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PLEASE CHECK FOR CHANGE INFORMATION AT THE REAR OF THIS MANUAL.

2445/2465
OPTION 05
TV OPTION
SERVICE

INSTRUCTION MANUAL

Tektronix, Inc.
P.O. Box 500
Beaverton, Oregon 97077

070-4630-00
Product Group 38

Serial Number _____

First Printing APR 1984

Scans
By
Artek Media

Artek Media
1042 Plummer Cir. SW
Rochester, MN 55902

www.artekmedia.com

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TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

LIST OF TABLES

OPERATORS SAFETY SUMMARY

The general safety information in this part of the summary is for both operating and servicing personnel. Specific warnings and cautions will be found throughout the manual where they apply and do not appear in this summary.

Terms in This Manual

CAUTION statements identify conditions or practices that could result in damage to the equipment or other property.

WARNING statements identify conditions or practices that could result in personal injury or loss of life.

Terms as Marked on Equipment

CAUTION indicates a personal injury hazard not immediately accessible as one reads the markings, or a hazard to property, including the equipment itself.

DANGER indicates a personal injury hazard immediately accessible as one reads the marking.

Symbols as Marked on Equipment


DANGER – High voltage.


Protective ground (earth) terminal.


ATTENTION – Refer to manual.

Power Source

This product is intended to operate from a power source that does not apply more than 250 volts rms between the supply conductors or between either supply conductor and ground. A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation.

Grounding the Product

This product is grounded through the grounding conductor of the power cord. To avoid electrical shock, plug the power cord into a properly wired receptacle before connecting to the product input or output terminals. A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation.

Danger Arising From Loss of Ground

Upon loss of the protective-ground connection, all accessible conductive parts (including knobs and controls that may appear to be insulating) can render an electric shock.

Use the Proper Power Cord

Use only the power cord and connector specified for your product.

Use only a power cord that is in good condition.

Use the Proper Fuse

To avoid fire hazard, use only a fuse of the correct type, voltage rating and current rating as specified in the parts list for your product.

Do Not Operate in Explosive Atmospheres

To avoid explosion, do not operate this product in an explosive atmosphere unless it has been specifically certified for such operation.

Do Not Remove Covers or Panels

To avoid personal injury, do not remove the product covers or panels. Do not operate product without the covers and panels properly installed.

SERVICE SAFETY SUMMARY

FOR QUALIFIED SERVICE PERSONNEL ONLY

Refer also to the preceding Operators Safety Summary.

Do Not Service Alone

Do not perform internal service or adjustment of this product unless another person capable of rendering first aid and resuscitation is present.

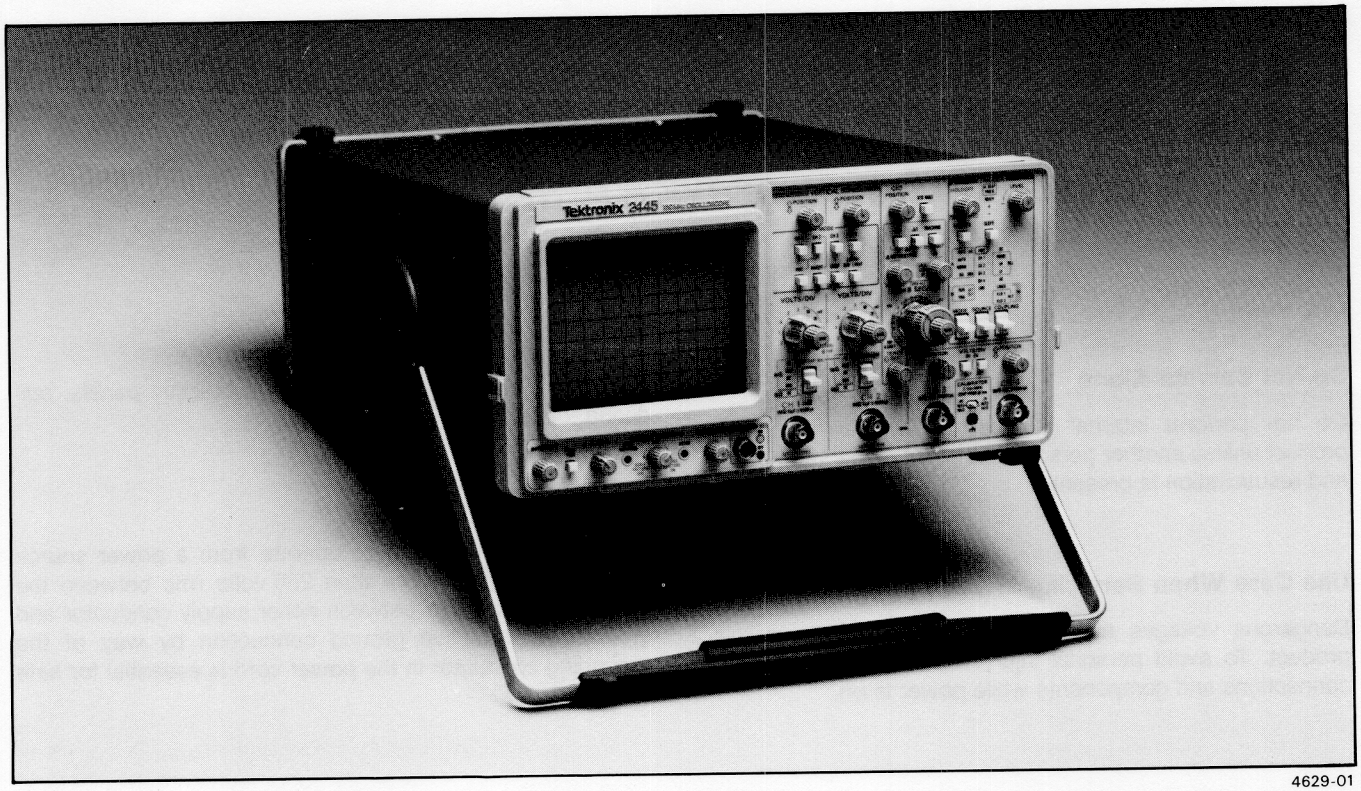
Use Care When Servicing With Power On

Dangerous voltages may exist at several points in this product. To avoid personal injury, do not touch exposed connections and components while power is on.

Disconnect power before removing protective panels, soldering, or replacing components.

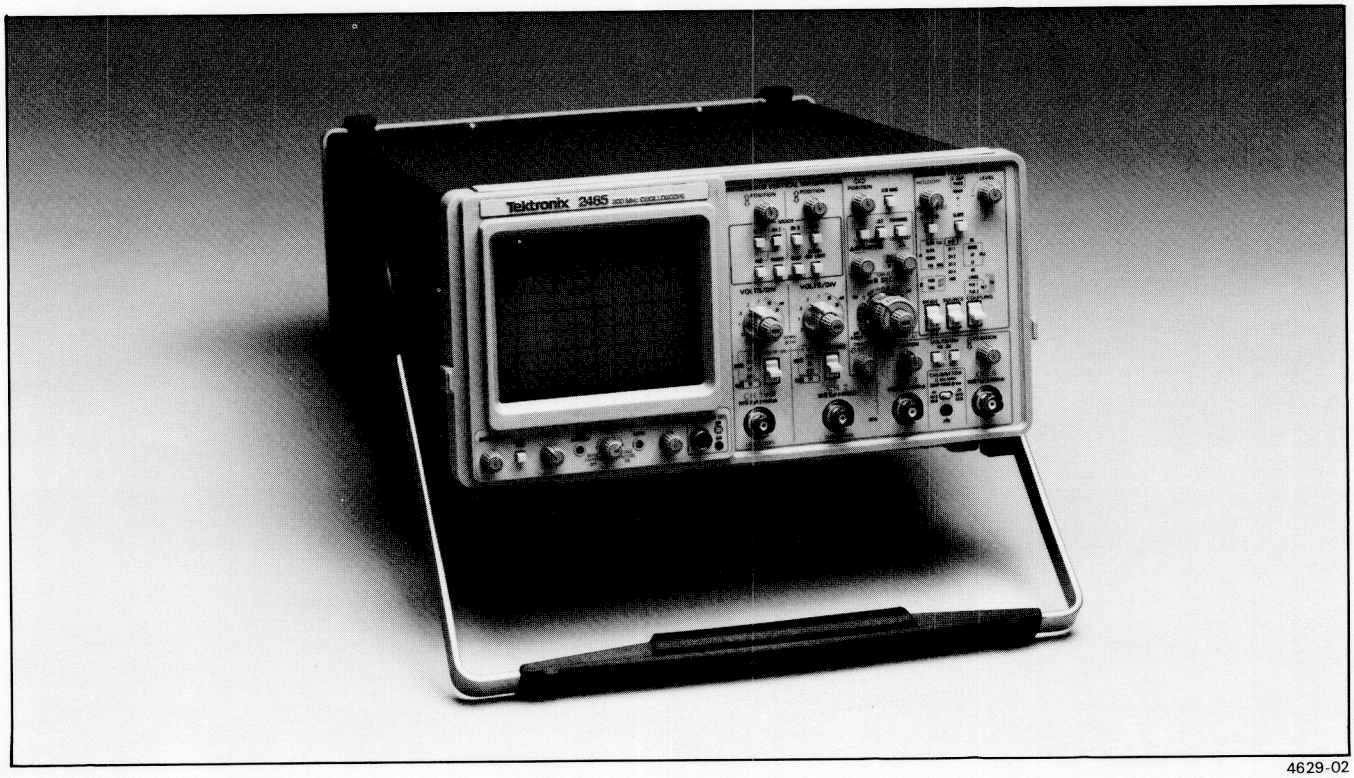
Power Source

This product is intended to operate from a power source that will not apply more than 250 volts rms between the supply conductors or between either supply conductor and ground. A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation.



4629-01

The 2445 Option 05 (TV) Oscilloscope.



4629-02

The 2465 Option 05 (TV) Oscilloscope.

SPECIFICATION

INTRODUCTION

The TEKTRONIX 2445 and 2465 Oscilloscopes with Option 05 (TV Option) have additional hardware and software features to simplify triggering and viewing of television signals. The option adds TV (back-porch) clamp circuitry to the Channel 2 input and TV trigger coupling modes are provided, allowing a user to select either horizontal or vertical sync pulses to obtain horizontal-line-sync or field-sync pulse triggering. This option permits the user to trigger on a specific line number within a TV field and provides sync polarity switching for either sync-negative or sync-positive composite video signals.

NOTE

Composite video is the picture waveform complete with vertical and horizontal blanking and sync. Composite sync is combined vertical and horizontal sync as a single waveform, but without video (picture) waveforms.

Both system-M and nonsystem-M protocols are available, providing compatibility with most television signal line-numbering protocols. Stable video rejection and sync separation are obtained from sync-positive or sync-negative, interlaced or non-interlaced scan, composite video signals having 525 to 1280 horizontal lines per frame and 50- or 60-Hz field rates.

STANDARD ACCESSORIES

In addition to the standard accessories listed in the standard oscilloscope manuals, the following TV Option accessories are provided:

1 2445/2465 Option 05, TV Option, Operators Manual

1 2445/2465 Option 05, TV Option, Service Manual

1 CCIR Graticule

1 NTSC Graticule

1 Polarized Viewing Hood

For part numbers, refer to Section 6, "Replaceable Parts List," in this manual. Your Tektronix representative or local Tektronix Field Office can also provide accessories information.

PERFORMANCE CONDITIONS

Except as noted in Tables 1-1 and 1-2 of this manual, the electrical, environmental, and mechanical characteristics of TV Option instruments are identical to those specified for standard instruments in the respective 2445 and 2465 Oscilloscope manuals.

Table 1-1
Option 05 Electrical Characteristics

Characteristics	Performance Requirements
VERTICAL DEFLECTION SYSTEM—CHANNEL 1 AND CHANNEL 2	
Frequency Response	For VOLTS/DIV switch settings between 5 mV and 0.2 V/div with VAR control in calibrated detent. Five-division, 50 kHz reference signal from a 50 Ω system. With external 50 Ω termination on 1 MΩ input.
Full Bandwidth	
50 kHz to 5 MHz	Within ±1%.
>5 MHz to 10 MHz	Within +1%, −2%.
>10 MHz to 30 MHz	Within +2%, −3%.
Bandwidth Limit	
50 kHz to 5 MHz	Within +1%, −4%.
Square Wave Flatness	With fast-rise step (rise time≤1 ns), 1 MΩ dc input coupling, an external 50 Ω termination, and VAR VOLTS/DIV control in calibrated detent. Exclude the first 50 ns following the step transition. For signals with rise times ≤10 ns, add 2% p-p between 155 ns and 165 ns after step transition.
Field Rate	
5 mV/div to 10 mV/div	1.5% p-p at 60 Hz with input signal of 0.1 V.
20 mV/div	1% p-p at 60 Hz with input signal of 0.1 V.
50 mV/div	1% p-p at 60 Hz with input signal of 1.0 V.
Line Rate	
5 mV/div to 10 mV/div	1.5% p-p at 15 kHz with input signal of 0.1 V.
20 mV/div	1% p-p at 15 kHz with input signal of 0.1 V.
50 mV/div	1% p-p at 15 kHz with input signal of 1.0 V.
TV (Back-Porch) Clamp (CH 2 only)	For VOLTS/DIV switch settings between 5 mV and 0.2 V with VAR control in calibrated detent. Six-division reference signal.
60 Hz Attenuation	≥18 dB.
Back-Porch Reference	Within 1.0 division of ground reference.

Table 1-1 (cont)

Characteristics	Performance Requirements
TRIGGERING	
Sync Separation	Stable video rejection and sync separation from sync-positive or sync-negative composite video, 525 to 1280 lines, 50 Hz or 60 Hz, interlaced or noninterlaced systems.
Trigger Modes	
Main Sweep	All lines: Field 1, selected line (1 to n); Field 2, selected line (1 to n); Alt fields, selected line (1 to n); where n is equal to or less than the number of lines in the frame and less than or equal to 1280.
Delayed Sweep	Delayed by time.
Input Signal Amplitude for Stable Triggering	
Channel 1 or Channel 2	Minimum for peak signal amplitude within 18 divisions of input ground reference.
Composite Video Composite Sync	1 division. 0.3 division.
Channel 3 or Channel 4	Minimum for peak signal amplitude within 9 divisions of input ground reference.
Composite Video Composite Sync	0.5 division. 0.25 division.

Table 1-2
Option 05 Mechanical Characteristics

Characteristics	Description
Weight	
With Power Cord, Cover, Pouch, Probes, Operators Manual, and Options	≤12.0 kg (26.4 lb).
Domestic Shipping Weight	≤17.6 kg (38.8 lb).

OPERATING INFORMATION

CONTROLS AND INDICATORS

FRONT-PANEL CONTROLS

Certain front-panel controls on the oscilloscope have dual modes of operation when the TV Option is installed. When the TV Option is enabled, the controls have the functions as described below. When the TV Option is not enabled, the controls have the functions described in the oscilloscope Operators manual and in other option Operators manuals if other options are installed.

See Figure 2-1 for the location of the TV Option front-panel controls.

(11) **CH 2 Input Coupling Switch**—Selects or deselects the TV (back-porch) clamp function.

UP:TV CLAMP—Activates the TV (back-porch) clamp when the switch is pushed up from the 1 MΩ AC position. The AC indicator LED will remain on and the message "TVC" will appear on the top line of the crt. The clamp sets the television signal back-porch amplitude to a constant dc level and eliminates vertical drift, hum, and tilt in the display. A stable display is provided despite changes in signal amplitude and average luminance levels. The TV (back-porch) clamp can be enabled even if TV trigger is deselected.

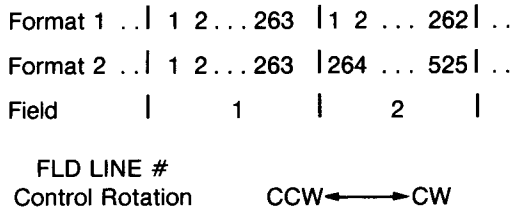
AC—Deactivates the TV (back-porch) clamp when the switch is pushed down once from the UP:TV CLAMP position. The AC indicator LED will remain on and the message "TVC" will be removed from the top of the crt display. The television signal's level will then be set by the average signal level and vary with that average level.

(32) **Δ-FLD LINE # Control**—Selects a specific line number within the field for triggering the oscilloscope when the TV Option is enabled and the Trigger COUPLING switch is set to FLD 1, FLD 2, or alternate FLD 1-FLD 2 mode. Possible line numbers range from 1 to the maximum number of lines per frame in the television signal being viewed. Rotating the control clockwise increases the line number; rotating it counterclockwise decreases the line number. See the "Δ-FLD LINE # Control" discussion in the "Operating Considerations" part of this section for further information about using this control.

When the line number setting reaches the maximum number of lines in a field and either FLD 1 or FLD 2 coupling is selected, additional clockwise turning of the control changes the line number to the beginning of the following field. If alternate FLD 1-FLD 2 coupling (ALT) is selected, further rotation of the control past the maximum number will only reset the count to 1.

When the line number setting reaches 1 and either FLD 1 or FLD 2 coupling is selected, counterclockwise rotation of the control will move the line number to the maximum line number of the previous field. If ALT coupling is selected, the line number will move to the maximum line number common to both fields.

See the "TV Protocol and Line-Numbering Format Selection" discussion in the "Preparation for Use" part of this section to choose the desired line number format. See the example below for operation with a 525-line interlaced scan signal.



(36) **TRIGGER COUPLING Switch and Indicators**—Selects and indicates one of four additional choices for trigger coupling. They are: FLD 1 (field 1), FLD 2 (field 2), ALT (alternate field 1-field 2), and LINES (horizontal TV-line sync triggering). The crt readout will display the trigger coupling mode.

FLD 1—Sweep is triggered on the first field of the input TV signal and the FLD 1 LED is illuminated. NORM trigger mode is automatically selected.

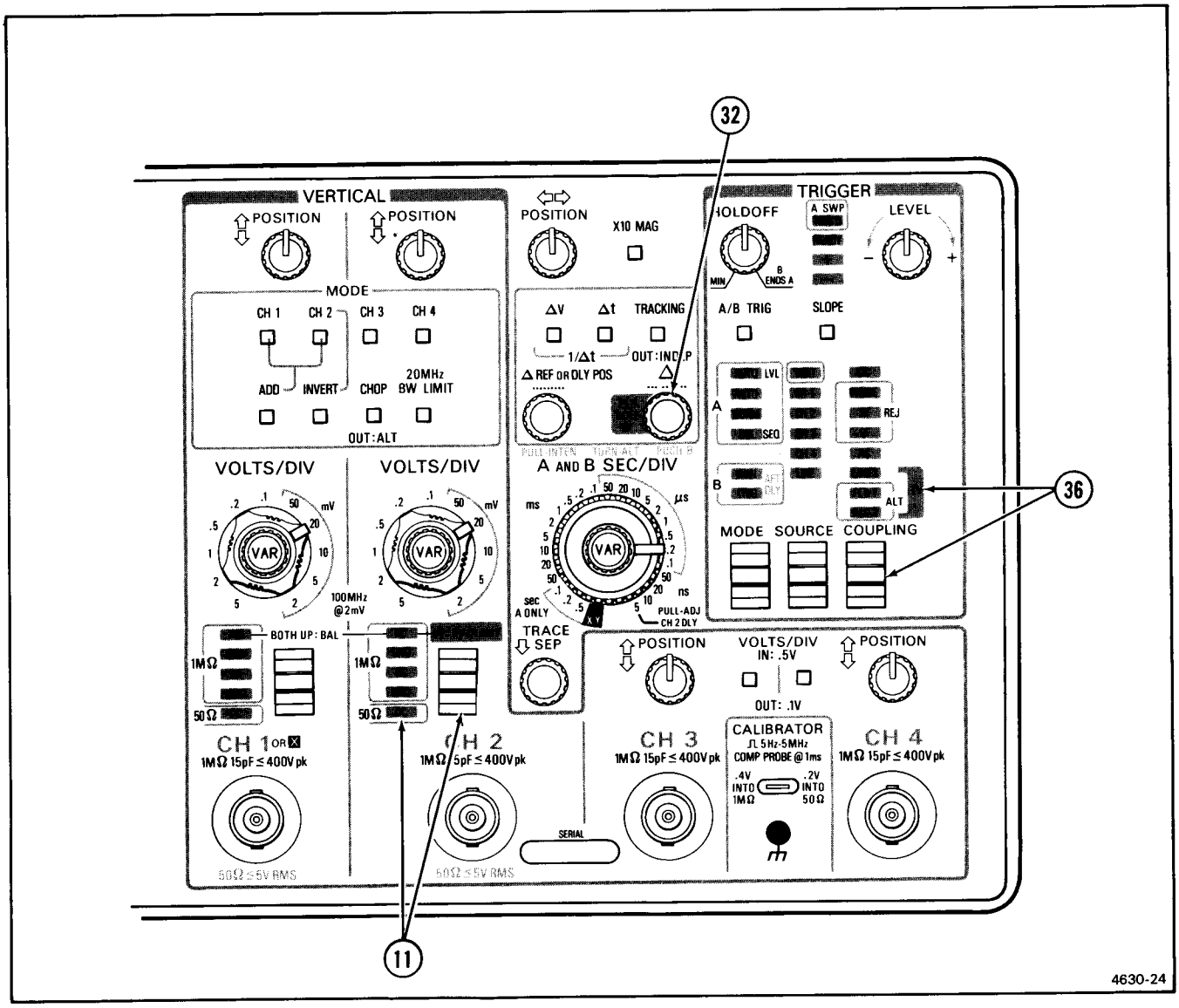


Figure 2-1. TV Option front-panel controls.

FLD 2—Sweep is triggered on the second field of the input TV signal and the FLD 2 LED is illuminated. NORM trigger mode is automatically selected.

ALT—Sweep is alternately triggered by the two TV fields and both the FLD 1 and FLD 2 LEDs are illuminated. NORM trigger mode is automatically selected.

When CHOP Vertical Mode is selected, all of the active channels are triggered alternately by field 1 and field 2 of the video signal. The two fields will appear overlayed.

When ALT Vertical Mode is selected and more than one channel is displayed, field 1 of the video signal will trigger the first active channel and field 2 will trigger the next active channel. When more than two channels are displayed, each additional channel will be triggered first by field 1 and then by field 2 of the video trigger signal, and its two fields will be overlayed.

LINES—Sweep will trigger when the holdoff time has elapsed and a TV horizontal line-sync pulse is encountered. The LINES LED is illuminated and AUTO trigger mode is automatically selected.

READOUT DISPLAYS

In addition to the readout displays for oscilloscope operation shown in Sections 3 and 6 in the oscilloscope Operators manual, an instrument equipped with the TV Option will display option status information when in any of the TV modes. Also see the "Operating Considerations" part of this section for additional information.

The crt readout will display TV Trigger information when the Trigger COUPLING switch is set to any of the TV trigger modes (FLD 1, FLD 2, ALT, or LINES) or when the TV (back-porch) clamp is active. The TV Option utilizes a display area of up to 12 characters that are normally located in the right half of the top display line of the crt readout. If the right half is not available, the TV Option information is displayed in the left half of the top line.

When field triggering is selected, the readout displays the line number selected for triggering the oscilloscope. The line number readout is followed by a delta (Δ) symbol if the FLD LINE # control is controlling the line number selection. If the Δ symbol is not present, the FLD LINE # control will not change the line number selection. The crt readout displays the message "TVC" whenever the TV (back-porch) clamp is active.

PREPARATION FOR USE

This part of the manual contains information related to the power-up of the standard instrument containing the TV Option. The power-up sequence of the oscilloscope is described, along with explanations of potential option-related error messages that may occur if the instrument is not functioning properly. Also included is initial setup information for the selection of the TV protocol and line number format parameters.

POWER-UP SEQUENCE

Before turning on power to the instrument, read Section 2, "Preparation for Use," in the oscilloscope Operators manual and follow the safety and precautionary information described there.

The power-up tests, automatically performed each time the oscilloscope is turned on, test both the standard oscilloscope circuitry and the TV Option circuitry. Tests specifically applicable to the TV Option are integrated into the power-up tests for the host oscilloscope and include the TV Kernel test.

Kernel Test

Operation of the TV Option memory (ROM) is checked by the standard instrument Kernel test. Kernel test failures will result in an attempt to flash the front-panel A SWP TRIG'D indicator.

NOTE

On some instruments having other options installed, the A/B TRIG button may be labeled A/B/MENU.

Even with a Kernel failure, pressing in the A/B TRIG switch may still place the instrument in an operating mode. However, if the operating mode is successfully entered, instrument operation may be unpredictable. If the instrument then functions adequately for your particular measurement requirement, it can be used; but refer it to a qualified service technician for repair of the problem as soon as possible.

Successful Power-Up Sequencing

When the power-up routine is successfully completed without a failure indication, the oscilloscope enters the normal operation state. The oscilloscope parameters are set to correspond with current front-panel switch positions and with switch functions that were established for at least 10 seconds before instrument power was last turned off. The instrument is now ready to make measurements as required.

POWER-DOWN SEQUENCE

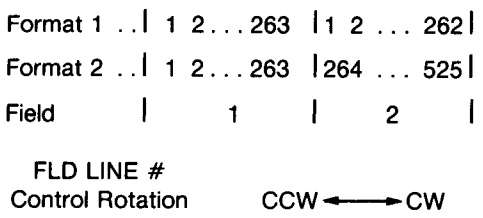
When the POWER switch is set to OFF, the instrument powers down and the instrument front panel settings that were unchanged for at least 10 seconds prior to power off will be stored for use the next time power is applied to the instrument.

