltage at the anodes of the two sections of CR134, and therefore the input voltage to the "X" Output Amplifier.

Trigger and Sweep

General. Circuits shown on the Sweep Board, on the Overall Block Diagram, appear on schematic diagram 2 (Trigger and Sweep). The TRIGGER SOURCE switch (S200) permits selecting the source of triggering signal. Triggering from any of the eight channels, the line frequency, or an external triggering signal is available. Although an input signal must be applied to a channel selected as the triggering source, the front panel switch for the channel need not be "ON".

A trigger pickoff lead from the output of each of the eight preamplifiers (see schematic diagram 1) is routed through connector J50, to eight of the positions of the TRIGGER SOURCE switch. With the TRIGGER SOURCE switch set to LINE, the line frequency ripple appearing across C610 (schematic 5) provides the triggering signal. With EXT selected, a signal connected to the rear panel EXT TRIG connector provides the triggering signal.

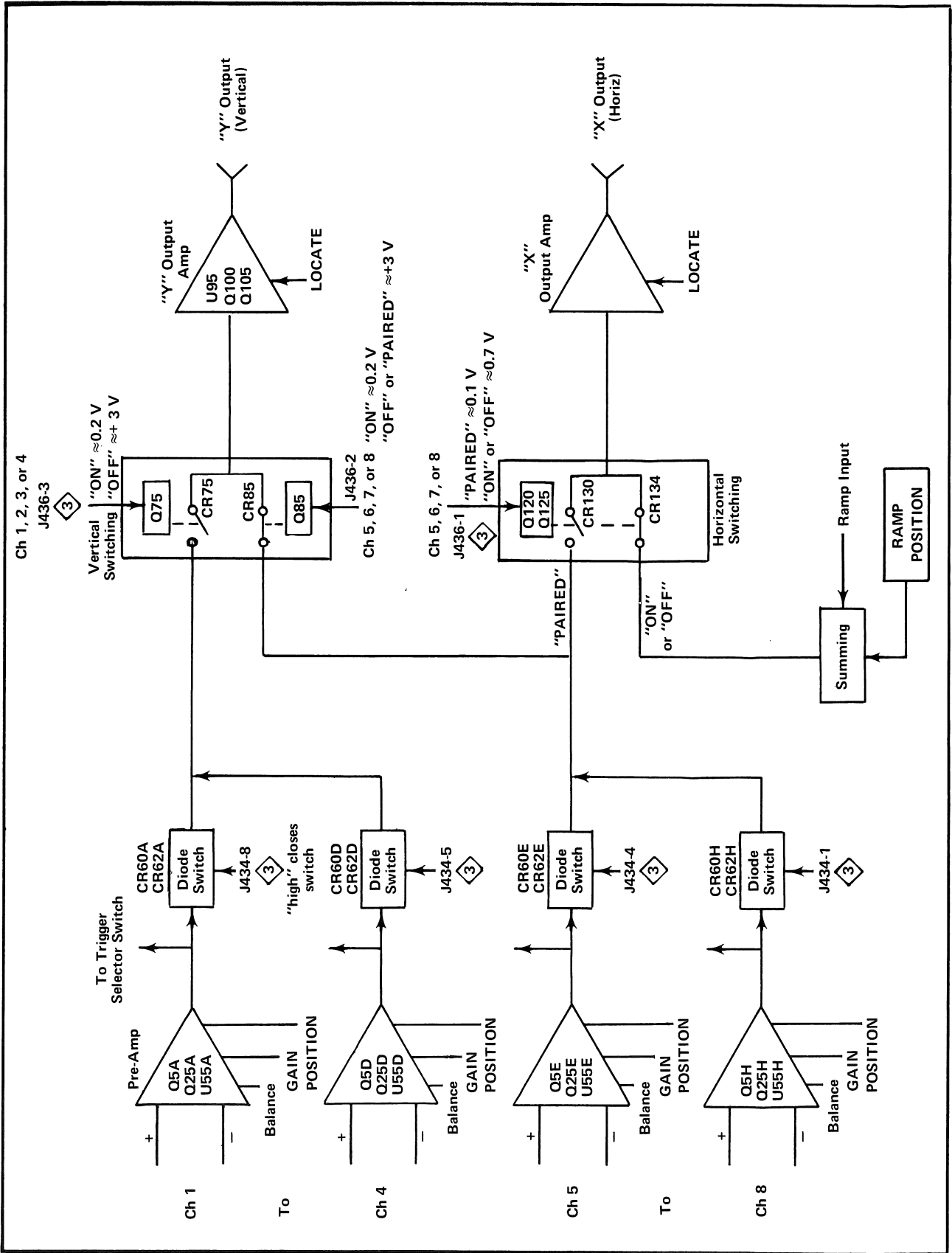


Fig. 3-2. Simplified diagram showing signal switching.

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Trigger Amplifier. The selected triggering signal is applied (through R206) to the gate of Q215A. The outputs of Q215 provide push-pull inputs to pins 3 and 4 of amplifier U230. An overall gain of about 50, from the gate of Q215A to pin 12 of U230, is provided by the Trigger Amplifier. Two internal adjustments, DC Level (R202) and DC Offset (R223) set the operating level at the Trigger Amplifier output.

Peak-to-Peak Detector. Circuit components used when AUTO P-P triggering is selected are shown in Fig. 3-3A. During AUTO P-P triggering the peak-to-peak value of signal at the Trigger Amplifier output determines the voltage across the TRIGGER LEVEL control. The peak-to-peak voltage across the TRIGGER LEVEL control is almost equal to, and directly proportional to, the Trigger Amplifier output voltage. Limiting in U230 prevents the Trigger Amplifier output voltage from exceeding a peak-to-peak value of about 12 volts.

With AC or DC triggering selected at the 4701 front panel, the components shown in Fig. 3-3B determine the voltage available across the TRIGGER LEVEL control.

Trigger Comparator and Polarity. The triggering signal is delivered to pin 4 of U285 through Comparator Q275 and Inverter Q280. A positive-going input signal appears at the base of Q275B as a positive-going signal, but is inverted at pin 4 of U285. Therefore, to trigger on the positive slope of an input signal, triggering must occur on the negative slope of the signal at the Trigger Input (pin 4) of U285. The level at pin 5 of U285 determines triggering polarity.

Sweep Control U285 and Miller Runup U310. Pin 14 of U285 is called the +Gate Output. It is connected to pin 1 of U310 (Miller Runup and Delay). The triggering signal at pin 4 of U285 causes a positive gate (logical 1) at pin 14 of U285, unless prevented by levels at other pins of U285.

A logical "1" at the Sweep Gate Input (pin 1) of U310 allows runup of the ramp. The ramp appears at pin 8 of U310, and runup of the ramp continues until pin 8 voltage reaches that applied to pin 6. Sweep Time adjustment R311 sets the voltage at pin 6 of U310. When the voltage at pin 8 of U310 equals that at pin 6, a fast positive-going pulse appears at pin 4 of U310. The positive pulse at pin 4 of U310 is coupled through CR295 to pin 1 of U285. The

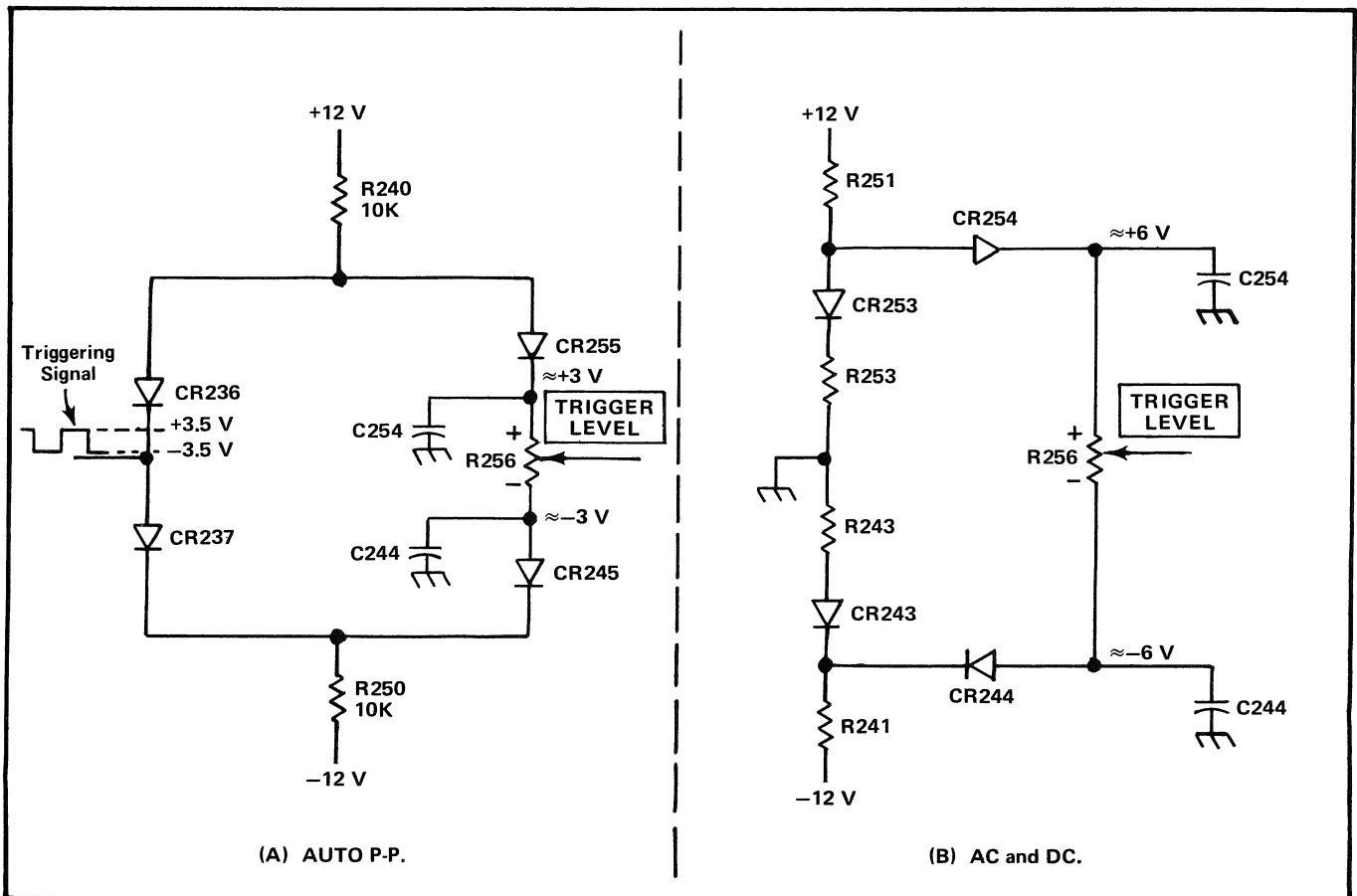


Fig. 3-3. TRIGGER LEVEL voltage sources.

positive pulse at pin 1 of U285 causes a logical "0" at pin 14 of U285 and at pin 1 of U310, ending the sweep.

Another sweep cannot be triggered until the holdoff capacitor connected to pin 11 of U285 charges from 0 V to about +3.5 V. The purpose and functioning of other pins of U285 and U310 is given in Tables 3-1 and 3-2.

TABLE 3-1
SWEEP GENERATOR INPUT-OUTPUT

Sweep Logic U285	
Terminal	Function
1 End Sweep	Current (logical 1) for at least 20 nanoseconds ends sweep. Current continuous locks out sweep. No input (logical 0) allows U285 to operate.
2 Not used	Grounded (chassis ground)
3 Not used	Grounded (chassis ground)
4 Trigger Input	Analog input, low impedance. Accepts analog current triggering signal. Trigger threshold: 0 current, $\pm 100 \mu\text{A}$.
5 Slope Select	Logical 1 permits trigger to be initiated on the positive slope of a triggering signal. Logical 0 permits trigger to be initiated on the negative slope of a trigger signal.
6 Single Sweep Control	Logical 1 permits repetitive sweep. Logical 0 allows only a single sweep to be produced unless reset (see pin 7).
7 Single Sweep Reset	Current into pin (logical 1) for at least 20 nanoseconds resets single sweep system, and allows sweep to be retriggered. After reset occurs, C292 and R292 permit this input to return to ground (logical 0).
8 GND/SUB STRATE	Provides ground reference for the device.
9 READY Lamp Output	Provides power to READY lamp when sweep is ready for triggering (Single Sweep Mode). Removes power, extinguishing lamp upon receipt of sweep trigger.

TABLE 3-1 (cont)

Terminal	Function
10 Lockout	Logical 1—sweep is locked out (cannot be started). Logical 0—lockout off.
11 Holdoff Timing	Connects timing components which set trigger lockout period after end of sweep. Capacitor discharges as soon as sweep is started, and timing starts at end of sweep as capacitor charges. When capacitor charges to upper threshold (+3.5 volts), new sweep can be produced either upon receipt of next trigger or if pin 12 is above its upper threshold (see pin 12).
12 Bright Baseline Timing/Off	Used in P-P Auto Triggering Mode to connect timing components which set bright baseline off period after trigger recognition. If triggering signal is absent or occurring at a rate less than 15 hertz, capacitor charges toward +3.5 volt threshold. Above this level, U285 is conditioned to provide a free running sweep at a rate determined by the sweep timing and holdoff RC. As soon as a trigger arrives at pin 4 of U285, pin 12 is driven to ground and C287 is discharged.
13 Bright Baseline Control	Current into pin (logical 1) for ≥ 20 nanoseconds keeps pin 12 at ground, holding Bright Baseline off. Baseline remains off for one timing period after current level is removed. No input (logical 0) allows Bright Baseline to function (see pin 12).
14 +Gate Output	Provides a 5 V source through 2.2 kilohms (logical 1) during sweep, driving current into pin 1 of U310. Logical 0 when sweep is not being produced.
15 -Gate Output	Logical 0 during sweep allowing current to be switched into the Z Axis Amplifier to unblank the CRT. Provides a logical 1 when sweep is not being produced. Maximum delay after fast-rise trigger initiation is 25 nanoseconds.

TABLE 3-1 (cont)

Terminal	Function
16 Power Supply	Supply voltage of 5 volts is applied.

TABLE 3-2
Miller Integrator U310

Terminal	Function
1 Sweep Gate In	Current into pin results in sawtooth voltage at pin 8.
2 Oscillation Suppressor	Connects discrete components to prevent oscillation of the Miller Integrator.
3 Ground	Provides ground reference to the device.
4 Delayed Gate Output	Provides a positive pulse to pin 1 of U285 when pin 8 of U310 reaches pin 6 voltage.
6 End Sweep Level	Connects voltage divider to a reference comparator inside the device, establishing the level at which the sweep sawtooth is terminated.
7 Power Supply	Supply voltage of +12 volts applied.
8 Sawtooth Output	Produces sweep sawtooth voltage when current is gated into pin 1. Sawtooth is positive-going.
9 Timing Current Input	Connects timing components which determine sweep rate.

Coding and Decoding 3

General. Circuits shown on the Counter Board, on the Overall Block Diagram, appear on schematic diagrams 3 and 4. Diagram 3 (Coding and Decoding) shows circuits represented by the following blocks: Binary Coder, BCD to Decimal Converter, Channel Selection Switches, Coding Gates, Error Detector, Output Gates, Vertical Switching Signal, Horizontal Switching Signal, and CH 5-8 Horizontal Control.

Binary Coder and BCD to Decimal Converter. The Binary Coder uses all or part of the following integrated circuits: U410, U412, U414, U416, U418, U420, and U422. The Binary Coder can be controlled remotely, by the Coding Gates, or it can control itself.

Four AND gates are shown to be a part of U410, U416, and U422. The bottom AND gate is effective during remote operation, the next one up is used during normal operation in the CHOP or ALT mode, and one or both of the top two AND gates are used if an error occurs while in the CHOP or ALT mode.

When CHOP or ALT is selected a "low" is applied (by switch S485 on diagram 4) via J424-2, to one input of the lower AND gates. Therefore, a "high" on the lines used for remote channel selection (the leads connected to J438-1, J438-2, and J438-3) is ineffective. The Coding Gates, however, can control the Binary Coder and therefore control channel selection. When S485 is switched to REMOTE, the line from J424-2 is "high" and the AND gates used for remote control are enabled, while those used by the Coding Gates are disabled.

If during CHOP or ALT operation an error occurs, the output of Error Detector U442 causes pin 1 of U420 to be "high", enabling the top two AND gates of U410, U416, and U422. The lower AND gate is still disabled by S485, while the AND gate used by the Coding Gates is disabled by a "low" from pin 4 of U420. The count of the Binary Coder changes by one each time a clock pulse occurs, until the error is corrected.

Three outputs (U412 pin 9, U418 pin 5, and U418 pin 9) of the Binary Coder are connected to J651 via J438. The information provided by these outputs provides a remote indication of which channel is presently being displayed. These same three outputs are also delivered to J437 (pins 3, 4, and 5) for future use.

The opposite outputs of the Binary Coder (U412 pin 8, U418 pin 6, and U418 pin 8) are applied to the inputs of BCD to Decimal Converter U434. The outputs of U434 (pins 1 through 9) select "ON" channels in numerical sequence if the CHOP or ALT switching mode is selected. The channel selected for display is determined by which of the output pins of U434 is "0" (at its low state). See Table 3-3.

Channel Selection Switches and Coding Gates. The eight front panel channel selecting switches (S430 through S446) shown on the lower left portion of the schematic are the Channel Selection switches. The Coding Gates are designated U444, U446A, and U446B.

TABLE 3-3

Channel Selected	Pins of U434										
	Inputs			Outputs							
	13	14	15	1	2	3	4	5	6	7	9
8	0	0	0	0	1	1	1	1	1	1	1
7	0	0	1	1	0	1	1	1	1	1	1
6	0	1	0	1	1	0	1	1	1	1	1
5	0	1	1	1	1	1	0	1	1	1	1
4	1	0	0	1	1	1	1	0	1	1	1
3	1	0	1	1	1	1	1	1	0	1	1
2	1	1	0	1	1	1	1	1	1	0	1
1	1	1	1	1	1	1	1	1	1	1	0

Logic provided by the channel selection switches and the Coding Gates converts the present channel output of U434 to the next "ON" channel output of the Coding Gates. The Coding Gates set the Binary Coder inputs to the levels required for selection of the next channel, and thereby provide automatic sequencing through "ON" channels. As an example, assume that the front panel switches for channels 1, 2, and 3 are positioned to "ON", and the remaining switches are "OFF". If the input and output levels of U434 are such that channel 1 is presently being displayed, the Coding Gate outputs will instruct the Binary Coder to select channel 2. However, the Binary Coder outputs will not switch to a channel 2 condition until a clock pulse arrives.

When the output of U434 is selecting the highest numbered "ON" channel, pin 11 of U442 will be "low" and the outputs of U446B, U446A, and U444 will indicate that channel 1 (or the lowest numbered "ON" channel) is the next channel. The "low" at pin 11 of U442 is delivered via J410A-2 to pin 1 of U488 (shown on schematic 4). This "low" notifies the AUTO ERASE circuit that the last "ON" channel is being displayed.

Error Detector and Output Gates. If an error exists in the system, the Error Detector will prevent the output of the Coding Gates from controlling the Binary Coder outputs. At the same time, the Output Gates will be disabled; thus, no signals will be displayed until the error is corrected. With an error in the system, the Binary Coder is not controlled by the Coding Gates but will sequence through the channels until the error is removed.

Assume that switches for channels 1, 2, and 3 are positioned to "ON", and all output pins of U434 are "high" except pin 9 which is "low" (0). Channel 1 is displayed and the outputs of the Coding Gates will cause the Binary Coder outputs to switch to channel 2 at the next clock pulse. If while channel 1 is being selected (by the output of U434) the front panel switch for channel 1 is switched to

"OFF", some of the Coding Gate input levels will change. Unless the Coding Gate outputs are prevented from controlling the Binary Coder, channel 8 will be selected when the next clock pulse occurs.

If only one front panel channel switch is at ON, all inputs to U442 are low. If more than one channel switch is at ON, one input of U442 is low. If while a channel is being displayed its front panel switch is positioned to OFF, the only low at the input of U442 is lost and the output of U442 goes low. When pin 8 of U442 goes low, and either CHOP or ALT mode is selected, pin 1 of U432 goes high. The high at pin 1 of U432 prevents the output of the Coding Gates from controlling the Binary Coder and keeps the output of all Output Gates (U436 and U438) low, thereby preventing display of any channel. The Binary Coder then free runs until the error is removed.

Channel Switching and Control. The portions of front panel switches for channels 5 through 8 (S440 through S446) shown at the lower right of the schematic are shown on the Overall Block Diagram as CH 5—8 Horiz.—Vert. Control. Two functions are performed by these switches. These switches provide routing of signals to circuits that will direct the channel 5 to 8 Pre-amplifier outputs to either the Vertical Amplifier (channel switch ON) or the Horizontal Amplifier (channel switch to PAIRED). These switches also determine the time at which switching diodes for channels 5, 6, 7, and 8 are turned on. Refer to the discussion of schematic 1 earlier in this section.

Chop Rate and Auto Erase 4

Chop Rate Oscillator. When CHOP is selected, the clocking frequency of the counter is determined by the Chop Rate Oscillator. The position of the internal Chop Rate switch (S455) determines the frequency of the clock and unblanking pulses.

If the output at pin 11 of U454 is low, diode CR454 is reverse-biased and a ramp voltage is produced at the emitter of Q462. The rate of ramp run up is dependent on capacitance (C455, C456, C457) and current through R455 and R456. Chop Rate adjustment R455 therefore provides a means of adjusting frequency.

Shortly after ramp run up starts, Q470 turn-on ends display blanking. When the ramp voltage reaches 5 to 6 volts Q475 turns on. Turn-on of Q475 causes pin 13 of U432 to go low, blanking the display and delivering a signal to U530. The output from pin 6 of U530 provides the clock pulse required by the Binary Coder for channel switching.

Shortly after Q475 turns on Q465 turns on, causing pin 11 of U454 to go high and end the ramp run up. Transistors

Circuit Description—4701

Q462 and Q465 immediately shut off, returning pin 11 of U454 to low and permitting another ramp run up.

If a Type 4501 Scan Converter is being supplied with inputs from the 4701, no channel switching or blanking occurs during the read portion of the Scan Converter read-write cycle. The Read-Write switching signal from the Scan Converter is applied to the base of Q450. The read portion of this signal turns on Q450, and pin 13 of U432 remains high. The display remains unblanked and since no clock pulses are sent to the counter, no channel switching occurs.

During the write interval of the Scan Converter, Q450 is shut off and the Chop Rate Oscillator now controls blanking and channel switching. When Q450 shuts off and pins 10 and 11 of U454 switch to low, thereby permitting run up of the Chop Rate Oscillator ramp. The Chop Rate Oscillator operates in the normal manner until the read interval starts. The Chop Rate adjustment (R455) is normally set (Chop Rate switch to HIGH) so that three chop cycles occur during the write interval. This permits display of signals from three channels during each write interval.

Unblanking can only occur during sweep time. During sweep time the Sweep Gate pulse keeps Q485 shut off. When the sweep ends, conduction of Q485 prevents pin 13 of U432 from being switched to high, and blanking occurs.

The Sweep Gate signal delivered to the base of Q485 also turns on Q498 during sweep time, if the STORE (gate out) position of switch S495 is selected. One use of this sweep gate pulse (collector of Q498) is as a WRITE ONLY command to the Type 4501 Scan Converter.

Erase Circuits. The 4701 can erase the display on the display device to which it is connected. Turn-on of Q518 provides an erase signal to pin 18 of J650. Transistor Q518 can be turned on by a low at pin 2 of U494. Pin 2 of U494 is low when the front panel ERASE switch is pushed in, or if the Remote Erase line connected to pin 18 of J651 is low.

The Auto Erase circuit provides another method of producing an erase signal. The Auto Erase circuit consists of Q500, Q515, and the inverter provided by pins 5 and 6 of U488. If Q500 is shut off, C512 charges through a value of resistance determined by the setting of the VIEW TIME control. When C512 voltage reaches the firing potential of Q515, an erase command results.

With CHOP selected, pin 5 is always held low by switch S485, and therefore pins 6 and 9 of U490 are always high.

Since pin 9 of U490 is always high, the level at pin 8 of U490 is always opposite to that at pin 10. During sweep time, pin 10 is low and pin 8 is high since the collector of Q485 is high during sweep time. When the sweep ends, pin 8 of U490 goes low causing pin 8 of U494 to go low and View Time to start.

When View Time ends, an erase command is sent to the display unit. The display device produces an erase pulse to erase the display and an erase interval pulse. The erase interval pulse is applied to the base of Q525. The negative-going leading edge of this pulse causes pin 11 of U494 to go high. Since pins 9 and 10 of U494 are already high, the leading edge of the erase pulse is ignored. The positive-going trailing edge of the erase pulse causes pin 10 of U494 to go low. Q500 is turned on and Q515 and Q518 are turned off. When pin 8 of U494 goes high, at the end of the erase interval, the collector of Q505 goes low, permitting the start of another sweep.

Auto Erase is inoperative if the VIEW TIME control is turned fully ccw to OFF or fully cw to SAVE, because Q500 cannot be shut off. With switch S485 set to ALT, additional circuitry is used. The additional circuits consist of U488 (pins 1 and 2) and U490 (pins 11, 12, 13, and 4, 5, 6). The additional circuitry is required, since in ALT all ON channels must be displayed before pin 8 of U494 is driven low to start the View Time and Erase cycles.

During the sweep for the highest numbered ON channel, pin 1 of U488 is low. Therefore, during this sweep pin 12 and 13 of U490 are high and C490 will discharge, producing a high at pin 9 of U490. When the sweep ends, pin 10 of U490 goes high. Pin 9 of U490 will remain high, due to C490, long enough for pin 8 of U490 and U494 to switch to low and start View Time.

Power Supply

General. Circuits shown on the Power Supply schematic provide the regulated +12 V, -12 V, and +5 volts required by circuits of the 4701.

+12 Volt Supply. The +12 volt supply consists of voltage regulator IC U618, Q615, and associated components. The +12 volt supply serves as the reference voltage for the -12 V and +5 volt supplies. An internal adjustment R616 (+12 volts) permits setting the output of the +12 volt supply to exactly +12 volts. The voltage across R614 (applied between pins 2 and 3 of U618) limits the maximum current through Q615 in event that the output of the +12 volt supply is shorted.

-12 Volt Supply. The -12 volt supply consists of Q620, U624, Q630, Q633, and Q635. An output of -12

volts from the -12 volt supply results in -6 volts at both inputs (pins 2 and 3) of U624. The input and output of U624 is therefore zero.

The regulated $+12$ volt supply is used as the reference voltage by the -12 volt supply. Any variation of the output voltage from -12 volts results in an input to U624. An error signal of the proper polarity appears at the output of U624, and is applied to the base of Q633. Transistor Q633 controls the base current of Q635, and therefore the voltage drop across series element Q635. Excessive current flow

through Q635 is prevented by the voltage drop across R634 causing turn-on of Q630. Turn-on of Q630 prevents further increase in the base current of Q633 and Q635.

+5 Volt Supply. The output of the $+5$ volt supply and the -12 volt supply is applied across resistors R647 and R648. Any variation in the output voltage from $+5$ volts causes the voltage at the minus input of U646 to vary from the zero volts present at the plus (+) input of U646. The resistance of series element Q645 is controlled by the output of U646 via Q640.

SECTION 4

SERVICING

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

Introduction

This section of the manual contains servicing information for use in preventive maintenance, corrective maintenance and troubleshooting.

PREVENTIVE MAINTENANCE

General

Preventive maintenance consists of cleaning, visual inspection, etc. Preventive maintenance performed on a regular basis may prevent instrument breakdown and will improve the reliability of this instrument. The severity of the environment to which it is subjected determines the frequency of maintenance. A convenient time to perform preventive maintenance is preceding recalibration of the instrument.

Cleaning

Dust in the interior of the instrument should be removed occasionally due to its electrical conductivity under high-humidity conditions. The best way to clean the interior is to blow off the accumulated dust with dry, low-pressure air. Remove any dirt which remains with a soft paint brush or a cloth dampened with a mild detergent and water solution. A cotton-tipped applicator is useful for cleaning in narrow spaces.

Visual Inspection

The unit should be inspected occasionally for such defects as broken connections, damaged or improperly installed circuit boards and heat-damaged parts.

The corrective procedure for most visible defects is obvious; however, particular care must be taken if heat-damaged components are found. Overheating usually indicates other trouble in the unit. It is important that the cause of overheating be corrected to prevent recurrence of the damage.

TROUBLESHOOTING

Introduction

The following information is provided to facilitate troubleshooting of the 4701. Information contained in other sections of this manual should be used with the following information to aid in locating the defective component. An understanding of the circuit operation is very helpful in locating troubles, particularly where integrated circuits are used. See the Circuit Description Section for complete information.

Internal Adjustments

General. Slight adjustment of most internal adjustments can usually be made without performing a complete instrument performance or calibration check.

NOTE

Do not change the setting of the +12 V Adjustment. Changing the setting normally requires that the complete Calibration Procedure be performed. The Calibration Procedure is given in Section 5 of this manual.

Listing of Adjustments. A complete listing of all the 4701 internal adjustments is given in Table 4-1. The remarks column of Table 4-1 should be consulted to determine if an internal adjustment will correct your problem. The location of circuit boards and adjustments within the instrument is shown in the Diagrams Section (Section 7) on the same page as the Overall Block Diagram.

Setting Internal Adjustments. The procedure for setting the internal adjustments is not given in this section of the manual although brief hints may be found in the Remarks column of Table 4-1. For further information on setting the internal adjustments consult the Calibration Section.

Troubleshooting Aids

Diagrams. Complete circuit diagrams are given on fold-out pages in the Diagrams Section. The component number and electrical value of each component in this unit are shown on the diagrams.

TABLE 4-1
Complete Listing of 4701 Calibration Adjustments

Amplifier Board				
Adjustment Name	Component Number	Schematic Number	Calibration Step	Remarks
¹ Balance	R8	1	2	Prevents trace movement when GAIN control is rotated throughout its range.
¹ High Frequency Compensation	C4 and C14	1	5	Affects instrument bandwidth and CMRR (common-mode rejection ratio)
Y Position	R91	1	3	Adjusted to provide a vertical positioning range of at least -0.8 V to +0.8 volts for all channels.
X Position	R141	1	4	Adjusted to provide a horizontal positioning range for channels 5 through 8 (when paired) of at least -0.8 volts to +0.8 V and a RAMP POSITIONING range of at least -0.3 V to +0.3 V.
Sweep Board				
DC Level	R202	2	9	Adjusted for zero volts at TP270 with TRIGGER MODE at DC.
DC Offset	R223	2	9	Adjusted for zero volts at TP270 with TRIGGER MODE at AC.
Auto P-P	R260	2	10	Adjusted for a stable display on AUTO P-P Mode with 50 mV trigger signal applied to EXT TRIGGER IN.
Sweep Time	R311	2	7	Used to calibrate timing of the internal time base to within 3% of TIME/SCAN setting.
Sweep Amplitude	R326	2	8	Used to set ramp amplitude at X output to 1 V for use with display devices requiring 1 V signal for full screen deflection.

¹ A Balance adjustment and two High Frequency Compensation adjustments are provided for each of the eight channels.

TABLE 4-1 (cont)

Adjustment Name	Component Number	Schematic Number	Calibration Step	Remarks
Counter Board				
Chop Rate	R455	4	12	Adjusts frequency of Chop Rate oscillator. Durations approximately 3 μ s with Chop Rate switch at HIGH.
Blanking	R535	4	13	Adjusts the amplitude of the blanking pulse to +1 V during unblanking time.
Power Supply Board				
+12 V	R616	5	1	Sets output of +12 V Supply to +12 volts.

Circuit Boards. The circuit board pictures are shown in the Diagrams Section. Each electrical component on the boards is identified by its circuit number. These pictures, used with the diagrams aid in locating the components mounted on the circuit boards.

Interconnections. Schematics are labeled to show connections to other schematic diagrams. The to/from information shown includes connector, pin, and schematic number. The notation J428-1 4 indicates connection to or from Pin 1 connector J428, on schematic diagram 4.

Semiconductor Lead Configuration. Fig. 4-1 shows the lead configuration for the semiconductors used in this instrument.

Troubleshooting Equipment

The following equipment is useful for troubleshooting.

1. Dynamic Transistor Tester

Description: Tektronix Type 576 Transistor-Curve Tracer or equivalent.

Purpose: To test the semiconductors used in this unit.

2. Volt-Ohmmeter

Description: 20,000 ohms/volt; 0 to 500 voltage range; accurate within 3%. Test probes must be well-insulated.

Purpose: To measure voltages and resistances.

3. Test Oscilloscope

Description: DC to above 5 MHz frequency response; 5 millivolts to 5 volts/division deflection factor. A 10X attenuator probe to prevent circuit loading.

Purpose: To check waveforms in this instrument.

Troubleshooting Techniques

1. **Check control Settings.** Incorrect control settings can indicate a trouble that does not exist. If there is any question about the correct function or operation of any control, refer to the operating instructions.

2. **Visual Check.** Visually check the portion of the instrument in which the trouble is located. Many troubles can be located by visual indications such as unsoldered connections, damaged components, etc.

3. **Check Voltages and Waveforms.** Often the defective component can be located by checking for the correct voltage or waveform in the circuit.

4. **Check Individual Components.** The following procedure describes methods of checking individual components.

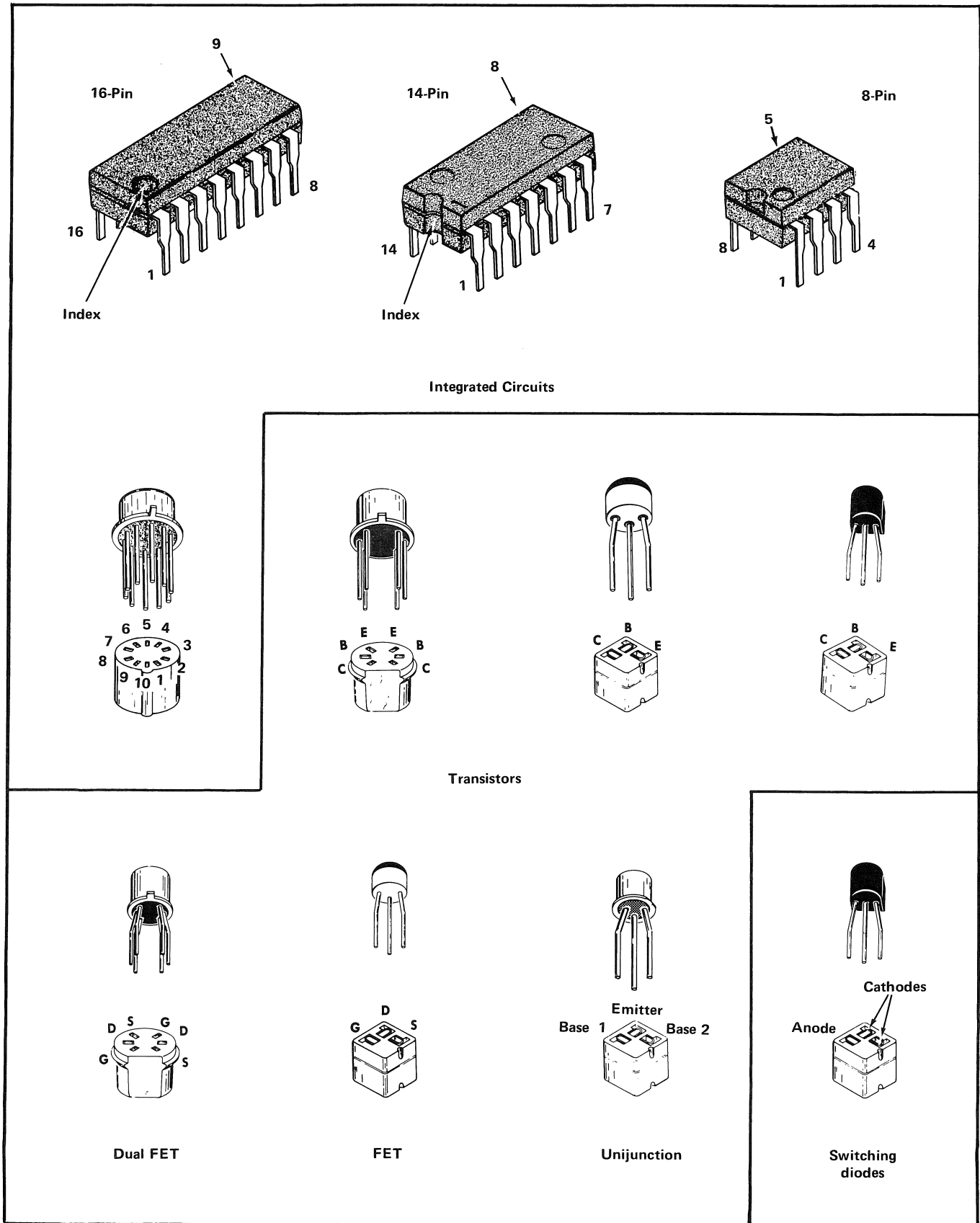


Fig. 4-1. Transistor and integrated circuit pin arrangement.

CAUTION

Power switch must be turned off before removing or replacing semiconductors.

A. TRANSISTORS

A good check of transistor operation is actual performance under operating conditions. A transistor can most effectively be checked by substituting a new transistor, or one which has been checked previously. However, be sure that circuit conditions are not such that a replacement transistor might also be damaged. If substitute transistors are not available, use a dynamic tester. Static-type testers are not recommended, since they do not check operation under simulated operating conditions.

B. INTEGRATED CIRCUITS

Integrated circuits can be checked with a voltmeter, test oscilloscope, or by direct substitution. A good understanding of the circuit description is essential to troubleshooting circuits using integrated circuits. In addition, logic levels and other operating information for the integrated circuits are given in the Circuit Description section. Use care when checking voltages and waveforms around the integrated circuits so that adjacent leads are not shorted together. A convenient means of clipping a test probe to the 14 and 16 pin integrated circuits is with an integrated-circuit test clip.

CORRECTIVE MAINTENANCE**General**

Corrective maintenance consists of component replacement and instrument repair. Special techniques required to replace components in this instrument are given here.

Locating Part Numbers

Parts located on the chassis are listed at the beginning of the Electrical Parts List. Removable circuit boards are assigned assembly numbers such as A1, A2, etc. The schematic diagrams are labeled to aid in locating parts in the parts list. For example if A2 appears on the schematic diagram, parts shown on the schematic are shown in the portion of the Parts List headed A2.

Obtaining Replacement Parts

Standard Parts. All electrical and mechanical part replacements may be obtained through your local Tektronix Field Office or representative. However, many of the

standard electronic components can be obtained locally in less time than is required to order them from Tektronix, Inc. Before purchasing or ordering replacement parts, check the parts list for value, tolerance, rating, and description. All replacement parts should be direct replacements unless it is known that a different component will not adversely affect instrument performance.

Special Parts. In addition to the standard electronic components, some special parts are used in this instrument. These parts are manufactured or selected by Tektronix, Inc. to meet specific performance requirements, or are manufactured for Tektronix Inc. in accordance with our specifications. These special parts are indicated in the Electrical Parts List by an asterisk preceding the part number. Most of the mechanical parts have been manufactured by Tektronix, Inc. Order all special parts directly from your local Tektronix Field Office or representative.

Ordering Parts. When ordering replacement parts from Tektronix, Inc., include the following information:

1. Instrument Type.
2. Instrument Serial Number.
3. A description of the part (if electrical, include circuit number).
4. Tektronix Part Number.

Soldering Techniques**WARNING**

Disconnect the unit from the power source before soldering.

Circuit Boards. The components mounted on the circuit boards can be replaced using normal circuit board soldering techniques. Keep the following points in mind when soldering on the circuit boards:

1. Use a pencil-type soldering iron with a power rating from 15 to 50 watts.
2. Apply heat from the soldering iron to the junction between the component and the circuit board.
3. Heat-shunt the lead of the component by means of a pair of long-nosed pliers.

Servicing—4701

4. Avoid excessive heating of the junction, as this could separate the circuit board wiring from the laminate.

5. Use electronic grade 60-40 tin-lead solder. Clip off any excess lead length and clean with a flux-removing solvent. Be careful that the solvent does not remove any printing from the circuit board.

Semiconductors. An extracting tool should be used to remove the 14-pin and 16-pin integrated circuits. This tool is available from Tektronix, Inc. Order Tektronix Part No. 003-0619-00. If an extracting tool is not available, pull slowly and evenly on both ends of the device. Try to avoid having one end of the integrated circuit disengage from the socket before the other, as the pins may be damaged.

Component Replacement

WARNING

Disconnect the equipment from the power source before replacing components.

General. The exploded-view drawings associated with the Mechanical Parts List (located after the diagram section on pull-out pages) may be helpful in the removal or disassembly of individual components or sub-assemblies.

Circuit Board Replacement. If a circuit board is damaged beyond repair, the entire assembly including all soldered-on components can be replaced. Part numbers are given in the Mechanical Parts List.

Semiconductor Replacement. Replacement semiconductors should be of the original type or a direct replacement. All transistor sockets are wired for the standard basing as used for metal-case transistors. If a replacement transistor is made by a different manufacturer than the original, check the manufacturer's basing diagram for correct basing.

SECTION 5

CALIBRATION

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

Introduction

This calibration procedure may be used to check circuit performance with respect to the applicable Performance Requirements listed in Section 1. The procedure also describes how to adjust the variable components for best instrument performance. To assure optimum performance, check the functioning of the instrument circuits every 1000 operating hours or every six months if used infrequently.

The index to the calibration steps may be used by an experienced calibrator as an abridged calibration procedure or as a performance check. In addition, the index may be reproduced and used as a calibration record for the 4701.

TEST EQUIPMENT REQUIRED

The listed items of test equipment and accessories, or their equivalents, are required for a complete calibration of the 4701. The specifications listed with an item are provided as a guide for the selection of substitute equipment.

Test equipment required for this calibration procedure can be obtained from Tektronix, Inc. Order by part number through your local Tektronix Field Office or representative.

1. Precision DC voltmeter. Accuracy within $\pm 1\%$. Range from zero to at least 12 volts.

2. Oscilloscope with calibrator providing a 1 kHz square-wave, Bandwidth from DC to at least 5 MHz, Deflection factors from 0.01 V/Div to 5 V/Div, Sweep Rates from 1 $\mu\text{s}/\text{Div}$ to 5 s/Div.

3. Display Device such as Tektronix 601, 602, 611, or 4501.

4. Sine wave generator providing frequencies from 20 Hz to 1 MHz with an accuracy of three per cent. Output voltage of at least 10 volts. Example, General Radio Type GR 1310.

5. Probe 1X. Tektronix Type P6011 probe was used. Tektronix Part No. 010-0193-00.

6. Coaxial cables (four). Impedance, 50 ohms; length 42 inches; with BNC connectors. Tektronix Part No. 012-0057-01.

7. Dual Input Coupler; 50 ohm with BNC connectors. Tektronix Part No. 067-0525-00.

8. Termination. Impedance, 50 ohms; accuracy, $\pm 2\%$; BNC connectors. Tektronix Part No. 011-0049-01.

9. Tools:

a. Screwdriver, 3 inch shaft; 3/32 inch wide bit for slotted screws. Tektronix Part No. 003-0192-00.

b. Insulated screwdriver, 1 1/2 inch shaft, non-metallic. Tektronix Part No. 003-0000-00.

10. OPTIONAL: (required only to check voltage regulation).

a. Variable autotransformer capable of supplying at least 25 watts over a voltage range of 90 to 136 volts. For example, General Radio Type W10MT3W Metered Variac Autotransformer for 115 V line.

INDEX

This index to the 4701 Calibration procedure may be used as a calibration guide for the experienced calibrator, or it may be reproduced and used as a calibration record.

4701, Serial No. _____

Calibration Date _____

Calibrator _____

1. Check or Adjust +12 V Supply $\pm 1\%$ Page 5-3 (R616)

Check -12 V and +5 V Supplies, $\pm 3\%$.

Calibration—4701

2. Check or Adjust Amplifier Balance Page 5-3
R8A through R8H. No trace movement as GAIN is rotated.
3. Check or Adjust Y (Vertical) Position range (R91) Page 5-3
−0.8 V to +0.8 V for all channels.
4. Check or Adjust X (Horiz.) Position range (R141) Page 5-4
From −0.3 V to +0.3 V using Ramp Position and −0.8 V to +0.8 V using channel 5, 6, 7, and 8 Position controls.
5. Check or Adjust HF Compensation Page 5-5
(C4A through C4H and C14A through C14H). Optimum square wave.
6. Check Gain. 1 V out with 1 to 10 V in. Page 5-6
Check CMRR. 100:1 at 100 kHz.
Check Bandwidth. DC to 1 MHz.
7. Check or Adjust Sweep Time (R311) Page 5-7
Correct timing, within 3%.
8. Check or Adjust Sweep Amplitude (R326) Page 5-7
Amplitude of 1 V.
9. Check or Adjust Level at TP270 Page 5-7
DC Mode (R202), AC Mode (R223)
10. Check or Adjust AUTO P-P (R260) Page 5-8
Stable triggering: 20 mV input, + and − polarity, Trig. Level centered.
11. Check Triggering Page 5-8
All modes, + and − polarity. Specifications in Section 1.

12. Check or Adjust Chop Rate (R455) Page 5-10
High rate period about 3 μ s.
13. Check or Adjust Blanking (R535) Page 5-10
Amplitude of 1 V at TP535.
14. Check VIEW TIME Page 5-11
From <100 ms to approximately 30 seconds.
15. Check Remote Functions Page 5-11
As given in Table 1-1 of Section 1.

CALIBRATION PROCEDURE

Complete Recalibration

The calibration steps are listed under four headings: Power Supply, Amplifier, Trigger and Sweep, and Counter Board. During a complete recalibration of the instrument, perform the steps in the order given in the calibration procedure. If the +12 V adjustment (listed under the heading of Power Supply) is moved, a complete recalibration of the instrument is normally required.

Partial Recalibration

A partial recalibration consists of making all adjustments under one heading, in the order given. For example, adjustments on the Counter Board may be reset without interacting with adjustments listed under the other headings.

Equipment Required and Control Settings

An "equipment required" list for each group of calibration steps is placed where required, throughout the calibration procedure. The initial control settings for the test equipment and the 4701 are given immediately below this Equipment Required list. The control settings given assume that other controls are in positions resulting from completion of the preceding step; therefore, during a partial calibration check it is recommended that the initial settings for controls not mentioned be those given for the Power Supply check.

Preliminary Procedure

1. Remove the covers from the 4701.

POWER SUPPLY

Equipment required for step 1
Precision DC voltmeter

Initial Control Settings

4701

All Channels	OFF
POLARITY	+
TRIGGER SOURCE	Channel 1
TRIGGER LEVEL	centered
TRIGGER MODE	AUTO P-P
TIME/SCAN	10 ms
SWEEP MODE	NORM
STORE/NONSTORE	NONSTORE
Switching	ALT
VIEW TIME	OFF

1. Check/Adjust +12 Volts (R616)

a. Check the output voltage of the +12 V supply, using an accurate voltage measuring instrument connected between the test point and ground indicated in Fig. 5-1.

b. The output voltage of the +12 volt supply must be +12 V ±1% (11.8 V to 12.12 V).

NOTE

If the setting of the +12 volt adjustment (R616) is changed, a complete recalibration of all internal adjustments may be required.

c. If the output voltage of the +12 volt supply is not +12 volts ±1%, adjust R616 for exactly +12 volts.

d. Check that the output of the -12 volt supply is -12 volts ±3%, at the test point indicated in Fig. 5-1.

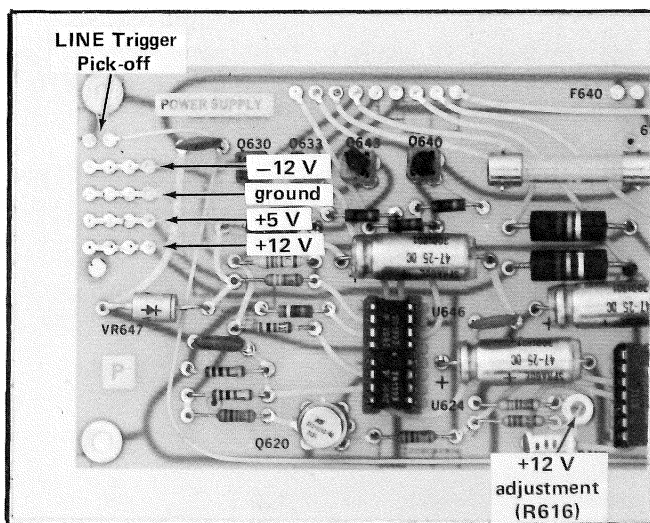


Fig. 5-1. Test points for checking Power Supply voltages.

e. Check that the output voltage of the +5 volt supply is +5 V ±3%, at the test point indicated in Fig. 5-1.

OPTIONAL CHECK (Power Supply Regulation)

f. A variable auto-transformer capable of supplying at least 25 watts over a voltage range of 90 to 136 volts can be used to check power supply regulation over the specified line voltage range. Output voltages of the +12 V, -12 V, and +5 volt supplies must meet accuracy requirements given in steps c, d, and e over the specified line voltage range.

AMPLIFIERS

Equipment required for steps 2, 3, 4 and 5
Oscilloscope
1X probe
Display Unit
Insulated Screwdriver

Control Settings

4701

Channel 1 ON

Oscilloscope

Trigger Internal, DC and AUTO
 Deflection factor 0.1 V/Div
 Sweep Rate 2 ms/Div

2. Check/Adjust Amplifier Balance (R8)

a. Connect a 1X probe to TP108 (see Fig. 5-2A).

b. While turning the channel 1 GAIN control from stop to stop, adjust R8A (Fig. 5-2B) for minimum vertical movement of the trace on the oscilloscope.

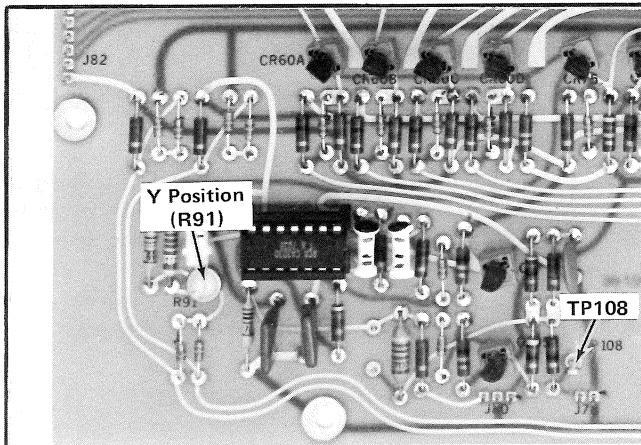
c. Turn channel 1 to OFF.

d. Turn on remaining channels one at a time and repeat steps b and c for each channel, using the proper adjustment for the channel being checked.