TV PROTOCOL AND LINE-NUMBERING FORMAT SELECTION

The following procedures are used to select a particular protocol or line-numbering format. Both involve access to Diagnostic Monitor routines (EXER 61 and EXER 62) and affect field triggering only (FLD 1, Alternate FLD 1-FLD 2, or FLD 2). TV protocol selection allows the user to choose between system-M and nonsystem-M protocols. Selecting the incorrect system for a given TV protocol will not affect the ability to trigger on a given TV waveform. It will, however, cause the line number displayed to be inaccurate. Line-numbering format selection allows the user to select a preferred line-numbering scheme. Format 1 references line one from the beginning of the field being used for trigger reference. Format 2 always references line one from the first line of Field 1.

Exercise procedure TV EXER 61, accessed via the oscilloscope Diagnostic Monitor, allows the user to select between system-M and nonsystem-M television protocols. When system-M is selected, the line count begins three lines before the field-sync pulse is encountered. If nonsystem-M is selected, the line count begins coincident with the field-sync pulse.

Exercise procedure TV EXER 62, accessed via the oscilloscope Diagnostic Monitor, allows the user to select one of two line-number formats as shown below.



To choose or determine the TV protocol:

1. Hold in both the ΔV and Δt buttons and push in the TRIGGER SLOPE button to enter the Diagnositic Monitor.

2. Repeatedly push up and release the TRIGGER MODE switch until the message "TV EXER 61" appears at the bottom-left corner of the crt.

3. Push up and release the COUPLING switch once, and the currently selected protocol will appear at the top of the crt display. The message meanings are as follows:

   LINE 1 OCCURS PRIOR TO FLD SYNC — System-M protocol is currently selected.

   LINE 1 COINCIDENT WITH FLD SYNC — Nonsystem-M protocol is currently selected.

4. If the desired protocol message is not displayed, push up and release the TRIGGER COUPLING switch once. The desired protocol message should now be displayed. Push down once on the TRIGGER COUPLING switch.

To choose or determine the line number format:

5. Push up and release the TRIGGER MODE switch. The message "TV EXER 62" will be displayed at the bottom-left corner of the crt.

6. Push up and release the COUPLING switch once to display the currently selected format at the top of the crt. The message meanings are as follows:

   LINE NO RESETS ON EACH FIELD—Format 1 is selected.

   LINE NO RESETS ON FLD 1 ONLY—Format 2 is selected.

7. If the desired line format message is displayed, exit the Diagnostic Monitor by pushing the A/B TRIG button to resume normal oscilloscope operation.

8. If the desired line format message is not displayed, push up and release the TRIGGER COUPLING switch once. The desired line format message should now be displayed. Push down once on the TRIGGER COUPLING switch.

9. Push the A/B TRIG button to exit the Diagnostic Monitor and resume normal oscilloscope operation.

OPERATING CONSIDERATIONS

Consult the oscilloscope Operators manual to acquire a thorough understanding of the operation of the standard instrument before trying to use the features of the TV Option. With the TV Option installed, all standard instrument functions (as explained in the respective oscilloscope technical manuals) remain unchanged.

FRONT-PANEL CONTROL AND SETUP CONSIDERATIONS

The following information is useful when using the oscilloscope in TV applications. To operate properly, observe the oscilloscope front-panel controls and input signal considerations.

TV Clamp

The TV (back-porch) clamp is used to stabilize ac-coupled TV waveforms and to remove tilt or hum present in the displayed TV waveform. If the Channel 2 signal is not composite video or composite sync or the sweep is not triggered on TV Sync, TV (back-porch) clamp operation is unpredictable.

If the TV (back-porch) clamp is enabled with no TV sync applied to the trigger, the CH 2 trace may drift vertically. This is normal; turning the TV (back-porch) clamp off will restore normal operation.

Use the procedure below to identify the signal type of an input signal to the CH 2 input connector.

1. Turn the TV (back-porch) clamp off and select CH 2 TRIGGER COUPLING.

2. Obtain a stable waveform using the desired TV trigger mode.

3. Determine whether the displayed signal is composite video or composite sync.

4. If necessary, turn the TV (back-porch) clamp on.

Δ-FLD LINE # Control

The Δ-FLD LINE # control is used for selecting a specific TV line within a field as well as positioning the Δ cursor. When it can be used for line number selection, a delta (Δ) symbol appears in the crt readout display following the line number. If a delta symbol is not displayed, the control is used to position the Δ cursor for the Δt, 1/Δt or ΔV functions. The following two paragraphs describe how to switch the function of the control from one to the other during a series of measurements.

To enable the control to select a TV line when it is currently controlling the Δ cursor, press the TRIGGER COUPLING switch once. This will not change the current coupling mode selected and the Δ symbol will appear in the crt readout next to the line number.

If the control is currently controlling TV line number selection and it is desired to make a Δt, 1/Δt, or ΔV measurement, press in the Δt button to get the Δt function, both the Δt and ΔV buttons to get the 1/Δt function, or the ΔV button to get the ΔV function. The control can now be used to position the Δ cursor.

Slope Selection

When using the TV trigger, select the proper slope for triggering on the TV signal. For sync-negative displayed signals, set the SLOPE switch to −. When triggering on sync-positive displayed signals, set the SLOPE switch to +.

Display Considerations

The TV Option circuitry does not detect the color burst phase or Bruch Sequence color burst blanking information. In a four-field Pal Sequence with Bruch Sequence color burst blanking, Fields 1 and 3 will be displayed when Field 1 is selected (odd fields), and fields 2 and 4 will be displayed when Field 2 is selected (even fields). On noninterlayed scan systems the TV Option detects start of field information only. Field 1 and Field 2 are then two consecutive fields of information.

MULTI-TRACE MODES. When using the TV trigger and multi-trace operation, the trigger source must not be VERT mode. When only one trace is displayed, the VERT position of the TRIGGER SOURCE switch may be used.

OVERSCANNED DISPLAYS. For various video measurements, it may be desirable to magnify the video waveform vertically beyond the limits of the screen. Under these circumstances, the trigger amplifiers or the option circuitry may be overloaded, blocking out some sync pulses in the vicinity of strong video transitions, or losing sync pulses altogether. To avoid overload problems, use one of the other vertical channels to supply a constant amplitude signal to the option circuitry while the overscanned observations are being made.

RF INTERFERENCE. Operation in the vicinity of some FM and TV transmitters may contain objectionable amounts of rf signal energy in the input signal, even when coaxial input connections are used. The front-panel 20 MHz BW LIMIT switch will usually eliminate such interference from the display, but will not affect the signal reaching the option circuitry. Where the rf interferes with option operation, external filters will be required.

MULTIPLE-DISPLAYED WAVEFORMS. Within a given frame, the color burst alternates phase every line. Since there are an odd number of lines per frame on interlaced scan systems a given line within a frame will alternate color burst phase between frames. This is readily apparent when viewing a specific line within a frame. Understanding this color burst phasing and how A and B sweeps are triggered is important when interpreting multiple-displayed waveforms.

Review the standard instrument operators manual parts on horizontal and delta measurements and delayed sweep operation.

In A Alt B mode, the sweeps are displayed as follows: A sweep, delayed (B) sweep, A sweep, delayed (B) sweep. In this mode, if Δt mode is selected and Fld 1 or Fld 2 trigger is selected, sweeps occur in the following order: A sweep, B sweep, A sweep, B sweep. Note that since B sweeps are essentially "interlaced" with the A sweep, each A and B sweep is triggered on every other frame. Since color burst phase alternates on every frame, the A and B displayed waveforms will each show one phase of the color burst information.

If A only or B only sweep mode is selected, sweeps are triggered on every frame and the displayed waveform will show both phases of the color burst.

Oscilloscope Dc Balance Routine

With the TV Option installed, the standard instrument dc balance routine can be accomplished with the CH 2 Input Coupling switch in either the 1 MΩ AC position or the TV CLAMP position.

Front-Panel Update

When any front-panel change is made and the TV (back-porch) clamp is enabled, the display may jump vertically. However, the TV (back-porch) clamp will return the back-porch level to its previous position.

CH 2 SIGNAL OUT Connector

To preserve waveform fidelity of a video signal applied to the CH 2 Input Connector when the TV Clamp is enabled, the CH 2 SIGNAL OUT connector on the instrument rear panel should be unterminated (open). If the connector is terminated into 50 Ω, there may be a slight shift in the back-porch level between adjacent lines of the video waveform.

IDENTIFYING FIELDS, FRAMES, AND LINES IN 525/60 AND 625/50 TV SYSTEMS

NTSC (CCIR System M)

Field 1 is defined as the field whose first equalizing pulse is one full H interval (63.5 μs) from the preceding horizontal sync pulse. The field 1 picture starts with a full line of video and its lines are numbered 1 through 263, starting with the leading edge of the first equalizing pulse. The first regular horizontal sync pulse after the second equalizing interval is the start of line 10.

Field 2 starts with an equalizing pulse a half-line interval from the preceding horizontal sync pulse. The field 2 picture starts with a half line of video and its lines are numbered 1 through 262, starting with the leading edge of the second equalizing pulse. After the second equalizing interval, the first full line is line 9.

CCIR System B and Similar 625/50 Systems (including PAL)

In most 625-line, 50-Hz field-rate systems, identification of parts of the picture relies primarily on continuous line numbering rather than on field-and-line identification, except for PAL systems.

The CCIR frame starts with the first (wide) vertical sync pulse following a field which ends with a half-line of video. The first line after the second equalizing interval is line 6; the

first picture line is line 23 (half-line of video). The first field of the frame contains lines 1 through the first half of line 313, and the picture ends with a full line of video (line 310).

The second field of the frame commences with the leading edge of the first (wide) vertical sync pulse (middle of line 313), and runs through line 625 (end of equalizing interval). The first full line after the equalizing interval is line 318; the picture starts on line 336 (full line).

The first field is referred to as "odd", and the second field as "even". Note that the identification systems for System-M and System-B are reversed.

In the four-field PAL sequence with Bruch Sequence Color-burst blanking, the fields are identified as follows:

Field 1: Field that follows a field ending in a half-line of video, when preceding field has color burst on the last full line. Field 1 lines are 1 through 312 and half of line 313. Color burst starts on line 7 of field 1; a half-line of video appears on line 23.

Field 2: Field that follows a field ending in a full line which does not carry color burst. Field 2 lines are the last half of line 313 through line 625. Color burst starts on line 319 (one line without burst following the last equalizing pulse); a full line of video appears at line 336.

Field 3: Field that follows a field ending in a half line when preceding field has no color burst on its last full line. Field 3 lines are 1 through the first half of line 313. Burst starts on line 6 (immediately following the last equalizing pulse); a half-line of video appears on line 23.

Field 4: Field that follows a field ending in a full line carrying color burst. Field 4 lines are the second half of line 313 through line 625. Color burst for field 4 starts on line 320 (two full lines without burst follow the last equalizing pulse); video starts with a full line on line 336.

GPIB CONTROLLABLE FUNCTIONS

If the GPIB Option is installed in the instrument, additional commands to control the TV Option via the GPIB are available. The commands are listed in Table 2-1, and only the upper-case characters of a command are required for recognition. See the GPIB Operators manual for additional information relating to GPIB operation.

When using the GPIB to set the field line number, the option should be stably triggered on a valid composite video or composite sync waveform. If it is not stably triggered, the max line in the option may be set to a low number. An error code may then result on the GPIB controller when an attempt is made to change the line number to what is believed to be a valid line number over the GPIB.

Table 2-1
GPIB Command Set for the TV Option

Header	Argument	Argument	Comments
ATRigger	COUpling: SLOpe:	FLD1 FLD2 ALTernate LINES PLUs MINUs	Selects TV option trigger mode from list. These commands are in addition to the A trigger commands used by the standard instrument.
ATRigger?	COUpling SLOpe		Query returns: ATR COU:string, SLO:string; where string is one of the respective argument parameters.
TVClamp	ON OFF		Causes the CH 2 input coupling to be switched to AC and the TV (back-porch) clamp to be active. If the TV (back-porch) clamp is enabled, the CH 2 input coupling is switched to AC and the TV (back-porch) clamp is turned off. Otherwise, no change to the CH 2 input coupling occurs.
TVClamp?			Query returns either TVC ON or TVC OFF.
TVLine	<nrx>		<nrx> is the TV line number chosen to trigger the oscilloscope.
TVLine?			Query returns present line number displayed.
LCNTStart	PREFId ATFId		Line count begins 3 lines before field-sync pulse (System-M). Line count begins at field-sync pulse (Nonsystem-M).
LCNTStart?			Query returns Line 1 definition: either LCNTS PREF or LCNTS ATF.
LCNTReset	F1Only BOTh		Line count is reset only on field 1 (Format 2). Both field 1 and field 2 reset the line counter (Format 1).
LCNTReset?			Query returns Line count reset status: either LCNTR F1O or LCNTR BOT.
ID?			See the GPIB Option manual system commands for details. The string returned for the TV Option is TV:FVz where z is the version number.

BASIC APPLICATIONS

The standard instrument with the TV Option provides an accurate and flexible measurement system for displaying and analyzing video information. After becoming familiar with the controls, indicators, operating considerations, and capabilities of the instrument, perform the following procedures to become familiar with the oscilloscope functions for making TV-related measurements.

Before proceeding with these instructions, refer to "Preparation for Use" in this section.

Verify that the POWER switch is OFF (push button out); then plug the power cord into the power outlet.

Initial Setup

a. Press in the POWER switch button (ON).

b. Set the instrument controls to obtain a baseline trace as follows:

Vertical

CH 2 POSITION	Midrange
MODE	CH 2
BW LIMIT	Off (button out)
CH 2 VOLTS/DIV	0.2 V
CH 2 VOLTS/DIV VAR	Calibrated detent
CH 2 Input Coupling	GND

Horizontal

A AND B SEC/DIV	Locked together at 5 ms
SEC/DIV VAR	Calibrated detent
POSITION	Midrange
X10 MAG	Off (button out)

Trigger

HOLDOFF	MIN (fully ccw)
LEVEL	Midrange
MODE	NORM
SOURCE	CH 2
COUPLING	FLD 1
SLOPE	– for sync-negative displayed signals and + for sync-positive displayed signals

c. Adjust the INTENSITY and READOUT INTENSITY controls for desired display and readout brightness and best trace definition.

d. Adjust the Vertical and Horizontal POSITION controls to position the trace within the graticule area.

Signal Input Coupling

This procedure demonstrates the appearance of a video signal with the different positions of the CH 2 Input Coupling switch (see Figure 2-2).

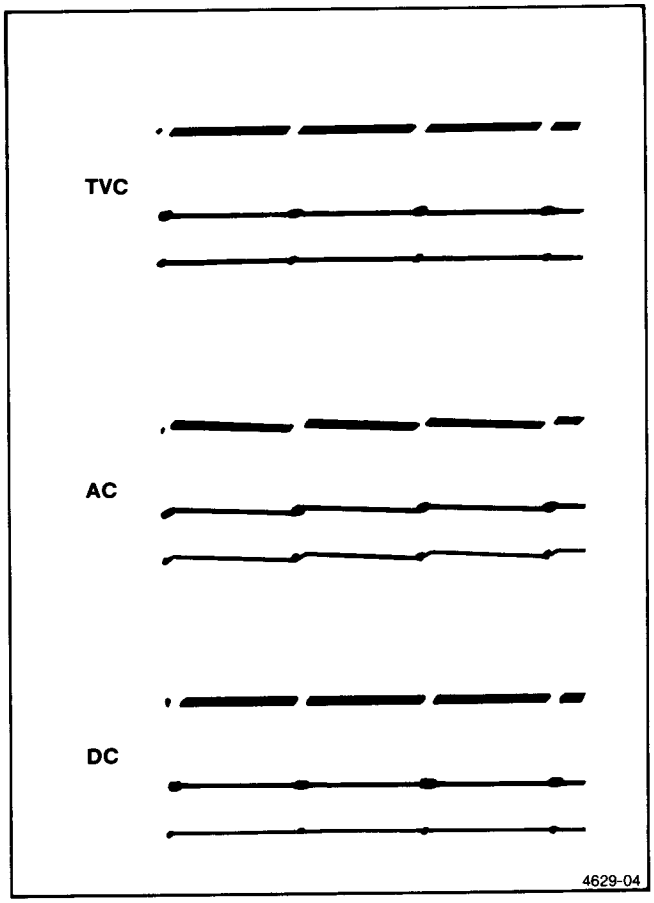


Figure 2-2. Appearance of video signal with CH 2 Input Coupling switch positions.

a. Connect a composite video signal to the CH 2 input connector and change the CH 2 Input Coupling switch to DC.

b. Obtain a stable baseline trace.

c. With the CH 2 Input Coupling switch in 1 MΩ DC, note that the signal edges are flat.

d. Set the CH 2 Input Coupling switch to 1 MΩ AC and note the tilt in the waveform due to the input coupling capacitance.

e. Set the CH 2 Input Coupling switch to TV CLAMP. Notice that the waveform no longer has tilt and has returned to a dc-coupled appearance.

Time Interval Measurements

This procedure demonstrates how to use the Δt cursors to make timing measurements on the video waveform.

a. Set the TRIGGER COUPLING switch to the LINES position and the A AND B SEC/DIV switches to 10 μs.

b. Push in the Δt button.

c. Use the Δ REF OR DLY control to position one cursor on the rising edge of the first sync pulse and use the Δ control to position the other cursor on the rising edge of the next sync pulse. The line interval period can now be read directly from the upper-right corner of the crt readout. On a 525-line/60-Hz interlaced system, the readout should be approximately 63.4 μs. A 625-line/50-Hz interlaced system should produce a readout of approximately 64.0 μs.

d. Push in both the ΔV and Δt buttons simultaneously to get the 1/Δt function. The crt readout now contains the line interval frequency. On a 525-line/60-Hz interlaced system, the readout should be approximately 15.8 kHz. A 625-line/50-Hz system should produce a readout of approximately 15.6 kHz.

The preceding procedure measured line intervals on those random lines of the video signal which triggered the oscilloscope sweep. To make a time interval measurement for a particular line within a field:

e. Set the TRIGGER COUPLING switch to either FLD 1 or FLD 2, depending on which field the desired line is in. The INTENSITY control may have to be adjusted to increase the trace brightness.

f. Adjust the FLD LINE # control until the desired line number appears in the crt readout. Specific time measurements on that particular line can now be made.

This procedure may also be used to measure the width of a sync pulse.

g. Set the CH 2 VOLTS/DIV, VAR, and POSITION controls so that the sync pulse exactly fills the screen between the 0% and 100% graticule lines. Enable the Δt function, push in the X10 MAG button, and position the sync pulse on screen using the Horizontal POSITION control.

h. Use the Δ REF OR DLY control to position one cursor at the 50% point of the leading edge of the sync pulse (at the center horizontal gratiucle line) and use the Δ control to position the other cursor at the 50% point of the trailing edge of the sync pulse. The sync pulse width can now be read directly from the upper-right corner of the crt readout.

Voltage and IRE Measurements

Voltage measurements can be made on the video signal using the ΔV cursors and the crt readout. In addition, IRE measurements expressed in percentages can also be made and displayed on the crt as a percent.

a. Push in the ΔV button, set the X10 MAG button out for X1 magnification, and return the CH 2 VOLTS/DIV VAR control to its calibrated detent. Waveform voltage measurements can now be made by using the Δ REF OR DLY and Δ controls to position the ΔV cursors at the desired points of the video signal. The crt readout will correspond to the voltage potential between the two points on the waveform.

b. Set the CH 2 VOLTS/DIV, VAR, and POSITION controls so that the back porch and the top of a 100%-modulated video signal exactly fill the screen between the 0% and 100% graticule lines.

c. Any part of the waveform can now be measured in IRE units by using the Δ REF OR DLY and Δ controls to position the ΔV cursors at the appropriate positions of the waveform. The crt readout will be a percentage which will correspond with the IRE measurement units.

THEORY OF OPERATION

INTRODUCTION

SECTION ORGANIZATION

This section contains a functional circuit description of the Option 05 (TV Option) circuitry for the 2445 and 2465 Oscilloscopes. The discussion begins with an overview of option functions and continues with detailed explanations of each major circuit. Reference is made to supporting schematic and block diagrams which aid in understanding the text. These diagrams show interconnections between parts of the circuitry, identify circuit components, list specific component values, and show interrelationships with the standard oscilloscope.

The detailed block and schematic diagrams are located in the tabbed "Diagrams" section at the rear of this manual.

The particular schematic diagram associated with each circuit description is identified in the text, and the diagram number is shown (enclosed within a diamond symbol) on the tab of the appropriate foldout page. For the best understanding of the circuit being described, refer to both the applicable schematic and block diagrams.

DIGITAL LOGIC CONVENTIONS

Digital logic circuits perform many functions within the instrument. The operation of these circuits is represented by specific logic symbology and terminology. Logic-function descriptions contained in this manual use the positive-logic convention. The specific voltages which constitute a HI or a LO vary between individual devices. For specific device characteristics, refer to the manufacturer's data book.

GENERAL CIRCUIT DESCRIPTION

Before individual circuits are discussed in detail, a general block-level discussion is provided to aid in understanding overall operation of the option circuitry. A simplified block diagram of the option, showing basic interconnections, is shown in Figure 3-1. The diamond-enclosed numbers in the blocks refer to the schematic diagrams at the rear of this manual in which the corresponding circuitry is located. Throughout this discussion, standard oscilloscope refers to the 2445 and 2465 Oscilloscopes without option circuitry.

The activities of the option are directed by the microprocessor contained in the standard oscilloscope. The microprocessor, under the control of firmware present in the option, monitors the option's functions and sets up the operating modes according to instructions received.

While executing the control program, the microprocessor retrieves previously stored calibration constants and front-panel settings and, as necessary, places program-generated data in temporary storage for later use. The electrically alterable read-only memory (EAROM) contained in the Buffer circuit board and the random access memory (RAM) contained in the standard instrument provide these storage locations.

BUFFER BOARD

The TV option connects to the standard oscilloscope through the Buffer circuit board. The Buffer board performs the following functions:

1. Buffers and modifies the timing of the microprocessor bus.

2. Distributes the microprocessor bus, power supplies, and analog signals from the standard oscilloscope to the options.
3. Provides additional ROM for interfacing options to the standard instrument.
4. Provides an EAROM for options use.
5. Provides a mechanical interface.

The microprocessor control bus, address bus, and data bus are buffered by Buffer board circuitry. Microprocessor bus timing for the options is modified by buffers on the Buffer board to make bus timing compatible with the options. The EAROM bus allows the microprocessor to access the option EAROM located on the Buffer board. These signal paths are used for communication between the TV option and the standard oscilloscope.

TV BOARD

The TV option adds hardware and software, to the 2445 and 2465 Oscilloscopes, to allow triggering on and viewing of complex television signals. The standard oscilloscope and the option are interconnected by the Buffer board. The TV board is divided into analog and digital sections.

Circuitry in the analog section processes composite video from the selected trigger source. If enabled, the TV (Back Porch) Clamp acts as a dc restorer to eliminate waveform tilt and prevent level changes due to changes in average picture level (APL). Sync pulses are extracted from the composite video by the Sync Pickoff comparator. The horizontal and vertical sync pulses are separated and used to produce the horizontal clock and field signals used by the digital circuitry.

The digital section contains the microprocessor interface which allows the microprocessor to control the option. It includes the Data Bus buffer, the Memory and I/O decoders, the Option Select register, and the EPROM. The TV Control register stores the option's control information. Sync pulses for TV field(s) are counted by counters in the Counter/Timer integrated circuit (IC). The Mode Select logic selects the proper signal to arm the Auxiliary Trigger generator. The Auxiliary Trigger generator triggers the standard instrument's sweep generator when sweep holdoff has ended and the selected horizontal sync pulse arrives.