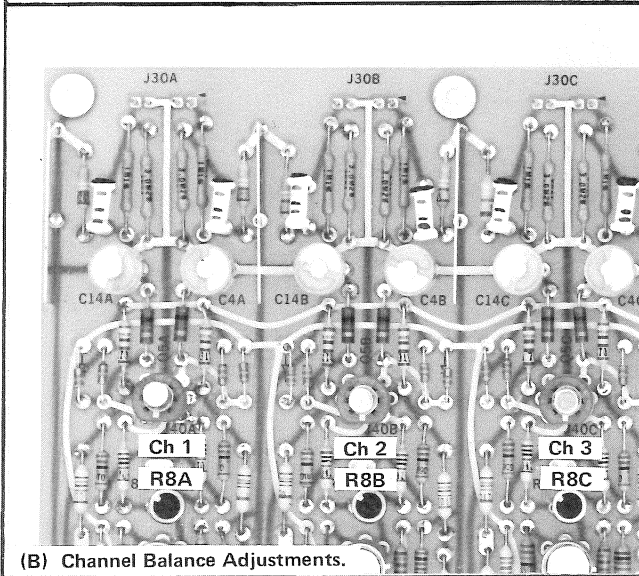
3. Check/Adjust Y Position Range (R91)

a. Set the oscilloscope to free run and a deflection factor of 0.5 V/Div.

b. Ground the oscilloscope input and adjust the trace to graticule center using the oscilloscope vertical positioning control.



(A) Location of TP108 on Amplifier Board.



(B) Channel Balance Adjustments.

Fig. 5-2. Location of TP108 and channel Balance adjustments.

- c. Reset the oscilloscope input coupling to DC.
- d. Set the POSITION controls for all channels fully ccw.
- e. Switch channel 1 to ON and note the DC level displayed.
- f. With channel 1 still ON, switch channel 2 to ON.
- g. Turn off the channel providing the largest negative positioning voltage (the level farthest from graticule center).

h. Turn channel 3 ON and compare with the channel left ON in step g above.

i. Again turn off the channel providing the most negative positioning voltage.

j. Continue through the remaining channels until the channel providing the least negative voltage (trace nearest graticule center of the oscilloscope) is identified.

k. Remember or record the channel just identified in step (j) above.

l. Rotate the POSITION controls for all channels fully cw and repeat steps (e) through (k) to determine the channel providing the least positive positioning voltage.

m. Turn off all channels except the two identified channels. The POSITION control for the least negative is turned fully ccw and the POSITION control for the least positive remains fully clockwise.

n. Adjust R91 (see Fig. 5-2) so that the least negative and the least positive positioning voltages are equally separated from ground (graticule center on the oscilloscope).

o. All channels must provide a positioning range from at least -0.8 V to $+0.8$ volt. If both of the two channels identified above provide this range the other channels will also.

4. Check/Adjust X Position Range (R141)

a. Connect a 1X probe to TP108 (Y output) and set your oscilloscope to 0.5 V/Div and a free run condition.

b. Check that the graticule center of your oscilloscope represents a 0 volt level if this was not done in steps 3b and 3c above.

c. Rotate the POSITION controls for channels 5 through 8 fully ccw.

d. Switch channel 5 to ON and all other channels to OFF.

e. Connect the 1X probe to TP108 and remember or record the voltage indicated by the oscilloscope.

f. Disconnect the 1X probe from TP108 and connect it to TP158 (X output).

g. Switch channel 1 to ON and channel 5 to PAIRED.

h. Adjust R141 (X Position), shown in Fig. 5-3, for the same voltage noted in part (e) of this step. This voltage must be more negative than -0.8 volt.

i. Rotate the channel 5 POSITION control fully cw and check for a voltage level more positive than $+0.8$ volt.

j. Switch channels 1 and 5 to OFF.

k. The positioning range provided by the channel 6 POSITION control can be checked by switching channel 2 to ON and channel 6 to PAIRED. The positioning range provided by the channel 6 POSITION control must be from at least -0.8 volt to $+0.8$ volt.

l. The positioning range of channel 7 and channel 8 POSITION controls can be checked for a range from -0.8 volt to $+0.8$ volt in the same manner as given above for channels 5 and 6. Normally checking the range of one channel (for example channel 5) at TP158 when PAIRED with that at TP108 when ON ensures that the other three POSITION controls will have sufficient range. The positioning range of all controls was checked in step (3) and part (h) of this step matched the PAIRED and ON levels.

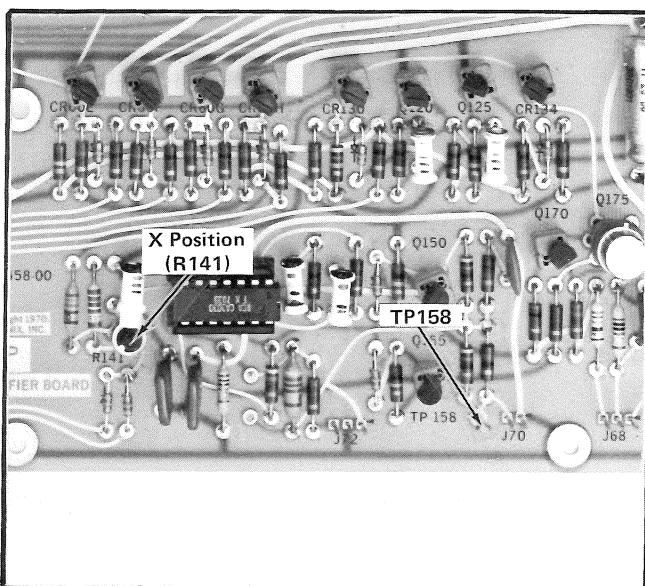


Fig. 5-3. Location of TP158 and X Position adjustment.

m. Switch all 4701 channels to OFF, and TIME/SCAN to 2 ms.

n. Set the oscilloscope Trigger Slope to (-) and adjust for a stable display (see Fig. 5-4).

o. Rotate the RAMP POSITION control fully cw and check that the voltage level at the start of the ramp is above (more positive than) -0.2 V.

p. Rotate the RAMP POSITION control fully ccw and check that the voltage level at the start of the ramp is more negative than -0.8 volt.

5. Check/Adjust High Frequency Compensation (C4 and C14)

a. Set all channel GAIN controls to approximate mid-position and channel 1 to ON.

b. Connect a 0.4 V, 1 kHz square wave from the oscilloscope calibrator to the (+) input of channel 1. Connect 1X probe to TP108.

c. Use the channel 1 POSITION control to set the bottom of the displayed waveform near the center of the display area of the display device.

d. Set the TRIGGER SOURCE to channel 1 and adjust the TRIGGER LEVEL if necessary.

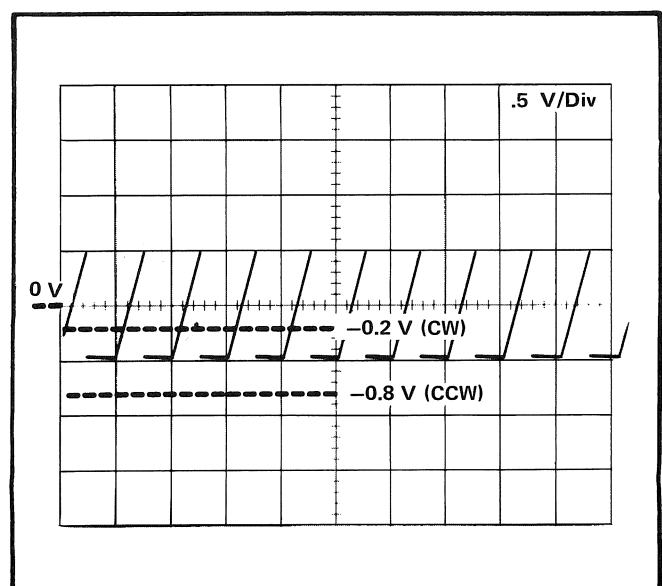


Fig. 5-4. Checking the range of the RAMP POSITION control.

Calibration—4701

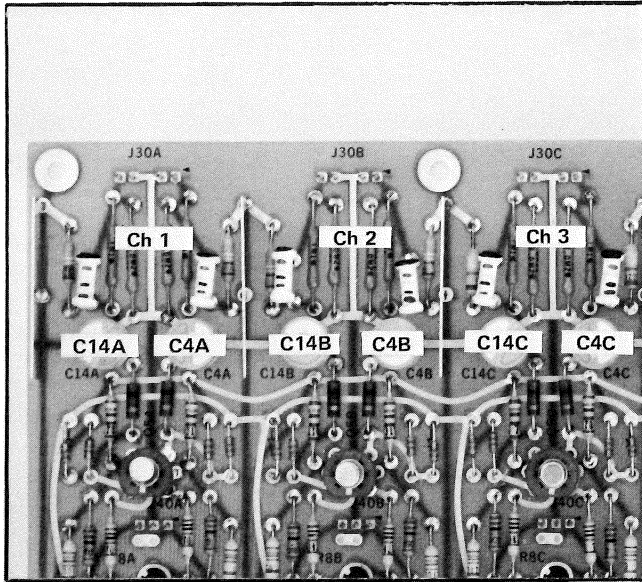


Fig. 5-5. High Frequency Compensation adjustments.

e. Adjust C4A for optimum displayed square wave (use an insulated screwdriver). See Fig. 5-5 for location of adjustments.

f. Connect the square wave to the (–) input of channel 1 and adjust C14A for optimum displayed square wave.

g. Turn channel 1 OFF and repeat parts (b) through (f) for channels 2 through 8, using the controls and capacitors for the ON channel.

Equipment required for step 6

Oscilloscope
1X probe
Sine Wave Generator
Dual Input Connector

Control Settings

4701

Channel 1 ON

GR 1310A (Signal Gen.)

Output Level 10 V
Output Frequency 100 kHz

6. Check GAIN Range, CMRR, and Bandwidth

a. Connect the output of the signal generator to the input of the dual input coupler.

b. Connect one of the coupler output connectors to the channel 1 (+) input connector. The unused coupler connector will be utilized in a later portion of this step.

c. Using the 1X probe connected to the oscilloscope input, check that the signal at TP108 (Y output) is not more than 1 V with the 4701 channel 1 GAIN control fully ccw.

d. Reduce the signal generator output voltage to 1 V.

e. Check that the signal displayed on the oscilloscope is at least 1 V with the channel 1 GAIN set fully cw.

f. Adjust the channel 1 GAIN control for exactly 1 V as displayed on the oscilloscope.

g. Connect the unused connector of the dual input connector to the channel 1 minus (–) input connector.

h. The signal displayed on the oscilloscope must not be more than 10 mV. If the displayed signal amplitude exceeds 10 mV, adjust C14A slightly to obtain an output of not more than 10 mV.

i. Disconnect the input signal to the channel 1 minus (–) input connector.

j. Do not disturb the channel 1 GAIN setting during the Bandwidth check that follows.

k. Set the signal generator output frequency to 1 MHz.

l. Check and adjust the signal generator output amplitude if necessary, for exactly 1 V at the channel 1 plus (+) input connector.

m. The amplitude of the 1 MHz signal at TP108 (Y output) must be at least 0.71 volt.

n. Repeat steps a through m for channels 2 through 8.

o. Switch all channels to OFF and disconnect the dual input coupler.

TRIGGER AND SWEEP

Equipment Required (steps 7 and 8)

Oscilloscope
1X probe

Control Settings

4701

TIME/SCAN 10 ms
VARIABLE CAL position

Oscilloscope

Time/Div 2 ms/Div
Volts/Div 1 V/Div

7. Check/Adjust Sweep Time (R311)

- a. Connect the 1X probe to TP285 (see Fig. 5-6).
- b. Check that the duration of the negative pulse is 10 ms (5 divisions) within 3%.
- c. Adjust R311 for a negative pulse duration of exactly 10 ms.
- d. Check remaining TIME/SCAN positions for a negative pulse duration within 3% of the TIME/SCAN setting.

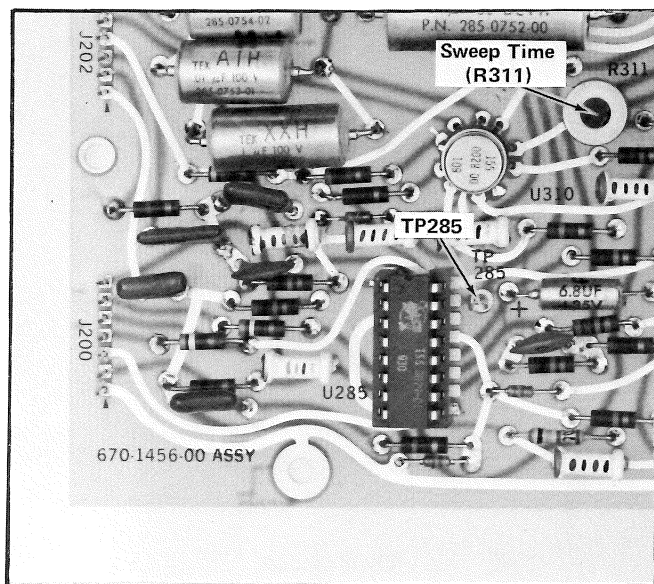


Fig. 5-6. Location of TP285 and R311 on the Sweep Board.

e. Return the 4701 TIME/SCAN to 10 ms and set the oscilloscope to 5 ms/Div.

f. Rotate the 4701 TIME/SCAN VARIABLE fully ccw and check for a negative pulse duration of at least 25 ms (5 divisions).

g. Return 4701 VARIABLE fully cw to CAL position.

8. Check/Adjust Sweep Amplitude (R326)

- a. Set the oscilloscope to 0.2 V/Div and 2 ms/Div.
- b. Connect the 1X probe to TP158 (see Fig. 5-3) and check for ramp amplitude of 1 V (5 divisions).
- c. Adjust R326 for a ramp amplitude of exactly 1 V.

Equipment Required for steps 9, 10, and 11

Oscilloscope
1X probe
50Ω Terminator
Signal Generator

Dual Input Coupler
5X Attenuator
Display Unit

Control Settings

4701

Trigger Mode AUTO P-P
Trigger Level centered

Oscilloscope

Volts/Div 50 mV
Time/Div 1 ms/Div

9. Check/Adjust level at TP270 (R202 and R223)

- a. Connect the 1X probe to TP108.
- b. Turn channel 1 ON and set the channel 1 POSITION control for a zero volt indication on the oscilloscope.
- c. Disconnect the 1X probe from TP108 and connect the probe to TP270 (see Fig. 5-7).
- d. Set the 4701 TRIGGER MODE to AC and adjust R223 for a zero volt indication on the oscilloscope.
- e. Set the 4701 TRIGGER MODE to DC and adjust R202 for a zero volt indication on the oscilloscope.

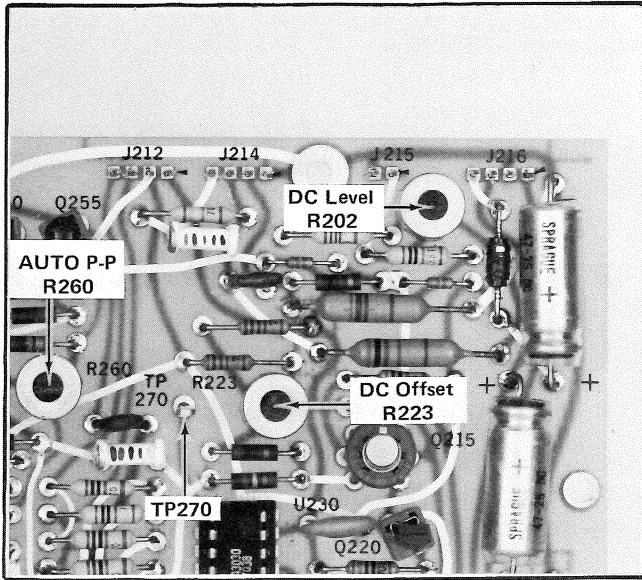


Fig. 5-7. Location of TP270, R223, R202 and R260 on the Sweep Board.

f. Connect 50Ω terminator on the 4701 rear panel EXT TRIG connector, set TRIGGER SELECTOR to EXT. Check for approximate zero volt indication on the oscilloscope for all 4701 trigger modes.

g. Remove the 50Ω terminator from the EXT TRIG input connector.

h. Disconnect the 1X probe from TP270.

10. Check/Adjust AUTO P-P (R260)

a. Set 4701 controls as follows:

TRIGGER POLARITY	+
TRIGGER LEVEL	centered
TRIGGER SOURCE	EXT
TRIGGER MODE	AUTO P-P
TIME/SCAN	.2 sec

b. Set the oscilloscope to 20 mV/Div and 20 ms/Div.

c. Set the signal generator frequency to 20 Hz and the output amplitude control almost fully ccw.

d. Connect the 5X attenuator to the signal generator output connector.

e. Connect one end of a coaxial cable to the 5X attenuator and the other end to the dual input coupler.

f. Connect the coupler to the channel 8 (+) input connector and to the EXT TRIGGER IN connector.

g. Connect the 1X probe from the oscilloscope to the channel 8 (+) input.

h. Adjust the signal generator output amplitude for a 50 mV (2 1/2 divisions) display on the oscilloscope.

i. Adjust R260 (see Fig. 5-7) for a stable display with + or - polarity selected.

j. Check for a stable display with TRIGGER MODE set to AC and DC.

11. Check Triggering

General. Check for a stable display on the display unit, with both + and - polarity selected and with the MODE switch at AUTO P-P, AC, and DC.

The TRIGGER LEVEL control may require a slight adjustment to find the optimum setting when switching polarity.

If no signal is displayed when the DC Mode is selected, change the setting of the POSITION control for the channel in use.

Check for a stable display on the display unit, for all conditions given in Table 5-1.

COUNTER BOARD

Equipment Required (steps 12 and 13)

Oscilloscope
10X probe
OPTIONAL: Type 4501 Scan Converter

Control Settings

4701

Trigger Switching	CHOP
Chop Rate Switch (S455)	HIGH (forward)

Oscilloscope

VOLTS/DIV	2 V/DIV
TIME/DIV	1 μs

TABLE 5-1
Complete 4701 Triggering Check

EXTERNAL Triggering

- a. Connect the signal generator output through the dual input coupler to the EXT TRIGGER IN and the channel 8 (+) input connector. Set the TRIGGER LEVEL control to midposition.
- b. A 5X attenuator may be required at the signal generator output to reduce the signal amplitude to the specified value.

4701		Oscilloscope			Signal Generator		Remarks
Trigger Source	TIME/SCAN	VOLTS/DIV	TIME/DIV	Displayed Divisions	Freq.	Output	
EXT	50 ms	20 mV	.1 s	2½	20 Hz	50 mV at Ch 8 input	Omit check at 20 Hz if checked during step 10. 1X probe is connected to channel 8 input.
EXT	2 μs	20 mV	.5 μs	2½	1 MHz		
LINE	.2 s	-----	-----	-----	-----	-----	Turn Ch 1 ON. Touch finger to Ch 1 input as source of line freq. signal.

Channel Signal Triggering (internal)

- a. Disconnect the dual input coupler from the 4701 and the coaxial cable.
- b. Set the GAIN controls of all channels fully cw, and POSITION controls to midposition.
- c. Determine the weakest triggering signal as follows: Apply a 1 MHz, 20 mV signal to the 4701 Ch 1 input. Switch all channels to ON and set TRIGGER SOURCE to Ch 1. Connect the 1X probe to TP270 and observe the amplitude on your oscilloscope. Connect the signal generator signal to the input of Ch 2 and set the TRIGGER SOURCE to 2. Repeat the above procedure for the remaining channels. The amplitude of triggering signal from each channel should be approximately the same. For the remainder of this check use Ch 1, or the channel providing the lowest amplitude signal at TP270 if a significant difference exists between channels.

Trigger Source	TIME/SCAN	VOLTS/DIV	TIME/DIV	Displayed Divisions	Freq.	Output	Remarks
Ch 1	2 μs	10 mV	.5 μs	2	1 MHz	20 mV at TP108	Connect 1X probe to TP108 (Y output)
same	20 μs	same	5 μs	same	100 kHz		
same	50 ms	same	.1 s	same	20 Hz		
same	.5 s	same	1 s	same	2 Hz		Check only on DC Trigger Mode. Set 4701 to SINGLE and STORE.

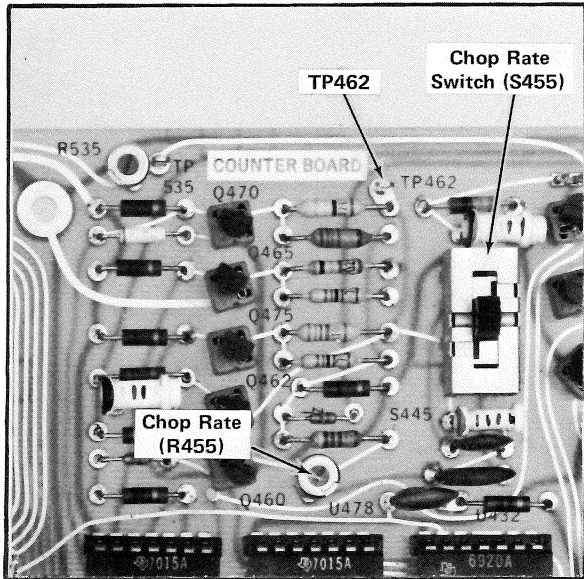


Fig. 5-8. Location of TP462, R455, and S455 on Counter Board.

12. Check/Adjust Chop Rate (R455)

- a. Connect 10X probe to TP462 (see Fig. 5-8). Connect a 5k resistor to probe tip if oscillations occur.
- b. Adjust R455 so that the period (time for one cycle) of the displayed waveform is 3 μ s. See Fig. 5-9A.
- c. Switch the Chop Rate Switch (S455) to MED (mid-position) and the oscilloscope to 10 μ s/Div, and check for a period of approximately 30 μ s.
- d. Switch the Chop Rate Switch to LOW and the oscilloscope to .1 ms/Div, and check for a period of approximately 450 μ s.

OPTIONAL CHECK: When the 4701 is used with a Tektronix Type 4501 Scan Converter, the 4701 Chop Rate may be set so that three channels are selected during each Write Interval (Type 4501 set to Write/Read Mode).

NOTE

When using a Type 4501 having a serial number from B010000 to B999999, be sure that pin 11 of J1302 is connected to pin 1 of J1304. Soldering a wire between these pins makes the 4501 Read/Write Switching Signal available at 25 pin connector J1302.

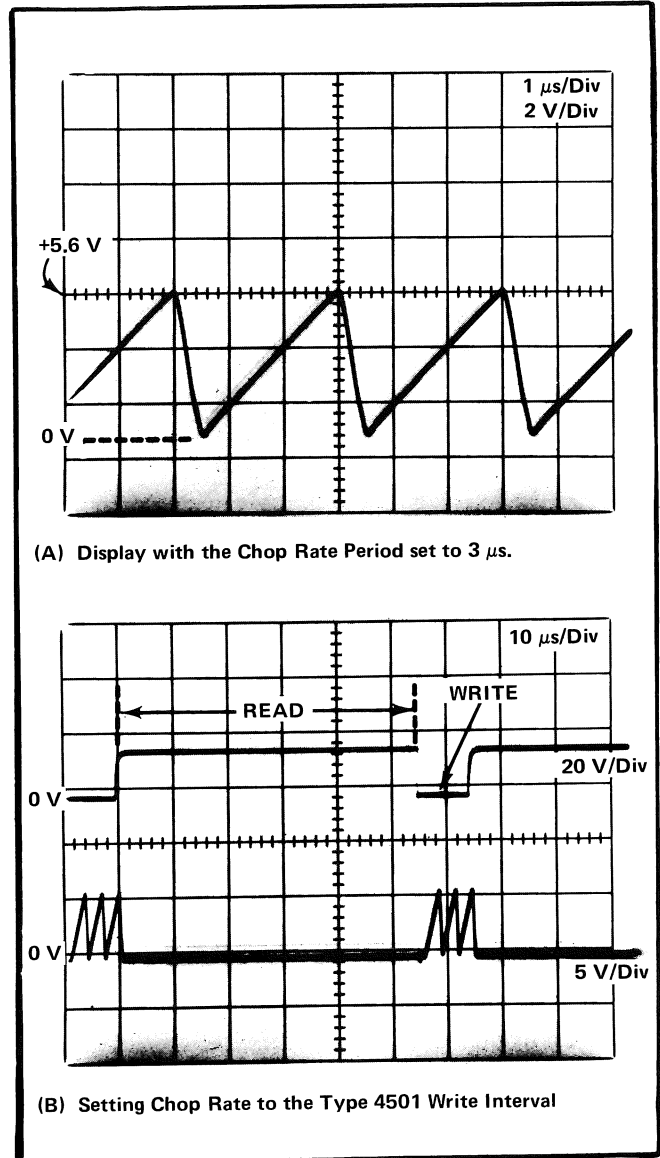


Fig. 5-9. Displays during Chop Rate adjustment.

- e. Connect J650 (upper 25 pin connector) on the 4701 to J1302 (25 pin connector) on the Type 4501, using the interconnecting cable supplied with the 4701.
- f. Switch the Type 4501 Power Switch to ON and set the Mode Switch to WRITE/READ.
- g. With the 4701 Chop Rate Switch set to HIGH, adjust Chop Rate Adjust R455 for three complete cycles during each Write Interval (see Fig. 5-9B).

13. Check/Adjust Blanking (R535)

- a. Connect the 1X probe to TP535.
- b. Adjust R535 for a pulse amplitude of 1 volt.