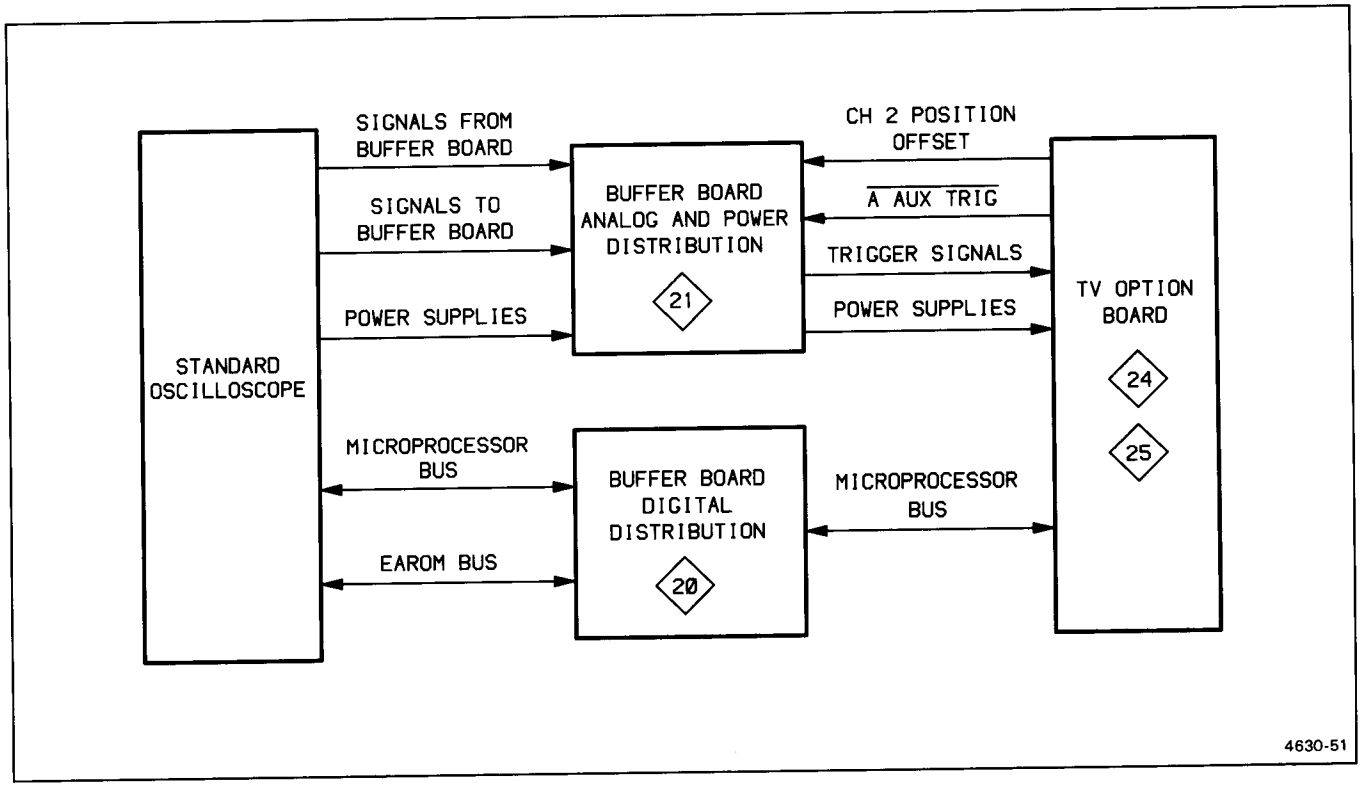


Figure 3-1. Simplified block diagram.

DETAILED CIRCUIT DESCRIPTION

INTRODUCTION

The following discussion provides detailed information concerning the electrical operation and circuit relationships of the 2445 and 2465 Buffer board and Television circuitry. Unique circuitry is described in detail, while circuits common in the electronics industry are not. The descriptions are supported by the associated detailed block diagram (Figure 7-3) and schematic diagrams located at the rear of this manual in the tabbed foldout pages.

BUFFER BOARD DIGITAL DISTRIBUTION

The Buffer Board Digital Distribution circuitry (see Diagram 20) interconnects the standard oscilloscope and the TV board. Most of the microprocessor signals are buffered and have their timing modified. In addition, some of the memory used for option functions is included on the Buffer board.

Electrically Alterable ROM

Nonvolatile storage for the calibration constants and power-down settings is provided by EAROM U4207. By using different clock sources, the microprocessor is able to select either EAROM U2008 in the standard oscilloscope or Buffer board EAROM U4207. The clock source for the Buffer board EAROM comes from U2308 pin 5 (see Diagram 2 in the standard oscilloscope manual). Mode control inputs C1 and C3 are interchanged between the two EAROMs to prevent data contention. A TTL-to-MNOS level shift of the clock signal is provided by Q4201. For additional information on EAROM operation, consult the "Theory of Operation" section of the standard oscilloscope service manual.

Address Decoding

Gates U4240A and U4240C partially decode the address bus. Enable BVMA U4240C pin 8 is HI for addresses from 1000-7FFF (this and all other address references are in hexadecimal), the address space used by the options including the Buffer board.

Enable $\overline{\text{BUFEN}}$ U4250C pin 8 is LO for the address space of 1000-1FFF. Address strobe $\overline{\text{LOWAD}}$ is active LO for the address space of XFFC-XFFF (where X is a don't care). These decoded address signals are used in selecting ROM U4260 on the Buffer board and disabling data bus buffer U4255.

Buffer Board ROM

Buffer board ROM U4260 is used to interface the option to the standard oscilloscope. Its output enable (at pin 20) is $\overline{\text{ROMEN}}$. The signals $\overline{\text{ROMEN}}$ and $\overline{\text{BUFEN}}$ are the same if P4256 is present. With $\overline{\text{ROMEN}}$ and $\overline{\text{BUFEN}}$ the same, the Buffer board ROM address space is 1000-1FFF. Whenever the Buffer board ROM is addressed, shift register U4275 (that controls the data bus buffer) is reset by $\overline{\text{ROMEN}}$. This prevents the Buffer board data bus buffer and the Buffer board ROM from driving the microprocessor side of the data bus at the same time.

Bus Buffers

The 10MHz clock signal of the standard oscilloscope is buffered by U4265D. The buffered clock (B10MHZ) clocks shift register U4275 and is also sent to the options.

The $\overline{\text{E}}$ clock, $\overline{\text{RESET}}$, VMA, and R/$\overline{\text{W}}$ are buffered by latch U4225. The pull-up on U4225 pin 12 allows $\overline{\text{RESET}}$ and $\overline{\text{E}}$ to pass through the latch unmodified. The buffered E clock is delayed more than 30 ns by R4265, C4265, and U4265C. This delayed BE clock latches $\overline{\text{VMA}}$, R/$\overline{\text{W}}$ (U4225) and the address bus (U4235 and U4245), which provides extra hold time on these signals for the options.

Data Bus Buffer

Data bus buffer U4255 is a bidirectional bus driver that is controlled by the signals on pin 1 and pin 19. Pin 1 controls the direction of data flow through the buffer, and pin 19 turns the drivers on and off. When pin 1 is HI, the buffer is configured to drive data from the microprocessor to the options. Conversely, when pin 1 is LO, the buffer is configured to drive data from an option to the microprocessor. Pin 1 is HI except when the microprocessor is reading data from an option.

Signals on pin 1 and pin 19 coordinate the states of U4255 so that data bus contention never occurs. Buffer U4255 drives two buses: the bus between U4255 and the Control board of the standard oscilloscope, and the bus between U4255 and the options. Both of these must be kept free of contentions (i.e., it is not allowed for more than one device to drive the bus at the same time). These two buses will be examined individually.

The bus between the Control board and U4255 is driven by the Control board during a write bus cycle, driven by the Control board during a read cycle from non-option space

(0000-0FFF and 8000-FFFF), driven by U4255 during a read cycle from option space (2000-7FFF), and driven by U4260 during a read from Buffer board ROM (1000-1FFF). The Control board changes its drivers from output to input on the rising edge of E (this is the high-true E, not the low-true $\overline{E}$ used by the option) when going from a write to a read cycle. It changes from input to output on the falling edge of R/$\overline{W}$ when going from a read to a write cycle. Data buffer U4255 drives the Control board data bus only when BVMA and BR/$\overline{W}$ are both true, i.e., a read cycle from the option is being performed. This is done by driving U4255 pin 1 from BVMA NANDed with BR/$\overline{W}$ (after passing through a delay consisting of two cycles of the 10 MHz clock). Pin 19 of U4255 is driven by $\overline{E}$ delayed for two cycles of the 10 MHz clock. This two-cycle delay ensures that U4255 will be driving the Control board data bus only in a read cycle from option address space, during a time interval starting after the rising edge of E and ending after the falling edge of E. A delay of two cycles of the 10 MHz clock is necessary to guarantee that the Control board data bus drivers have turned off before U4255 starts driving the bus. This is a period of time when the Control board never drives the data bus during a read cycle. Shift register stages in U4275 are cleared by $\overline{ROMEN}$, forcing U4255 pin 19 HI while Buffer board ROM is being read.

The bus between U4255 and the options must be driven by U4255 during a write cycle to the options (2000-7FFF) and may be driven by an option only during a read cycle from the option (2000-7FFF). Bus driver U4255 actually drives the bus to the option during all cycles except read cycles from 1000-7FFF. The bus is driven by an option only while E is true during an option read cycle. Address bus driver U4255 drives the bus during an option write cycle while U4255 pin 19 is LO, but in this case pin 19 is delayed from $\overline{E}$ only by one cycle of the 10 MHz clock, driving the data to the options as soon as it is available from the microprocessor.

TELEVISION OPTION CIRCUIT BOARD

The TV Option circuit board adds hardware and firmware that allows triggering on and viewing of television signals. The TV board is divided into analog and digital sections. The following descriptions are supported by the circuit timing diagram (Figure 7-6) located in the tabbed foldout pages in the rear of the manual.

The analog section is composed of the composite video signal processing circuitry. This section includes signal amplification, automatic gain control, back-porch clamping, sync pickoff, and sync separation circuitry. Clocks at the horizontal (line) rate and a field indicator signal are sent to the digital section. The digital section contains the microprocessor interface and circuitry that triggers the standard instrument's sweep generator. The trigger is generated when the selected horizontal sync pulse (line) occurs.

Analog Circuitry

The TV option Analog circuitry (see Diagram 24) processes the composite video. Back-porch level control, horizontal clock, and vertical field signals are produced for other circuitry in the instrument.

VARIABLE GAIN AMPLIFIER. The Variable Gain Amplifier stage amplifies the input composite video signal. The front-panel SLOPE switch determines whether the amplifier is inverting or noninverting.

Differential amplifier U5436 amplifies the input composite video signal. It contains two pairs of switching transistors that provide signal inversion when desired. The Sync Tip Clamp and Automatic Gain Control circuitry controls the channel resistance of Q5530, which determines the gain of the amplifier. The gain is automatically adjusted to maintain proper sync-tip level. With no input signal, the gain is maximum.

The composite video signal is applied to one input of the differential amplifier at pin 3 of U5436 and to Dc Offset amplifier U5636B. The input to the Dc Offset amplifier is filtered by R5433 and C5630, a low-pass filter, making its output the dc component of the composite video signal. This filtered output is then applied to the other input of U5436 at pin 11.

Four transistors of U5436 are controlled by the SLOPE signal from U5764. When SLOPE is HI, the transistors connected to pins 2 and 9 will be biased on, and the collector signal at pin 8 will drive Q5528. When SLOPE is LO, the transistors connected to pins 13 and 6 will be on, and the collector signal at pin 14, which is inverted with respect to both the input signal and the signal at pin 8, will drive Q5528.

Common-base transistor Q5528 level shifts the signal from U5436 and provides voltage gain to drive U5427D. For stable triggering, the composite video signal which drives U5427D must be sync-negative; if the displayed input signal is sync-positive, the SLOPE switch must be pushed to invert the signal.

FIXED GAIN AMPLIFIER AND BACK-PORCH CLAMP. The second-stage amplifier circuitry provides additional gain to the video signal from the Variable Gain Amplifier. Also, additional start-up circuitry is used to set amplifier parameters when a signal is first applied.

Additional amplification is provided by U5427. Transistors U5427A and U5427B form a differential amplifier, with U5427C supplying their emitter current. The output of U5427B drives the input of the Sync Pickoff comparator.

When a signal is first applied, the amplifier operating levels are established by feedback. The channel resistance of Q5530 is minimum when no signal is applied. This will set up the circuitry for maximum gain to enable the feedback circuits, the Back Porch clamp, and the Sync Tip Clamp and Automatic Gain Control. Once a signal is applied, Q5625 and associated circuitry will increase the dc level associated with the input signal if any of the signal is below ground. When the signal is below ground, diode CR5526 will forward bias, shutting off Q5625 and forward biasing CR5623. This reduces the output voltage of U5636C and decreases the base drive voltage on U5427B. This raises the transistor's collector voltage and turns off CR5526.

SYNC PICKOFF COMPARATOR. The comparator, composed of Q5515 and Q5512, is switched by the sync pulse. The switching threshold is set, by the values of resistors R5611 and R5622, at about 50% of the sync level. The collector output of Q5512 is the composite sync waveform; the output of Q5515 is the inverse of the output of Q5512.

SYNC-TIP CLAMP AND AUTOMATIC GAIN CONTROL. Transconductance operational amplifier U5410 acts as a sync-tip clamp and controls the gain of U5436 by altering the channel resistance of Q5530. The operational amplifier's gain is determined by the current into pin 5. The amplifier is enabled on sync tips when pin 5 is HI (−14.4 V). One input of the operational amplifier is grounded, and the other has the collector signal of U5427B applied through R5525. The operational amplifier, when enabled at the start of a sync pulse by the collector of Q5512 going LO, alters the channel resistance of Q5530, keeping the signal level at the collector of U5427B at about 0.5 V for the duration of the sync pulse. When pin 5 is LO (−15 V), U5410 is off and C5419 acts as a sample and hold to maintain bias on Q5530.

Diode CR5522 reduces amplifier gain when the sync tip is below −0.2 V. If the diode becomes forward biased, Q5518 turns on if it is not on already. Amplifier U5410 can then increase the channel resistance of Q5530 and thus reduce the amplifier gain.

BACK-PORCH CLAMP. Transconductance operational amplifier U5310 acts as a back-porch clamp to control the level of the video signal during the back-porch period. Its gain is determined by the current into pin 5. When the amplifier is enabled, pin 5 is HI (−14.6 V). When the collector signal of Q5515 goes negative, the resulting pulse coupled through C5726 turns off U5712A. The positive-going signal on the collector of U5712A enables U5310 during the back-porch time. The output of U5310 drives voltage-follower U5636C, which in turn establishes the base voltage of U5427B. The collector signal of U5427B drives U5310 pin 3 through R5525 and R5523. This feedback loop will establish zero volts on pin 3 of U5310 during the back-porch time, with a resulting collector voltage on U5427B of about 4.5 V. When U5310 pin 5 is LO (−15 V), U5310 is turned off and C5631 acts as a sample and hold to maintain the bias on U5427B.

VERTICAL BACK-PORCH CLAMP. The Vertical Back-Porch Clamp clamps the back-porch level of the displayed signal to about zero volts.

Input to level comparators U5755 and U5855 is a sample of the signal (CH2 PO) in the Channel 2 vertical preamp. The output of the clamp, CH2 OFFSET, supplies a dc offset to the vertical preamp. The level comparators supply a dc offset of the proper polarity and magnitude to cause CH2 PO to be about zero volts during the back-porch interval.

Any color burst on the signal is removed by R5754 and C5755. The signal is then compared to ground during the back-porch interval by either U5755 or U5855. The dc offset required to bring the back-porch level to zero volts is sampled and held by C5640 and C5545. Operational amplifiers U5636D and U5636A supply the drive required by the preamp.

When the CH2 VOLTS/DIV switch is at 2 mV, 5 mV, 10 mV, 100 mV, or 1 V/DIV; FAST/SLOW is LO, turning on U5728E. The channel resistance of Q5442 will then decrease, making C5640 part of the sample-and-hold capacitance. R5812, R5820, C5545, and C5640 control the large signal ac response of the Vertical Back-Porch Clamp during the sampling period.

BACK-PORCH CLAMP SWITCHING. The Back-Porch Clamp Switching circuitry determines when the Vertical Back-Porch Clamp is active and which of its level comparators is used.

When the back-porch clamp is not enabled, CLAMP will be LO, turning U5728D on. The HI on the collector of U5728D turns on U5712B, 5712C, and Q5736. This keeps both comparators (U5755 and U5855) off and the inputs to U5636A and U5636D grounded. With this circuitry disabled, the Channel 2 vertical preamp circuitry does not receive a dc offset voltage from the comparators.

When the back-porch clamp is enabled, CLAMP will be HI, turning U5728D off. The LO on the collector of U5728D turns Q5736 off, enabling U5636A and U5636D, and allows U5712E and U5712D to turn off either U5712B or U5712C. This allows one of the comparators (U5755 or U5855) to turn on. Either U5755 or U5855 is gated on during the back-porch interval when U5712A turns off. With the Vertical Back-Porch Clamp enabled, the back porch of the displayed signal is clamped to ground. However, when the Phase Locked Loop is not locked, the Vertical Back-Porch Clamp is turned off through R5831.

Comparator selection, either U5755 or U5855, is controlled by the CH2 INVERT signal. The signal from Channel 2 is inverted by U5855, but not by U5755. If the front-panel INVERT switch is pushed in, the signal from the preamp must be inverted by U5855. This is because the preamp's signal is sampled after inversion takes place in the preamp. If CH2 INVERT is LO, U5712E is on and U5712D is off. The HI on the collector of U5712E turns on U5712B which turns off U5855. If U5855 is off, the input signal will not be inverted. The LO on the collector of U5712D turns off U5712C, enabling U5755; during the back porch interval the collector of U5712A will be HI, turning on U5755. If CH2 INVERT is HI, the circuitry operates similarly. However, this time U5755 is turned off and U5855 is turned on, inverting the signal from the preamp.

If the back-porch clamp is enabled during the back-porch interval, transistor U5712A turns on either U5755 or U5855. However, the dc offset generated by U5755 and U5855 must be maintained during the entire horizontal interval. Between back-porch intervals, while U5755 and U5855 are turned off, the required offset is maintained by C5545 and if Q5442 is on by C5640.

PULSE STRETCHER, EQUALIZING PULSE REMOVER, AND AUTO BASELINE GENERATOR. The Pulse Stretcher and Equalizing Pulse Remover stretches the horizontal sync pulses and removes every other equalizing pulse from the input composite sync. The Auto Baseline Generator generates the HORIZ CLK signal used in generating triggers.

The leading edge of each sync pulse turns on U5728C. This reverse biases CR5831, turning off U5728B. The HI on the collector of U5728B keeps U5728C on and reverse biases CR5735. The collector of U5728B remains HI until C5830 charges to about 1.4 volts. The resulting square wave passes through CR5774, becoming HORIZ CLK.

To avoid passing every equalizing pulse and serrated pulse, the output of the Delayed Horizontal Clock circuit is coupled through R5832, keeping U5728B turned on and its collector LO midway between horizontal sync pulses.

The Auto Baseline Generator combines (ORs) the horizontal sync stripped from the input signal and the H clock produced by the Phase Locked Loop divider. The H clock is first delayed by R5864 and C5773. The H clock input allows HORIZ CLK to be produced when in LINES TRIGGER COUPLING, both when there is no input signal and during vertical sync pulses without serrations. Producing HORIZ CLK at these times generates a trigger and therefore a base-line trace.

PHASE LOCKED LOOP. The Phase Locked Loop (PLL) generates signals used in identifying individual fields in interlaced scan systems.

PLL U5845 operates at twice the horizontal clock frequency. Its output, 2XH, is divided by two by U5645B, producing both H and $\overline{\text{HORIZ CLK}}$. Horizontal sync from the input signal is input to U5845 at pin 14. The $\overline{\text{HORIZ CLK}}$ generated by the PLL through U5645B is input to U5845 at pin 3. Equalizing pulses and the vertical sync are removed from the PLL inputs by U5838B and U5838C (see Figure 7-6).

Pin 1 of the Phase Locked Loop (U5845) is LO whenever the signals on pin 3 and pin 14 do not coincide (horizontal sync at pin 14 not in phase with $\overline{\text{HORIZ CLK}}$ at pin 3). The PLL error signal at pin 1 is stretched by R5755 and C5865 and then inverted by Q5860. When the collector of Q5860 is HI, Vertical Sync (U5756A) and the Delayed Horizontal Clock (U4645A) are reset, and the equalizing pulses and vertical sync are no longer removed from the inputs by U5838B and U5838C. This lets the Phase Locked Loop see the entire input signal while it's trying to lock on the input.

DELAYED HORIZONTAL CLOCK. The Delayed Horizontal Clock is used to remove equalizing pulses from the horizontal sync. The horizontal clock (H) is clocked through U5645A by $\overline{\text{2XH}}$. This delays the horizontal clock by 1/4 of a horizontal clock cycle.

VERTICAL SYNC. The Vertical Sync circuitry outputs a pulse for both the Field 1 and the Field 2 vertical sync pulses. The VERTICAL SYNC signal is produced by clocking $\overline{\text{COMPOSITE SYNC}}$ into U5756A using the inverted two times horizontal clock ($\overline{\text{2XH}}$). During the period of vertical sync, $\overline{\text{COMPOSITE SYNC}}$ will be HI during the rising edge of $\overline{\text{2XH}}$. During the remainder of the field, $\overline{\text{COMPOSITE SYNC}}$ will be LO during the rising edge of $\overline{\text{2XH}}$.

FIELD SYNC GENERATOR. The Field Sync Generator generates FIELD (for interlaced scan signals it identifies the field, while for noninterlaced scan signals it identifies vertical sync only), using the Horizontal clock (H) and VERTICAL SYNC signals. Counters in the digital section use FIELD in selecting either the Field 1 or Field 2 line counter.

Both U5456B and U5756B generate FIELD ID at the same time. On interlaced scan signals, FIELD ID is produced by U5456B pin 12. It is HI during Field 1 and LO during Field 2. The FIELD ID signal generated by U5456B identifies fields of interlaced scan signals.

Both changing FIELD ID signals will be absent in noninterlaced scan systems. This absence, at U5756B, is detected by the interlaced scan detector (U5756B, U5728A, and Q5735). When the FIELD ID signal is static, the interlaced scan detector enables circuitry that generates FIELD at the vertical rate.

During interlaced scan signals, the changing FIELD ID signal from U5756B keeps U5728A and Q5735 on. The LO on the collector of U5728A allows U5456B to continue generating the normal FIELD signal. The HI on the emitter of Q5735 keeps U5456A set, preventing it from affecting the FIELD signal.

During a noninterlaced scan signal, the FIELD ID signals generated by U5756B and U5456B will be static. The dc level on U5756B is blocked by C5651, turning off U5728A and Q5735. The HI on the collector of U5728A resets U5456B, preventing it from affecting the FIELD signal. The LO on the collector of Q5735 allows VERTICAL SYNC to clock U5456A, producing FIELD. The FIELD signal generated by U5456A has no relation to Field 1 and Field 2.

The AND gate composed of CR5653, CR5655, and R5652 selects the signal produced by either U5456B or U5456A. The selected signal becomes FIELD.

Digital Circuitry

The TV Option Digital circuitry (see Diagram 25) provides an interface to the microprocessor and generates a trigger to the standard instrument's sweep generator.

MEMORY AND I/O DECODERS. This circuitry decodes the address bus, generating enabling signals and strobes that allow the microprocessor to control the various circuit functions and devices, as in the standard oscilloscope (see "Address Decode" description in the service manual of the standard oscilloscope). The TV Option memory map is shown in Table 3-1.

OPTION SELECT REGISTER. The Option Select register, U5880D, enables and disables access to TV option circuitry. Whenever there is a write to address 7FFF, data bus line BBD5 is latched into the register. If BBD5 is HI, TV option circuitry will be selected for memory and I/O accesses within the paged address space (4000-7FFF). If BBD5 is LO, the TV option is deselected. While the TV option is deselected, the Option Select register is the only TV circuitry that can be accessed by the microprocessor.

Table 3-1
TV Option Memory Map

Address	Description	Device No.
1000-1FFF	Buffer board ROM	U44260
4000-7FFF	Data Bus buffer	U5459
4000-5FFF	ROM	U5565
6000-7F7F	ROM image	U5565
7F80-7F87	Counter/Timer IC registers	U5575
7F88-7F8E	TV Control register images	U5764
7F8F	TV Control register, write only	U5764
7F90-7F97	Counter/Timer image	U5575
7F98-7F9E	Mode Select register images	U5880A,B,C
7F9F	Mode Select register, write only	U5880A,B,C
7FA0-7FA7	Counter/Timer image	U5575
7FA8-7FAF	TV Control register images	U5764
7FB0-7FB7	Counter/Timer image	U5575
7FB8-7FBF	Mode Select register images	U5880A,B,C
7FC0-7FFE	Option Select register images	U5880D
7FFF	Option Select register	U5880D

DATA BUS BUFFER. The data bus is buffered by bidirectional buffer U5459. It is enabled by BVMA, BA14, and the Option Select register through U5790A, U5390A, and U5390B. The direction of data is controlled by BR/$\overline{W}$.

EPROM. The EPROM U5565 is enabled by the Option Select register through U5770E. Data from the EPROM is sent over the data bus when one of its addresses is decoded by U5790C, U5380, U5390B, and U5390A.

TV CONTROL REGISTER. The TV Control register is written to by the microprocessor to:

1. Display the option's status $\overline{\text{LINES}}$, $\overline{\text{FLD1}}$, and $\overline{\text{FLD2}}$) on the TRIGGER COUPLING indicators.
2. Control the polarity (SLOPE) of the sync tips of the composite video used in the analog section of the circuitry.
3. Control the back-porch clamp circuitry (CH2 INVERT, CLAMP, and FAST/$\overline{\text{SLOW}}$).
4. Enable the TV Option's Auxiliary Trigger generator.

The microprocessor writes to the register whenever the option is selected and the register's address is decoded by U5680A, U5890A, U5680C, U5390C, U5580E, U5380, and U5390B.

COUNTER/TIMER. Counter/Timer U5575 contains three programmable counters used to determine the maximum number of lines in a given field and to produce a selected delay. The delay is varied to select any specific line in the selected field as the trigger point.

The Counter/Timer is enabled whenever its address is decoded by U5680C and BA3 is LO. Access to the internal registers is controlled by BA0, BA1, BA2, and BR/$\overline{\text{W}}$.