Equipment Required (steps 14 and 15)

- Oscilloscope
- Display Unit
- 1X and 10X probe

Control Settings

4701

MODE	AUTO P-P
SWEEP MODE	NORM
STORE/NONSTORE	STORE
TIME/SCAN	2 ms

14. Check VIEW TIME (Auto Erase)

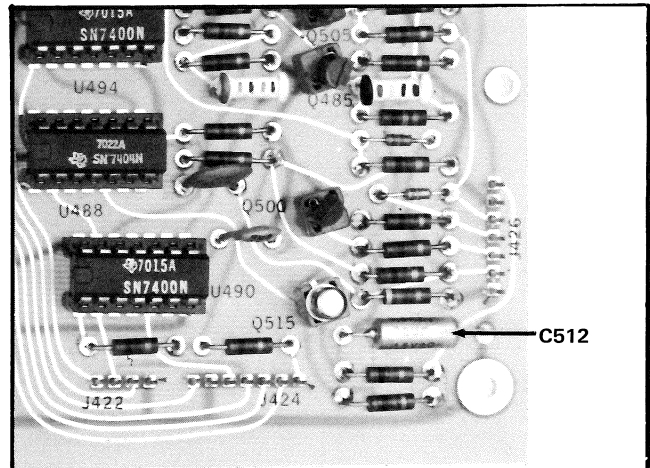
- a. Set at least one channel to ON.
- b. Turn VIEW TIME control fully ccw to OFF.
- c. Slowly turn the VIEW TIME control clockwise until just out of the detent. This is the minimum VIEW TIME setting and should be less than 100 ms.
- d. Set the 0 V reference on your oscilloscope three divisions below graticule center.
- e. Connect a 10X probe to the ungrounded side of C512 (see Fig. 5-10A).
- f. Set your oscilloscope to 0.2 V/Div and 50 ms/Div and measure VIEW TIME (see Fig. 5-10B).
- g. Change oscilloscope TIME/DIV to 5 sec/Div.
- h. Rotate the VIEW TIME control fully cw to SAVE, and note that a spot is slowly moving across the oscilloscope CRT along the 0 V reference level.
- i. Slowly turn the VIEW TIME control ccw from the SAVE position until a gradual upward movement of the spot is detected. This is the maximum VIEW TIME setting, and should be about 30 seconds.

15. Check Remote Functions

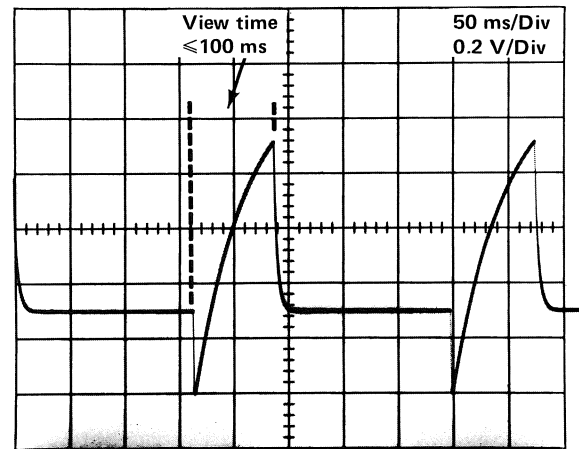
(See Table 1-1 in Section 1.)

Controlling the Display Device (J650).

- a. Grounding pin 6 of J650 switches the Display Device to NONSTORE.
- b. Grounding pin 18 erases the display.



(A)



(B)

Fig. 5-10. Location of C512 on the Counter Board.

- c. If a Type 4501 (Mode to WRITE/READ or READ ONLY) is used, grounding pin 22 will switch the Type 4501 to the WRITE ONLY Mode.

Functions and Information (J651).

- a. Grounding pin 10 of J651 switches the 4701 to channel 1.
- b. Grounding pin 18 erases the Display Device.
- c. Channel selection and channel identify coding is given in the tables of Section 1.

PARTS LIST ABBREVIATIONS

BHB	binding head brass	int	internal
BHS	binding head steel	lg	length or long
cap.	capacitor	met.	metal
cer	ceramic	mtg hdw	mounting hardware
comp	composition	OD	outside diameter
conn	connector	OHB	oval head brass
CRT	cathode-ray tube	OHS	oval head steel
csk	countersunk	P/O	part of
DE	double end	PHB	pan head brass
dia	diameter	PHS	pan head steel
div	division	plstc	plastic
elect.	electrolytic	PMC	paper, metal cased
EMC	electrolytic, metal cased	poly	polystyrene
EMT	electrolytic, metal tubular	prec	precision
ext	external	PT	paper, tubular
F & I	focus and intensity	PTM	paper or plastic, tubular, molded
FHB	flat head brass	RHB	round head brass
FHS	flat head steel	RHS	round head steel
Fil HB	fillister head brass	SE	single end
Fil HS	fillister head steel	SN or S/N	serial number
h	height or high	S or SW	switch
hex.	hexagonal	TC	temperature compensated
HHB	hex head brass	THB	truss head brass
HHS	hex head steel	thk	thick
HSB	hex socket brass	THS	truss head steel
HSS	hex socket steel	tub.	tubular
ID	inside diameter	var	variable
inc	incandescent	w	wide or width
		WW	wire-wound

PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial or model number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

SPECIAL NOTES AND SYMBOLS

- | | |
|-----------------|---|
| ×000 | Part first added at this serial number |
| 00× | Part removed after this serial number |
| *000-0000-00 | Asterisk preceding Tektronix Part Number indicates manufactured by or for Tektronix, Inc., or reworked or checked components. |
| Use 000-0000-00 | Part number indicated is direct replacement. |

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SECTION 6

ELECTRICAL PARTS LIST

CHASSIS

Values are fixed unless marked Variable.

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	No. Disc	Description
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Capacitors

Tolerance $\pm 20\%$ unless otherwise indicated.

C612	290-0317-00		1000 μ F	Elect.	40 V	+100%—10%
C620	290-0317-00		1000 μ F	Elect.	40 V	+100%—10%
C640	290-0029-00		2000 μ F	Elect.	20 V	

Bulbs

DS297	150-0048-00		Incandescent, # 683			
DS640	150-0065-00		Incandescent, 10 V, 40 mA, green lens			

Fuse

F601	159-0029-00		0.3 A	3 AG Slo-Blo		
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Connectors

J650	131-0569-00		Receptacle, electrical, male			
J651	131-0569-00		Receptacle, electrical, male			

Transistors

Q615	*151-0148-00		Silicon	NPN	TO-66	Tek Spec
Q635	151-0227-00		Silicon	PNP	TO-66	2N3741
Q645	*151-0148-00		Silicon	NPN	TO-66	Tek Spec

Resistors

Resistors are fixed, composition, $\pm 10\%$ unless otherwise indicated.

R31A-1-R31H-1 ¹	311-1181-00		5 k Ω x 5 k Ω , Var			
R31A-2-R31H-2 ²	311-1181-00		5 k Ω x 5 k Ω , Var			
R177 ³	311-1194-00		500 Ω , Var			
R256	311-0467-00		100 k Ω , Var			
R340	309-0094-00		6 M Ω	$\frac{1}{2}$ W	Prec	1%

¹Furnished as a unit with R31A-2 to R31H-2.

²Furnished as a unit with R31A-1 to R31H-1.

³Furnished as a unit with S110A, B.

Electrical Parts List—4701

CHASSIS (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	No. Disc	Description
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Resistors (cont)

R341	309-0023-00		2 MΩ	1/2 W Prec	1%
R342	323-0481-00		1 MΩ	1/2 W Prec	1%
R343	309-0004-00		600 kΩ	1/2 W Prec	1%
R344	323-0414-00		200 kΩ	1/2 W Prec	1%
R345	323-0385-00		100 kΩ	1/2 W Prec	1%
R346	323-0364-00		60.4 kΩ	1/2 W Prec	1%
R347	323-0318-00		20 kΩ	1/2 W Prec	1%
R348	323-0318-00		20 kΩ	1/2 W Prec	1%
R349	311-1180-00		5 kΩ, Var		
R511	311-1196-00		1 MΩ, Var		

Switches

Wired or Unwired

S110A,B ⁴					
S200	260-1242-00		Rotary		TRIGGER LEVEL SOURCE
S205	260-1244-00		Lever		TRIGGER MODE
S265	260-1246-00		Lever		Sweep Mode
S280	260-0640-00		Lever		POLARITY
S340	260-1241-00		Rotary		TIME/SCAN
S349 ⁵					
S430	260-0776-00		Lever		
S432	260-0776-00		Lever		
S434	260-0776-00		Lever		
S436	260-0776-00		Lever		
S440	260-1245-00		Lever		
S442	260-1245-00		Lever		
S444	260-1245-00		Lever		
S446	260-1245-00		Lever		
S485	260-1247-00		Lever		Store Non Store
S495	260-0776-00		Lever		
S511 ⁶					ERASE
S601	260-0834-00		Toggle		ON-OFF
S603	260-0675-00		Slide		DPDT 115 V/230 V

Transformer

T601	*120-0729-00		Power
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⁴Furnished as a unit with R177.

⁵Furnished as a unit with R349.

⁶Furnished as a unit with R511.

A1 AMPLIFIER Circuit Board Assembly

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
*670-1458-00		Complete Board		
Capacitors				
Tolerance $\pm 20\%$ unless otherwise indicated.				
C2A-C2H	281-0564-00		24 pF	Cer 500 V 5%
C4A-C4H	281-0092-00		9-35 pF, Var	
C12A-C12H	281-0564-00		24 pF	Cer 500 V 5%
C14A-C14H	281-0092-00		9-35 pF, Var	
C36A-C36H	283-0059-01		1 μ F	Cer 25 V +80%—20%
C45A-C45H	281-0529-00		1.5 pF	Cer 500 V ± 0.25 pF
C50A-C50H	281-0529-00		1.5 pF	Cer 500 V ± 0.25 pF
C52A-C52H	281-0564-00		24 pF	Cer 500 V 5%
C54A-C54H	283-0003-02		0.01 μ F	Cer 150 V
C56A-C56H	281-0564-00		24 pF	Cer 500 V 5%
C71	281-0525-00		470 pF	Cer 500 V
C81	281-0525-00		470 pF	Cer 500 V
C92	281-0512-00		27 pF	Cer 500 V 10%
C94	281-0564-00		24 pF	Cer 500 V 5%
C95	283-0059-01		1 μ F	Cer 25 V +80%—20%
C97	281-0564-00		24 pF	Cer 500 V 5%
C99	283-0059-01		1 μ F	Cer 25 V +80%—20%
C115	283-0003-02		0.01 μ F	Cer 150 V
C121	281-0525-00		470 pF	Cer 500 V
C125	281-0525-00		470 pF	Cer 500 V
C142	281-0512-00		27 pF	Cer 500 V 10%
C144	281-0564-00		24 pF	Cer 500 V 5%
C145	283-0059-01		1 μ F	Cer 25 V +80%—20%
C147	281-0564-00		24 pF	Cer 500 V 5%
C149	283-0059-01		1 μ F	Cer 25 V +80%—20%
C165	283-0003-02		0.01 μ F	Cer 150 V
C175	283-0059-01		1 μ F	Cer 25 V +80%—20%
C180	290-0287-00		47 μ F	Elect. 25 V
C182	290-0287-00		47 μ F	Elect. 25 V
C184	290-0287-00		47 μ F	Elect. 25 V
C351	281-0504-00		10 pF	Cer 500 V 10%

A1 AMPLIFIER Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
Semiconductor Device, Diodes				
CR4A-CR4H	*152-0185-00		Silicon	Replaceable by 1N4152
CR5A-CR5H	*152-0185-00		Silicon	Replaceable by 1N4152
CR14A-CR14H	*152-0185-00		Silicon	Replaceable by 1N4152
CR15A-CR15H	*152-0185-00		Silicon	Replaceable by 1N4152
CR60A-CR60H	152-0501-00		Silicon	Dual, Common Anode, 70 V, 200 mA, TO-92
CR62A-CR62H	*152-0185-00		Silicon	Replaceable by 1N4152
CR73	*152-0185-00		Silicon	Replaceable by 1N4152
CR75	152-0501-00		Silicon	Dual, Common Anode, 70 V, 200 mA, TO-92
CR83	*152-0185-00		Silicon	Replaceable by 1N4152
CR85	152-0501-00		Silicon	Dual, Common Anode, 70 V, 200 mA, TO-92
CR91	*152-0185-00		Silicon	Replaceable by 1N4152
CR92	*152-0185-00		Silicon	Replaceable by 1N4152
CR100	*152-0185-00		Silicon	Replaceable by 1N4152
CR104	*152-0185-00		Silicon	Replaceable by 1N4152
CR123	*152-0185-00		Silicon	Replaceable by 1N4152
CR127	*152-0185-00		Silicon	Replaceable by 1N4152
CR130	152-0501-00		Silicon	Dual, Common Anode, 70 V, 200 mA, TO-92
CR134	152-0501-00		Silicon	Dual, Common Anode, 70 V, 200 mA, TO-92
CR141	*152-0185-00		Silicon	Replaceable by 1N4152
CR142	*152-0185-00		Silicon	Replaceable by 1N4152
CR150	*152-0185-00		Silicon	Replaceable by 1N4152
CR154	*152-0185-00		Silicon	Replaceable by 1N4152
CR190	*152-0185-00		Silicon	Replaceable by 1N4152
CR191	*152-0185-00		Silicon	Replaceable by 1N4152
CR193	*152-0185-00		Silicon	Replaceable by 1N4152
CR194	*152-0185-00		Silicon	Replaceable by 1N4152
Transistors				
Q5A-Q5H	151-1036-00		Silicon	JFET TO-71 N channel, dual
Q25A-Q25H	151-0232-00		Silicon	NPN TO-78 Dual
Q75	151-0190-02		Silicon	NPN TO-92 2N3904
Q85	151-0190-02		Silicon	NPN TO-92 2N3904
Q100	151-0190-02		Silicon	NPN TO-92 2N3904
Q105	151-0188-00		Silicon	PNP TO-92 2N3906
Q120	151-0190-02		Silicon	NPN TO-92 2N3904
Q125	151-0190-02		Silicon	NPN TO-92 2N3904
Q150	151-0190-02		Silicon	NPN TO-92 2N3904
Q155	151-0188-00		Silicon	PNP TO-92 2N3906

A1 AMPLIFIER Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description		
Transistors (cont)						
Q170	151-0188-00		Silicon	PNP	TO-92	2N3906
Q175	151-0232-00		Silicon	NPN	TO-78	Dual
Resistors						
Resistors are fixed, composition, $\pm 10\%$ unless otherwise indicated.						
R1A-R1H	319-0054-00		3 M Ω	$\frac{1}{4}$ W	Prec	2%
R2A-R2H	319-0031-00		1 M Ω	$\frac{1}{4}$ W	Prec	1%
R4A-R4H	321-0452-00		499 k Ω	$\frac{1}{8}$ W	Prec	1%
R5A-R5H	315-0101-00		100 Ω	$\frac{1}{4}$ W		5%
R7A-R7H	321-0193-00		1 k Ω	$\frac{1}{8}$ W	Prec	1%
R8A-R8H	311-0634-00		500 Ω , Var			
R9A-R9H	321-0218-00		1.82 k Ω	$\frac{1}{8}$ W	Prec	1%
R11A-R11H	319-0054-00		3 M Ω	$\frac{1}{4}$ W	Prec	2%
R12A-R12H	319-0031-00		1 M Ω	$\frac{1}{4}$ W	Prec	1%
R14A-R14H	321-0452-00		499 k Ω	$\frac{1}{8}$ W	Prec	1%
R15A-R15H	315-0101-00		100 Ω	$\frac{1}{4}$ W		5%
R17A-R17H	321-0193-00		1 k Ω	$\frac{1}{8}$ W	Prec	1%
R19A-R19H	321-0218-00		1.82 k Ω	$\frac{1}{8}$ W	Prec	1%
R21A-R21H	321-0170-00		576 Ω	$\frac{1}{8}$ W	Prec	1%
R23A-R23H	321-0212-00		1.58 k Ω	$\frac{1}{8}$ W	Prec	1%
R25A-R25H	321-0291-00		10.5 k Ω	$\frac{1}{8}$ W	Prec	1%
R26A-R26H	321-0213-00		1.62 k Ω	$\frac{1}{8}$ W	Prec	1%
R30A-R30H	321-0085-00		75 Ω	$\frac{1}{8}$ W	Prec	1%
R33A-R33H	321-0324-00		23.2 k Ω	$\frac{1}{8}$ W	Prec	1%
R34A-R34H	321-0321-00		21.5 k Ω	$\frac{1}{8}$ W	Prec	1%
R38A-R38H	321-0436-00		340 k Ω	$\frac{1}{8}$ W	Prec	1%
R39A-R39H	321-0364-00		60.4 k Ω	$\frac{1}{8}$ W	Prec	1%
R40A-R40H	321-0085-00		75 Ω	$\frac{1}{8}$ W	Prec	1%
R43A-R43H	321-0324-00		23.2 k Ω	$\frac{1}{8}$ W	Prec	1%
R44A-R44H	321-0321-00		21.5 k Ω	$\frac{1}{8}$ W	Prec	1%
R45A-R45H	321-0356-00		49.9 k Ω	$\frac{1}{8}$ W	Prec	1%
R50A-R50H	321-0316-00		19.1 k Ω	$\frac{1}{8}$ W	Prec	1%
R52A-R52H	315-0202-00		2 k Ω	$\frac{1}{4}$ W		5%
R56A-R56H	315-0202-00		2 k Ω	$\frac{1}{4}$ W		5%
R58A-R58H	315-0102-00		1 k Ω	$\frac{1}{4}$ W		5%
R60A-R60H	315-0512-00		5.1 k Ω	$\frac{1}{4}$ W		5%
R62A-R62H	315-0202-00		2 k Ω	$\frac{1}{4}$ W		5%
R66	315-0123-00		12 k Ω	$\frac{1}{4}$ W		5%
R68	315-0123-00		12 k Ω	$\frac{1}{4}$ W		5%
R70	315-0102-00		1 k Ω	$\frac{1}{4}$ W		5%

A1 AMPLIFIER Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description		
Resistors (cont)						
R71	315-0102-00		1 k Ω	1/4 W		5%
R73	315-0102-00		1 k Ω	1/4 W		5%
R75	315-0512-00		5.1 k Ω	1/4 W		5%
R80	315-0102-00		1 k Ω	1/4 W		5%
R81	315-0102-00		1 k Ω	1/4 W		5%
R83	315-0102-00		1 k Ω	1/4 W		5%
R85	315-0512-00		5.1 k Ω	1/4 W		5%
R87	315-0473-00		47 k Ω	1/4 W		5%
R90	321-0229-00		2.37 k Ω	1/8 W	Prec	1%
R91	311-0634-00		500 Ω , Var			
R92	321-0297-00		12.1 k Ω	1/8 W	Prec	1%
R94	315-0202-00		2 k Ω	1/4 W		5%
R95	315-0472-00		4.7 k Ω	1/4 W		5%
R97	315-0202-00		2 k Ω	1/4 W		5%
R100	315-0103-00		10 k Ω	1/4 W		5%
R102	315-0470-00		47 Ω	1/4 W		5%
R104	315-0103-00		10 k Ω	1/4 W		5%
R106	315-0470-00		47 Ω	1/4 W		5%
R108	315-0510-00		51 Ω	1/4 W		5%
R110	315-0152-00		1.5 k Ω	1/4 W		5%
R112	321-0258-00		4.75 k Ω	1/8 W	Prec	1%
R113	321-0193-00		1 k Ω	1/8 W	Prec	1%
R115	315-0221-00		220 Ω	1/4 W		5%
R120	315-0102-00		1 k Ω	1/4 W		5%
R121	315-0102-00		1 k Ω	1/4 W		5%
R123	315-0102-00		1 k Ω	1/4 W		5%
R125	315-0103-00		10 k Ω	1/4 W		5%
R127	315-0102-00		1 k Ω	1/4 W		5%
R130	315-0512-00		5.1 k Ω	1/4 W		5%
R132	315-0473-00		47 k Ω	1/4 W		5%
R134	315-0512-00		5.1 k Ω	1/4 W		5%
R140	321-0229-00		2.37 k Ω	1/8 W	Prec	1%
R141	311-0634-00		500 Ω , Var			
R142	321-0297-00		12.1 k Ω	1/8 W	Prec	1%
R144	315-0202-00		2 k Ω	1/4 W		5%
R145	315-0472-00		4.7 k Ω	1/4 W		5%
R147	315-0202-00		2 k Ω	1/4 W		5%
R150	315-0103-00		10 k Ω	1/4 W		5%
R152	315-0470-00		47 Ω	1/4 W		5%
R154	315-0103-00		10 k Ω	1/4 W		5%

A1 AMPLIFIER Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description		
Resistors (cont)						
R156	315-0470-00		47 Ω	1/4 W		5%
R158	315-0510-00		51 Ω	1/4 W		5%
R160	315-0512-00		5.1 k Ω	1/4 W		5%
R162	321-0258-00		4.75 k Ω	1/8 W	Prec	1%
R163	321-0193-00		1 k Ω	1/8 W	Prec	1%
R165	315-0221-00		220 Ω	1/4 W		5%
R170	315-0102-00		1 k Ω	1/4 W		5%
R171	315-0182-00		1.8 k Ω	1/4 W		5%
R173	315-0222-00		2.2 k Ω	1/4 W		5%
R174	321-0318-00		20 k Ω	1/8 W	Prec	1%
R175	321-0318-00		20 k Ω	1/8 W	Prec	1%
R176	321-0245-00		3.48 k Ω	1/8 W	Prec	1%
R179	321-0262-00		5.23 k Ω	1/8 W	Prec	1%
R190	315-0222-00		2.2 k Ω	1/4 W		5%
R194	315-0222-00		2.2 k Ω	1/4 W		5%
R351	315-0754-00		750 k Ω	1/4 W		5%

Integrated Circuits

U55A-U55H	156-0136-00	Op amp., replaceable by RCA CA3030
U95	156-0136-00	Op amp., replaceable by RCA CA3030
U145	156-0136-00	Op amp., replaceable by RCA CA3030

A2 SWEEP Circuit Board Assembly

*670-1456-00

Complete Board

Capacitors

Tolerance $\pm 20\%$ unless otherwise indicated.

C204	283-0198-01	0.22 μ F	Cer	50 V	
C206	281-0524-00	150 pF	Cer	500 V	
C228	281-0605-00	200 pF	Cer	500 V	
C230	281-0504-00	10 pF	Cer	500 V	10%
C232	283-0003-00	0.01 μ F	Cer	150 V	
C234	281-0504-00	10 pF	Cer	500 V	10%
C244	283-0164-01	2.2 μ F	Cer	25 V	
C254	283-0164-01	2.2 μ F	Cer	25 V	
C257	283-0000-02	0.001 μ F	Cer	500 V	
C267	283-0059-01	1 μ F	Cer	25 V	+80%—20%

A2 SWEEP Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description		
Capacitors (cont)						
C270	281-0524-00		150 pF	Cer	500 V	
C284	281-0523-00		100 pF	Cer	350 V	
C287	290-0261-00		6.8 μ F	Elect.	35 V	
C290	283-0110-01		0.005 μ F	Cer	150 V	
C292	281-0546-00		330 pF	Cer	500 V	10%
C293	281-0589-00		170 pF	Cer	500 V	5%
C295	281-0523-00		100 pF	Cer	350 V	
C304	283-0110-01		0.005 μ F	Cer	150 V	
C311	283-0003-02		0.01 μ F	Cer	150 V	
C320 ^s	*295-0149-00		0.001 μ F	Timing Capacitor Assembly		
C321			0.01 μ F			
C323			0.1 μ F			
C325			1 μ F			
C327			10 μ F			
C328	281-0511-00		22 pF	Cer	500 V	10%
C329	281-0523-00		100 pF	Cer	350 V	
C330	283-0221-01		0.47 μ F	Cer	50 V	
C334	283-0059-01		1 μ F	Cer	25 V	+80%—20%
C336	283-0164-01		2.2 μ F	Cer	25 V	
C380	290-0287-00		47 μ F	Elect.	25 V	
C382	290-0287-00		47 μ F	Elect.	25 V	
C384	290-0287-00		47 μ F	Elect.	25 V	

Semiconductor Device, Diodes

CR208	*152-0185-00	Silicon	Replaceable by 1N4152
CR209	*152-0185-00	Silicon	Replaceable by 1N4152
CR236	*152-0185-00	Silicon	Replaceable by 1N4152
CR237	*152-0185-00	Silicon	Replaceable by 1N4152
CR243	*152-0185-00	Silicon	Replaceable by 1N4152
CR244	*152-0185-00	Silicon	Replaceable by 1N4152
CR245	*152-0185-00	Silicon	Replaceable by 1N4152
CR253	*152-0185-00	Silicon	Replaceable by 1N4152
CR254	*152-0185-00	Silicon	Replaceable by 1N4152
CR255	*152-0185-00	Silicon	Replaceable by 1N4152
CR266	*152-0185-00	Silicon	Replaceable by 1N4152
CR269	*152-0185-00	Silicon	Replaceable by 1N4152
CR295	*152-0185-00	Silicon	Replaceable by 1N4152

^sIndividual timing capacitors in this assembly must be ordered by the 9 digit part number, letter suffix and tolerance printed on the timing capacitor to be replaced.

Example: F—
285-XXXX-XX

The letter suffix and the tolerance should be the same for all of the timing capacitors in the assembly.

A2 SWEEP Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description		
Inductors						
L380	108-0226-00			100 μ H		
L384	108-0226-00			100 μ H		
Transistors						
Q215	151-1036-00		Silicon	JFET	TO-71	N channel, dual
Q220	151-0190-02		Silicon	NPN	TO-92	2N3904
Q255	151-1005-00		Silicon	FET	TO-18	N channel, junction type
Q260	151-0190-02		Silicon	NPN	TO-92	2N3904
Q275	151-0232-00		Silicon	NPN	TO-78	Dual
Q280	151-0188-00		Silicon	PNP	TO-92	2N3906
Resistors						
Resistors are fixed, composition, $\pm 10\%$ unless otherwise indicated.						
R201	321-0322-00		22.1 k Ω	$\frac{1}{8}$ W	Prec	1%
R202	311-0950-00		10 k Ω , Var			
R203	321-0289-00		10 k Ω	$\frac{1}{8}$ W	Prec	1%
R204	323-0472-00		806 k Ω	$\frac{1}{2}$ W	Prec	1%
R206	321-0423-00		249 k Ω	$\frac{1}{8}$ W	Prec	1%
R208	323-0489-00		1.21 M Ω	$\frac{1}{2}$ W	Prec	1%
R209	315-0101-00		100 Ω	$\frac{1}{4}$ W		5%
R211	321-0193-00		1 k Ω	$\frac{1}{8}$ W	Prec	1%
R212	321-0268-00		6.04 k Ω	$\frac{1}{8}$ W	Prec	1%
R213	321-0289-00		10 k Ω	$\frac{1}{8}$ W	Prec	1%
R215	321-0193-00		1 k Ω	$\frac{1}{8}$ W	Prec	1%
R216	321-0268-00		6.04 k Ω	$\frac{1}{8}$ W	Prec	1%
R217	321-0289-00		10 k Ω	$\frac{1}{8}$ W	Prec	1%
R218	321-0193-00		1 k Ω	$\frac{1}{8}$ W	Prec	1%
R219	321-0108-00		130 Ω	$\frac{1}{8}$ W	Prec	1%
R221	315-0105-00		1 M Ω	$\frac{1}{4}$ W		5%
R222	321-0297-00		12.1 k Ω	$\frac{1}{8}$ W	Prec	1%
R223	311-0732-00		1 k Ω , Var			
R224	321-0297-00		12.1 k Ω	$\frac{1}{8}$ W	Prec	1%
R226	315-0274-00		270 k Ω	$\frac{1}{4}$ W		5%
R227	315-0151-00		150 Ω	$\frac{1}{4}$ W		5%
R228	315-0512-00		5.1 k Ω	$\frac{1}{4}$ W		5%
R230	315-0102-00		1 k Ω	$\frac{1}{4}$ W		5%
R234	315-0102-00		1 k Ω	$\frac{1}{4}$ W		5%
R240	321-0289-00		10 k Ω	$\frac{1}{8}$ W	Prec	1%

A2 SWEEP Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff Disc	Description
Resistors (cont)			
R241	321-0289-00	10 k Ω	1/8 W Prec 1%
R243	321-0303-00	14 k Ω	1/8 W Prec 1%
R250	321-0289-00	10 k Ω	1/8 W Prec 1%
R251	321-0289-00	10 k Ω	1/8 W Prec 1%
R253	321-0303-00	14 k Ω	1/8 W Prec 1%
R260	311-0732-00	1 k Ω , Var	
R261	315-0123-00	12 k Ω	1/4 W 5%
R262	315-0222-00	2.2 k Ω	1/4 W 5%
R264	315-0222-00	2.2 k Ω	1/4 W 5%
R266	315-0223-00	22 k Ω	1/4 W 5%
R267	315-0562-00	5.6 k Ω	1/4 W 5%
R269	315-0152-00	1.5 k Ω	1/4 W 5%
R270	315-0103-00	10 k Ω	1/4 W 5%
R271	315-0473-00	47 k Ω	1/4 W 5%
R273	315-0682-00	6.8 k Ω	1/4 W 5%
R275	321-0268-00	6.04 k Ω	1/8 W Prec 1%
R277	321-0289-00	10 k Ω	1/8 W Prec 1%
R279	321-0272-00	6.65 k Ω	1/8 W Prec 1%
R280	315-0183-00	18 k Ω	1/4 W 5%
R281	321-0297-00	12.1 k Ω	1/8 W Prec 1%
R282	321-0229-00	2.37 k Ω	1/8 W Prec 1%
R284	321-0268-00	6.04 k Ω	1/8 W Prec 1%
R285	321-0268-00	6.04 k Ω	1/8 W Prec 1%
R287	315-0223-00	22 k Ω	1/4 W 5%
R292	315-0202-00	2 k Ω	1/4 W 5%
R293	315-0106-00	10 M Ω	1/4 W 5%
R295	315-0103-00	10 k Ω	1/4 W 5%
R300	315-0392-00	3.9 k Ω	1/4 W 5%
R301	315-0392-00	3.9 k Ω	1/4 W 5%
R304	315-0683-00	68 k Ω	1/4 W 5%
R306	315-0222-00	2.2 k Ω	1/4 W 5%
R310	321-0248-00	3.74 k Ω	1/8 W Prec 1%
R311	311-0953-00	2.5 k Ω , Var	
R312	321-0248-00	3.74 k Ω	1/8 W Prec 1%
R314	315-0621-00	620 Ω	1/4 W 5%
R316	315-0183-00	18 k Ω	1/4 W 5%
R325	321-0314-00	18.2 k Ω	1/8 W Prec 1%
R326	311-0732-00	1 k Ω , Var	
R327	321-0210-00	1.5 k Ω	1/8 W Prec 1%
R329	315-0131-00	130 Ω	1/4 W 5%
R332	315-0272-00	2.7 k Ω	1/4 W 5%
R334	315-0470-00	47 Ω	1/4 W 5%

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
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Integrated Circuits

U230	156-0136-00			Op amp., replaceable by RCA CA3030
U285	*155-0029-01			Sweep control
U310	*155-0028-00			Miller integrator

A3 COUNTER Circuit Board Assembly

*670-1455-00

Complete Board

Capacitors

Tolerance $\pm 20\%$ unless otherwise indicated.

C400	283-0059-01	1 μ F	Cer	25 V	+80%—20%
C450	281-0629-00	33 pF	Cer	600 V	5%
C455	283-0114-01	0.0015 μ F	Cer	200 V	5%
C456	283-0004-02	0.02 μ F	Cer	150 V	
C457	281-0523-00	100 pF	Cer	350 V	
C460	281-0519-00	47 pF	Cer	500 V	10%
C482	281-0523-00	100 pF	Cer	350 V	
C486	281-0564-00	24 pF	Cer	500 V	5%
C490	283-0000-02	0.001 μ F	Cer	500 V	
C493	281-0523-00	100 pF	Cer	350 V	
C496	281-0523-00	100 pF	Cer	350 V	
C509	283-0059-01	1 μ F	Cer	25 V	+80%—20%
C512	290-0134-00	22 μ F	Elect.	15 V	
C522	283-0003-02	0.01 μ F	Cer	150 V	
C530	283-0078-00	0.001 μ F	Cer	500 V	
C534	281-0580-00	470 pF	Cer	500 V	10%
C542	290-0287-00	47 μ F	Elect.	25 V	
C544	290-0215-00	100 μ F	Elect.	25 V	
C546	283-0164-01	2.2 μ F	Cer	25 V	

Semiconductor Device, Diodes

CR454	*152-0185-00	Silicon	Replaceable by 1N4152
CR470	152-0079-00	Germanium	HD1841
CR477	*152-0185-00	Silicon	Replaceable by 1N4152
CR502	*152-0185-00	Silicon	Replaceable by 1N4152
CR520	*152-0185-00	Silicon	Replaceable by 1N4152
CR528	*152-0185-00	Silicon	Replaceable by 1N4152

A3 COUNTER Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
Transistors				
Q450	151-0190-02		Silicon	NPN TO-92 2N3904
Q460	*151-0195-00		Silicon	NPN TO-92 Replaceable by MPS 6515
Q462	151-0190-02		Silicon	NPN TO-92 2N3904
Q465	151-0190-02		Silicon	NPN TO-92 2N3904
Q470	151-0190-02		Silicon	NPN TO-92 2N3904
Q475	151-0190-02		Silicon	NPN TO-92 2N3904
Q485	151-0190-02		Silicon	NPN TO-92 2N3904
Q498	151-0190-02		Silicon	NPN TO-92 2N3904
Q500	151-0190-02		Silicon	NPN TO-92 2N3904
Q505	151-0190-02		Silicon	NPN TO-92 2N3904
Q515	151-0504-00		Silicon	TO-18 Unijunction 2N4851
Q518	151-0190-02		Silicon	NPN TO-92 2N3904
Q525	151-0190-02		Silicon	NPN TO-92 2N3904

Resistors

Resistors are fixed, composition, $\pm 10\%$ unless otherwise indicated.

R400	315-0102-00	1 k Ω	$\frac{1}{4}$ W	5%
R410	315-0102-00	1 k Ω	$\frac{1}{4}$ W	5%
R414	315-0102-00	1 k Ω	$\frac{1}{4}$ W	5%
R418	315-0102-00	1 k Ω	$\frac{1}{4}$ W	5%
R420	315-0102-00	1 k Ω	$\frac{1}{4}$ W	5%
R450	315-0103-00	10 k Ω	$\frac{1}{4}$ W	5%
R452	315-0102-00	1 k Ω	$\frac{1}{4}$ W	5%
R454	315-0102-00	1 k Ω	$\frac{1}{4}$ W	5%
R455	311-0607-00	10 k Ω , Var		
R456	321-0347-00	40.2 k Ω	$\frac{1}{8}$ W	Prec 1%
R457	315-0202-00	2 k Ω	$\frac{1}{4}$ W	5%
R460	315-0243-00	24 k Ω	$\frac{1}{4}$ W	5%
R462	315-0221-00	220 Ω	$\frac{1}{4}$ W	5%
R464	321-0268-00	6.04 k Ω	$\frac{1}{8}$ W	Prec 1%
R465	321-0306-00	15 k Ω	$\frac{1}{8}$ W	Prec 1%
R467	315-0222-00	2.2 k Ω	$\frac{1}{4}$ W	5%
R470	321-0164-00	499 Ω	$\frac{1}{8}$ W	Prec 1%
R472	321-0358-00	52.3 k Ω	$\frac{1}{8}$ W	Prec 1%
R474	315-0222-00	2.2 k Ω	$\frac{1}{4}$ W	5%
R476	321-0265-00	5.62 k Ω	$\frac{1}{8}$ W	Prec 1%
R477	321-0306-00	15 k Ω	$\frac{1}{8}$ W	Prec 1%
R479	315-0222-00	2.2 k Ω	$\frac{1}{4}$ W	5%
R480	315-0102-00	1 k Ω	$\frac{1}{4}$ W	5%
R482	315-0202-00	2 k Ω	$\frac{1}{4}$ W	5%
R484	315-0202-00	2 k Ω	$\frac{1}{4}$ W	5%

A3 COUNTER Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description	
Resistors (cont)					
R486	315-0103-00		10 k Ω	1/4 W	5%
R488	315-0102-00		1 k Ω	1/4 W	5%
R489	315-0102-00		1 k Ω	1/4 W	5%
R491	315-0102-00		1 k Ω	1/4 W	5%
R493	315-0202-00		2 k Ω	1/4 W	5%
R494	315-0202-00		2 k Ω	1/4 W	5%
R496	315-0103-00		10 k Ω	1/4 W	5%
R500	315-0202-00		2 k Ω	1/4 W	5%
R501	315-0202-00		2 k Ω	1/4 W	5%
R502	315-0202-00		2 k Ω	1/4 W	5%
R504	315-0202-00		2 k Ω	1/4 W	5%
R506	315-0103-00		10 k Ω	1/4 W	5%
R508	315-0202-00		2 k Ω	1/4 W	5%
R509	315-0202-00		2 k Ω	1/4 W	5%
R512	315-0202-00		2 k Ω	1/4 W	5%
R514	315-0101-00		100 Ω	1/4 W	5%
R516	315-0101-00		100 Ω	1/4 W	5%
R520	315-0102-00		1 k Ω	1/4 W	5%
R521	315-0472-00		4.7 k Ω	1/4 W	5%
R522	315-0202-00		2 k Ω	1/4 W	5%
R523	315-0202-00		2 k Ω	1/4 W	5%
R524	315-0202-00		2 k Ω	1/4 W	5%
R526	315-0103-00		10 k Ω	1/4 W	5%
R528	315-0752-00		7.5 k Ω	1/4 W	5%
R530	315-0100-00		10 Ω	1/4 W	5%
R532	315-0102-00		1 k Ω	1/4 W	5%
R535	311-0635-00		1 k Ω , Var		
R542	301-0100-00		10 Ω	1/2 W	5%

Switch

Wired or Unwired			
S455	260-0984-00	Slide	CHOP RATE

Integrated Circuits

U410	156-0031-00	4-wide 2-input, and-or-invert gate, replaceable by T.I. SN7454N
U412	156-0041-00	Dual D flip-flop, replaceable by T.I. SN7474N
U414	156-0043-00	Quad 2-input NOR gate, replaceable by T.I. SN7402N
U416	156-0031-00	4-wide 2-input, and-or-invert gate, replaceable by T.I. SN7454N
U418	156-0041-00	Dual D flip-flop, replaceable by T.I. SN7474N

A3 COUNTER Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
Integrated Circuits (cont)				
U420	156-0043-00			Quad 2-input NOR gate, replaceable by T.I. SN7402N
U422	156-0031-00			4-wide 2-input, and-or-invert gate, replaceable by T.I. SN7454N
U426	156-0092-00			Hex. inverter, w/open collector, replaceable by T.I. SN7405N
U430	156-0058-00			Hex. inverter, replaceable by T.I. SN7404N
U432	156-0043-00			Quad 2-input NOR gate, replaceable by T.I. SN7402N
U434	156-0061-00			BCD to dec decoder, replaceable by T.I. SN7442N
U436	156-0043-00			Quad 2-input NOR gate, replaceable by T.I. SN7402N
U438	156-0043-00			Quad 2-input NOR gate, replaceable by T.I. SN7402N
U440	156-0092-00			Hex. inverter w/open collector, replaceable by T.I. SN7405N
U442	156-0035-00			8-input gate, replaceable by T.I. SN7403N
U444	156-0034-00			Dual 4-input gate, replaceable by T.I. SN7420N
U446	156-0034-00			Dual 4-input gate, replaceable by T.I. SN7420N
U454	156-0030-00			Quad 2-input gate, replaceable by T.I. SN7400N
U478	156-0030-00			Quad 2-input gate, replaceable by T.I. SN7400N
U488	156-0058-00			Hex. inverter, replaceable by T.I. SN7404N
U490	156-0030-00			Quad 2-input gate, replaceable by T.I. SN7400N
U494	156-0030-00			Quad 2-input gate, replaceable by T.I. SN7400N
U530	156-0072-00			Monostable Multi, replaceable by T.I. SN74121N

A4 POWER SUPPLY Circuit Board Assembly

*670-1457-00

Complete Board

Capacitors

Tolerance $\pm 20\%$ unless otherwise indicated.

C610	283-0110-01	0.005 μ F	Cer	150 V	
C615	290-0287-00	47 μ F	Elect.	25 V	
C618	281-0523-00	100 μ F	Cer	350 V	
C626	283-0059-01	1 μ F	Cer	25 V	+80% —20%
C634	290-0287-00	47 μ F	Elect.	25 V	
C638	283-0003-02	0.01 μ F	Cer	150 V	
C647	290-0287-00	47 μ F	Elect.	25 V	

Semiconductor Device, Diodes

CR610	152-0488-00	Silicon	Rectifier Bridge 220 V, 1.5 A
CR640	152-0488-00	Silicon	Rectifier Bridge 220 V, 1.5 A
VR647	152-0309-00	Zener	1N3828A 1 W, 6.2 V, 5%

A4 POWER SUPPLY Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
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Fuse

F640	159-0042-00		3/4 A	3AG Fast-Blo
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Transistors

Q620	*151-0261-00		Silicon	PNP	TO-78	Tek Spec, dual
Q630	151-0188-00		Silicon	PNP	TO-92	2N3906
Q633	151-0188-00		Silicon	PNP	TO-92	2N3906
Q640	151-0190-02		Silicon	NPN	TO-92	2N3904
Q643	151-0190-02		Silicon	NPN	TO-92	2N3904

Resistors

Resistors are fixed, composition, $\pm 10\%$ unless otherwise indicated.

R610	315-0105-00		1 M Ω	1/4 W		5%
R611	315-0104-00		100 k Ω	1/4 W		5%
R614	308-0058-00		1.5 Ω	1 W	WW	
R615	321-0254-00		4.32 k Ω	1/8 W	Prec	1%
R616	311-0635-00		1 k Ω , Var			
R617	321-0272-00		6.65 k Ω	1/8 W	Prec	1%
R621	321-0306-00		15 k Ω	1/8 W	Prec	1%
R623	321-0306-00		15 k Ω	1/8 W	Prec	1%
R624	321-0277-00		7.5 k Ω	1/8 W	Prec	1%
R625	321-0289-00		10 k Ω	1/8 W	Prec	1%
R626	321-0289-00		10 k Ω	1/8 W	Prec	1%
R630	315-0102-00		1 k Ω	1/4 W		5%
R634	308-0058-00		1.5 Ω	1 W	WW	
R642	315-0102-00		1 k Ω	1/4 W		5%
R644	315-0101-00		100 Ω	1/4 W		5%
R646	*308-0141-00		1 Ω	1/2 W	WW	5%
R647	321-0260-00		4.99 k Ω	1/8 W	Prec	1%
R648	321-0296-00		11.8 k Ω	1/8 W	Prec	1%
R649	315-0392-00		3.9 k Ω	1/4 W		5%

Integrated Circuits

U618	156-0071-00		Volt. reg, replaceable by Fairchild μ A723C			
U624	156-0067-00		Op amp., replaceable by Fairchild μ A741C			
U646	156-0067-00		Op amp., replaceable by Fairchild μ A741C			

SECTION 7

DIAGRAMS AND CIRCUIT BOARD ILLUSTRATIONS

Symbols and Reference Designators

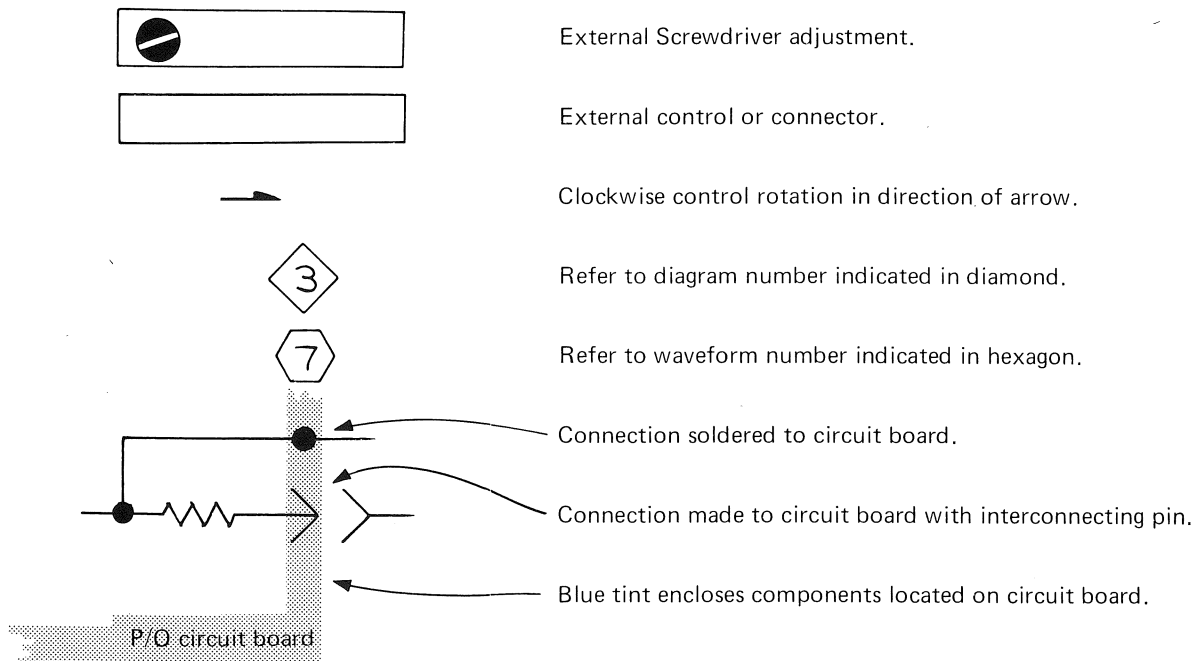
Electrical components shown on the diagrams are in the following units unless noted otherwise:

- Capacitors = Values one or greater are in picofarads (pF).
 Values less than one are in microfarads (μ F).
 Resistors = Ohms (Ω)

Symbols used on the diagrams are based on USA Standard Y32.2-1967.

Logic symbology is based on MIL-STD-806B in terms of positive logic. Logic symbols depict the logic function performed and may differ from the manufacturer's data.

The following special symbols are used on the diagrams:

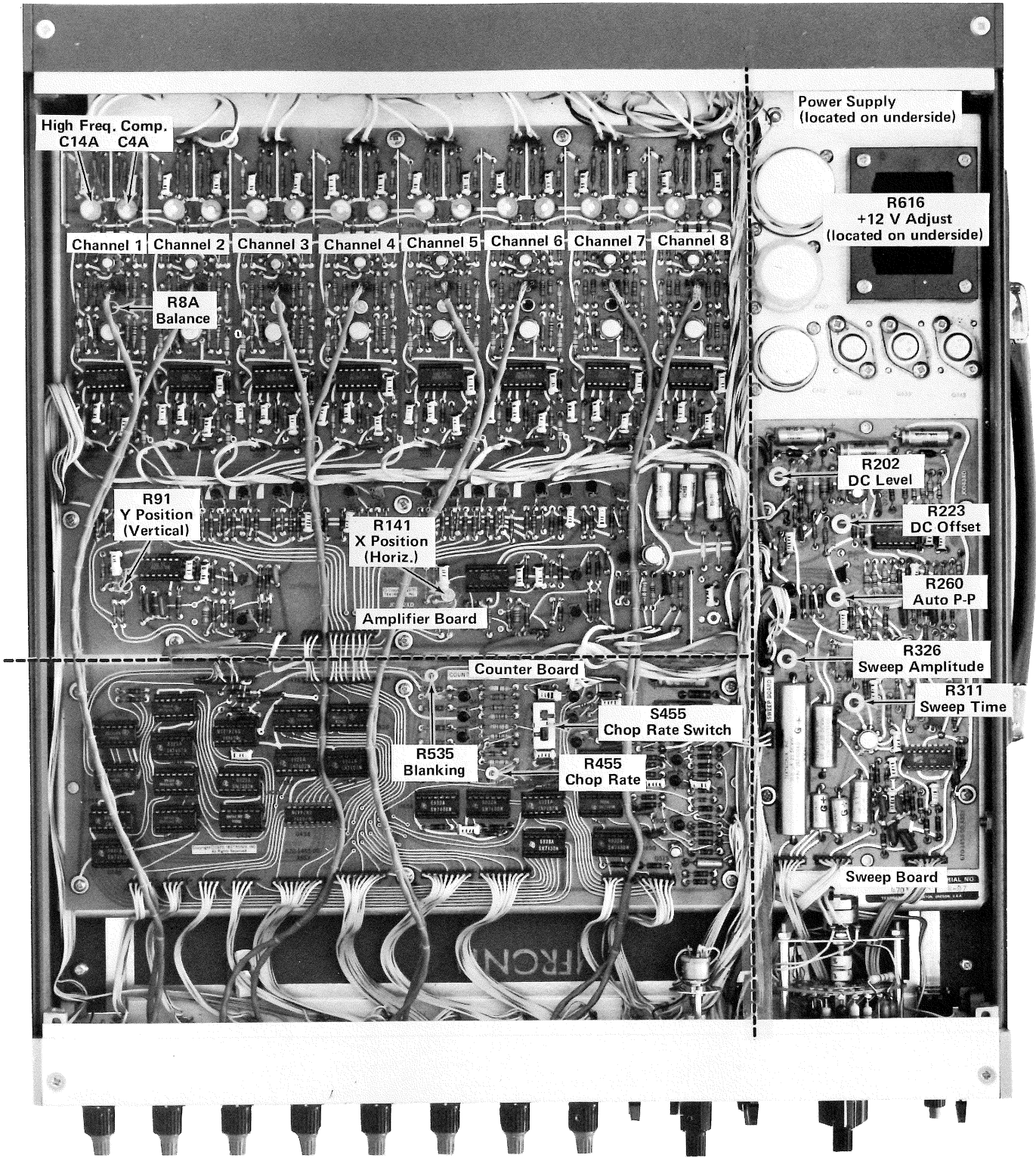


The following prefix letters are used as reference designators to identify components or assemblies on the diagrams.