Counters 1 and 2 are used, in single-shot mode, to produce the proper delays for trigger points delayed from the Field 1 and Field 2 vertical sync pulses respectively. Counter 3 is used to count the number of lines in the selected field. Each counter counts $\overline{\text{HORIZ CLK}}$ (applied to the C inputs) during the respective counter's field. The FIELD pulse is applied to inputs G1 and G3; the pulse is inverted by U5770F and applied to input G2.

The outputs of Counters 1 and 2 provide a LO pulse out to U5775D and U5775A. The pulse out occurs when the sync pulse for the line prior to the one selected is reached. If the desired line is too near the start of its field, the counter for the other field is used, and the counter starts counting at the beginning of its field. Counting continues until the desired sync pulse for the line prior to the one selected is reached; this may mean counting past the start of the next field. Then, the counter generates the output pulse.

Starting the count at the beginning of the previous field is necessary for the first three lines of a field in systems where line 1 is coincident with the field pulse (nonsystem-M), and for the first six lines in systems where line 1 is three lines before the field pulse (system-M). Lines 1 through 3 of system-M signals cannot be delayed from their corresponding field sync pulse because they occur before the field pulse. The following three lines for system-M signals (where line 1 is three lines before the field sync) and the first three lines for nonsystem-M signals (where line 1 is coincident with the field pulse) must be delayed from the previous field because:

1. The horizontal clock coincident with the field pulse does not cause a count to occur; it only starts the counting process.
2. The counters must arm the trigger generator on the line preceding the selected line.
3. The counter will not generate a delay of zero (there must be at least a one count delay).
4. The counter's output goes LO one count (line) after the count reaches zero.

AUXILIARY TRIGGER GENERATOR. The Auxiliary Trigger generator produces the signal that triggers the sweep generator in the standard instrument when the appropriate horizontal line is reached.

Trigger generation in the option and in the standard instrument is similar. Neither is allowed to produce triggers during sweep retrace (holdoff). After holdoff, the trigger circuitry is made ready to produce a trigger (armed). In the standard instrument and for LINES TV TRIGGER COUPLING in the option, the triggers are armed at the end of holdoff. For FLD1, FLD2, and ALT TV TRIGGER COUPLING in the option, the Auxiliary Trigger generator is not armed until the sync pulse for the line prior to the one selected is reached. When the next horizontal sync pulse (the line selected for triggering) is reached, the trigger circuitry produces the trigger.

Trigger holdoff information is provided by AHO through U5580F to U5590A pin 1. When AHO is HI, both U5590A and U5590B are reset, holding off the generation of triggers. After holdoff time has ended (AHO LO), the Mode Selection logic will set U5590A, arming the trigger generator. The next time HORIZ CLK goes HI at U5590B pin 11, U5590B will set, generating a trigger.

MODE SELECT LOGIC. The Mode Select Logic selects the signal used to arm the Auxiliary Trigger generator. The three arming signals used are: the output of Counter 1 at U5575 pin 27 (Field 1 line counter), the output of Counter 2 at U5575 pin 3 (Field 2 line counter), and the A Holdoff at U5580F pin 13 (AHO) going LO.

The arming signal selected is controlled by the Mode Select register (U5880A, U5880B, and U5880C). The register receives the present TV Trigger mode information from the microprocessor. The three select lines are: Alt (U5880A pin 5), DSMODE (U5880B pin 6), and LINES (U5880C pin 15). If LINES TV TRIGGER COUPLING is selected, LINES will be HI. If ALT FLD TV TRIGGER COUPLING is selected, ALT will be HI. In Alternate mode, DSMODE selects Field 1 or Field 2.

A trigger can not occur until after holdoff ends (holdoff ends when AHO goes LO) and the Auxiliary Trigger generator is armed. In the following discussion, it is assumed that holdoff has just ended. This means AHO U5580F pin 13 just went LO and no longer holds the arming flip-flop, U5590A, reset.

In Lines mode, U5880C pin 15 is HI, enabling U5790B. Whenever holdoff ends, AHO goes LO, U5580F pin 12 and U5790B pin 4 go HI, and U5790B pin 6 and U5590A pin 4 go LO, setting arming flip-flop U5590A. With the arming flip-flop set, trigger generator U5590B is no longer held reset. The next HORIZ CLK to U5590B pin 11 sets the flip-flop, generating a trigger.

In Lines mode: a trigger is generated, the sweep runs, holdoff occurs, the trigger generator is armed as soon as holdoff goes LO, and the next trigger occurs when the next horizontal sync pulse arrives. This gives a trace which is stable with respect to horizontal sync pulses (lines), but is not stable with respect to vertical sync pulses (fields) or the video information on any given line.

If Field 1 or Field 2 TV Trigger modes are selected, the ALT, DSMODE, and LINES signals are all LO. With ALT LO, U5775B pin 4 and U5775C pin 10 are both LO. This makes U5775B pin 6, U5775A pin 2, U5775C pin 8, and U5775D pin 12 all HI, enabling U5775A and U5775D. With both gates enabled, either the Field 1 counter or the Field 2 counter can arm the trigger generator.

The counter used is determined by the microprocessor's setup of the Counter/Timer. The output of the unused counter is LO. Depending on which counter is selected, when the trigger count is reached, the output of either U5775A or U5775D will go HI. This will make both inputs of U5790D HI, and its output LO. The LO is inverted to a HI by U5580D, setting arming flip-flop U5590A.

In the field modes: a trigger is generated; the sweep runs; holdoff occurs; holdoff ends; the sync pulse for the line prior to the selected horizontal line occurs, arming the Auxiliary Trigger generator; and the next horizontal sync pulse arrives, generating the next trigger. This gives a trace which is stable with respect to horizontal sync pulses (lines), vertical sync pulses (fields), and the video information on the selected lines.

Alternate TV Trigger mode may be used with Alternate Vertical mode. In Alternate TV Trigger mode, the selected horizontal line of Field 1 triggers the sweep for the first active vertical channel, and the selected horizontal line of Field 2 triggers the sweep for the next active vertical channel.

If Alternate TV Trigger mode is selected, the ALT signal is HI, and the DSMODE signal controls whether or not the $\overline{DS}$ signal is inverted. With ALT HI, both U5775B and U5775C are enabled. With DSMODE LO, the output of U5890B will be the input $\overline{DS}$. $\overline{DS}$ will be HI during the sweep for the first active vertical channel, and LO during the sweep of the next active vertical channel. The $\overline{DS}$ signal through U5775B and U5775C allows only one counter's output at a time to get through to arm the Auxiliary Trigger generator. The state of $\overline{DS}$ changes with each sweep, allowing the opposite counter (field) to arm the trigger generator.

When the DSMODE signal is HI, U5890B inverts $\overline{DS}$. Operation of the circuitry is now the same as stated for Alternate TV Trigger mode except: Counter 2 arms the trigger generator for the first active channel's sweep, and Counter 1 arms the trigger generator for the next active channel's sweep. This reversal of roles is required whenever the line selected for triggering is near the start of the field.

PERFORMANCE CHECK AND ADJUSTMENT PROCEDURES

INTRODUCTION

This section contains the Option 05 (TV) portion of the instrument's performance check and adjustment procedures. The "Performance Check Procedure" is used to verify that the instrument's performance meets the requirements listed in the "Specification" (Section 1). The "Adjustment Procedure" is used to restore optimum performance or return the option to conformance with its "Performance Requirements" as listed in the "Specification".

Instrument performance should be checked after every 2000 hours of operation or once each year if used infrequently. A more frequent interval may be necessary if your instrument is subjected to harsh environments or severe usage. The results of these periodic checks will determine the need for recalibration.

Before performing either procedure, ensure that the LINE VOLTAGE SELECTOR switch is set for the ac power source being used (see "Preparation for Use" in Section 2 of the standard instrument service manual). Connect the instrument to be checked and the test equipment to an appropriate power source.

Turn the instrument on and ensure that no error message is displayed on the crt. If the instrument displays "DIAGNSTIC. PUSH A/B TRIG TO EXIT" at power on, one of the power-up tests has failed. If the error message on the bottom line of the crt is "TEST 04 FAIL XX" where XX is X1, 1X, or 11, the stored calibration data is in error and the instrument should be recalibrated by a qualified service technician before performing the "Performance Check Procedure". If any other error messages occur, the failure is probably not related to calibration and the instrument should be repaired by a qualified service technician before performing either procedure.

TEST EQUIPMENT

The test equipment listed in Table 4-1 is a complete list of the equipment required to accomplish both the "Performance Check Procedure" and the "Adjustment Procedure". To assure accurate measurements, it is important that test equipment used for making these checks meet or exceed the specifications described in Table 4-1. When considering use of equipment other than that recommended, utilize the "Minimum Specification" column to determine whether available test equipment will suffice.

The procedures in this section are written using the equipment listed in Table 4-1. When substitute equipment is used, control settings stated in the test setup and in the procedures may need to be altered.

Detailed operating instructions for test equipment are not given in this procedure. If more operating information is required, refer to the appropriate test-equipment instruction manual.

LIMITS AND TOLERANCES

The tolerances given in these procedures are valid for an instrument that has been previously calibrated in an ambient temperature between +20°C and +30°C. The instrument must also have had at least a 20-minute warm-up period. To assure instrument performance, perform all steps in the following procedures at the same ambient temperature. When performing these checks, it is assumed that the standard instrument meets all of its "Performance Requirements" as stated in the "Specification" (Section 1) of the standard instrument service manual.

Table 4-1
Test Equipment Required

Item No. and Description	Minimum Specification	Examples of Suitable Test Equipment
1. TV Mainframe	Conforms to TV system requirements.	TEKTRONIX 1410 (NTSC Systems). TEKTRONIX 1411 (PAL Systems). TEKTRONIX 1412 (PAL-M Systems).
2. Sync Generator	Conforms to TV system requirements. Variable amplitude sync.	TEKTRONIX SPG2 (NTSC Systems).[a] TEKTRONIX SPG12 (PAL Systems).[a] TEKTRONIX SPG22 (PAL-M Systems).[a]
3. Linearity Generator	Conforms to TV system requirements.	TEKTRONIX TSG3 (NTSC Systems). TEKTRONIX TSG13 (PAL Systems). TEKTRONIX TSG23 (PAL-M Systems).
4. Sinewave Oscillator	Frequency: Adjustable to 60 Hz. Amplitude: Adjustable to 3 V p-p into 75 Ω.	TEKTRONIX SG 502 RC Oscillator.[b]
5. Leveled Sinewave Generator	Frequency: 250 kHz to 30 MHz. Output amplitude: variable to 5 V p-p. Output impedance: 50 Ω. Reference frequency: 50 kHz. Amplitude accuracy: constant within 3% of a reference frequency as output frequency changes.	TEKTRONIX SG 503 Leveled Sinewave Generator.[b]
6. Pulse Generator	Period: variable to 15 μs. Pulse width: 2 μs.	TEKTRONIX PG 502 Pulse Generator.[b]
7. Calibration Generator	Fast-rise signal level: 1 V. Repetition rate: variable to 100 kHz. Rise time: 1 ns or less. Flatness: ±0.5%. Leading edge aberrations: within 2%.	TEKTRONIX PG 506 Calibration Generator.[b]
8. Precision Cable	Impedance: 50 Ω.	Tektronix Part No. 012-0482-00.
9. Cable	Impedance: 50 Ω.	Tektronix Part No. 012-0057-01.
10. Cable (2 required)	Impedance: 75 Ω.	Tektronix Part No. 012-0074-00.
11. Termination	Impedance: 50 Ω.	Tektronix Part No. 011-0049-01.
12. Termination	Impedance: 75 Ω.	Tektronix Part No. 011-0055-00.
13. 10X Attenuator (2 required)	Ratio: 10X. Impedance: 50 Ω.	Tektronix Part No. 011-0059-02.
14. 10X Attenuator	Ratio: 10X. Impedance: 75 Ω.	Tektronix Part No. 011-0061-00.

[a]With Option AA.

[b]Requires a TM 5000-Series power-module mainframe.

PERFORMANCE CHECK PROCEDURE

This procedure is used to verify proper operation of the option and may be used to determine the need for readjustment. This check may also be used as an acceptance test and as a preliminary troubleshooting aid. Perform all steps, both in the sequence presented and in their entirety, to ensure that control settings are correct for the following step.

PREPARATION

Removing the wrap-around cover is not necessary to perform this procedure. All checks are made using operator accessible controls and connectors.

All the test equipment items listed in Table 4-1 are required to perform this procedure. Since detailed operating instructions for the test equipment are not provided in this procedure, refer to the appropriate test-equipment instruction manual if additional information is required.

TV OPTION CHECKS

1. Instrument Setup

a. Hold in both the ΔV and Δt buttons and push in the TRIGGER SLOPE button to enter the Diagnostic Monitor.

b. Repeatedly push up and release the TRIGGER MODE switch until the message "TV EXER 61" appears at the bottom-left corner of the crt display.

c. If using an NTSC system, push up and release the TRIGGER COUPLING switch until the message "LINE 1 OCCURS PRIOR TO FLD SYNC" appears at the top of the crt display. For PAL or SECAM systems, push up and release the TRIGGER COUPLING switch until the message "LINE 1 COINCIDENT WITH FLD SYNC" appears at the top of the crt display. For other systems, make the appropriate selection.Then push down on the TRIGGER COUPLING switch.

d. Push up and release the TRIGGER MODE switch. The message "TV EXER 62" will be displayed at the bottom-left corner of the crt display.

e. If using an NTSC system, push up and release the TRIGGER COUPLING switch until the message "LINE NO RESETS ON EACH FIELD" appears at the top of the crt display. For PAL or SECAM systems, push up and release the TRIGGER COUPLING switch until the message "LINE NO RESETS ON FLD 1 ONLY" appears at the top of the crt display. For other systems, make the appropriate selection. Then push down on the TRIGGER COUPLING switch.

f. Push the A/B TRIG button to exit the Diagnostic Monitor.

g. Set the instrument controls as follows:

Vertical

POSITION Controls	Midrange
MODE	
CH 1	On (button in)
CH 2, CH 3, and CH 4	Off (buttons out)
ADD and INVERT	Off (buttons out)
ALT/CHOP	ALT (button out)
20 MHz BW LIMIT	On (button in)
VOLTS/DIV	
CH 1	0.2 V
CH 2	50 mV
CH 3 and CH 4	0.1 V (buttons out)
CH 1 and CH 2 VAR	In detent
Input Coupling	
CH 1 and CH 2	1 MΩ DC

Horizontal

POSITION	Midrange
X10 MAG	Off (button out)
A SEC/DIV	2 ms (knobs locked)
SEC/DIV VAR	In detent
Sweep	A

Delta Function Controls

ΔV and Δt	Off (press and release until associated readout is off)
TRACKING	Off (button out)

Trigger

HOLDOFF	MIN (Fully CCW)
LEVEL	Midrange
A/B TRIG	A
SLOPE	+
MODE	AUTO LVL
SOURCE	VERT
COUPLING	DC

2. Check Square-Wave Flatness

a. Connect a fast-rise, positive-going square-wave output via a 50-Ω cable and a 50-Ω termination to the CH 1 input connector. Use Tek PG 502

b. Set the generator to produce a 60-Hz, 5-division display.

c. Set the CH 1 VOLTS/DIV switch to 50 mV. Use the CH 1 POSITION control to bring the top of the waveform on screen.

NOTE

As a convenient way to exclude the first 50 ns of the trace in the following parts, reduce the trace intensity until the leading edge of the signal is not visible.

d. CHECK—Display aberrations are within 1% (0.2 division or less). Exclude the first 50 ns following the step transition from the measurement.

e. Set:

CH 1 VERTICAL MODE	Off (button out)
CH 2 VERTICAL MODE	On (button in)

f. Move the cable from the CH 1 input connector to the CH 2 input connector. Use the CH 2 POSITION control to bring the top of the waveform on screen.

g. CHECK—Display aberrations are within 1% (0.2 division or less). Exclude the first 50 ns following the step transition from the measurement.

h. Set the CH 2 VOLTS/DIV switch to 20 mV.

i. Set the generator to produce a 5-division display.

j. CHECK—Display aberrations are within 1% (0.05 division or less). Exclude the first 50 ns following the step transition from the measurement.

k. Set:

CH 1 VERTICAL MODE	On (button in)
CH 2 VERTICAL MODE	Off (button out)
CH 1 VOLTS/DIV	20 mV

l. Move the cable from the CH 2 input connector to the CH 1 input connector.

m. CHECK—Display aberrations are within 1% (0.05 division or less). Exclude the first 50 ns following the step transition from the measurement.

n. Set:

CH 1 VOLTS/DIV	0.2 V
CH 2 VOLTS/DIV	50 mV
A SEC/DIV	10 μs

o. Set the generator to produce a 15-kHz, 5-division display.

p. Repeat parts c through m.

q. Disconnect the test equipment from the instrument.

3. Check Frequency Bandwidth Limit

a. Set:

CH 1 and CH 2 VOLTS/DIV	10 mV
A SEC/DIV	0.1 ms
A TRIGGER	AUTO

b. Connect the leveled sine-wave generator output via a precision 50-Ω cable, two 50-Ω 10X attenuators, and a 50-Ω termination to the CH 1 input connector.

c. Set the generator to produce a 50-kHz, 5-division display.

d. Increase the generator output frequency to 5 MHz.

e. CHECK—Display amplitude is between 4.80 and 5.05 divisions in amplitude.

f. Set the 20 MHz BW LIMIT switch to Off (button out).

g. Repeat parts c and d.

h. CHECK—Display amplitude is between 4.95 and 5.05 divisions in amplitude.

i. Increase the generator output frequency to 10 MHz.

j. CHECK—Display amplitude is between 4.90 and 5.05 divisions in amplitude.

k. Increase the generator output frequency to 30 MHz.

l. CHECK—Display amplitude is between 4.85 and 5.10 divisions in amplitude.

m. Set:

CH 1 VOLTS/DIV	50 mV
20 MHz BW LIMIT	On (button in)

n. Remove one of the 10X attenuators from the input signal path.

o. Repeat parts c through l.

p. Set:

CH 1 VOLTS/DIV	0.2 V
20 MHz BW LIMIT	On (button in)

q. Remove the last 10X attenuator from the input signal path.

r. Repeat parts c through l.

s. Move the cable from the CH 1 input connector to the CH 2 input connector and add the two 10X attenuators back into the input signal path.

t. Set:

CH 1 VERTICAL MODE	Off (button out)
CH 2 VERTICAL MODE	On (button in)
20 MHz BW LIMIT	On (button in)

u. Repeat parts c through r using the Channel 2 controls.

v. Disconnect the test equipment from the instrument.

4. Check TV (Back-Porch) Clamp (CH 2 only)

a. Set:

CH 1 VOLTS/DIV	0.5 V
CH 2 VOLTS/DIV	50 mV
20 MHz BW LIMIT	On (button in)
A SEC/DIV	5 ms
SLOPE	—
TRIGGER MODE	AUTO LVL
TRIGGER SOURCE	LINE

b. Connect the sine-wave oscillator output via a 75-Ω cable to the CH 2 input connector.

c. Connect the composite sync output via a 75-Ω cable and a 75-Ω termination to the CH 1 input connector.

d. Set the oscillator to produce a 60-Hz, 6-division display. Adjust the oscillator frequency control to produce as stable a display as possible.

e. Set:

CH 2 Input Coupling	TV CLAMP
A SEC/DIV	0.1 ms
TRIGGER SOURCE	CH 1
TRIGGER COUPLING	LINES

f. CHECK—Display amplitude is 1 division or less.

g. Set:

CH 2 VOLTS/DIV	0.1 V
CH 2 Input Coupling	1 MΩ DC

h. Set the oscillator to produce a 6-division display.

i. Set the CH 2 Input Coupling to TV CLAMP.

j. CHECK—Display amplitude is 1 division or less.

k. Set:

CH 2 VOLTS/DIV	0.2 V
CH 2 Input Coupling	1 MΩ DC

l. Repeat parts h through j.

m. Disconnect the test equipment from the instrument.

5. Check Back-Porch Reference

a. Set:

CH 2 Input Coupling	GND
A SEC/DIV	1 μs
TRIGGER SOURCE	VERT

b. Set the trace to the center horizontal graticule line using the Channel 2 POSITION control.

c. Connect a 100%-modulated composite video signal via a 75-Ω cable and a 75-Ω termination to the CH 2 input connector.

d. Set the CH 2 Input Coupling to TV CLAMP.

e. CHECK—That the back-porch level is within 1 division of the center horizontal graticule line.

f. Disconnect the test equipment from the instrument.

6. Check Triggering

a. Set:

CH 2 VOLTS/DIV	20 mV
CH 2 Input Coupling	1 MΩ DC
A SEC/DIV	2 μs
TRIGGER COUPLING	DC
TRIGGER MODE	AUTO LVL
Δt	On (enter the 1/Δt mode)
TRACKING	On (button in)

b. Use the Δ REF OR DLY POS control to align its cursor with the second vertical graticule line.

c. Use the Δ control to produce a Δt reading of 2 μs.

d. Connect the pulse generator output via a 50-Ω cable, a 50-Ω 10X attenuator, and a 50-Ω termination to the CH 2 input connector.

e. Use the Δ control to produce a Δt reading of 15 μs. Set the generator to produce a signal that has a negative pulse 3 divisions in amplitude, 2 μs wide, and a period of approximately 15 μs.

f. Set TRIGGER COUPLING to LINES.

g. Use the Horizontal POSITION control to align the positive edge of the first pulse with the Δ REF OR DLY POS cursor.

h. Set the CH 2 VOLTS/DIV switch to 0.2 V. Use the Δ control to produce a Δt reading of 13 μs.

i. Reduce the generator period to the point where the display is stably triggered, but any further reduction would result in an unstable display.

j. CHECK—That the positive edge of the second pulse is located in the area between the two cursors.

k. Set:

CH 2 INVERT	On (button in)
TRIGGER SLOPE	+

l. Adjust the pulse width so that the negative edge of the second pulse is aligned with the second cursor.

m. Reduce the generator period to the point where the display is stably triggered, but any further reduction would result in an unstable display.

n. CHECK—That the negative edge of the second pulse is located in the area between the two cursors.

o. Disconnect the test equipment from the instrument.

7. Check Trigger Modes

a. Set:

CH 2 INVERT	Off (button out)
CH 2 VOLTS/DIV	0.5 V
ΔV and Δt	Off
A SEC/DIV	0.1 ms
TRIGGER SLOPE	–
TRIGGER COUPLING	FLD 1

b. Connect the composite sync output via a 75-Ω cable and a 75-Ω termination to the CH 2 input connector.

c. Rotate the Δ control until the readout indicates that the first line of the video signal is displayed ("F1:1").

d. CHECK—That the oscilloscope is triggered on the first line of field 1.

e. CHECK—That rotating the Δ control a small amount counterclockwise changes the readout to indicate the highest line number in the previous field for a multifield input signal. For example, using an NTSC signal, the readout would be "F2:262".

f. CHECK—That the oscilloscope is triggered on the last line of field 2.

g. CHECK—That rotating the Δ control counterclockwise backwards through the second field of the signal eventually changes the readout to indicate the highest line number in the previous field for a multifield input signal. For example, using an NTSC signal, the readout would change to "F1:263".

h. CHECK—That the oscilloscope is triggered on the last line of field 1.

i. Set TRIGGER COUPLING to ALT.

j. Rotate the Δ control until the readout indicates that the first lines of the two frames are displayed ("ALT:1").

k. CHECK—That the oscilloscope is triggered on the correct lines of the two fields.

l. CHECK—That rotating the Δ control a small amount counterclockwise changes the readout to indicate the highest line number common to both fields for a multifield input signal. For example, using an NTSC signal, the readout would be "ALT:262".

m. CHECK—That the oscilloscope is triggered on the correct lines of the two fields.

n. Disconnect the test equipment from the instrument.

8. Check Input Signal Amplitude

a. Set:

CH 1 VOLTS/DIV	1 V
CH 2 VOLTS/DIV	0.1 V
A SEC/DIV	0.2 ms
TRIGGER COUPLING	FLD 1

b. Connect the linearity generator output via a 75-Ω cable and a 75-Ω termination to the CH 2 input connector.

c. Set the generator to produce an output of full field and an IRE level of 0. Set all other generator buttons out. Then remove the color-burst signal by setting the sync generator GEN LOCK button out.

d. Rotate the Δ control until the readout indicates that the first line of the video signal is displayed ("F1:1").

e. Set the CH 2 VOLTS/DIV switch to 1 V.

f. CHECK—That the display is triggered and stable.

g. Set:

CH 2 INVERT	On (button in)
TRIGGER SLOPE	+

h. CHECK—That the display is triggered and stable.

i. Move the cable from the CH 2 input connector to the CH 1 input connector.

j. Set:

CH 1 VERTICAL MODE	On (button in)
CH 2 VERTICAL MODE	Off (button out)
TRIGGER SLOPE	–

k. CHECK—That the display is triggered and stable.

l. Change the generator output to produce a 100 IRE level signal.

m. CHECK—That the display is triggered and stable.

n. Set:

CH 1 VERTICAL MODE	Off (button out)
CH 2 VERTICAL MODE	On (button in)
CH 2 Input Coupling	TV CLAMP
TRIGGER SLOPE	+

o. Move the cable from the CH 1 input connector to the CH 2 input connector.

p. CHECK—That the display is triggered and stable.

q. Set:

CH 2 INVERT	Off (button out)
TRIGGER SLOPE	—

r. CHECK—That the display is triggered and stable.

s. Disconnect the signal from the CH 2 input connector. Connect the output of the composite sync generator to the CH 3 input connector via a 75-Ω cable, a 75-Ω 10X attenuator, and a 75-Ω termination.

t. Set:

CH 2 VERTICAL MODE	Off (button out)
CH 3 VERTICAL MODE	On (button in)

u. Adjust the generator output to produce a 1.25-division display.

v. Set the CH 3 VOLTS/DIV to 0.5 V (button in).

w. CHECK—That the display is triggered and stable.

x. Set:

CH 3 VERTICAL MODE	Off (button out)
CH 4 VERTICAL MODE	On (button in)

y. Move the signal input from the CH 3 input connector to the CH 4 input connector.

z. Repeat parts u through w using the Channel 4 controls.

aa. Disconnect the cable from the composite sync output and connect it to the linearity generator output.

ab. Set CH 3 and CH 4 VOLTS/DIV to 0.1 V.

ac. Adjust the generator output to produce a 0.5-division display by varying the signal IRE level.

ad. CHECK—That the display is triggered and stable.

ae. Move the signal input from the CH 4 input connector to the CH 3 input connector.

af. Set:

CH 3 VERTICAL MODE	On (button in)
CH 4 VERTICAL MODE	Off (button out)

ag. Repeat parts ac and ad.

ah. Disconnect the test equipment from the instrument.