A	Assembly, separable or repairable (circuit board, etc.)	LR	Inductor/resistor combination
AT	Attenuator, fixed or variable	M	Meter
B	Motor	Q	Transistor or silicon-controlled rectifier
BT	Battery	P	Connector, movable portion
C	Capacitor, fixed or variable	R	Resistor, fixed or variable
CR	Diode, signal or rectifier	RT	Thermistor
DL	Delay line	S	Switch
DS	Indicating device (lamp)	T	Transformer
F	Fuse	TP	Test point
FL	Filter	U	Assembly, inseparable or non-repairable (integrated circuit, etc.)
H	Heat dissipating device (heat sink, heat radiator, etc.)	V	Electron tube
HR	Heater	VR	Voltage regulator (zener diode, etc.)
J	Connector, stationary portion	Y	Crystal
K	Relay		
L	Inductor, fixed or variable		

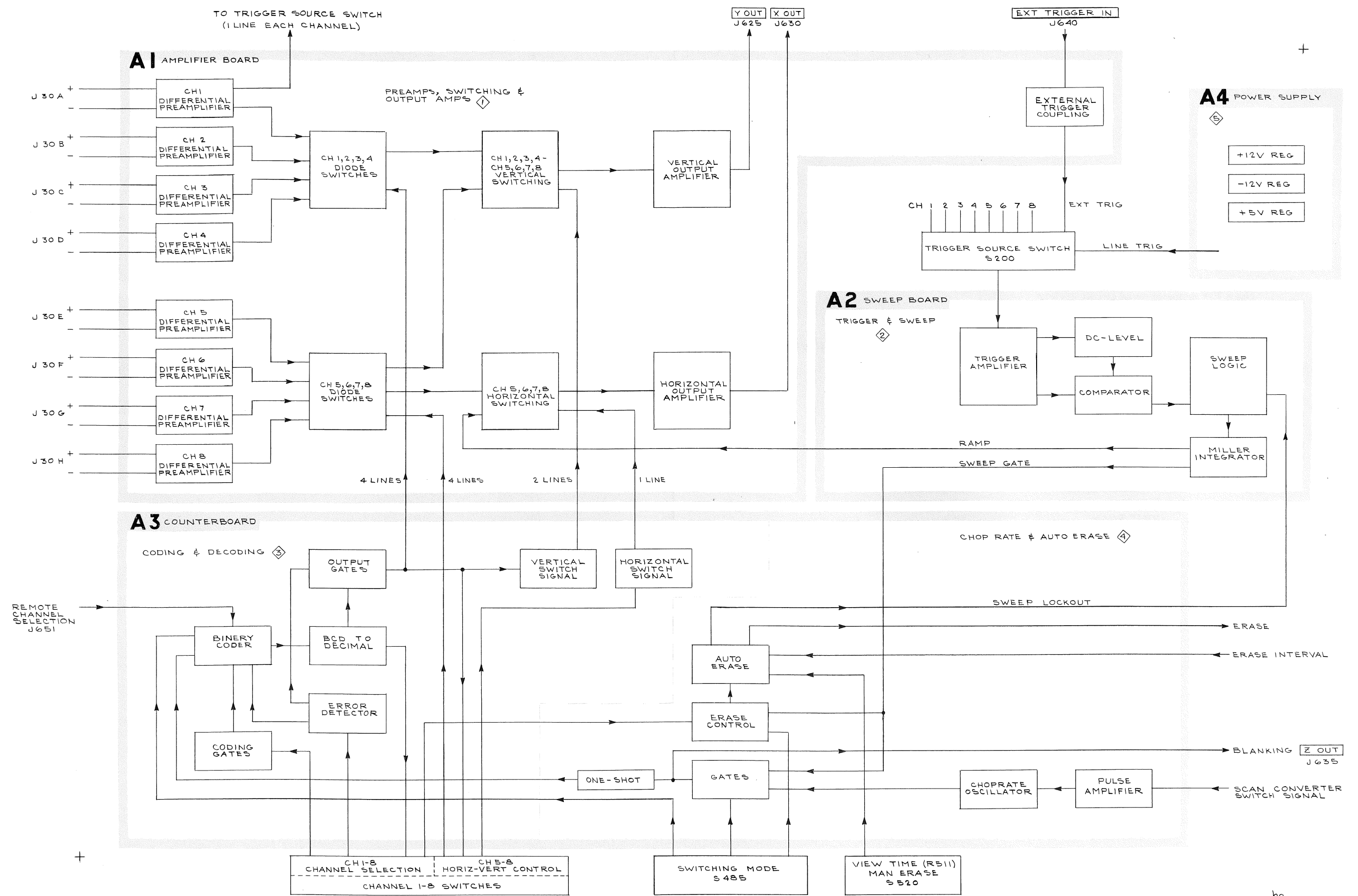
Diagram and Assembly Index

Assembly No.	Name	Schematic
A1	Amplifier Board	①
A2	Sweep Board	②
A3	Counter Board	③ and ④
A4	Power Supply	⑤



Ⓐ

Location of Circuit Boards and Adjustments



WAVEFORM CONDITIONS

A 4 volt, 1 kHz square wave is applied to the 4701 channel 1 (+) input.

Schematic 

Use a 10X probe to avoid circuit loading

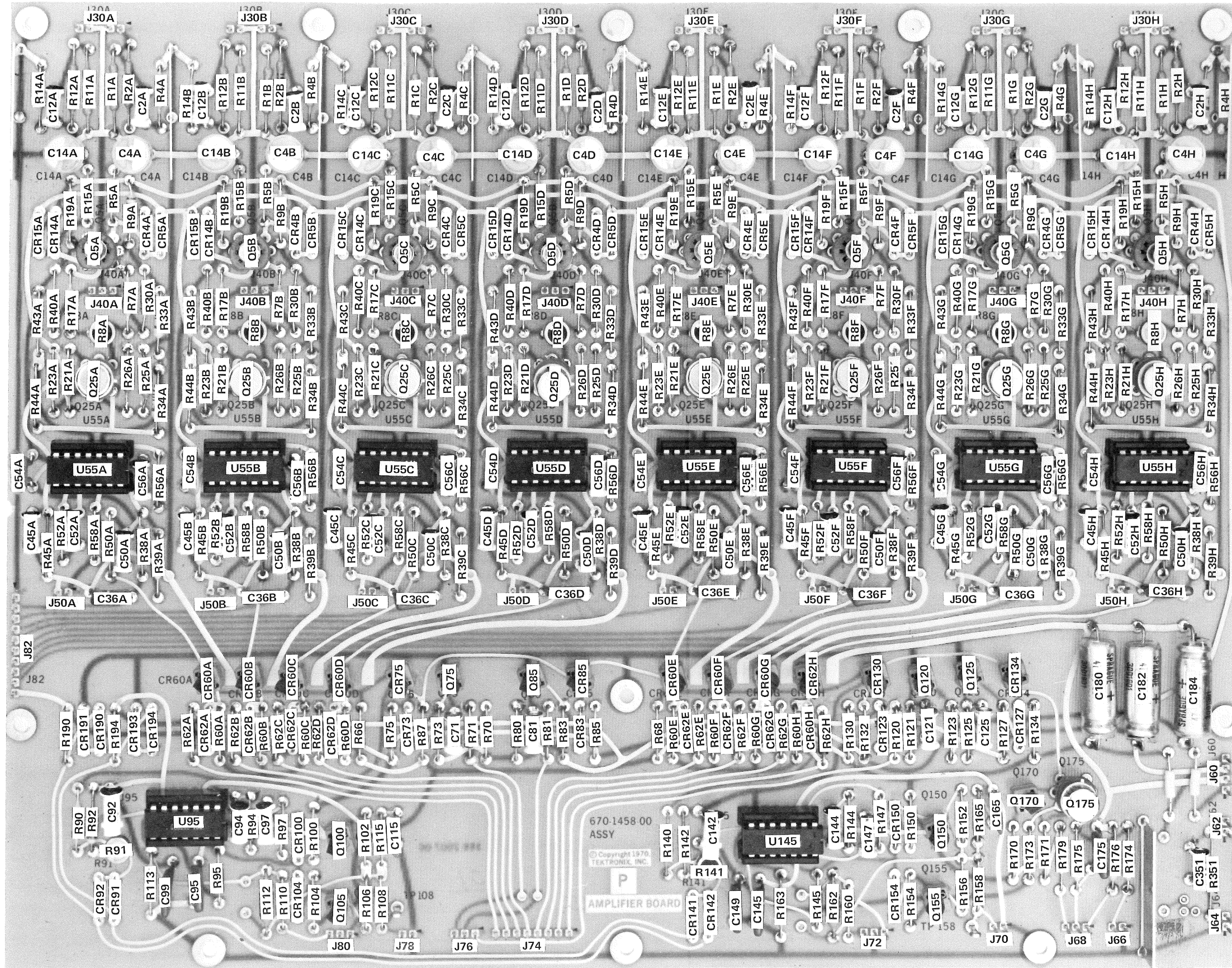
Control settings for the 4701 and the Test Oscilloscope are as given below unless otherwise noted on the individual waveforms.

4701

Channel 1	ON
POLARITY	+
TRIGGER SOURCE	CH 1
TRIGGER LEVEL	midposition
MODE	P-P AUTO
TIME/SCAN	10 ms
SWEEP MODE	NORM
STORE/NONSTORE	NONSTORE
CHOP/ALT/REMOTE	ALT
RAMP POSITION	midposition
VIEW TIME	OFF
GAIN (CH 1)	set for 1 V at TP108
CHOP RATE Sw.	LOW RATE

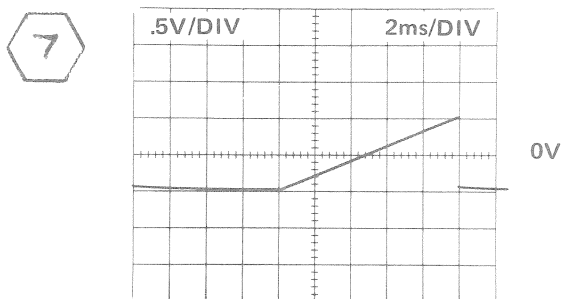
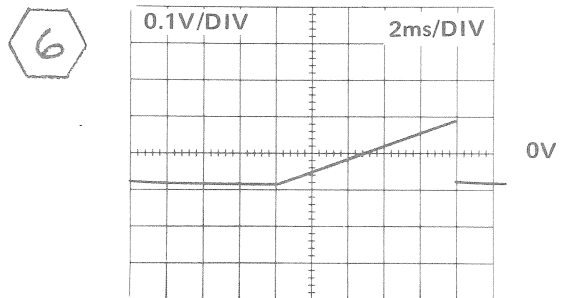
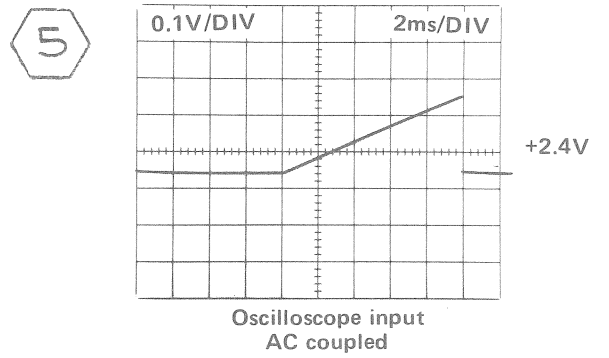
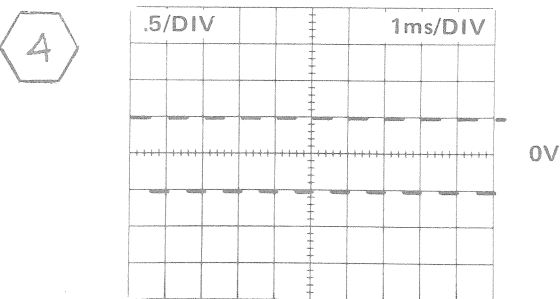
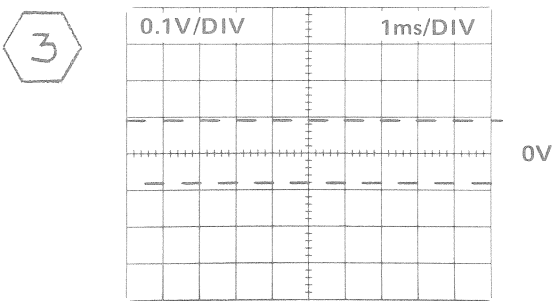
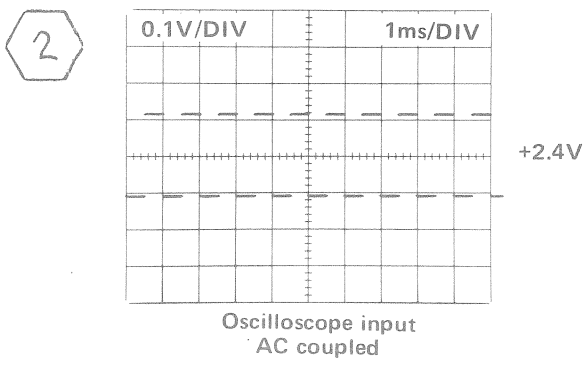
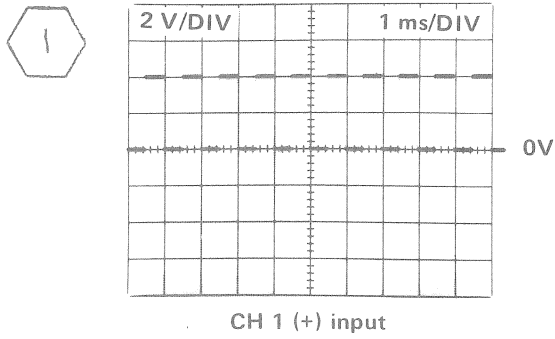
Oscilloscope

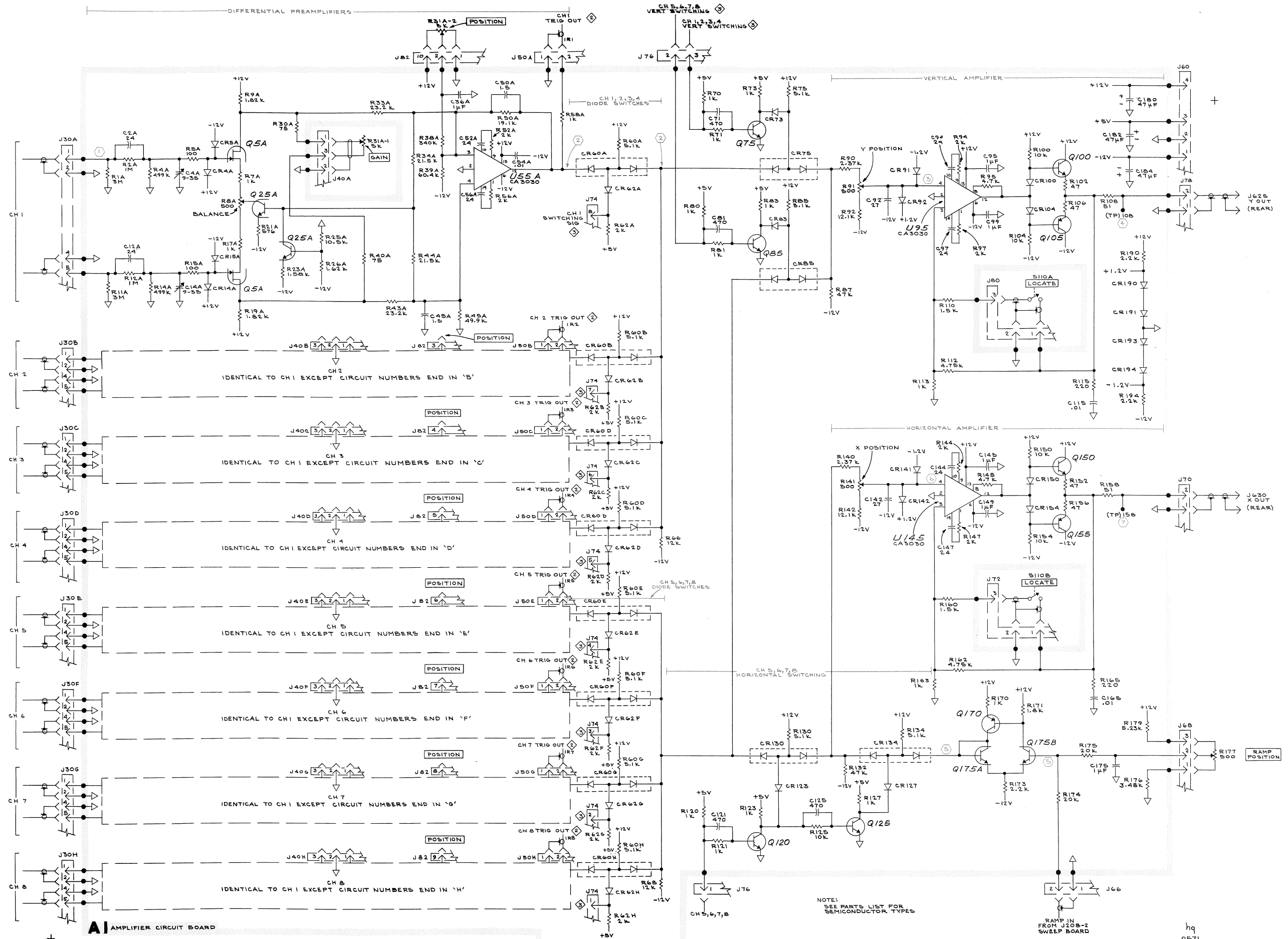
Input coupling	DC
Trigger	Internal



AMPLIFIER Board

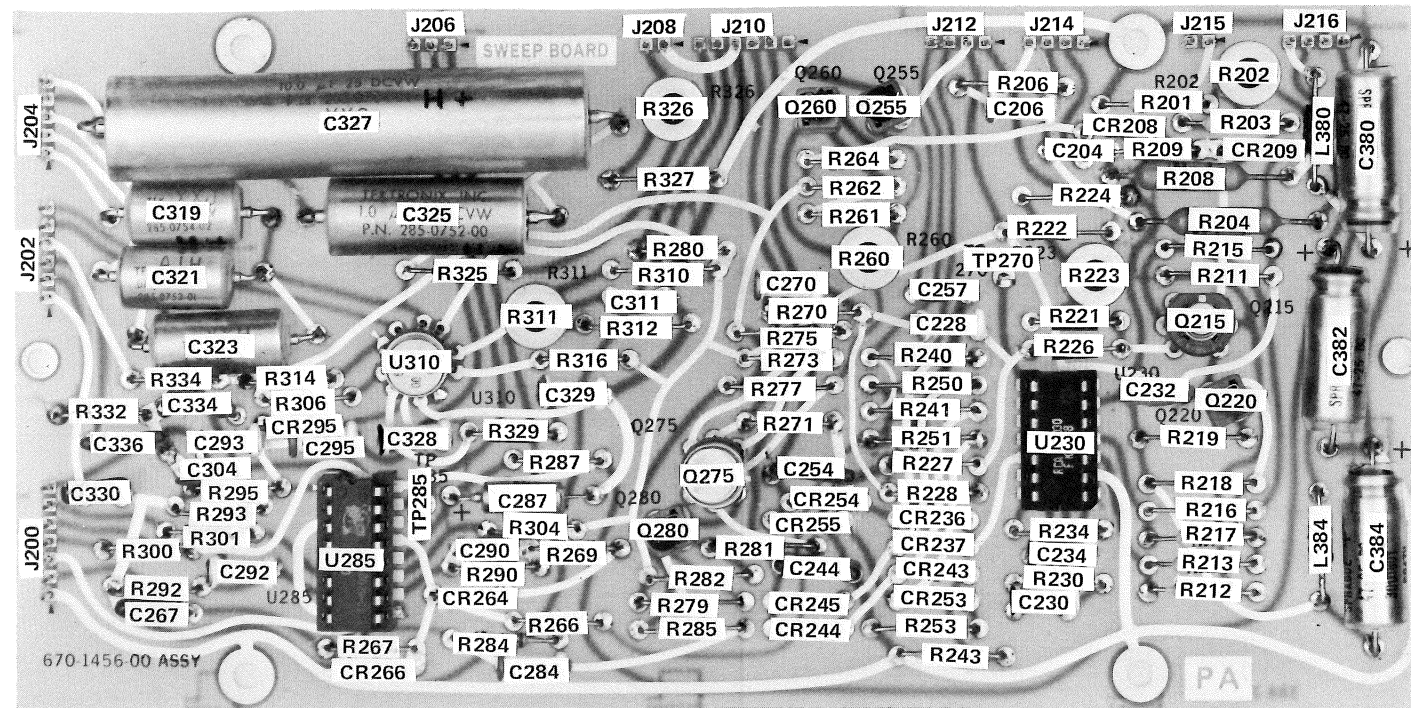
Ⓐ



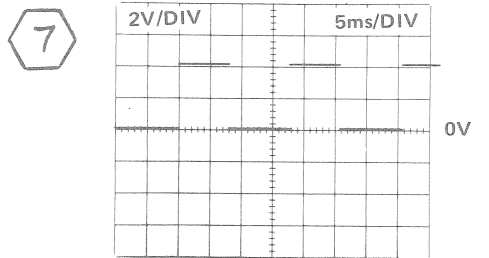
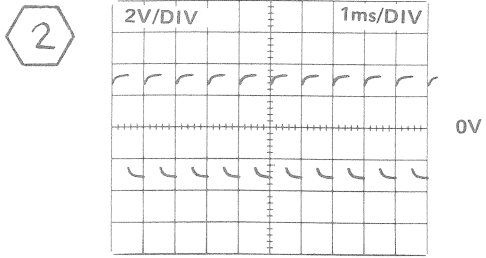
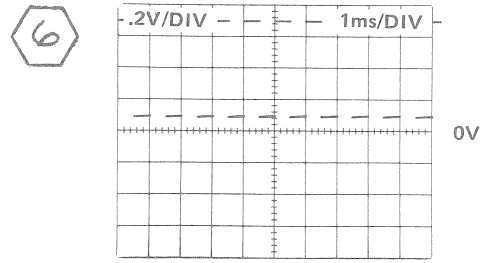
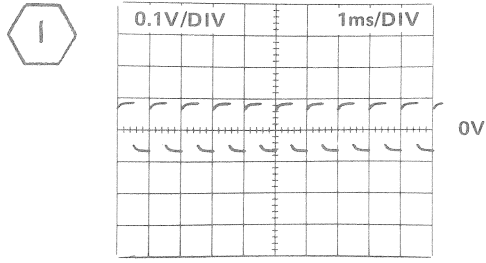


AI AMPLIFIER CIRCUIT BOARD

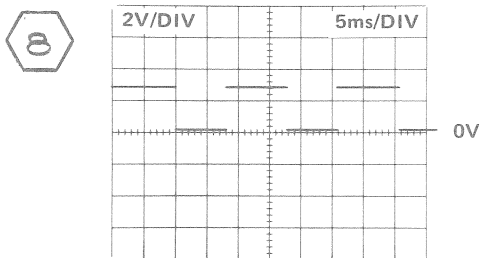
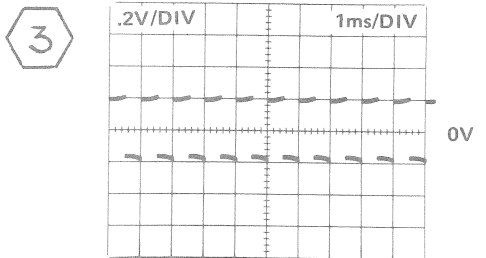
NOTES:
SEE PARTS LIST FOR
SEMICONDUCTOR TYPES



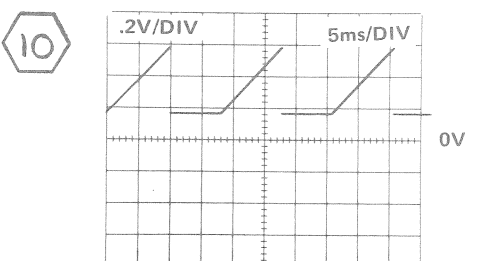
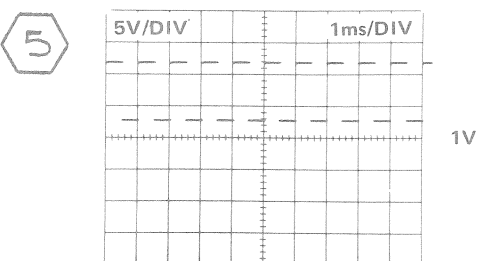
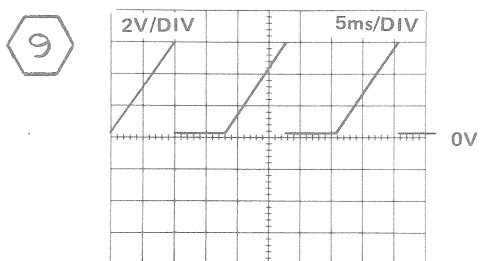
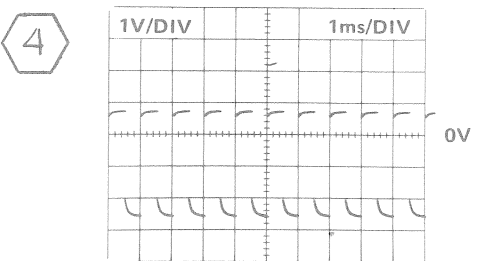
SWEEP Board