ADJUSTMENT PROCEDURE

The "Adjustment Procedure" is used to restore optimum performance or return the option to conformance with its "Performance Requirements" as listed in the "Specification" (Section 1). The TV Option should only be adjusted when the standard instrument is known to meet its "Performance Requirements" as stated in the "Specification" section of its manual.

Adjustment of the instrument must be done at an ambient temperature between +20°C and +30°C, and the instrument must have had a warm-up period of at least 20 minutes. Performing this procedure while the temperature is drifting or before the standard instrument is calibrated may cause erroneous calibration settings.

To perform this procedure, it is necessary to remove the wrap-around cabinet from the instrument. See the standard instrument "Maintenance" section for instructions on removing the cabinet.

Equipment Required (see Table 4-1):

Leveled Sinewave Generator (Item 5)
Calibration Generator (Item 7)
Precision 50-Ω Cable (Item 8)
50-Ω Termination (Item 11)
Two 50-Ω 10X Attenuators (Item 13)

INITIAL CONTROLS SETTINGS

Vertical

CH 1 POSITION	Midrange
MODE	
CH 1	On (button in)
CH 2, CH 3, and CH 4	Off (buttons out)
20 MHz BW LIMIT	On (button in)
VOLTS/DIV	
CH 1	10 mV
CH 1 VAR	In detent
Input Coupling	
CH 1	1 MΩ DC

Horizontal

POSITION	Midrange
X10 MAG	Off (button out)
A SEC/DIV	1 μs
SEC/DIV VAR	In detent
Sweep	A

Trigger

HOLDOFF	MIN (Fully CCW)
LEVEL	Midrange
A/B TRIG	A
SLOPE	+
MODE	AUTO LVL
SOURCE	VERT
COUPLING	DC

ADJUST FLATNESS

a. Connect a fast-rise, positive-going square-wave output via a precision 50-Ω cable, a 50-Ω 10X attenuator, and a 50-Ω termination to the CH 1 input connector.

b. Set the generator to produce a 100-kHz, 5-division display.

NOTE

Adjust the coils in the following part so that their slugs are out approximately the same amount.

c. ADJUST—Coils L619 and L644 for as flat a response as possible. These coils are located on the Main circuit board, which is part of the standard instrument. See the standard instrument service manual for coil locations.

d. Disconnect the test equipment from the instrument.

e. Set the A SEC/DIV control to 0.1 ms

f. Connect the leveled sine-wave generator output via a precision 50-Ω cable, two 50-Ω 10X attenuators, and a 50-Ω termination to the CH 1 input connector.

g. Set the generator to produce a 50-kHz, 5-division display.

h. Increase the generator output frequency to 5 MHz.

i. CHECK—Display amplitude is between 4.80 and 5.05 divisions in amplitude.

j. Set the A SEC/DIV control to 1 μs and disconnect the test equipment from the instrument.

k. Repeat parts a through j until no further improvement is noted.

MAINTENANCE

This section contains information for troubleshooting the 2445 and 2465 Option 05, TV Option. Maintenance information contained in the standard instrument Service Manual also applies to maintenance of this option. To function properly, the option requires a working standard oscilloscope and Buffer board.

TROUBLESHOOTING

Preventive maintenance performed on a regular basis should reveal most potential problems before an instrument malfunctions. However, should troubleshooting be required, the following information is provided to facilitate location of a fault. In addition, the material presented in the "Theory of Operation" and "Diagrams" sections of this manual and the "Troubleshooting" section of the standard instrument's service manual may be helpful while troubleshooting.

GENERAL TROUBLESHOOTING PROCEDURE

The information presented here is intended to complement the information contained in the "Troubleshooting Procedures" part of the "Diagrams" section of the manual. Become familiar with the rest of the information in this section before proceeding with instrument troubleshooting. If the instrument will run the diagnostic routines as described in the "Diagnostic Routines" part of this section, perform the routines to help localize the instrument problems.

First make sure that the standard instrument functions properly. The option assembly will have to be removed to verify this. Then make sure that the Buffer board functions properly. To do this, the board will have to be connected to the standard instrument using the extender cables and all the option boards will have to be removed. Then verify that each option works properly by checking the operation of each option one at a time. Consult each option's service manual for operating and troubleshooting information and extender cable use. After all the options are working correctly, reassemble the instrument.

DIAGNOSTIC ROUTINES

Control of Diagnostic routines and their display format is the same as for the standard instrument.

Kernel Tests

The standard instrument's Kernel tests include checks to determine if the Buffer board and any options are present. A ROM checksum test is performed on the Buffer board ROM and each option ROM contained in the instrument.

A failure of a Kernel test is considered "fatal" to the operation of the microprocessor system. Kernel test failures will result in an attempt to flash the front-panel A SWP TRIG'D indicator and illuminate certain other front-panel indicators with an error code. The code points to the failure area as indicated in Table 5-1. Tables 5-2 and 5-3 are used to determine the option and device numbers used in Table 5-1. Only the TV Option, GPIB Option, Buffer board, and standard instrument codes are given in Table 5-1.

Table 5-1
Kernel Test Failure Codes

Failure Codes		Failing Device
Option	Device	
0	0	Control Board RAM (U2496)
0	1	ROM at E000 (hex) (U2178)
0	2	ROM at C000 (hex) (U2378)
0	3	ROM at A000 (hex) (U2362)
0	4	ROM at 8000 (hex) (U2162)
1	1	GPIB Board ROM U4715
1	2	GPIB Board ROM U4710
1	4	GPIB Board RAM U4811
6	1	TV Board ROM U5565
F	1	Buffer Board ROM U4260

Table 5-2
Front-Panel LED Option Codes

Option Code				Option Number (in hex)	Option Name
CH 1 LED (bit 3)	CH 2 LED (bit 2)	CH 3 LED (bit 1)	CH 4 LED (bit 0)		
OFF	OFF	OFF	OFF	0	Standard Instrument
OFF	OFF	OFF	ON	1	Option 10 (GPIB)
OFF	ON	ON	OFF	6	Option 05 (TV)
OFF	ON	ON	ON	7	Option 01 (DMM)
ON	OFF	OFF	OFF	8	Option 06 (C/T/T)
ON	OFF	OFF	OFF	8	Option 09 (WR)
ON	ON	ON	ON	F	Buffer Board

Table 5-3
Front-Panel LED Device Codes

Device Codes			Device Number
Ready LED (bit 2)	+ LED (bit 1)	− LED (bit 0)	
OFF	OFF	OFF	0
OFF	OFF	ON	1
OFF	ON	OFF	2
OFF	ON	ON	3
ON	OFF	OFF	4
ON	OFF	ON	5
ON	ON	OFF	6
ON	ON	ON	7

Even if a failure is reported, the A/B TRIG (sometimes labeled A/B/MENU, dependent upon which option is installed) switch may be pushed (or the GPIB command NORM may be used) to try to resume normal instrument operation. However, because of the failure, operation of specific instrument functions is unpredictable.

Confidence Tests

Option 05 related Confidence tests, Exerciser routines, and their associated error codes are listed in Table 5-4. Instrument Confidence tests are performed automatically at power-up if the Kernel tests are completed successfully. These routines may be initiated by the operator from the Diagnostic Monitor by:

1. Pushing the TRIGGER SLOPE switch while holding in both the ΔV and Δt switches to access the Diagnostic Menu.

2. Select the desired test number by repeatedly pushing the TRIGGER MODE switch up, until the test number appears in the Diagnostic Menu of the crt readout.

3. Start the test procedure by pushing up on the TRIGGER COUPLING switch.

4. If a failure is reported in the Diagnostic Menu, refer the instrument to a qualified service technician.

5. When the procedure ends, exit the Diagnostic Menu by pushing the A/B TRIG switch.

EAROM TEST (BU TEST F1). Checks EAROM to verify its contents and the interface circuitry.

Read/Write Test—The contents of one location are read, modified, and then reread to verify operation of the device interface.

Test checks: EAROM input and output lines, EAROM mode control, EAROM reading and writing, and EAROM clock.

Checksum Test—The contents of locations containing calibration constants and power-down settings are checksummed using a spiral-add technique. The result is compared to the contents of location 0.

Test checks: EAROM addressing and EAROM contents.

Table 5-4
Diagnostic and Exerciser Routines

Routine Type	Test Number	Routine Name	Error Code	Error Code Meaning
Buffer Board Test	F1	EAROM Test	X8 1X	Bad read after write. Bad checksum.
Buffer Board Exerciser	F1	Option Identification	None	
Buffer Board Exerciser	F2	Page Selection	None	
Exerciser	02	EAROM Examine	None	
TV Exerciser	61	Line 1 Format Selection	None	
TV Exerciser	62	TV Protocol Selection	None	

Exerciser Routines

Operation of Exerciser routines is the same as for the standard instrument. The Exerciser routines allow the operator to set and examine various bytes of control data used in determining option function.

OPTION IDENTIFICATION (BU EXER F1). This routine displays the option designator for all installed options across the top line of the crt readout. Option designators are listed in Table 5-5.

Table 5-5
Option Designators

Option	Option Designator
Buffer Board	BU
GPIB	GP
TV	TV
DMM	DM
Counter/Timer/Trigger	CT
Word Recognizer	CT

PAGE SELECTION (BU EXER F2). This routine continuously selects and deselects each of the option page registers.

EAROM EXAMINE (EXER 02). This is the standard instrument EAROM Examine routine. Locations 64 (hex) to C7 (hex) access the Buffer Board EAROM.

TV PROTOCOL SELECTION (TV EXER 61). This routine allows the starting position of Line 1 to be selected. The starting position may be either three lines prior to the field sync pulse (system-M) or coincident with the field sync pulse (nonsystem-M). Selecting the incorrect system for a given TV protocol will not affect the ability to trigger on a given TV waveform, but it will cause the line number displayed to be inaccurate. Use of this routine is described in Section 2 of this manual.

TV LINE 1 FORMAT SELECTION (TV EXER 62). This routine allows the selection of the TV line numbering format. Line numbering can be selected to reset on each field or on field 1 only. Use of this routine is described in Section 2 of this manual.

EXTENDER CABLE USE

An extender cable kit, which can be ordered from Tektronix, Inc., is needed when troubleshooting an instrument containing options. The kit is used when troubleshooting the standard instrument by itself or when connecting a removed option assembly to the standard instrument for troubleshooting purposes.

Table 5-6 lists all cables contained in the kit (Tektronix Part Number 020-1075-00). In addition to the cables, the kit contains 12 zero-ohm jumpers (Tektronix Part Number 131-0993-00). The procedures that follow reference the cables by numbers as shown in column one. See Figure 5-1 for a pictorial representation of each cable to aid in cable identification.

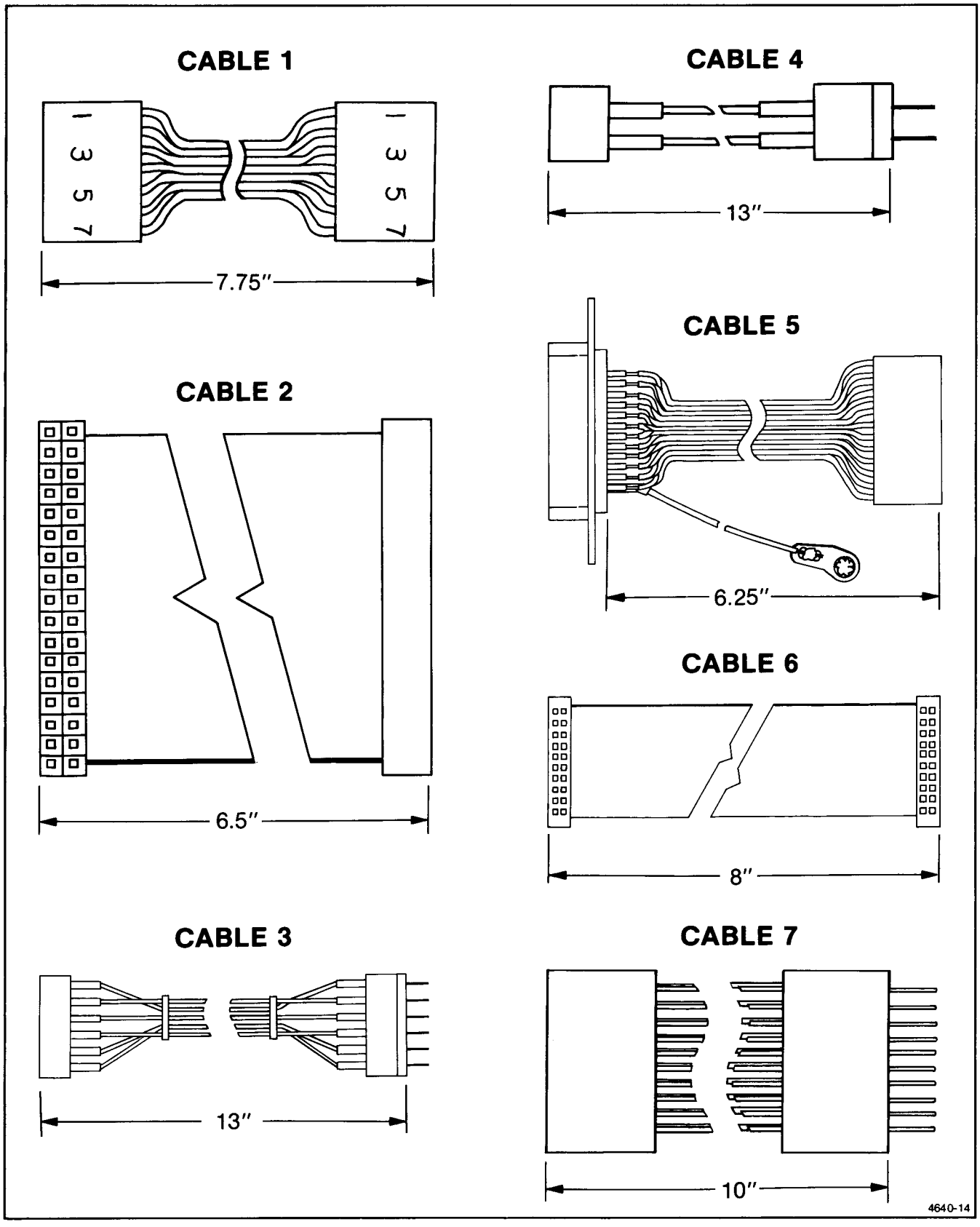


Figure 5-1. Option extender cables.

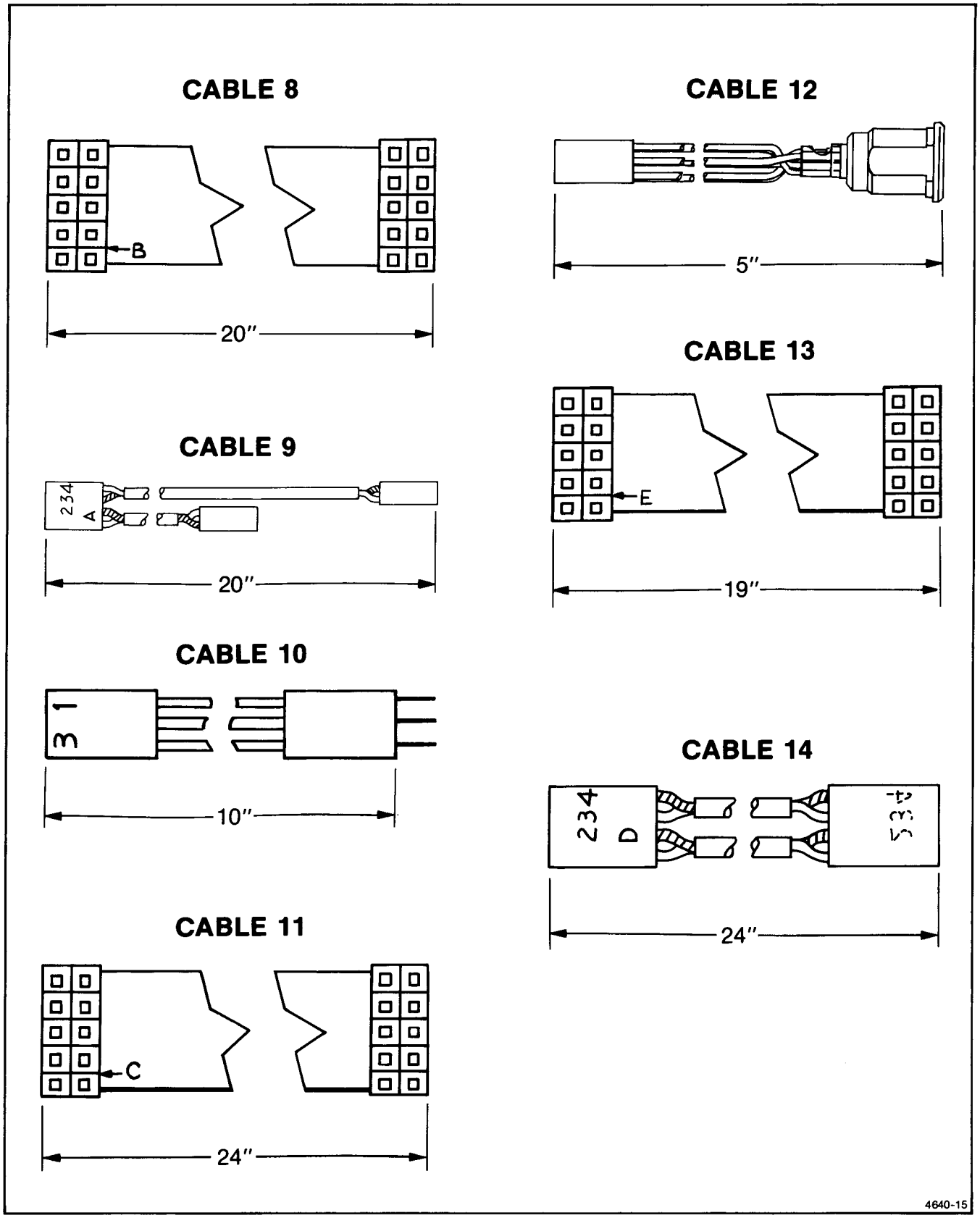


Figure 5-1 (cont). Option extender cables.

Table 5-6
Extender Cables

Cable Number	Tektronix Part No.	Option Usage
1	175-7183-00	All
2	175-7184-00	All
3	175-9178-00	All
4	175-9181-00	All
5	175-7215-00	GPIB
6	175-9179-00	GPIB
7	175-9182-00	GPIB
8	175-9175-00	TV
9	175-9180-00	TV
10	175-9183-00	TV
11	175-9174-00	TV,C/T/T
12	175-7932-00	WR
13	175-9176-00	C/T/T
14	175-9177-00	C/T/T

Instrument Troubleshooting Without Options

To troubleshoot the standard instrument with the option assembly removed, perform the following steps to complete the signal paths required for operation of the standard instrument circuitry. Note that all of the steps will not necessarily be performed; do only those steps that apply to your instrument.

NOTE

In the following steps, P100, P101, and P102 are all located on the Main board in the standard instrument.

1. If the instrument contained the GPIB Option, use cable 7 to connect front-panel cable connector P4256 and Control-board connector P651.

2. If the instrument contained the TV Option, connect pins 9 and 10 of P100 using the extender cable kit jumpers.

3. If the instrument contained the TV or C/T/T Options, connect pins 3 and 4 of P102 and pins 7 and 8 of P102, using the extender cable kit jumpers.

4. If the instrument contained the C/T/T Option, connect pins 1 and 3 of P101 and pins 6 and 8 of P101, using the extender cable kit jumpers.

Instrument Troubleshooting With Options

To operate the instrument and its options with the option assembly removed for troubleshooting, the option assembly is placed upside down and to the right of the standard instrument (see Figure 5-2). The arrows represent the extender cables that are connecting the option assembly and the standard instrument.

Connecting all the extender cables is not required for each option. Column three in Table 5-6 lists which extender cables are used to connect and operate a particular option whose operation is in question. Cable number and Buffer board-standard instrument interconnection information for the TV option is shown in Figure 5-3. The "Troubleshooting Procedures" in the "Diagrams" section of this manual contain information about cable usage during the troubleshooting session.

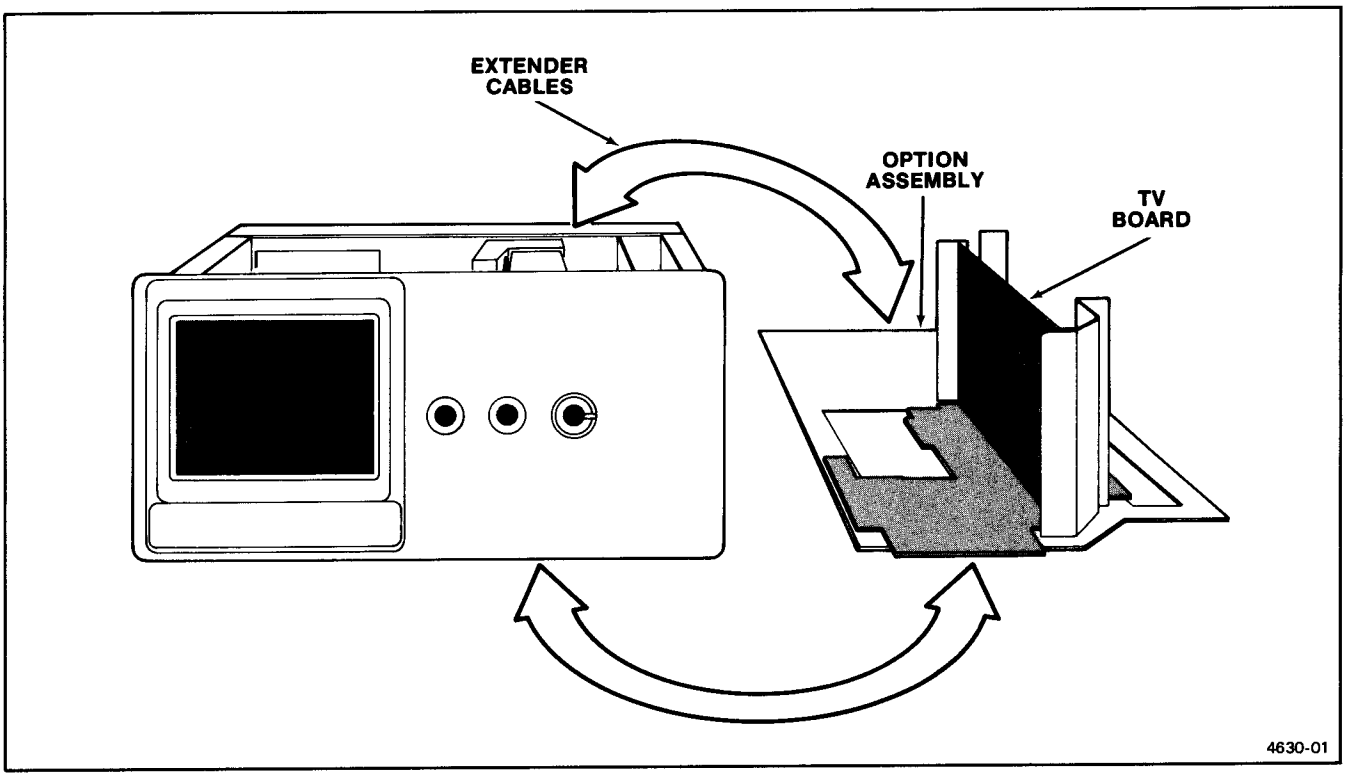


Figure 5-2. Orientation of assemblies when using extender cables.