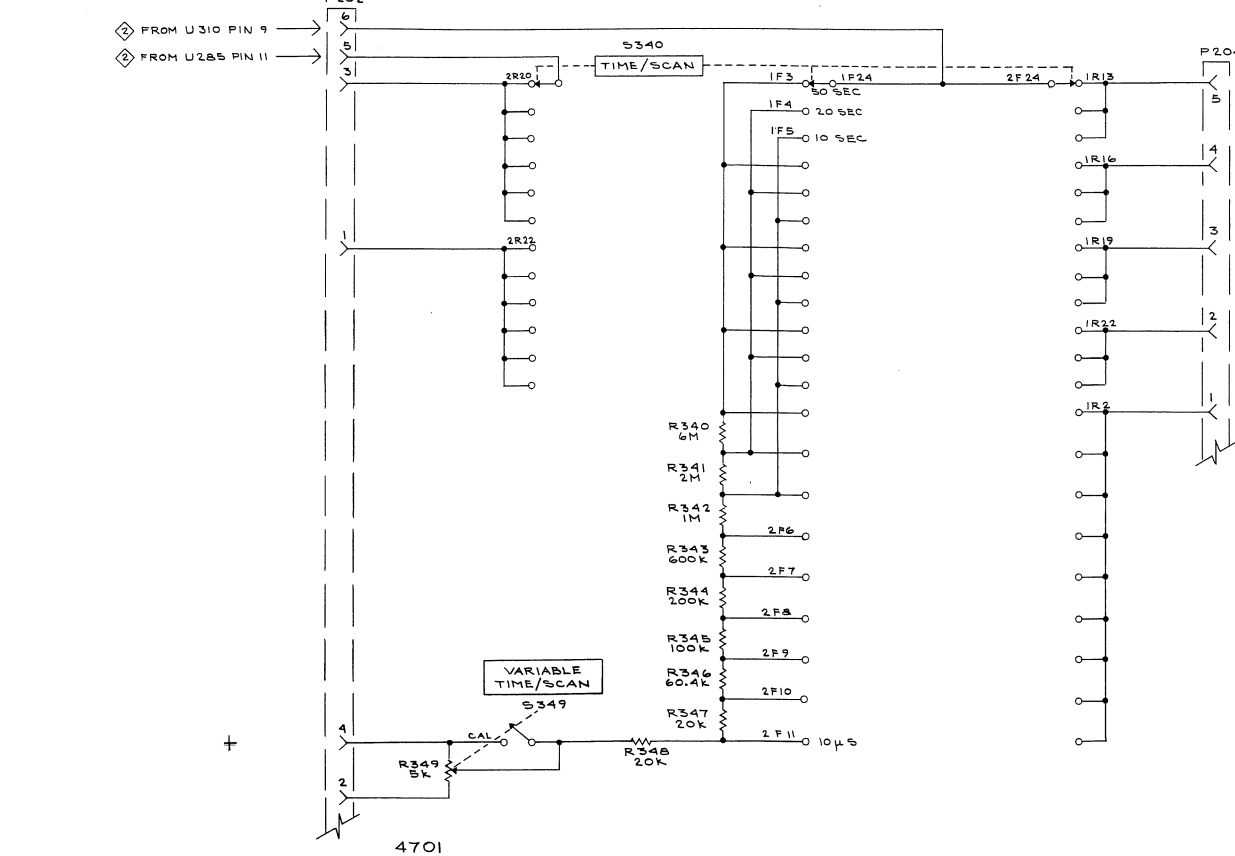
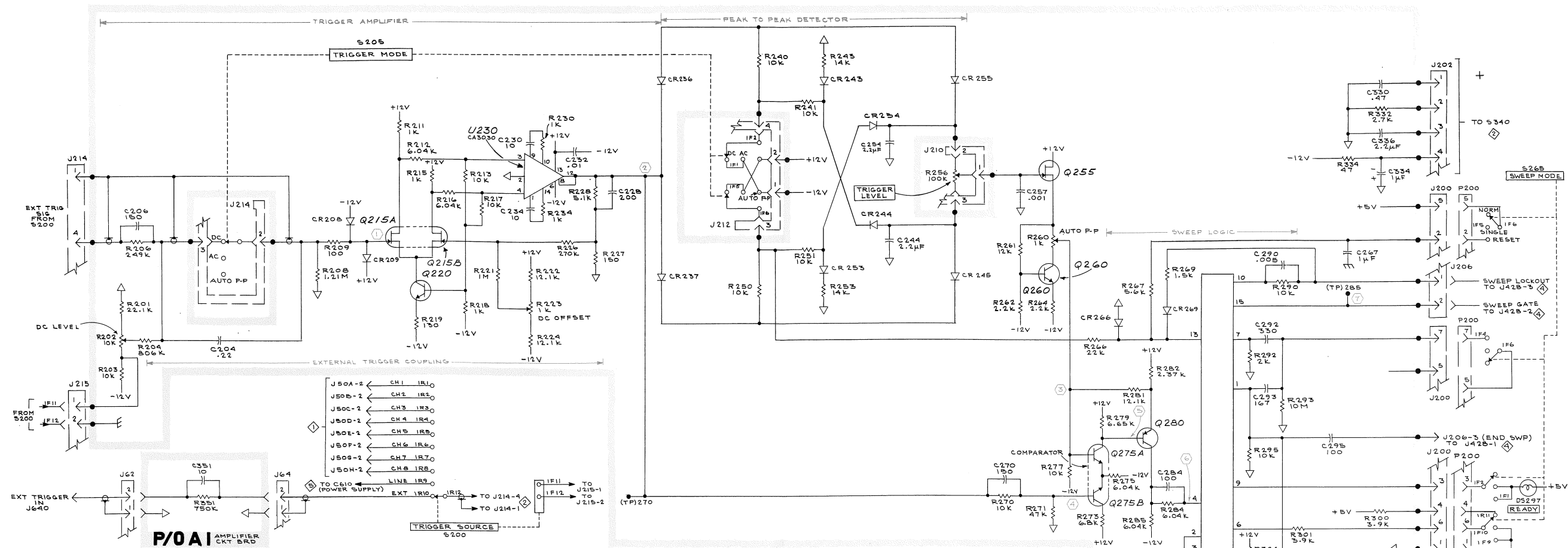


Use Ext Trig to
scope from
U285 pin 14



Return to Internal Trigger



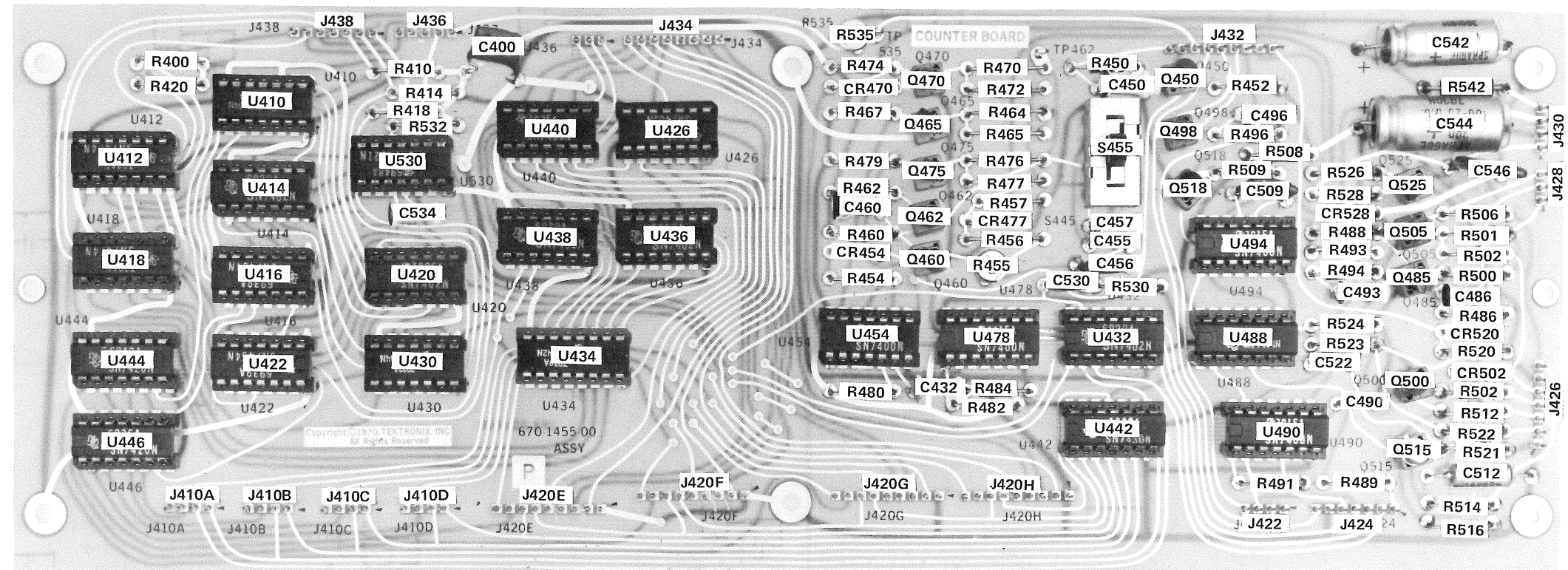


NOTE:
SEE PARTS LIST FOR
SEMICONDUCTOR TYPES

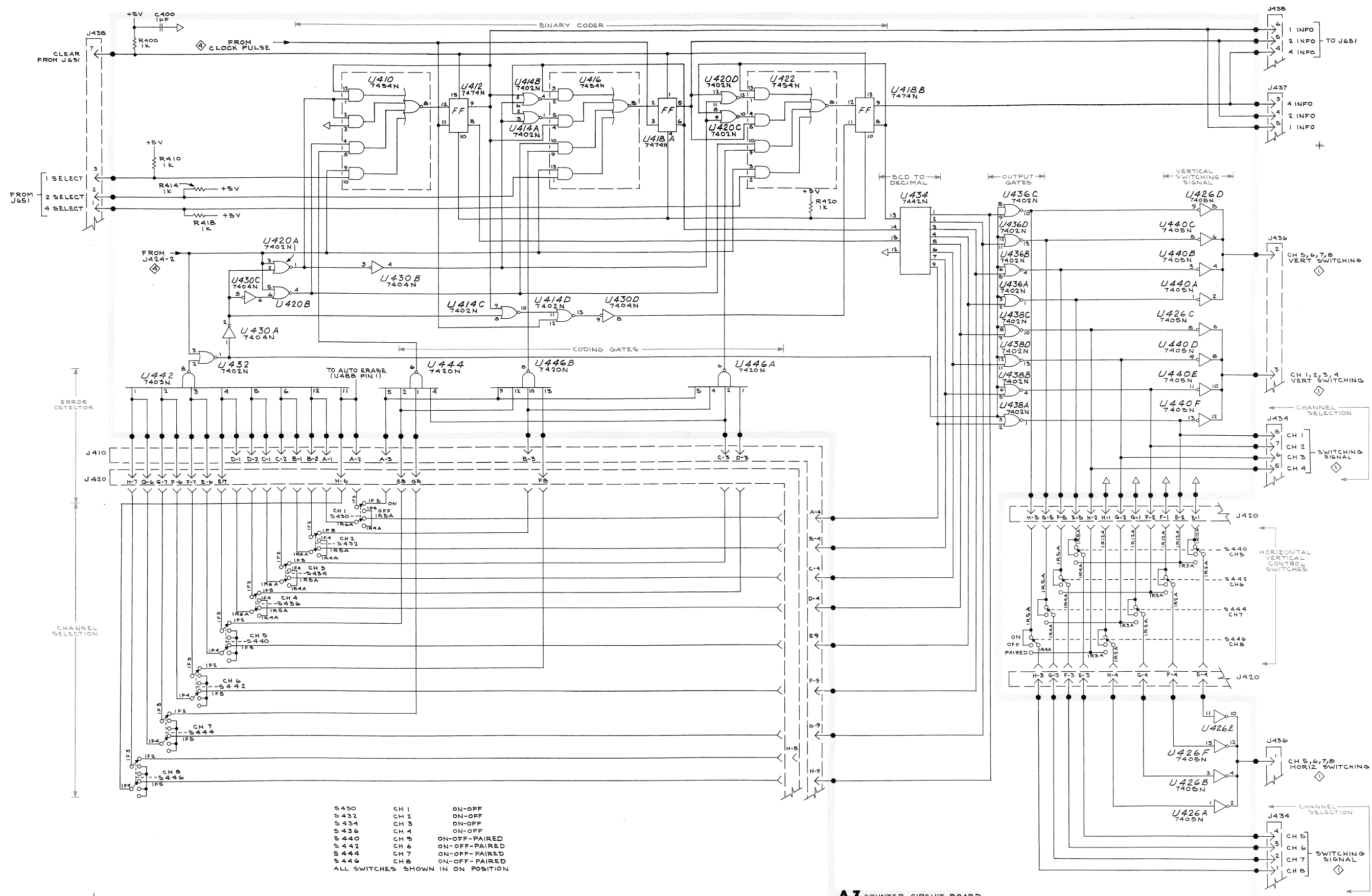
A2 SWEEP CIRCUIT BOARD

TRIGGER & SWEEP

TRIGGER & SWEEP



COUNTER Board

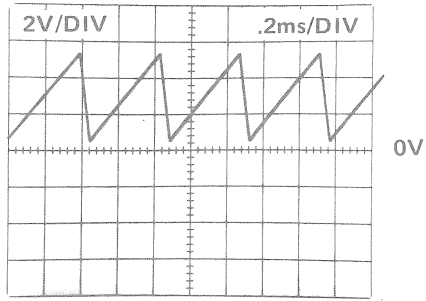


S 430	CH 1	ON-OFF
S 431	CH 2	ON-OFF
S 432	CH 3	ON-OFF
S 433	CH 4	ON-OFF
S 434	CH 5	ON-OFF
S 435	CH 6	ON-OFF-PAIRED
S 436	CH 7	ON-OFF-PAIRED
S 437	CH 8	ON-OFF-PAIRED
S 438	CH 9	ON-OFF-PAIRED

ALL SWITCHES SHOWN IN ON POSITION

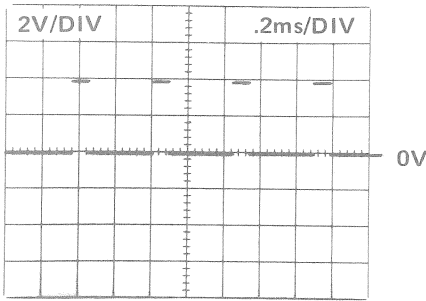
A3 COUNTER CIRCUIT BOARD

1



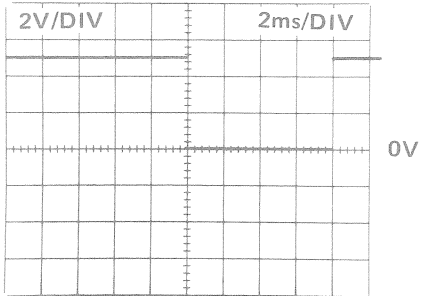
External Trigger from U432 pin 10 CHOP MODE

2

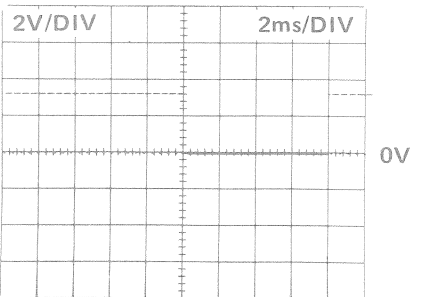


CHOP MODE

3

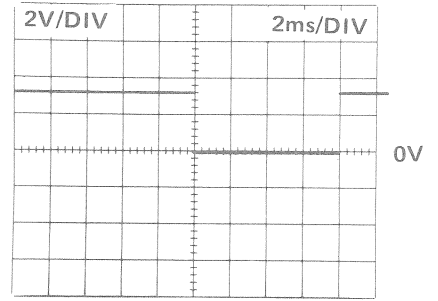


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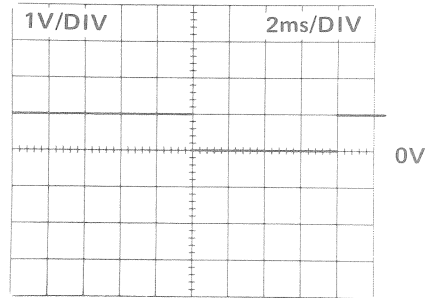
External Trigger from collector of Q485 CHOP MODE

4a

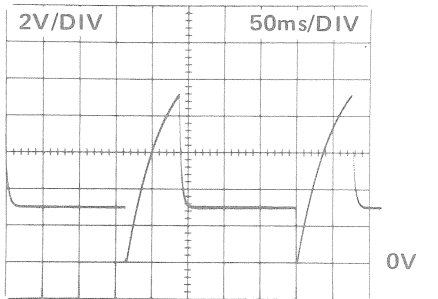


External Trigger from collector of Q485

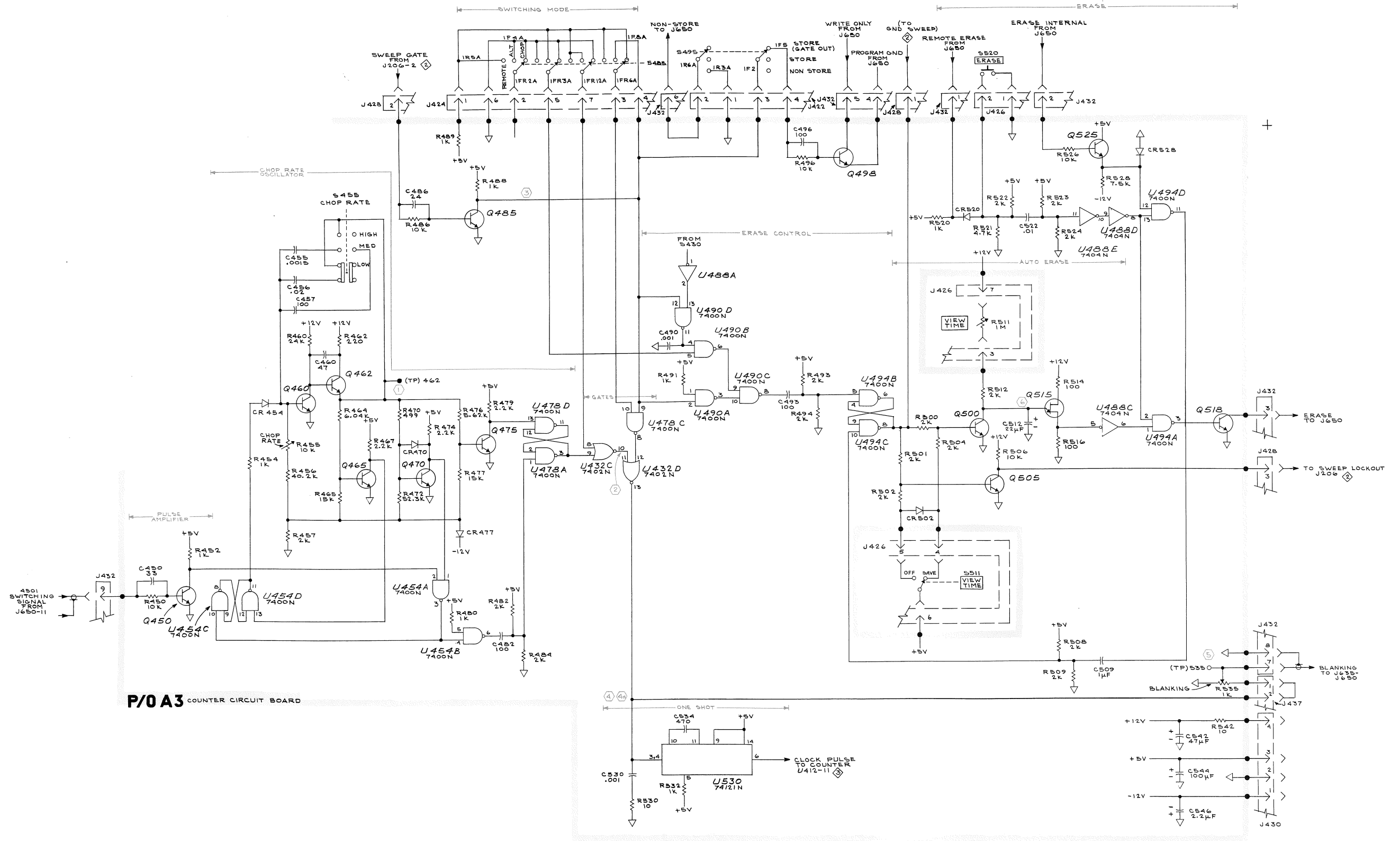
5



6



VIEW TIME set to minimum STORE/NONSTORE to STORE



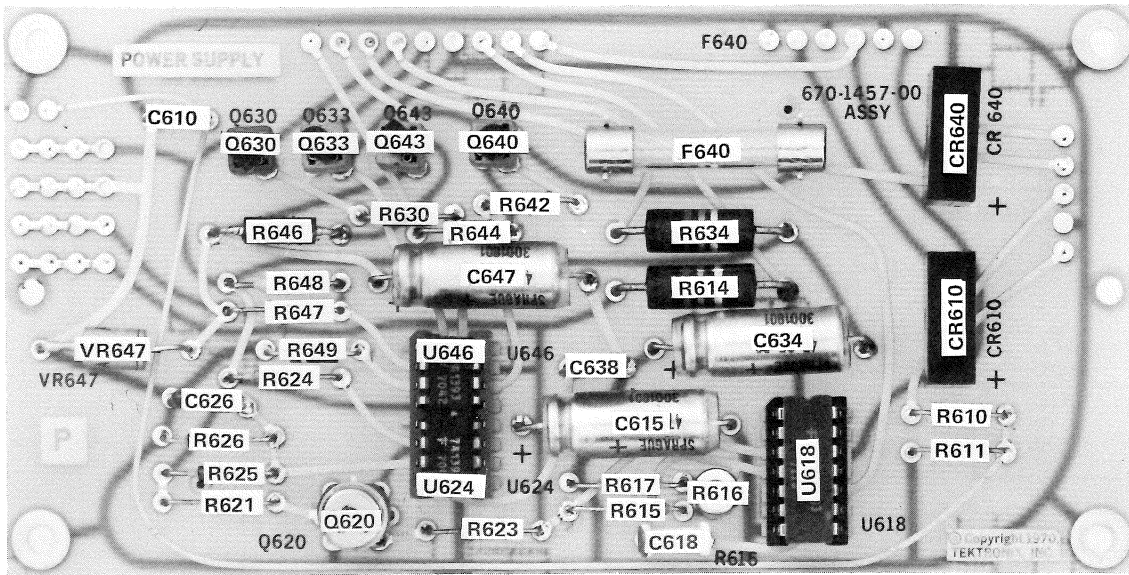
P/O A3 COUNTER CIRCUIT BOARD

4701

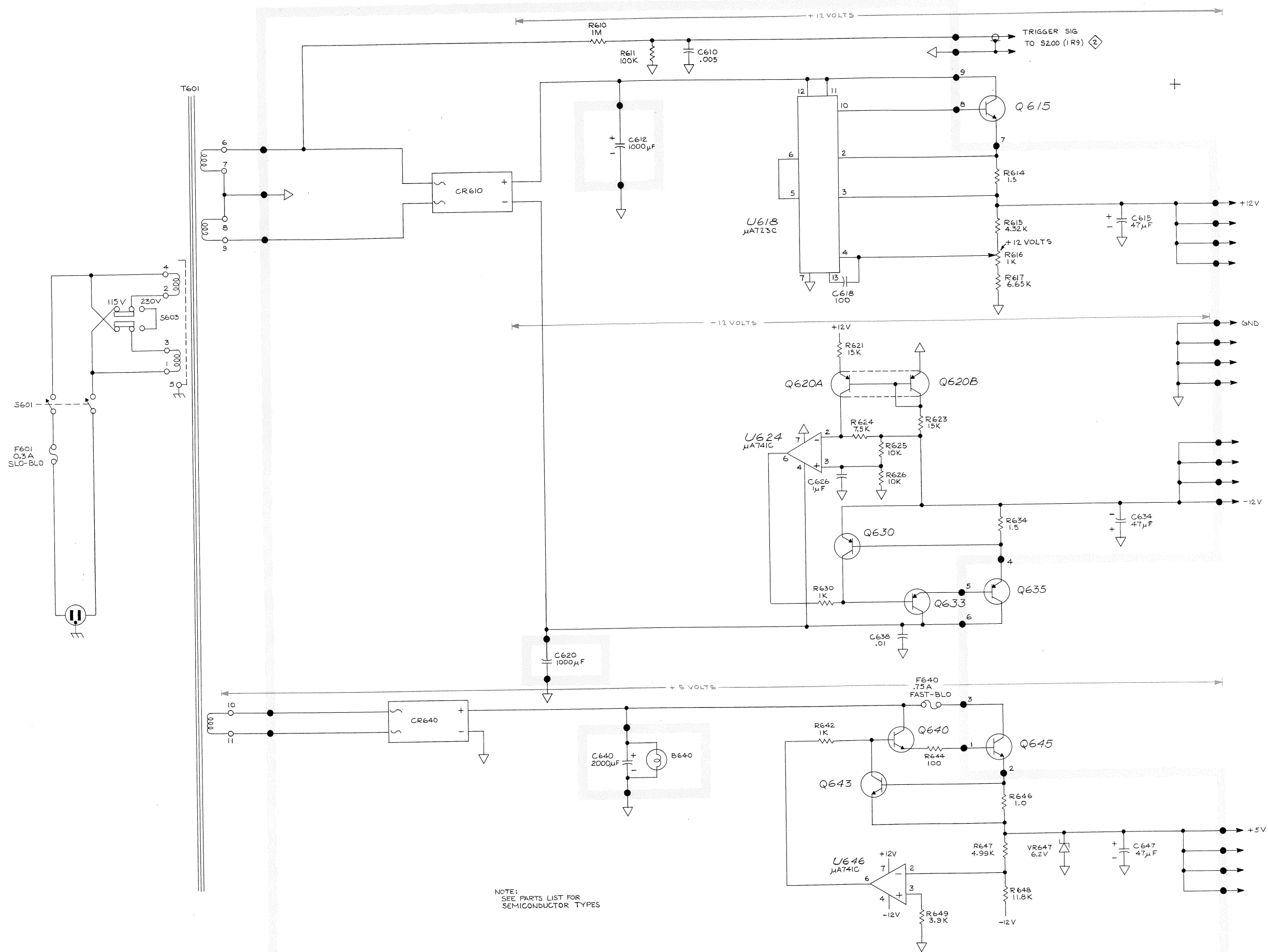
CHOP RATE & AUTO ERASE

CHOP RATE & AUTO ERASE

hq
0571



POWER SUPPLY Board



NOTE:
SEE PARTS LIST FOR
SEMICONDUCTOR TYPES

A4 POWER SUPPLY CIRCUIT BOARD

FIGURE AND INDEX NUMBERS

Items in this section are referenced by figure and index numbers to the illustrations which appear either on the back of the diagrams or on pullout pages immediately following the diagrams of the instruction manual.

INDENTATION SYSTEM

This mechanical parts list is indented to indicate item relationships. Following is an example of the indentation system used in the Description column.

Assembly and/or Component
Detail Part of Assembly and/or Component
mounting hardware for Detail Part
Parts of Detail Part
mounting hardware for Parts of Detail Part
mounting hardware for Assembly and/or Component

Mounting hardware always appears in the same indentation as the item it mounts, while the detail parts are indented to the right. Indented items are part of, and included with, the next higher indentation.

Mounting hardware must be purchased separately, unless otherwise specified.

PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial or model number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

Change information, if any, is located at the rear of this manual.

ABBREVIATIONS AND SYMBOLS

For an explanation of the abbreviations and symbols used in this section, please refer to the page immediately preceding the Electrical Parts List in this instruction manual.

SECTION 8

MECHANICAL PARTS LIST

FIGURE 1 EXPLODED & STANDARD ACCESSORIES

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	No. Disc	Q					Description	
				t	y	1	2	3		4
1-1	366-0215-02			13						KNOB, lever switch
-2	366-1183-00			8						KNOB, gray—POSITION (CHANNEL 1 THRU 8)
	- - - - -			-						each knob includes:
	- - - - -			1						SETSCREW
-3	366-1101-00			8						KNOB, charcoal—GAIN (CHANNEL 1 THRU 8)
	- - - - -			-						each knob includes:
	213-0153-00			1						SETSCREW, 5-40 x 0.125 inch, HSS
-4	366-1023-01			1						KNOB, charcoal—LEVEL
	- - - - -			-						knob includes:
	213-0153-00			1						SETSCREW, 5-40 x 0.125 inch, HSS
-5	366-1029-00			1						KNOB, charcoal—TRIGGER SOURCE
	- - - - -			-						knob includes:
	213-0153-00			2						SETSCREW, 5-40 x 0.125 inch, HSS
-6	366-1059-00			2						KNOB, gray—LOCATE & ERASE
-7	366-1215-00			2						KNOB, charcoal—RAMP POSITION & VIEW TIME
	- - - - -			-						each knob includes:
	213-0153-00			1						SETSCREW, 5-40 x 0.125 inch, HSS
-8	366-1031-00			1						KNOB, red—VARIABLE CAL
	- - - - -			-						knob includes:
	213-0153-00			1						SETSCREW, 5-40 x 0.125 inch, HSS
-9	366-1037-00			1						KNOB, charcoal—TIME/SCAN
	- - - - -			-						knob includes:
	213-0153-00			2						SETSCREW, 5-40 x 0.125 inch, HSS
-10	260-0776-00			4						SWITCH, lever—ON-OFF (CHANNEL 1 THRU 4)
	- - - - -			-						mounting hardware for each: (not included w/switch)
-11	220-0413-00			2						NUT, switch mounting, 4-40 x 0.188 x 0.562 inch long
-12	260-0776-00			1						SWITCH, lever—STORE
	- - - - -			-						mounting hardware: (not included w/switch)
-13	220-0413-00			2						NUT, switch mounting, 4-40 x 0.188 x 0.562 inch long
-14	260-1245-00			4						SWITCH, lever—ON-OFF-PAIRED (CHANNEL 5 THRU 8)
	- - - - -			-						mounting hardware for each: (not included w/switch)
-15	220-0413-00			2						NUT, switch mounting, 4-40 x 0.188 x 0.562 inch long

FIGURE 1 EXPLODED & STANDARD ACCESSORIES (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff Disc	Q † y	Description				
				1	2	3	4	5
1-16	260-1247-00		1	SWITCH, lever—CHOP				
	- - - - -		-	mounting hardware: <i>(not included w/switch)</i>				
-17	220-0413-00		2	NUT, switch mounting, 4-40 x 0.188 x 0.562 inch long				
-18	260-0640-00		1	SWITCH, lever—POLARITY				
	- - - - -		-	mounting hardware: <i>(not included w/switch)</i>				
-19	220-0413-00		2	NUT, switch mounting, 4-40 x 0.188 x 0.562 inch long				
-20	260-1244-00		1	SWITCH, lever—MODE				
	- - - - -		-	mounting hardware: <i>(not included w/switch)</i>				
-21	220-0413-00		2	NUT, switch mounting, 4-40 x 0.188 x 0.562 inch long				
-22	260-1246-00		1	SWITCH, lever—SWEEP MODE				
	- - - - -		-	mounting hardware: <i>(not included w/switch)</i>				
-23	220-0413-00		2	NUT, switch mounting, 4-40 x 0.188 x 0.562 inch long				
-24	260-0834-00		1	SWITCH, toggle—POWER				
	- - - - -		-	mounting hardware: <i>(not included w/switch)</i>				
-25	210-0562-00		1	NUT, hex., 0.25-40 x 0.312 inch				
-26	210-0940-00		1	WASHER, flat, 0.25 ID x 0.375 inch OD				
-27	210-0223-00		1	LUG, solder, 0.25 inch ID, SE				
-28	- - - - -		10	RESISTOR, variable				
	- - - - -		-	mounting hardware for each: <i>(not included w/resistor)</i>				
-29	210-0583-00		1	NUT, hex., 0.25-32 x 0.312 inch				
-30	210-0940-00		1	WASHER, flat, 0.25 ID x 0.375 inch OD				
-31	260-1241-00		1	SWITCH, rotary—TIME/SCAN, unwired				
	- - - - -		-	mounting hardware: <i>(not included w/switch)</i>				
-32	210-0590-00		1	NUT, hex., 0.375-32 x 0.438 inch				
-33	210-0840-00		1	WASHER, flat, 0.39 ID x 0.562 inch OD				
-34	- - - - -		1	RESISTOR, variable				
	- - - - -		-	mounting hardware: <i>(not included w/resistor)</i>				
-35	210-0583-00		2	NUT, hex., 0.25-32 x 0.312 inch				
-36	210-0046-00		1	WASHER, lock, internal, 0.261 ID x 0.40 inch OD				
-37	376-0051-00		1	COUPLING, flexible				
	- - - - -		-	coupling includes:				
	213-0022-00		4	SETSCREW, 4-40 x 0.188 inch, HSS				
	354-0251-00		2	RING, coupling				
	376-0049-00		1	COUPLING, plastic				

FIGURE 1 EXPLODED & STANDARD ACCESSORIES (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff Disc	Q					Description	
			t	y	1	2	3		4
1-38	384-1034-00		1						SHAFT, extension, 3.14 inches long
-39	260-1242-00		1						SWITCH, rotary—TRIGGER SOURCE, unwired
	- - - - -		-						mounting hardware: <i>(not included w/switch)</i>
-40	210-0590-00		1						NUT, hex., 0.375-32 x 0.438 inch
-41	210-0840-00		1						WASHER, flat, 0.39 ID x 0.562 inch OD
-42	- - - - -		1						RESISTOR, variable
	- - - - -		-						mounting hardware: <i>(not included w/resistor)</i>
-43	210-0583-00		2						NUT, hex., 0.25-32 x 0.312 inch
-44	210-0046-00		1						WASHER, lock, internal, 0.261 ID x 0.40 inch OD
-45	376-0050-00		1						COUPLING, flexible
	- - - - -		-						coupling includes:
	213-0022-00		4						SETSCREW, 4-40 x 0.188 inch, HSS
	354-0251-00		2						RING, coupling
	376-0046-00		1						COUPLING, plastic
-46	384-1098-00		1						SHAFT, extension, 2.05 inches long
-47	136-0164-00		1						SOCKET, light
	- - - - -		-						mounting hardware: <i>(not included w/socket)</i>
-48	220-0480-02		1						NUT, dodecagon, 0.377-32 x 0.438 inch
-49	210-0978-00		1						WASHER, flat, 0.375 ID x 0.50 inch OD
-50	210-0012-00		1						WASHER, lock, internal, 0.375 ID x 0.50 inch OD
-51	210-0590-00		1						NUT, hex., 0.375-32 x 0.438 inch
-52	333-1441-00		1						PANEL, front
-53	352-0157-00		1						HOLDER, lamp
-54	378-0602-00		1						LENS, indicator light
-55	200-0935-00		1						CAP, lamp holder
-56	386-1991-00		1						SUBPANEL, front
	- - - - -		-						mounting hardware: <i>(not included w/subpanel)</i>
-57	212-0040-00		4						SCREW, 8-32 x 0.375 inch, 100° csk, FHS
-58	386-1663-00 ¹		1						PLATE, handle mounting
	- - - - -		-						plate includes:
-59	344-0098-00		2						CLIP
-60	367-0037-00		1						HANDLE
	- - - - -		-						mounting hardware: <i>(not included w/handle)</i>
-61	212-0506-00		2						SCREW, 10-32 x 0.375 inch, 100° csk, FHS
	- - - - -		-						mounting hardware: <i>(not included w/plate)</i>
-62	212-0557-00		2						SCREW, 10-32 x 0.50 inch, RHS
-63	220-0410-00		2						NUT, keps, 10-32 x 0.375 inch
-64	426-0758-00		1						FRAME SECTION, cabinet, right
	- - - - -		-						mounting hardware: <i>(not included w/frame section)</i>
-65	212-0040-00		8						SCREW, 8-32 x 0.375 inch, 100° csk, FHS
-66	210-0458-00		4						NUT, keps, 8-32 x 0.344 inch

¹4701 ONLY

FIGURE 1 EXPLODED & STANDARD ACCESSORIES (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff Disc	Q					Description	
			t	y	1	2	3		4
1-67	426-0757-00		1						1 FRAME SECTION, cabinet, left
	- - - - -		-						mounting hardware: <i>(not included w/frame section)</i>
-68	212-0040-00		8						SCREW, 8-32 x 0.375 inch, 100° csk, FHS
-69	210-0458-00		4						NUT, keps, 8-32 x 0.344 inch
-70	124-0252-00		4						STRIP, trim
-71	426-0763-01 ¹		2						FRAME SECTION, plated
-72	426-0763-03		2						FRAME SECTION, painted
-73	426-0755-00		1						FRAME SECTION, cabinet, top rear
	- - - - -		-						mounting hardware: <i>(not included w/frame section)</i>
-74	212-0040-00		2						SCREW, 8-32 x 0.375 inch, 100° csk, FHS
-75	212-0004-00		4						SCREW, 8-32 x 0.312 inch, PHS
-76	426-0756-00		1						FRAME SECTION, cabinet, bottom rear
	- - - - -		-						mounting hardware: <i>(not included w/frame section)</i>
-77	212-0040-00		2						SCREW, 8-32 x 0.375 inch, 100° csk, FHS
-78	212-0004-00		4						SCREW, 8-32 x 0.312 inch, PHS
-79	386-1978-00		1						SUBPANEL, rear
	- - - - -		-						mounting hardware: <i>(not included w/subpanel)</i>
-80	212-0040-00		1						SCREW, 8-32 x 0.375 inch, 100° csk, FHS
	212-0023-00		3						SCREW, 8-32 x 0.375 inch, PHS
-81	210-0458-00		4						NUT, keps, 8-32 x 0.344 inch
-82	131-0106-00		19						CONNECTOR, receptacle, female BNC, w/hardware
-83	131-0106-00		1						CONNECTOR, receptacle, female BNC, w/hardware
	- - - - -		-						mounting hardware: <i>(not included w/connector)</i>
-84	210-0255-00		1						LUG, solder, 0.375 inch diameter, SE
-85	386-1995-00		1						PLATE, connector mounting
	- - - - -		-						mounting hardware: <i>(not included w/plate)</i>
-86	212-0004-00		4						SCREW, 8-32 x 0.312 inch, PHS
-87	161-0033-00		1						CABLE ASSEMBLY, power
-88	358-0161-00		1						BUSHING, strain relief
-89	131-0569-00		2						CONNECTOR, receptacle, 25 pin
	- - - - -		-						mounting hardware for each: <i>(not included w/connector)</i>
-90	129-0260-00		2						POST, stud, 4-40 inch threads
-91	210-0586-00		2						NUT, keps, 4-40 x 0.25 inch
-92	200-0237-00		1						COVER, fuseholder, plastic

¹4701 ONLY

FIGURE 1 EXPLODED & STANDARD ACCESSORIES (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	No. Disc	Q					Description	
				t	y	1	2	3		4
1-	352-0002-00			1						FUSEHOLDER ASSEMBLY
	- - - - -			-						fuseholder assembly includes:
-93	352-0010-00			1						FUSEHOLDER
-94	200-0582-00			1						CAP, fuse
-95	210-0873-00			1						WASHER, rubber, 0.50 ID x 0.638 inch OD
-96	- - - - -			1						NUT, fuseholder
-97	670-1457-00			1						CIRCUIT BOARD ASSEMBLY—POWER SUPPLY A4
	- - - - -			-						circuit board assembly includes:
	388-2008-00			1						CIRCUIT BOARD
-98	136-0220-00			4						SOCKET, transistor, 3 pin, square
-99	136-0235-00			1						SOCKET, transistor, 6 pin
-100	136-0260-00			1						SOCKET, integrated circuit, 16 pin
-101	136-0269-00			1						SOCKET, integrated circuit, 14 pin
-102	344-0154-00			2						CLIP, fuse
	- - - - -			-						mounting hardware: (not included w/circuit board assembly)
-103	211-0116-00			4						SCREW, sems, 4-40 x 0.312 inch, PHB
-104	670-1455-00			1						CIRCUIT BOARD ASSEMBLY—COUNTER A3
	- - - - -			-						circuit board assembly includes:
	388-2010-00			1						CIRCUIT BOARD
-105	131-0608-00			107						TERMINAL, pin, 0.365 inch long
-106	136-0220-00			13						SOCKET, transistor, 3 pin, square
-107	136-0260-00			1						SOCKET, integrated circuit, 16 pin
-108	136-0269-00			22						SOCKET, integrated circuit, 14 pin
	214-0579-00			2						PIN, test point (not shown)
-109	260-0984-00			1						SWITCH, slide
	- - - - -			-						mounting hardware: (not included w/circuit board assembly)
-110	211-0116-00			6						SCREW, sems, 4-40 x 0.312 inch, PHB
-111	670-1456-00			1						CIRCUIT BOARD ASSEMBLY—SWEEP A2
	- - - - -			-						circuit board assembly includes:
	388-2009-00			1						CIRCUIT BOARD
-112	131-0608-00			41						TERMINAL, pin, 0.365 inch long
-113	136-0220-00			4						SOCKET, transistor, 3 pin, square
-114	136-0235-00			2						SOCKET, transistor, 6 pin
-115	136-0241-00			1						SOCKET, integrated circuit, 10 pin
-116	136-0260-00			1						SOCKET, integrated circuit, 16 pin
-117	136-0269-00			1						SOCKET, integrated circuit, 14 pin
-118	214-0579-00			2						PIN, test point (not shown)
	- - - - -			-						mounting hardware: (not included w/circuit board assembly)
-119	211-0116-00			4						SCREW, sems, 4-40 x 0.312 inch, PHB

FIGURE 1 EXPLODED & STANDARD ACCESSORIES (cont)

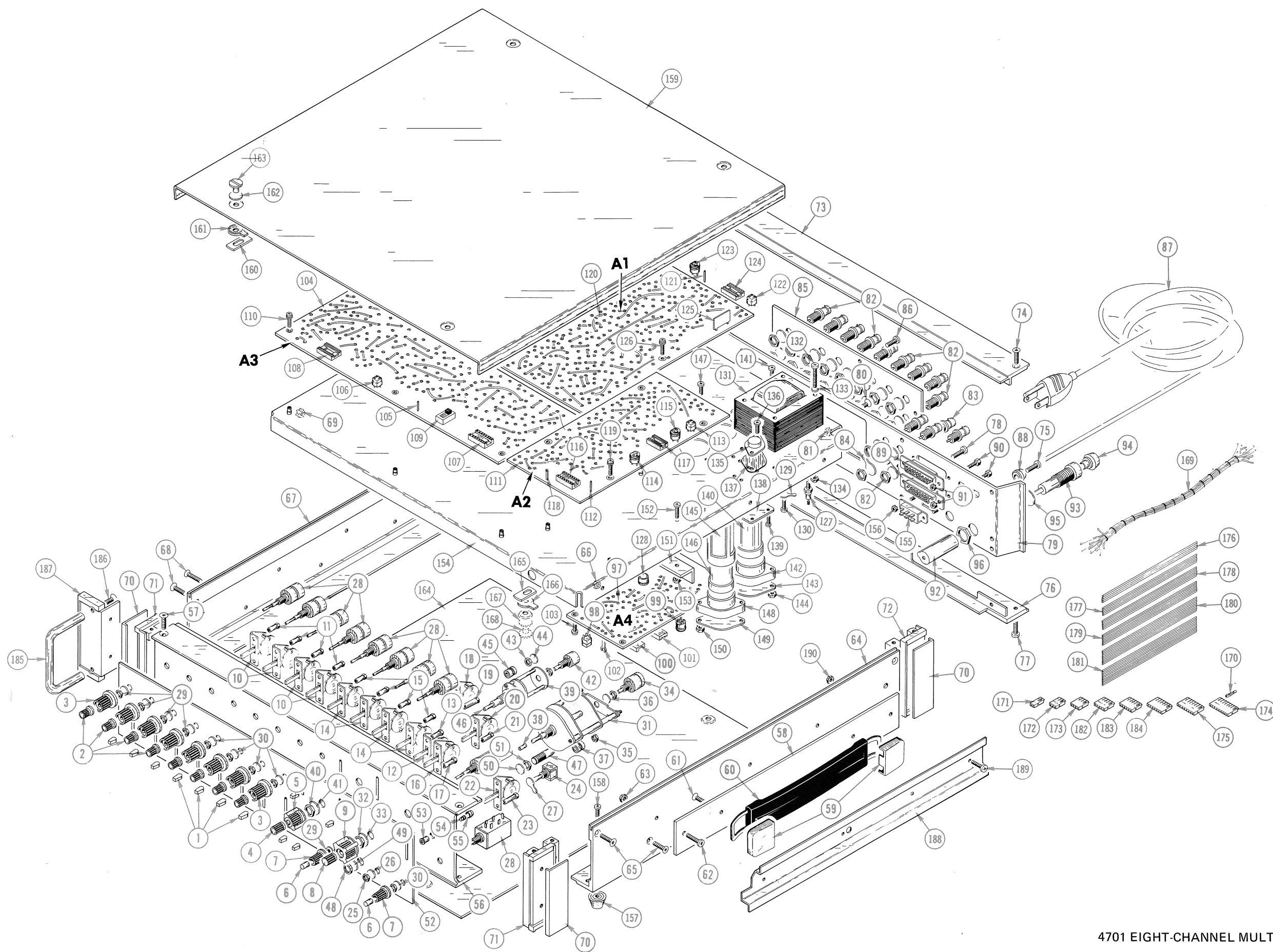
Fig. & Index No.	Tektronix Part No.	Serial/Model Eff	No. Disc	Q					Description	
				t	y	1	2	3		4
1-120	670-1458-00			1						CIRCUIT BOARD ASSEMBLY—AMPLIFIER A1
	- - - - -			-						circuit board assembly includes:
	388-2007-00			1						CIRCUIT BOARD
-121	131-0608-00			112						TERMINAL, pin, 0.365 inch long
-122	136-0220-00			21						SOCKET, transistor, 3 pin, square
-123	136-0235-00			17						SOCKET, transistor, 6 pin
-124	136-0269-00			10						SOCKET, integrated circuit, 14 pin
	214-0579-00			2						PIN, test point (not shown)
-125	337-0607-00			10						SHIELD, electrical
	- - - - -			-						mounting hardware: (not included w/circuit board assembly)
-126	211-0116-00			11						SCREW, sems, 4-40 x 0.312 inch, PHB
-127	129-0006-00			1						POST, connecting
	- - - - -			-						mounting hardware: (not included w/post)
	210-0457-00			1						NUT, keps, 6-32 x 0.312 inch
-128	348-0056-00			2						GROMMET, 0.375 inch diameter
-129	210-0202-00			1						LUG, solder, SE #6
	- - - - -			-						mounting hardware: (not included w/lug)
-130	211-0507-00			1						SCREW, 6-32 x 0.312 inch, PHS
	210-0457-00			1						NUT, keps, 6-32 x 0.312 inch
-131	- - - - -			1						TRANSFORMER
	- - - - -			-						mounting hardware: (not included w/transformer)
-132	211-0530-00			4						SCREW, 6-32 x 1.75 inches, PHS
-133	210-0823-00			4						WASHER, fiber, 0.125 ID x 0.25 inch OD
-134	210-0457-00			4						NUT, keps, 6-32 x 0.312 inch
-135	- - - - -			3						TRANSISTOR
	- - - - -			-						mounting hardware for each: (not included w/transistor)
-136	213-0041-00			2						SCREW, thread forming, 6-32 x 0.375 inch, THS
-137	386-0143-00			1						PLATE, mica, 0.80 x 1.35 inches long
-138	136-0270-00			3						SOCKET, transistor
	- - - - -			-						mounting hardware for each: (not included w/socket)
-139	213-0088-00			2						SCREW, thread forming, 4-24 x 0.25 inch, PHS
-140	- - - - -			1						CAPACITOR
	- - - - -			-						mounting hardware: (not included w/capacitor)
-141	211-0516-00			2						SCREW, 6-32 x 0.875 inch, PHS
-142	432-0048-00			1						BASE, capacitor mounting, large, plastic
-143	386-0254-00			1						PLATE, fiber, large
-144	210-0457-00			2						NUT, keps, 6-32 x 0.312 inch

FIGURE 1 EXPLODED & STANDARD ACCESSORIES (cont)

Fig. & Index	Tektronix Part No.	Serial/Model No.		Q † y	Description	
		Eff	Disc			1
1-145	200-0533-00			1	COVER, capacitor	
-146	- - - - -			2	CAPACITOR	
	- - - - -			-	mounting hardware for each: <i>(not included w/capacitor)</i>	
-147	211-0516-00			2	SCREW, 6-32 x 0.875 inch, PHS	
-148	432-0047-00			1	BASE, capacitor mounting, small, plastic	
-149	386-0252-00			1	PLATE, fiber, small	
-150	210-0457-00			2	NUT, keps, 6-32 x 0.312 inch	
-151	386-1979-00			1	STIFFENER, chassis	
	- - - - -			-	mounting hardware: <i>(not included w/stiffener)</i>	
-152	212-0023-00			4	SCREW, 8-32 x 0.375 inch, PHS	
-153	210-0458-00			4	NUT, keps, 8-32 x 0.344 inch	
-154	441-1004-00			1	CHASSIS, main	
-155	260-0675-00			1	SWITCH, slide—VOLTAGE RANGE SELECTOR	
	- - - - -			-	mounting hardware: <i>(not included w/switch)</i>	
-156	210-0406-00			2	NUT, hex., 4-40 x 0.188 inch	
	210-0004-00			2	WASHER, lock, internal, 0.12 ID x 0.26 inch OD	
-157	348-0080-01 ¹			4	FOOT, cabinet	
	- - - - -			-	mounting hardware for each: <i>(not included w/foot)</i>	
-158	211-0542-00			1	SCREW, 6-32 x 0.312 inch, THS	
-159	390-0211-00			1	CABINET TOP	
	- - - - -			-	cabinet top includes:	
	214-0816-00			4	LATCH ASSEMBLY	
	- - - - -			-	each latch assembly includes:	
-160	386-1151-00			1	PLATE, locking	
-161	386-0227-00			1	PLATE, index	
	214-0603-02			1	SECURING PIN ASSEMBLY	
	- - - - -			-	securing pin assembly includes:	
-162	214-0604-00			1	SPRING, latch	
-163	214-0603-01			1	PIN, securing	
-164	390-0210-00			1	CABINET BOTTOM	
	- - - - -			-	cabinet bottom includes:	
	214-0816-00			4	LATCH ASSEMBLY	
	- - - - -			-	each latch assembly includes:	
-165	386-1151-00			1	PLATE, locking	
-166	386-0227-00			1	PLATE, index	
	214-0603-02			1	SECURING PIN ASSEMBLY	
	- - - - -			-	securing pin includes:	
-167	214-0604-00			1	SPRING, latch	
-168	214-0603-01			1	PIN, securing	
-169	179-1654-00			1	WIRING HARNESS, switch	
	- - - - -			-	wiring harness includes:	
-170	131-0707-00			11	CONNECTOR, terminal	
	131-0708-00			2	CONNECTOR, terminal	
-171	352-0169-00			2	HOLDER, terminal connector, 2 wire <i>(black)</i>	
-172	352-0161-00			3	HOLDER, terminal connector, 3 wire <i>(black)</i>	

¹4701 ONLY

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4701 EIGHT-CHANNEL MULTIPLEXER



MANUAL CHANGE INFORMATION

At Tektronix, we continually strive to keep up with latest electronic developments by adding circuit and component improvements to our instruments as soon as they are developed and tested.

Sometimes, due to printing and shipping requirements, we can't get these changes immediately into printed manuals. Hence, your manual may contain new change information on following pages.

A single change may affect several sections. Sections of the manual are often printed at different times, so some of the information on the change pages may already be in your manual. Since the change information sheets are carried in the manual until ALL changes are permanently entered, some duplication may occur. If no such change pages appear in this section, your manual is correct as printed.

ELECTRICAL PARTS LIST AND SCHEMATIC CORRECTION

A2 SWEEP

Circuit Board Assembly

ADD:

C294	281-0550-00	120 pF	Cer	500 V	10%
R291	315-0335-00	3.3 M	1/4 W		5%

CHANGE TO:

R292	315-0512-00	5.1 k Ω	1/4 W		5%
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