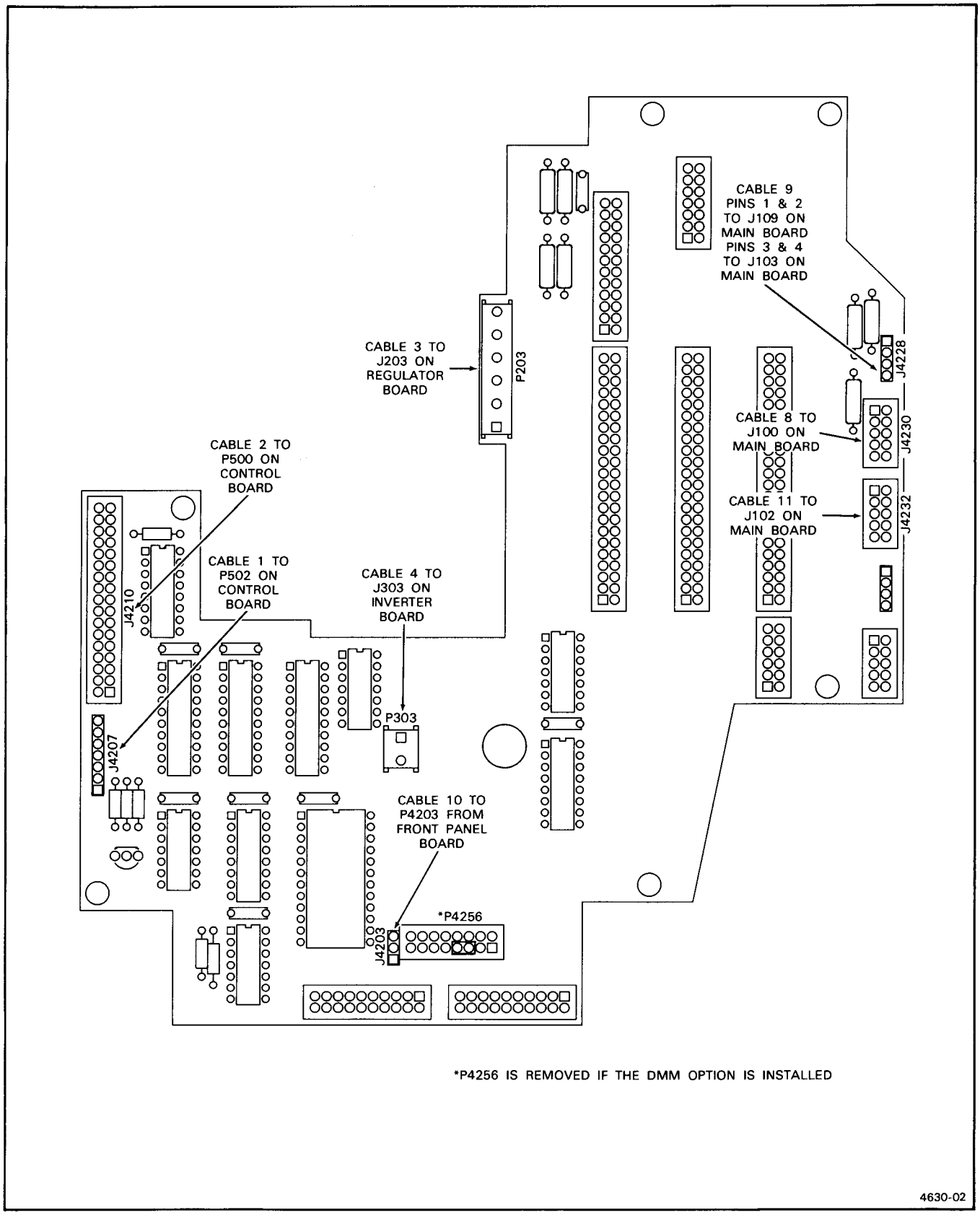


Figure 5-3. Extender cable connection points for troubleshooting.

CORRECTIVE MAINTENANCE

Corrective maintenance for the TV Option is the same as for the standard instrument unless stated otherwise in this section.

REMOVAL AND REPLACEMENT INSTRUCTIONS

The TV Option board and the Buffer board may be removed for repair or replacement using the following procedures. Before beginning any procedure, read the information at the beginning of the "Removal and Replacement Instructions" section in the standard instrument manual. If additional options are installed in the instrument, consult that particular option's service manual for removal and replacement information that may impact the following procedures.

TV Board Removal

To remove the TV board for repair or replacement:

1. Perform the "Cabinet Removal" procedure as outlined in the "Removal and Replacement Instructions" in the standard instrument manual.

2. Perform the first six steps of the "Top-Cover Plate Removal" procedure as outlined in the "Removal and Replacement Instructions" in the standard instrument service manual.

3. Remove the two top securing screws located at the right-center portion of the top-cover plate.

4. Lift the top-cover plate above the instrument approximately 2 inches.

5. Disconnect two cables at the right-front edge of the Buffer board (P4207 and P4210).

6. Disconnect three cables at the left-front edge of the Buffer board (P4228, P4230, and P4232).

7. Lift and rotate the option assembly about the front panel until the assembly is almost upside down.

8. Disconnect cable P4203 at the front edge of the Buffer board.

9. Remove the TV board from the option assembly by lifting it straight out from the Buffer board. Note the option assembly slot that the TV board is removed from for installation reference.

CAUTION

When securing the option assembly back into the main instrument, be sure that the connector cables are indexed correctly. Also check that the cables are not crimped and that P203 and P303 are seated correctly in their connectors. The two circuit board retainers located along the right edge of the top cover plate should securely engage the Readout board.

To reinstall the TV board and option assembly into the standard instrument, perform the reverse of the preceding steps.

Buffer Board Removal

To remove the Buffer board for repair or replacement:

1. Perform the preceding "TV Board Removal" procedure.

2. Remove the five securing screws that attach the Buffer board to the Vertical Board support.

3. Remove the Buffer board from the top-plate cover and option assembly.

To reinstall the Buffer board and option assembly into the standard instrument, perform the reverse of the preceding steps.

? Signature Not Verified
ARTEK MEDIA
Digitally signed by ARTEK MEDIA
DN: cn=ARTEK MEDIA, o=DC Henderson, c=US
Date: 2004.12.12 15:12:59 -06'00'

REPLACEABLE PARTS

PARTS ORDERING INFORMATION

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

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

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

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

ITEM NAME

In the Parts List, an Item Name is separated from the description by a colon (:). Because of space limitations, an Item Name may sometimes appear as incomplete. For further Item Name identification, the U.S. Federal Cataloging Handbook H6-1 can be utilized where possible.

FIGURE AND INDEX NUMBERS

Items in this section are referenced by figure and index numbers to the illustrations.

INDENTATION SYSTEM

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

1 2 3 4 5 *Name & Description*

Assembly and/or Component
Attaching parts for Assembly and/or Component
- - - * - - -
Detail Part of Assembly and/or Component
Attaching parts for Detail Part
- - - * - - -
Parts of Detail Part
Attaching parts for Parts of Detail Part
- - - * - - -

Attaching Parts always appear in the same indentation as the item it mounts, while the detail parts are indented to the right. Indented items are part of, and included with, the next higher indentation. The separation symbol - - - * - - - indicates the end of attaching parts.

Attaching parts must be purchased separately, unless otherwise specified.

ABBREVIATIONS

"	INCH
#	NUMBER SIZE
ACTR	ACTUATOR
ADPTR	ADAPTER
ALIGN	ALIGNMENT
AL	ALUMINUM
ASSEM	ASSEMBLED
ASSY	ASSEMBLY
ATTEN	ATTENUATOR
AWG	AMERICAN WIRE GAGE
BD	BOARD
BRKT	BRACKET
BRS	BRASS
BRZ	BRONZE
BSHG	BUSHING
CAB	CABINET
CAP	CAPACITOR
CER	CERAMIC
CHAS	CHASSIS
CKT	CIRCUIT
COMP	COMPOSITION
CONN	CONNECTOR
COV	COVER
CPLG	COUPLING
CRT	CATHODE RAY TUBE
DEG	DEGREE
DWR	DRAWER
ELCTRN	ELECTRON
ELEC	ELECTRICAL
ELCTLT	ELECTROLYTIC
ELEM	ELEMENT
EPL	ELECTRICAL PARTS LIST
EQPT	EQUIPMENT
EXT	EXTERNAL
FIL	FILLISTER HEAD
FLEX	FLEXIBLE
FLH	FLAT HEAD
FLTR	FILTER
FR	FRAME or FRONT
FSTNR	FASTENER
FT	FOOT
FXD	FIXED
GSKT	GASKET
HDL	HANDLE
HEX	HEXAGON
HEX HD	HEXAGONAL HEAD
HEX SOC	HEXAGONAL SOCKET
HLCPS	HELICAL COMPRESSION
HLEXT	HELICAL EXTENSION
HV	HIGH VOLTAGE
IC	INTEGRATED CIRCUIT
ID	INSIDE DIAMETER
IDENT	IDENTIFICATION
IMPLR	IMPELLER
IN	INCH
INCAND	INCANDESCENT
INSUL	INSULATOR
INTL	INTERNAL
LPHLDR	LAMPHOLDER
MACH	MACHINE
MECH	MECHANICAL
MTG	MOUNTING
NIP	NIPPLE
NON WIRE	NOT WIRE WOUND
OBD	ORDER BY DESCRIPTION
OD	OUTSIDE DIAMETER
OVH	OVAL HEAD
PH BRZ	PHOSPHOR BRONZE
PL	PLAIN or PLATE
PLSTC	PLASTIC
PN	PART NUMBER
PNH	PAN HEAD
PWR	POWER
RCPT	RECEPTACLE
RES	RESISTOR
RGD	RIGID
RLF	RELIEF
RTNR	RETAINER
SCH	SOCKET HEAD
SCOPE	OSCILLOSCOPE
SCR	SCREW
SE	SINGLE END
SECT	SECTION
SEMICOND	SEMICONDUCTOR
SHLD	SHIELD
SHLDR	SHOULDERED
SKT	SOCKET
SL	SLIDE
SLFLKG	SELF-LOCKING
SLVG	SLEEVING
SPR	SPRING
SQ	SQUARE
SST	STAINLESS STEEL
STL	STEEL
SW	SWITCH
T	TUBE
TERM	TERMINAL
THD	THREAD
THK	THICK
TNSN	TENSION
TPG	TAPPING
TRH	TRUSS HEAD
V	VOLTAGE
VAR	VARIABLE
W/	WITH
WSHR	WASHER
XFMR	TRANSFORMER
XSTR	TRANSISTOR

CROSS INDEX—MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip
00779	AMP, INC.	P.O. BOX 3608	HARRISBURG, PA 17105
01121	ALLEN-BRADLEY COMPANY	1201 2ND STREET SOUTH	MILWAUKEE, WI 53204
01295	TEXAS INSTRUMENTS, INC. SEMICONDUCTOR GROUP	P.O. BOX 5012	DALLAS, TX 75222
02735	RCA CORPORATION, SOLID STATE DIVISION	ROUTE 202	SOMERVILLE, NY 08876
04222	AVX CERAMICS, DIVISION OF AVX CORP.	P O BOX 867	MYRTLE BEACH, SC 29577
04713	MOTOROLA, INC., SEMICONDUCTOR PROD. DIV.	5005 E MCDOWELL RD,PO BOX 20923	PHOENIX, AZ 85036
05397	UNION CARBIDE CORPORATION, MATERIALS SYSTEMS DIVISION	11901 MADISON AVENUE	CLEVELAND, OH 44101
07263	FAIRCHILD SEMICONDUCTOR, A DIV. OF FAIRCHILD CAMERA AND INSTRUMENT CORP.	464 ELLIS STREET	MOUNTAIN VIEW, CA 94042
12969	UNITRODE CORPORATION	580 PLEASANT STREET	WATERTOWN, MA 02172
22526	BERG ELECTRONICS, INC.	YOUK EXPRESSWAY	NEW CUMBERLAND, PA 17070
27014	NATIONAL SEMICONDUCTOR CORP.	2900 SEMICONDUCTOR DR.	SANTA CLARA, CA 95051
27264	MOLEX PRODUCTS CO.	5224 KATRINE AVE.	DOWNERS GROVE, IL 60515
34335	ADVANCED MICRO DEVICES	901 THOMPSON PL.	SUNNYVALE, CA 94086
50434	HEWLETT-PACKARD COMPANY	640 PAGE MILL ROAD	PALO ALTO, CA 94304
51642	CENTRE ENGINEERING INC.	2820 E COLLEGE AVENUE	STATE COLLEGE, PA 16801
56289	SPRAGUE ELECTRIC CO.	87 MARSHALL ST.	NORTH ADAMS, MA 01247
72982	ERIE TECHNOLOGICAL PRODUCTS, INC.	644 W. 12TH ST.	ERIE, PA 16512
80009	TEKTRONIX, INC.	P O BOX 500	BEAVERTON, OR 97077
91637	DALE ELECTRONICS, INC.	P. O. BOX 609	COLUMBUS, NE 68601
96733	SAN FERNANDO ELECTRIC MFG CO	1501 FIRST ST	SAN FERNANDO, CA 91341

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
				ASSEMBLIES		
A1	670-7276-XX			CKT BOARD ASSY:MAIN	80009	670-7276-XX
	----- -----			(2465 OPTION 05-SEE 070-3831-00 MANUAL)		
A1	670-7285-XX			CKT BOARD ASSY:MAIN	80009	670-7285-XX
	----- -----			(2445 OPTION 05-SEE 070-3829-00 MANUAL)		
A20	670-7830-01			CKT BOARD ASSY:BUFFER	80009	670-7830-01
	----- -----			(2445/2465 OPTION 4Z)		
A25	670-7784-01			CKT BOARD ASSY:TV OPTION	80009	670-7784-01
A20	670-7830-01			CKT BOARD ASSY:BUFFER	80009	670-7830-01
A20C4215	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A20C4224	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A20C4240	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A20C4241	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A20C4255	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A20C4260	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A20C4265	281-0764-00			CAP.,FXD,CER DI:82PF,5%,100V	56289	492CCOG820J100B
A20C4270	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A20C4280	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A20J651	131-0608-00			TERMINAL,PIN:0.365 L X 0.025 PH BRZ GOLD	22526	47357
A20J651	----- -----			(QUANTITY OF 20)		
A20J4203	131-0608-00			TERMINAL,PIN:0.365 L X 0.025 PH BRZ GOLD	22526	47357
A20J4203	----- -----			(QUANTITY OF 3)		
A20J4207	131-0608-00			TERMINAL,PIN:0.365 L X 0.025 PH BRZ GOLD	22526	47357
A20J4207	----- -----			(QUANTITY OF 7)		
A20J4210	131-0608-00			TERMINAL,PIN:0.365 L X 0.025 PH BRZ GOLD	22526	47357
A20J4210	----- -----			(QUANTITY OF 34)		
A20J4220	131-0589-00			TERMINAL,PIN:0.46 L X 0.025 SQ	22526	48283-029
A20J4220	----- -----			(QUANTITY OF 14)		
A20J4221	131-0589-00			TERMINAL,PIN:0.46 L X 0.025 SQ	22526	48283-029
A20J4221	----- -----			(QUANTITY OF 24)		
A20J4228	131-2919-00			CONN,RCPT,ELEC:HEADER,1 X 4,0.1 SPACING	00779	87232-4
A20J4230	131-2920-00			CONN,RCPT,ELEC:HEADER,2 X 5,0.1 SPACING	00779	86479-3
A20J4232	131-2920-00			CONN,RCPT,ELEC:HEADER,2 X 5,0.1 SPACING	00779	86479-3
A20J4234	131-2919-00			CONN,RCPT,ELEC:HEADER,1 X 4,0.1 SPACING	00779	87232-4
A20J4236	131-2920-00			CONN,RCPT,ELEC:HEADER,2 X 5,0.1 SPACING	00779	86479-3
A20J4238	131-0589-00			TERMINAL,PIN:0.46 L X 0.025 SQ	22526	48283-029
A20J4238	----- -----			(QUANTITY OF 12)		
A20J4240A	131-1742-00			TERMINAL,PIN:0.662 L X 0.025 SQ PH BRS		
A20J4240A	----- -----			(QUANTITY OF 40)		
A20J4240B	131-0589-00			TERMINAL,PIN:0.46 L X 0.025 SQ	22526	48283-029
A20J4240B	----- -----			(QUANTITY OF 4)		
A20J4242	131-0589-00			TERMINAL,PIN:0.46 L X 0.025 SQ	22526	48283-029
A20J4242	----- -----			(QUANTITY OF 44)		
A20J4243	131-0589-00			TERMINAL,PIN:0.46 L X 0.025 SQ	22526	48283-029
A20J4243	----- -----			(QUANTITY OF 44)		
A20J4256	131-1742-00			TERMINAL,PIN:0.662 L X 0.025 SQ PH BRS		
A20J4256	----- -----			(QUANTITY OF 2)		
A20J4258	131-0608-00			TERMINAL,PIN:0.365 L X 0.025 PH BRZ GOLD	22526	47357
A20J4258	----- -----			(QUANTITY OF 20)		
A20J4330	131-0608-00			TERMINAL,PIN:0.365 L X 0.025 PH BRZ GOLD	22526	47357
A20J4330	----- -----			(QUANTITY OF 14)		
A20J4330	131-1742-00			TERMINAL,PIN:0.662 L X 0.025 SQ PH BRS		
A20J4330	----- -----			(QUANTITY OF 2)		

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A25	670-7784-01			CKT BOARD ASSY:TV OPTION	80009	670-7784-01
A25C5331	290-0808-00			CAP.,FXD,ELCTLT:2.7UF,10%,20V	05397	T3228275K020AS
A25C5374	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A25C5419	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A25C5458	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A25C5465	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A25C5490	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A25C5540	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A25C5543	281-0814-00			CAP.,FXD,CER DI:100PF,10%,100V	04222	GC101A101K
A25C5545	281-0826-00			CAP.,FXD,CER DI:2200PF,5%,100V	12969	CGB222KEX
A25C5612	283-0024-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	72982	8121N083Z5U0104Z
A25C5613	281-0767-00			CAP.,FXD,CER DI:330PF,20%,100V	12969	CGB331MEN
A25C5625	281-0788-00			CAP.,FXD,CER DI:470PF,10%,100V	96733	R3015
A25C5627	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A25C5630	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A25C5631	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A25C5633	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A25C5639	290-0246-00			CAP.,FXD,ELCTLT:3.3UF,10%,15V	56289	162D335X9015CD2
A25C5640	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	04222	MA201C103KAA
A25C5651	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A25C5680	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A25C5690	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A25C5720	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A25C5724	281-0814-00			CAP.,FXD,CER DI:100PF,10%,100V	04222	GC101A101K
A25C5726	281-0814-00			CAP.,FXD,CER DI:100PF,10%,100V	04222	GC101A101K
A25C5728	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A25C5731	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A25C5734	281-0863-00			CAP.,FXD CER DI:240PF,5%,100V	04222	GC101A241J
A25C5740	283-0059-00			CAP.,FXD,CER DI:1UF,+80-20%,50V	51642	400050Z5U105Z
A25C5755	281-0786-00			CAP.,FXD,CER DI:150PF,10%,100V	51642	G1710100NP0151K
A25C5757	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
A25C5770	283-0421-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	04222	DG015E104Z
A25C5773	281-0814-00			CAP.,FXD,CER DI:100PF,10%,100V	04222	GC101A101K
A25C5775	281-0813-00			CAP.,FXD CER DI:0.047UF,20%,50V	04222	GC705-E-473M
A25C5810	283-0059-00			CAP.,FXD,CER DI:1UF,+80-20%,50V	51642	400050Z5U105Z
A25C5830	281-0820-00			CAP.,FXD,CER DI:680PF,10%,50V	05397	C114K681K1X5CA
A25C5848	281-0788-00			CAP.,FXD,CER DI:470PF,10%,100V	96733	R3015
A25C5853	283-0059-00			CAP.,FXD,CER DI:1UF,+80-20%,50V	51642	400050Z5U105Z
A25C5865	281-0812-00			CAP.,FXD,CER DI:1000PF,10%,100V	04222	MA101C102KAA
A25CR5522	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A25CR5526	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A25CR5623	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A25CR5641	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A25CR5653	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A25CR5655	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A25CR5721	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A25CR5735	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A25CR5751	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A25CR5772	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A25CR5774	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A25CR5776	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A20P203	131-2924-00			CONN,RCPT,ELEC:HEADER,1 X 6,0.2 SPACING	27264	10-51-1061
A20P303	131-2923-00			CONN,RCPT,ELEC:HEADER,1 X 2,0.2 SPACING	27264	10-51-1021
A20Q4201	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
A20R4200	321-0085-00			RES.,FXD,FILM:75 OHM,1%,0.125W	91637	MFF1816G75R00F
A20R4201	321-0085-00			RES.,FXD,FILM:75 OHM,1%,0.125W	91637	MFF1816G75R00F
A20R4202	321-0122-00			RES.,FXD,FILM:182 OHM,1%,0.125W	91637	MFF1816G182R0F
A20R4203	321-0105-00			RES.,FXD,FILM:121 OHM,1%,0.125W	91637	MFF1816G121R0F
A20R4204	315-0512-00			RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
A20R4205	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A20R4206	315-0512-00			RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
A20R4207	321-0105-00			RES.,FXD,FILM:121 OHM,1%,0.125W	91637	MFF1816G121R0F
A20R4208	321-0122-00			RES.,FXD,FILM:182 OHM,1%,0.125W	91637	MFF1816G182R0F
A20R4224	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A20R4265	315-0681-00			RES.,FXD,CMPSN:680 OHM,5%,0.25W	01121	CB6815
A20U4207	156-1566-00			MICROCIRCUIT,DI:EPROM,100 X 14	80009	156-1566-00
A20U4225	156-1318-00			MICROCIRCUIT,DI:4-BIT BISTABLE LATCH SCR	01295	SN74LS375
A20U4235	156-1065-01			MICROCIRCUIT,DI:OCTAL D TYPE TRANS LATCHES	34335	AM74LS373
A20U4240	156-0718-03			MICROCIRCUIT,DI:TRIPLE 3-INP NOR GATE	01295	SN74LS27
A20U4245	156-1065-01			MICROCIRCUIT,DI:OCTAL D TYPE TRANS LATCHES	34335	AM74LS373
A20U4250	156-0386-02			MICROCIRCUIT,DI:TRIPLE 3-INP NAND GATE	27014	DM74LS10N
A20U4255	156-1111-02			MICROCIRCUIT,DI:OCTAL BUS TRANSCEIVERS	01295	SN74LS245JP3
A20U4260	160-1833-05			MICROCIRCUIT,DI:4096 X 8 EPROM,PRGM	80009	160-1833-05
A20U4265	156-0383-02			MICROCIRCUIT,DI:QUAD 2-INP NOR GATE	01295	SN74LS02
A20U4275	156-0392-03			MICROCIRCUIT,DI:QUAD LATCH W/CLEAR	01295	SN74S175NP3
A20U4280	156-0866-02			MICROCIRCUIT,DI:13 INP NAND GATES,SCRN	80009	156-0866-02

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A25CR5823	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A25CR5825	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A25CR5831	152-0322-00			SEMICOND DEVICE:SILICON,15V,HOT CARRIER	50434	5082-2672
A25CR5867	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
A25P4220	131-2889-00			CONN,RCPT,ELEC:CKT BD,HORIZ,2 X 7,0.100 SP	00779	86063-3
A25P4242	131-2887-00			CONN,RCPT,ELEC:CKT BD,HORIZ,2 X 22,0.100SP	00779	1-86063-8
A25Q5370	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
A25Q5442	151-1059-00			TRANSISTOR:SILICON,FE,N-CHANNEL	80009	151-1059-00
A25Q5512	151-0188-00			TRANSISTOR:SILICON,PNP	04713	SPS6868K
A25Q5515	151-0188-00			TRANSISTOR:SILICON,PNP	04713	SPS6868K
A25Q5518	151-0188-00			TRANSISTOR:SILICON,PNP	04713	SPS6868K
A25Q5528	151-0188-00			TRANSISTOR:SILICON,PNP	04713	SPS6868K
A25Q5530	151-1059-00			TRANSISTOR:SILICON,FE,N-CHANNEL	80009	151-1059-00
A25Q5625	151-0188-00			TRANSISTOR:SILICON,PNP	04713	SPS6868K
A25Q5735	151-0188-00			TRANSISTOR:SILICON,PNP	04713	SPS6868K
A25Q5736	151-1059-00			TRANSISTOR:SILICON,FE,N-CHANNEL	80009	151-1059-00
A25Q5860	151-0188-00			TRANSISTOR:SILICON,PNP	04713	SPS6868K
A25R5319	315-0123-00			RES.,FXD,CMPSN:12K OHM,5%,0.25W	01121	CB1235
A25R5322	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A25R5329	315-0392-00			RES.,FXD,CMPSN:3.9K OHM,5%,0.25W	01121	CB3925
A25R5330	315-0121-00			RES.,FXD,CMPSN:120 OHM,5%,0.25W	01121	CB1215
A25R5333	321-0280-00			RES.,FXD,FILM:8.06K OHM,1%,0.125W	91637	MFF1816G80600F
A25R5334	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A25R5335	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A25R5336	321-0280-00			RES.,FXD,FILM:8.06K OHM,1%,0.125W	91637	MFF1816G80600F
A25R5370	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A25R5371	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A25R5421	315-0125-00			RES.,FXD,CMPSN:1.2M OHM,5%,0.25W	01121	CB1255
A25R5422	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
A25R5423	315-0564-00			RES.,FXD,CMPSN:560K OHM,5%,0.25W	01121	CB5645
A25R5424	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A25R5429	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
A25R5432	321-0251-00			RES.,FXD,FILM:4.02K OHM,1%,0.125W	91637	MFF1816G40200F
A25R5433	315-0394-00			RES.,FXD,CMPSN:390K OHM,5%,0.25W	01121	CB3945
A25R5434	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A25R5443	315-0204-00			RES.,FXD,CMPSN:200K OHM,5%,0.25W	01121	CB2045
A25R5444	315-0334-00			RES.,FXD,CMPSN:330K OHM,5%,0.25W	01121	CB3345
A25R5445	315-0163-00			RES.,FXD,CMPSN:16K OHM,5%,0.25W	01121	CB1635
A25R5519	315-0223-00			RES.,FXD,CMPSN:22K OHM,5%,0.25W	01121	CB2235
A25R5523	315-0122-00			RES.,FXD,CMPSN:1.2K OHM,5%,0.25W	01121	CB1225
A25R5524	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A25R5525	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
A25R5540	315-0303-00			RES.,FXD,CMPSN:30K OHM,5%,0.25W	01121	CB3035
A25R5541	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
A25R5542	315-0121-00			RES.,FXD,CMPSN:120 OHM,5%,0.25W	01121	CB1215
A25R5544	315-0121-00			RES.,FXD,CMPSN:120 OHM,5%,0.25W	01121	CB1215
A25R5556	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A25R5557	315-0203-00			RES.,FXD,CMPSN:20K OHM,5%,0.25W	01121	CB2035
A25R5610	315-0112-00			RES.,FXD,CMPSN:1.1K OHM,5%,0.25W	01121	CB1125
A25R5611	315-0512-00			RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
A25R5612	315-0182-00			RES.,FXD,CMPSN:1.8K OHM,5%,0.25W	01121	CB1825

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A25R5622	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A25R5623	315-0432-00			RES.,FXD,CMPSN:4.3K OHM,5%,0.25W	01121	CB4325
A25R5624	315-0392-00			RES.,FXD,CMPSN:3.9K OHM,5%,0.25W	01121	CB3925
A25R5626	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
A25R5627	315-0162-00			RES.,FXD,CMPSN:1.6K OHM,5%,0.25W	01121	CB1625
A25R5628	321-0219-00			RES.,FXD,FILM:1.87K OHM,1%,0.125W	91637	MFF1816G18700F
A25R5629	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A25R5632	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
A25R5652	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A25R5656	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A25R5657	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
A25R5720	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
A25R5722	315-0911-00			RES.,FXD,CMPSN:910 OHM,5%,0.25W	01121	CB9115
A25R5723	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
A25R5725	315-0273-00			RES.,FXD,CMPSN:27K OHM,5%,0.25W	01121	CB2735
A25R5729	315-0474-00			RES.,FXD,CMPSN:470K OHM,5%,0.25W	01121	CB4745
A25R5730	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
A25R5732	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
A25R5733	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
A25R5735	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A25R5736	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A25R5737	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A25R5738	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A25R5739	315-0393-00			RES.,FXD,CMPSN:39K OHM,5%,0.25W	01121	CB3935
A25R5750	315-0154-00			RES.,FXD,CMPSN:150K OHM,5%,0.25W	01121	CB1545
A25R5752	315-0751-00			RES.,FXD,CMPSN:750 OHM,5%,0.25W	01121	CB7515
A25R5754	315-0511-00			RES.,FXD,CMPSN:510 OHM,5%,0.25W	01121	CB5115
A25R5755	315-0563-00			RES.,FXD,CMPSN:56K OHM,5%,0.25W	01121	CB5635
A25R5756	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
A25R5760	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A25R5771	315-0333-00			RES.,FXD,CMPSN:33K OHM,5%,0.25W	01121	CB3335
A25R5810	315-0332-00			RES.,FXD,CMPSN:3.3K OHM,5%,0.25W	01121	CB3325
A25R5811	307-0104-00			RES.,FXD,CMPSN:3.3 OHM,5%,0.25W	01121	CB33G5
A25R5812	315-0243-00			RES.,FXD,CMPSN:24K OHM,5%,0.25W	01121	CB2435
A25R5813	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A25R5820	315-0243-00			RES.,FXD,CMPSN:24K OHM,5%,0.25W	01121	CB2435
A25R5822	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A25R5823	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A25R5824	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
A25R5825	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
A25R5826	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
A25R5827	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
A25R5858	315-0392-00			RES.,FXD,CMPSN:3.9K OHM,5%,0.25W	01121	CB3925
A25R5829	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
A25R5830	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A25R5831	315-0203-00			RES.,FXD,CMPSN:20K OHM,5%,0.25W	01121	CB2035
A25R5832	315-0123-00			RES.,FXD,CMPSN:12K OHM,5%,0.25W	01121	CB1235
A25R5833	315-0621-00			RES.,FXD,CMPSN:620 OHM,5%,0.25W	01121	CB6215
A25R5834	315-0391-00			RES.,FXD,CMPSN:390 OHM,5%,0.25W	01121	CB3915
A25R5847	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A25R5850	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A25R5851	315-0334-00			RES.,FXD,CMPSN:330K OHM,5%,0.25W	01121	CB3345
A25R5852	315-0752-00			RES.,FXD,CMPSN:7.5K OHM,5%,0.25W	01121	CB7525
A25R5853	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025

REPLACEABLE MECHANICAL PARTS

PARTS ORDERING INFORMATION

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

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

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

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

ITEM NAME

In the Parts List, an Item Name is separated from the description by a colon (:). Because of space limitations, an Item Name may sometimes appear as incomplete. For further Item Name identification, the U.S. Federal Cataloging Handbook H6-1 can be utilized where possible.

FIGURE AND INDEX NUMBERS

Items in this section are referenced by figure and index numbers to the illustrations.

INDENTATION SYSTEM

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

1 2 3 4 5 Name & Description

Assembly and/or Component
Attaching parts for Assembly and/or Component
- - - * - - -
Detail Part of Assembly and/or Component
Attaching parts for Detail Part
- - - * - - -
Parts of Detail Part
Attaching parts for Parts of Detail Part
- - - * - - -

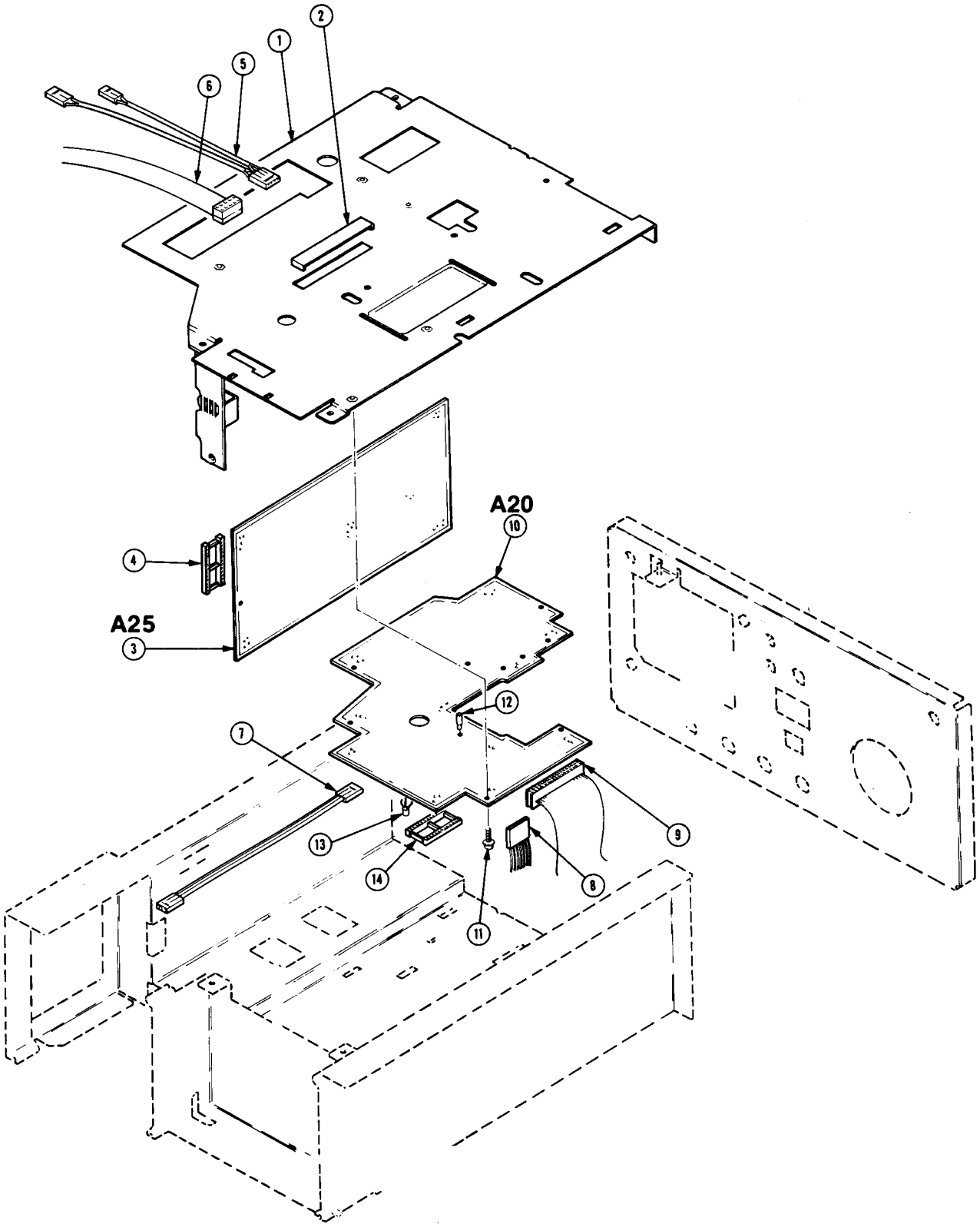
Attaching Parts always appear in the same indentation as the item it mounts, while the detail parts are indented to the right. Indented items are part of, and included with, the next higher indentation. The separation symbol - - - * - - - indicates the end of attaching parts.

Attaching parts must be purchased separately, unless otherwise specified.

CROSS INDEX—MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip
00779	AMP, INC.	P.O. BOX 3608	HARRISBURG, PA 17105
01536	CAMCAR DIV OF TEXTRON INC. SEMS PRODUCTS UNIT	1818 CHRISTINA ST.	ROCKFORD, IL 61108
09922	BURNDY CORPORATION	RICHARDS AVENUE	NORWALK, CT 06852
80009	TEKTRONIX, INC.	P O BOX 500	BEAVERTON, OR 97077

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A25R5864	315-0272-00			RES.,FXD,CMPSN:2.7K OHM,5%,0.25W	01121	CB2725
A25R5868	315-0683-00			RES.,FXD,CMPSN:68K OHM,5%,0.25W	01121	CB6835
A25R5891	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
A25U5310	156-0912-01			MICROCIRCUIT,LI:OPNL AMPL,SCREENED	02735	CA3080EX
A25U5315	156-0991-00			MICROCIRCUIT,LI:VOLTAGE REGULATOR	04713	MC78L05ACP
A25U5380	156-0465-02			MICROCIRCUIT,DI:8 INP NAND GATE	01295	SN74LS30NP3
A25U5390	156-0480-02			MICROCIRCUIT,DI:QUAD 2 INP & GATE	01295	SN74LS08NP3
A25U5410	156-0912-01			MICROCIRCUIT,LI:OPNL AMPL,SCREENED	02735	CA3080EX
A25U5427	156-0048-00			MICROCIRCUIT,LI:FIVE NPN TRANSISTOR ARRAY	02735	CA3046
A25U5436	156-1349-00			MICROCIRCUIT,LI:DUAL INDEP DIFF AMPL	02735	CA3054
A25U5456	156-0366-02			MICROCIRCUIT,DI:DUAL D FLIP-FLOP,CHK	80009	156-0366-02
A25U5459	156-1111-02			MICROCIRCUIT,DI:OCTAL BUS TRANSCEIVERS	01295	SN74LS245JP3
A25U5565	160-2216-00			MICROCIRCUIT,DI:8192 X 8 EPROM,PRGM	80009	160-2216-00
A25U5575	156-1426-00			MICROCIRCUIT,DI:PROGRAMMABLE TIMER MODULE	04713	MC68B40P
A25U5580	156-0385-02			MICROCIRCUIT,DI:HEX INVERTER	01295	SN74LS04
A25U5590	156-0388-03			MICROCIRCUIT,DI:DUAL D FLIP-FLOP	07263	74LS74A
A25U5636	156-1200-01			MICROCIRCUIT,LI:OPERATIONAL AMPL,QUAD	01295	TL074CN/PEP3
A25U5645	156-0366-02			MICROCIRCUIT,DI:DUAL D FLIP-FLOP,CHK	80009	156-0366-02
A25U5680	156-0481-02			MICROCIRCUIT,DI:TRIPLE 3 INP & GATE	27014	DM74LS11NA+
A25U5712	156-1381-00			MICROCIRCUIT,LI:XSTR ARRAY	02735	CA3096AE-17
A25U5728	156-1381-00			MICROCIRCUIT,LI:XSTR ARRAY	02735	CA3096AE-17
A25U5755	156-0912-01			MICROCIRCUIT,LI:OPNL AMPL,SCREENED	02735	CA3080EX
A25U5756	156-0366-02			MICROCIRCUIT,DI:DUAL D FLIP-FLOP,CHK	80009	156-0366-02
A25U5764	156-1065-01			MICROCIRCUIT,DI:OCTAL D TYPE TRANS LATCHES	34335	AM74LS373
A25U5770	156-0385-02			MICROCIRCUIT,DI:HEX INVERTER	01295	SN74LS04
A25U5775	156-0382-02			MICROCIRCUIT,DI:QUAD 2-INP NAND GATE	01295	SN74LS00
A25U5790	156-0382-02			MICROCIRCUIT,DI:QUAD 2-INP NAND GATE	01295	SN74LS00
A25U5835	156-0382-02			MICROCIRCUIT,DI:QUAD 2-INP NAND GATE	01295	SN74LS00
A25U5838	156-0575-03			MICROCIRCUIT,DI:3 INPUT NOR GATE,SELECTED	80009	156-0575-03
A25U5845	156-0704-00			MICROCIRCUIT,LI:PHASE LOCK LOOP	04713	MC14046CP
A25U5855	156-0912-01			MICROCIRCUIT,LI:OPNL AMPL,SCREENED	02735	CA3080EX
A25U5880	156-1981-00			MICROCIRCUIT,DI:QUAD J-K FLIP-FLOP,SCREENED		
A25U5890	156-0381-02			MICROCIRCUIT,DI:QUAD 2-INP EXCL OR GATE	01295	SN74LS86
VR5420	152-0175-00			SEMICOND DEVICE:ZENER,0.4W,5.6V,5%	04713	SZG35008
VR5866	152-0760-00			SEMICOND DEVICE:ZEN,SI,6.2V,2%,400MW	04713	SZ630205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A20
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Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
1-	----- -----			1		TV OPTION 05,2445/2465		
-1	407-1473-00			1		.BRACKET,SUPPORT:CKT BD,ALUMINUM		
-2	200-2871-00			1		.COVER,ELEC CONN:PLASTIC		
-3	----- -----			1		.CKT BOARD ASSY:TV OPTION		
	----- -----			-		.(SEE A25 REPL)		
-4	136-0755-00			1		..SKT,PL-IN ELEK:MICROCIRCUIT,28 DIP	09922	DILB28P-108
-5	175-7925-00			1		.CABLE ASSY RF:50 OHM COAX,19.0 L	T1549	OBD
	----- -----			-		.(BUFFER BOARD TO MAIN BOARD AT POSITION A		
-6	175-9478-00			1		.CA ASSY,RF:75 OHM COAX,12.0 L,0-N	80009	175-9478-00
	----- -----			-		.BUFFER BOARD TO MAIN BOARD AT POSITION A)		
	175-7927-00			1		.CA ASSY,SP,ELEC:10,28 AWG,11.0 L,RIBBON	80009	175-7927-00
	----- -----			-		.(BUFFER BOARD TO MAIN BOARD AT POSITON C)		
-7	175-7930-00			1		.CA ASSY,SP,ELEC:3,26 AWG,11.0 L,RIBBON	80009	175-7930-00
-8	175-7183-00			1		.CA ASSY,SP,ELEC:7,22 AWG,7.75 L,RIBBON	80009	175-7183-00
-9	175-7184-00			1		.CA ASSY,SP,ELEC:34,28 AWG,6.5 L,RIBBON	80009	175-7184-00
-10	----- -----			1		.CKT BOARD ASSY:BUFFER		
	----- -----			-		.(SEE A20 REPL)		
						.**********(ATTACHING PARTS)**********		
-11	211-0711-00			5		.SCR,ASSEM WSHR:6-32 X 0.25 L,PNH,TORX	01536	ORD BY DESCR
						.**********(END ATTACHING PARTS)*********		
	----- -----			-		.CKT BOARD ASSY INCLUDES:		
-12	361-1252-00			5		..SPACER,CKT BD:0.1 ID X 0.188 OD X 0.185		
-13	131-0993-00			1		..BUS,CONDUCTOR:2 WIRE BLACK	00779	850100-01
-14	136-0751-00			1		..SKT,PL-IN ELEK:MICROCKT,24 PIN	09922	DILB24P108
	343-0149-00			2		.CLAMP,LOOP:NYLON	80009	343-0149-00
	333-2992-00			1		.PANEL,FRONT:2445 OPT. 05 ONLY	80009	333-2992-00
	333-2994-00					.PANEL,FRONT:2445 OPT. 05 & OPT. 06 COMB	80009	333-2994-00
	333-2989-00			1		.PANEL,FRONT:2265 OPT. 05 ONLY	80009	333-2989-00
	333-2991-00			1		.PANEL,FRONT:2465 OPT. 05 & OPT. 06 COMB	80009	333-2991-00
						STANDARD ACCESSORIES		
	070-4629-00			1		MANUAL,TECH:OPERATORS,2445/2465 OPT. 05	80009	070-4629-00
	070-4630-00			1		MANUAL,TECH:SERVICE,2445/2465 OPT.05	80009	070-4630-00
	016-0180-00			1		VISOR,CRT:	80009	016-0180-00
	378-0199-01			1		FILTER,LT,CRT:BLUE,4.1 X 3.32 X 0.03	80009	378-0199-01
	378-0199-02			1		FILTER,LT,CRT:BLUE,4.1 X 3.32,ACRYLIC	80009	378-0199-02

DIAGRAMS AND CIRCUIT BOARD ILLUSTRATIONS

Symbols

Graphic symbols and class designation letters are based on ANSI Standard Y32.2-1975.

Logic symbology is based on ANSI Y32.14-1973 in terms of positive logic. Logic symbols depict the logic function performed and may differ from the manufacturer's data.

The overline on a signal name indicates that the signal performs its intended function when it is in the low state.

Abbreviations are based on ANSI Y1.1-1972.

Other ANSI standards that are used in the preparation of diagrams by Tektronix, Inc. are:

Y14.15, 1966	Drafting Practices.
Y14.2, 1973	Line Conventions and Lettering.
Y10.5, 1968	Letter Symbols for Quantities Used in Electrical Science and Electrical Engineering.

American National Standard Institute
1430 Broadway
New York, New York 10018

Component Values

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

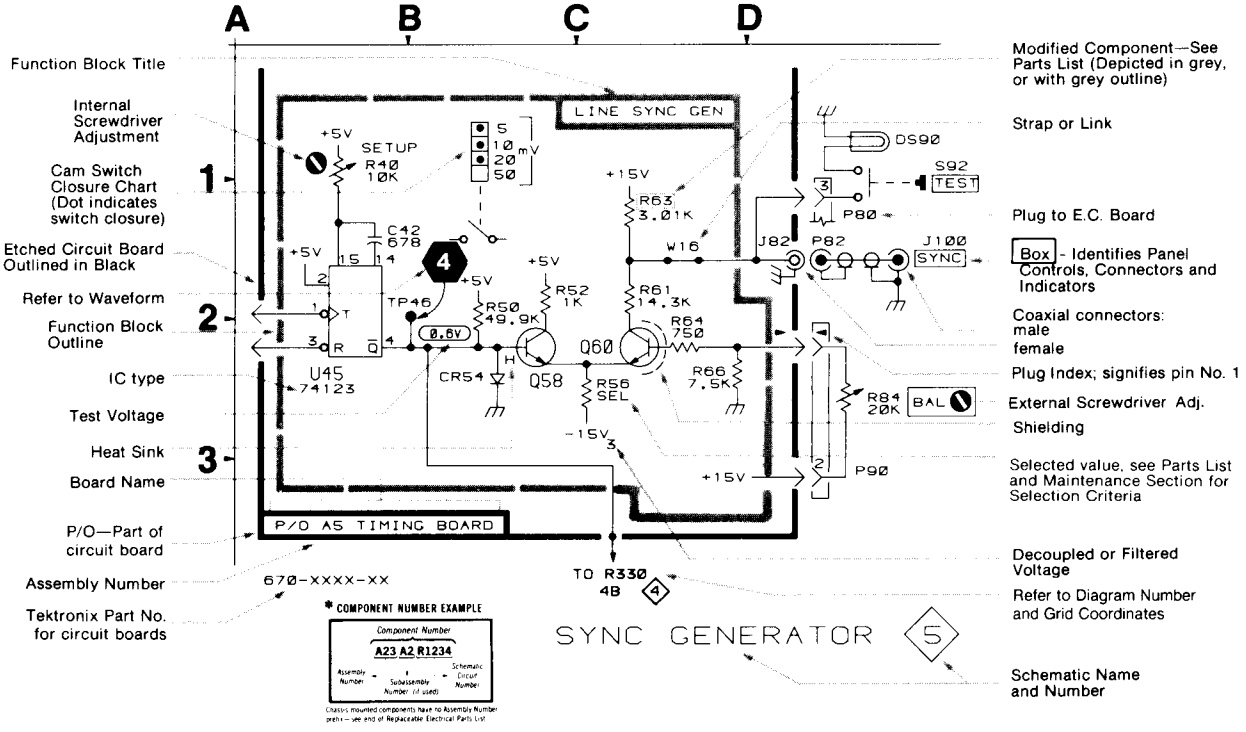
Capacitors = Values one or greater are in picofarads (pF). Values less than one are in microfarads (μF).
Resistors = Ohms (Ω).

The information and special symbols below may appear in this manual.

Assembly Numbers and Grid Coordinates

Each assembly in the instrument is assigned an assembly number (e.g., A20). The assembly number appears on the circuit board outline on the diagram, in the title for the circuit board component location illustration, and in the lookup table for the schematic diagram and corresponding component locator illustration. The Replaceable Electrical Parts list is arranged by assemblies in numerical sequence; the components are listed by component number *(see following illustration for constructing a component number).

The schematic diagram and circuit board component location illustration have grids. A lookup table with the grid coordinates is provided for ease of locating the component. Only the components illustrated on the facing diagram are listed in the lookup table. When more than one schematic diagram is used to illustrate the circuitry on a circuit board, the circuit board illustration may only appear opposite the first diagram on which it was illustrated; the lookup table will list the diagram number of other diagrams that the circuitry of the circuit board appears on.



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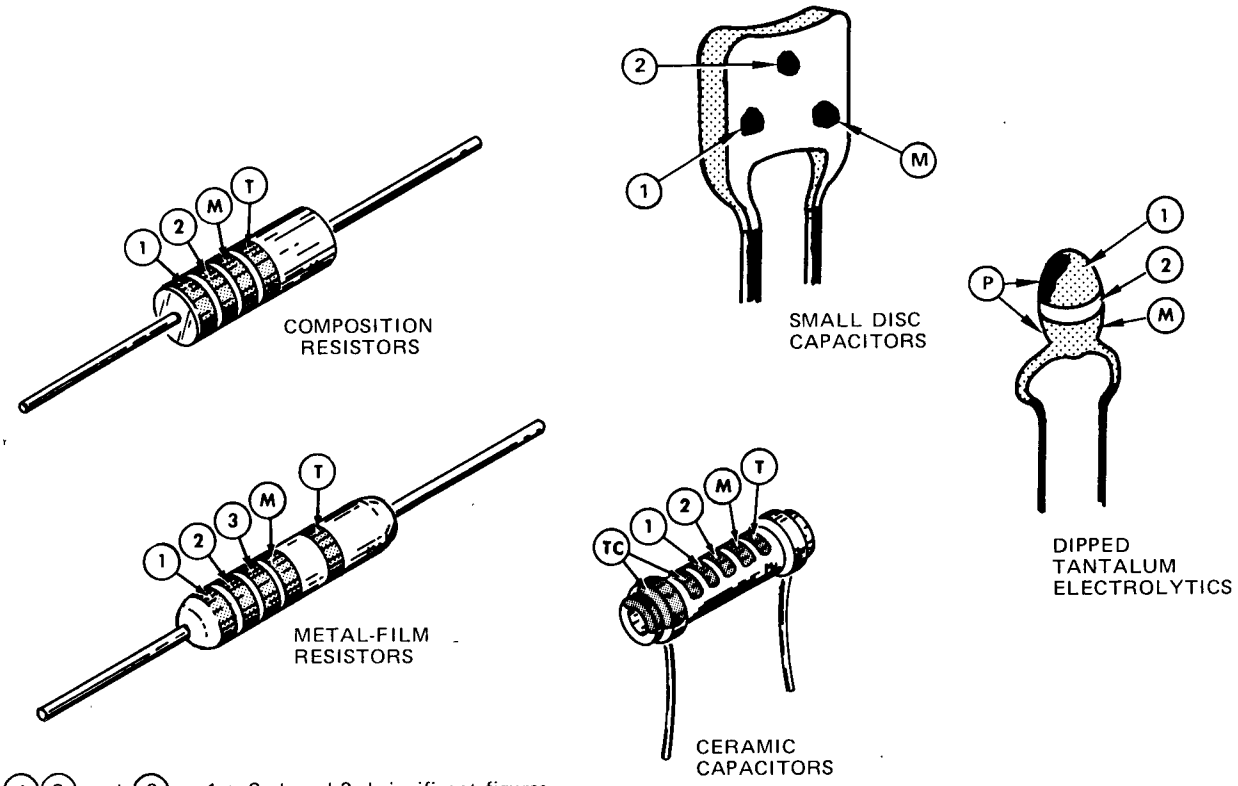
COLOR CODE



(1) (2) and (3) – 1st, 2nd, and 3rd significant figures

(M) –multiplier (T) –tolerance

(TC) –temperature coefficient

(P) –polarity and voltage rating

(T) and/or (TC) color code may not be present on some capacitors

COLOR	SIGNIFICANT FIGURES	RESISTORS		CAPACITORS			DIPPED TANTALUM VOLTAGE RATING
		MULTIPLIER	TOLERANCE	MULTIPLIER	TOLERANCE		
					over 10 pF	under 10 pF	
BLACK	0	1	---	1	±20%	±2 pF	4 VDC
BROWN	1	10	±1%	10	±1%	±0.1 pF	6 VDC
RED	2	10^2 or 100	±2%	10^2 or 100	±2%	---	10 VDC
ORANGE	3	10^3 or 1 K	±3%	10^3 or 1000	±3%	---	15 VDC
YELLOW	4	10^4 or 10 K	±4%	10^4 or 10,000	+100% –9%	---	20 VDC
GREEN	5	10^5 or 100 K	±½%	10^5 or 100,000	±5%	±0.5 pF	25 VDC
BLUE	6	10^6 or 1 M	±¼%	10^6 or 1,000,000	---	---	35 VDC
VIOLET	7	---	±1/10%	---	---	---	50 VDC
GRAY	8	---	---	10^{-2} or 0.01	+80% –20%	±0.25 pF	---
WHITE	9	---	---	10^{-1} or 0.1	±10%	±1 pF	---
GOLD	–	10^{-1} or 0.1	±5%	---	---	---	---
SILVER	–	10^{-2} or 0.01	±10%	---	---	---	---
NONE	–	---	±20%	---	±10%	±1 pF	---

(1861-20A)4206-31

Figure 7-1. Color code for resistors and capacitors.

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FIG. 7-2 LOCATING COMPONENT EXAMPLE

To identify any component mounted on a circuit board and to locate that component in the appropriate schematic diagram

1. Locate the Circuit Board Illustration

a. In the instrument identify the Assembly Number of the circuit board in question. The Assembly Number is usually printed on the upper left corner of the circuit board on the component side.

b. In the manual locate and pull out tabbed page whose title corresponds with the Assembly Number of the circuit board. Circuit board assembly numbers and board nomenclature are printed on the back side of the tabs (facing the rear of the manual).

2. Determine the Circuit Number

a. Compare the circuit board with its illustration and locate the desired component by area and shape on the illustration.

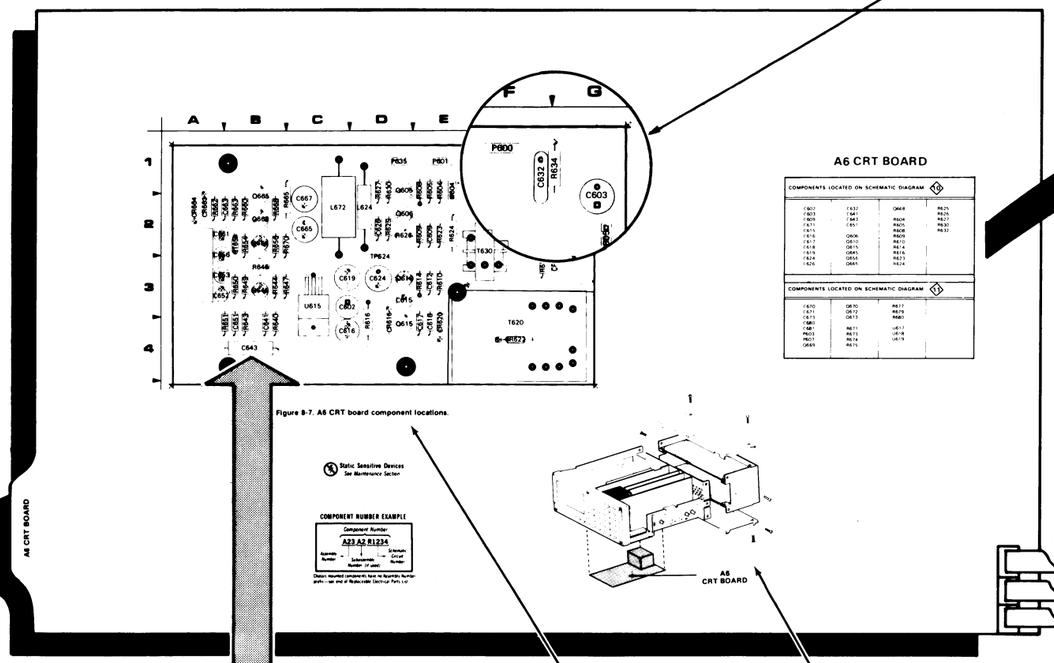
b. Scan the table adjacent to the Circuit Board Illustration and find the Circuit Number of the desired component.

c. Determine the Schematic Diagram Number in which the component is located.

3. Locate the Cor

a. Locate and correspond determinec and numbe (facing the

b. Scan the schematic desired cor



A6 CRT BOARD

COMPONENTS LOCATED ON SCHEMATIC DIAGRAM 10

C602	C632	Q668	R625
C603	C641		R626
C609	C643	R604	R627
C671	C651	R605	R630
C615		R608	R632
C616	Q606	R609	
C617	Q610	R610	
C618	Q615	R614	
C619	Q645	R616	
C624	Q656	R623	
C626	Q665	R624	

COMPONENTS LOCATED ON SCHEMATIC DIAGRAM 11

C670	Q670	R677	
C671	Q672	R679	
C673	Q673	R680	
C680			
C681	R671	U617	
P603	R673	U618	
P607	R674	U619	
Q669	R675		

COMPONENT LOCATION TABLE

CRT CIRCUIT DIAGRAM 10

A6 ASSEMBLY

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
C602	2C	3C	Q656	2F	2B
C603	1C	1G	Q665	1G	1B
C609	4E	2E	Q668	2G	2B
C612	7C	3E			
C615	7C	3D	R604	4C	1E
C616	2C	3C	R605	5D	1E
C617	7D	3D	R608	4E	1D
C618	7E	3E	R609	4E	2D
C619	6E	3C	R610	7B	3E
C624	4F	3D	R614	7C	3D
C626	7G	2D	R616	1C	3D
C632	8G	1E	R623	4D	2E
C643	3D	4B	R625	7F	2D
C651	3E	3B	R626	7F	2D
		3B	R627	7G	1D
			R630	4F	1D
Q606	4E	2D			
Q610	7C	3D	TP624	3B	2D
Q615	7D	3D			
Q645	3E	3B	U615	1D	3C

CHASSIS MOUNTED PARTS

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
L635	51	CHASSIS	V635	6J	CHASSIS

MANUAL BINDER

MANUAL BINDER

PULL OUT PAGE TABS FOR CIRCUIT BOARD ILLUSTRATION

ASSEMBLY NUMBER AND CIRCUIT BOARD NAME

ILLUSTRATION FOR INSTRUMENT CIRCUIT BOARD LOCATION

4. Determine the Circuit Board Illustration and Component Location

a. From the schematic diagram, determine the Assembly Number of the circuit board on which the component is mounted. This information is boxed and located in a corner of the heavy line that distinguishes the board outline.

b. Scan the Component Location Table for the Assembly Number just determined and find the Circuit Number of the desired component.

c. Under the BOARD LOCATION column, read the grid coordinates for the desired component.

5. Locate the Component on the Circuit Board

a. In the manual, locate and pull out the tabbed page whose title and Assembly Number correspond with the desired circuit board. This information is on the back side of the tabs.

b. Using the Circuit Number and grid coordinates, locate the component on the Circuit Board Illustration.

c. In the circuit board location illustration, determine the location of the circuit board in the instrument.

d. Find the circuit board in the instrument and compare it with its illustration in the manual to locate the desired component on the board.

Figure 7-2. Locating components on schematic diagram and circuit board illustrations.

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etermine the Circuit Number

Compare the circuit board with its illustration and locate the desired component by area and shape on the illustration.

Scan the table adjacent to the Circuit Board Illustration and find the Circuit Number of the desired component.

Determine the Schematic Diagram Number in which the component is located.

3. Locate the Component on the Schematic Diagram

a. Locate and pull out tabbed page whose number and title correspond with the Schematic Diagram Number just determined in the table. Schematic diagram nomenclature and numbers are printed on the front side of the tabs (facing the front of the manual).

b. Scan the Component Location Table adjacent to the schematic diagram and find the Circuit Number of the desired component.

c. Under the SCHEM LOCATION column, read the grid coordinates for the desired component.

d. Using the Circuit Number and grid coordinates, locate the component on the schematic diagram.

A6 CRT BOARD

COMPONENTS LOCATED ON SCHEMATIC DIAGRAM 10

C602	C632	Q668	R625
C603	C641		R626
C609	C643	R604	R627
C671	C651	R605	R630
C615		R608	R632
C616	Q606	R609	
C617	Q610	R610	
C618	Q615	R614	
C619	Q645	R616	
C624	Q656	R623	
C626	Q665	R624	

COMPONENTS LOCATED ON SCHEMATIC DIAGRAM 11

C670	Q670	R677	
C671	Q672	R679	
C673	Q673	R680	
C680			
C681	R671	U617	
P603	R673	U618	
P607	R674	U619	
Q669	R675		

CRT CIRCUIT DIAGRAM 10

MANUAL BINDER

A6 ASSEMBLY

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
C602	2C	3C	Q656	2F	2B
C603	1C	1G	Q665	1G	1B
C609	4E	2E	Q668	2G	2B
C612	7C	3E			
C615	7C	3D	R604	4C	1E
C616	2C	3C	R605	5D	1E
C617	7D	3D	R608	4E	1D
C618	7E	3E	R609	4E	2D
C619	6E	3C	R610	7B	3E
C624	4F	3D	R614	7C	3D
C626	7G	2D	R616	1C	3D
C632	8G	1E	R623	4D	2E
C643	3D	4B	R625	7F	2D
C651	3E	3B	R626	7F	2D
			R627	7G	1D
			R630	4F	1D
Q606	4E	2D			
Q610	7C	3D	TP624	3B	2D
Q615	7D	3D			
Q645	3E	3B	U615	1D	3C

CHASSIS MOUNTED PARTS

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
L635	5I	CHASSIS	V635	6J	CHASSIS

COMPONENT LOCATION TABLE

PULL OUT PAGE TABS FOR SCHEMATIC DIAGRAMS

CRT CIRCUIT 10

PARTIAL A6 CRT CIRCUIT BOARD

CRT CIRCUIT 10

SCHEMATIC DIAGRAM NAME AND NUMBER

Numeral and letter at signal lines to or from other diagrams indicates the grid coordinates on another schematic (for example: 4E)

To identify any component in a schematic diagram and to locate that component on its respective circuit board.

ILLUSTRATION FOR INSTRUMENT CIRCUIT BOARD LOCATION

d Illustration and Component

agram, determine the Assembly oard on which the component is on is boxed and located in a corner istinguishes the board outline.

Location Table for the Assembly l and find the Circuit Number of the

OCATION column, read the grid red component.

s on schematic diagram and circuit board illustrations.

(3516-81)4206-33

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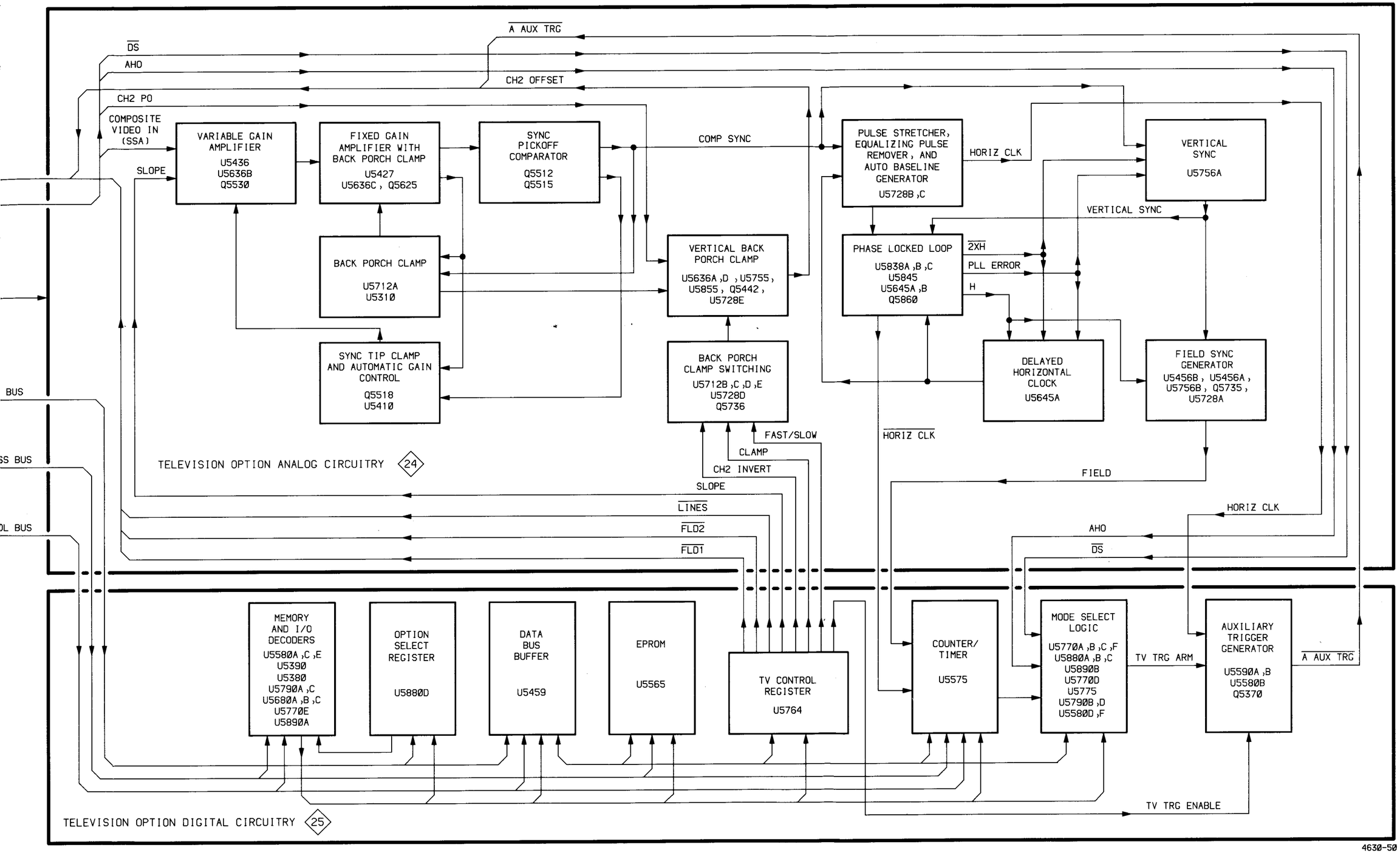

Figure 7-3. Detailed block diagram.

STANDARD OSCILLOSCOPE

BUFFER BOARD ANALOG AND POWER DISTRIBUTION 21

SIGNALS FROM OPTION

SIGNALS TO OPTION

ANALOG SIGNALS FROM BUFFER BOARD

ANALOG SIGNALS TO BUFFER BOARD

POWER SUPPLIES

POWER TO ALL CIRCUITS

DATA BUS BUFFER U4255

DATA BUS

ADDRESS BUS BUFFERS U4235, U4245

ADDRESS BUS

CONTROL BUS BUFFERS U4225, U4265

CONTROL BUS

MICROPROCESSOR BUS

ROM U4260

EAROM BUS

OPTION EAROM U4207

BUFFER BOARD DIGITAL DISTRIBUTION 20

$\overline{DS}$

AHO

CH2 PO

COMPOSITE VIDEO IN (SSA)

SLOPE

VARIABLE GAIN AMPLIFIER U5436 U5636B Q5530

FIXED GAIN AMPLIFIER WITH BACK PORCH CLAMP U5427 U5636C, Q5625

SYNC PICKOFF COMPARATOR Q5512 Q5515

BACK PORCH CLAMP U5712A U5310

SYNC TIP CLAMP AND AUTOMATIC GAIN CONTROL Q5518 U5410

$\overline{A\ AUX\ TRG}$

CH2 OFFSET

COMP SYNC

VERTICAL BACK PORCH CLAMP U5636A,D, U5755, U5855, Q5442, U5728E

BACK PORCH CLAMP SWITCHING U5712B,C,D,E U5728D Q5736

FAST/SLOW

CLAMP

CH2 INVERT

SLOPE

$\overline{LINES}$

$\overline{FLD2}$

$\overline{FLD1}$

TELEVISION OPTION ANALOG CIRCUITRY 24

MEMORY AND I/O DECODERS U5580A,C,E U5390 U5380 U5790A,C U5680A,B,C U5770E U5890A

OPTION SELECT REGISTER U5880D

DATA BUS BUFFER U5459

EPROM U5565

TV CONTROL REGISTER U5764

TELEVISION OPTION DIGITAL CIRCUITRY 25

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Figure 7-3. Detailed block diagram.

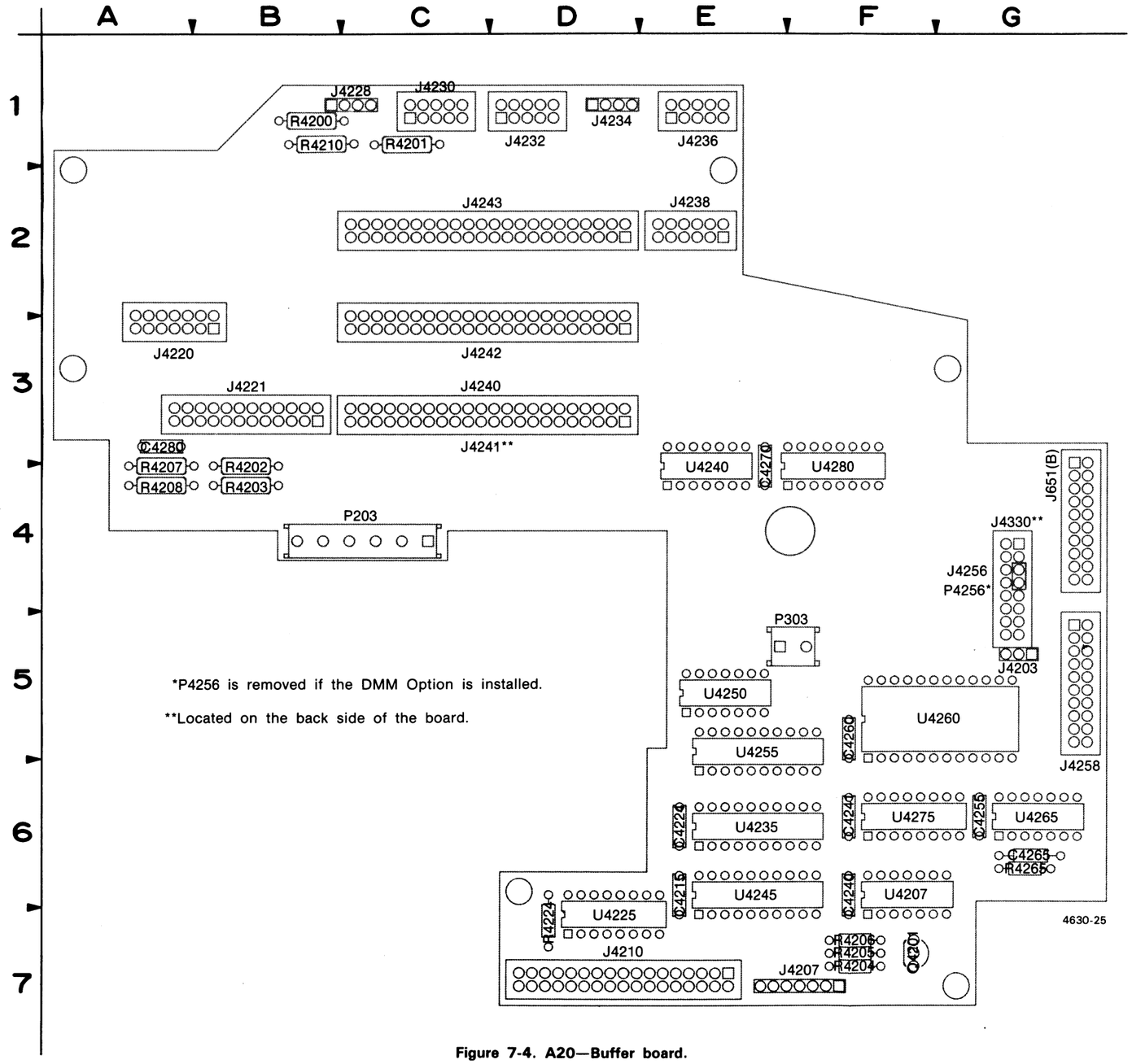
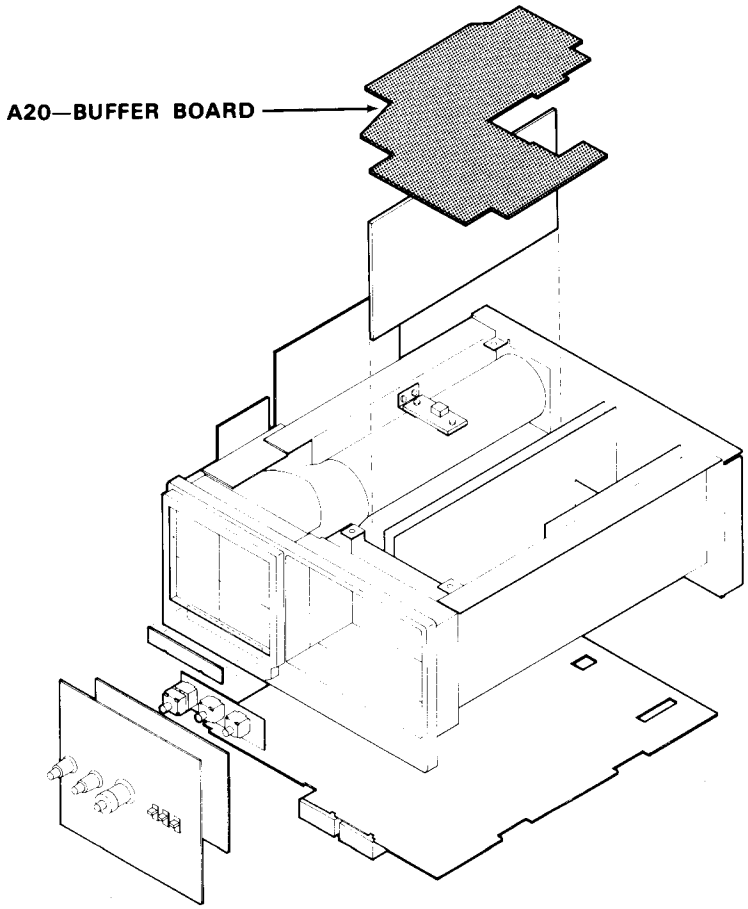


Figure 7-4. A20—Buffer board.

Scans by => ARTEK MEDIA © 2003-2005

A20—BUFFER BOARD

CIRCUIT NUMBER	SCHEM NUMBER	CIRCUIT NUMBER	SCHEM NUMBER	CIRCUIT NUMBER	SCHEM NUMBER
C4215	21	J4243	20	U4225	21
C4224	21	J4243	21	U4235	20
C4240	21	J4256	20	U4235	21
C4241	21	J4258	21	U4240	20
C4255	21	J4330	20	U4240	20
C4260	21	J4330	21	U4240	20
C4265	20	J651(B)	21	U4240	21
C4270	21	P203	21	U4245	20
C4280	21	P303	21	U4245	21
J4203	21	P4256	20	U4250	20
J4207	20	Q4201	20	U4250	20
J4210	20	R4200	21	U4250	20
J4220	21	R4201	21	U4250	21
J4221	21	R4202	21	U4255	20
J4228	21	R4203	21	U4255	21
J4230	21	R4204	20	U4260	20
J4232	21	R4205	20	U4260	21
J4234	21	R4206	20	U4265	20
J4236	21	R4207	21	U4265	20
J4238	21	R4208	21	U4265	20
J4240	20	R4210	21	U4265	20
J4240	21	R4224	20	U4265	21
J4241	20	R4265	20	U4275	20
J4241	21	U4207	20	U4275	21
J4242	20	U4207	20	U4280	20
J4242	21	U4225	20	U4280	21



Scans by ARTEK MEDIA =>

BUFFER BOARD DIGITAL DISTRIBUTION

ASSEMBLY A20

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
C4265	2C	6G	R4204	9B	7F	U4250A	9G	5E
			R4205	9B	7F	U4250B	4E	5E
J4207	7B	7F	R4206	9B	7F	U4250C	10F	5E
J4210	1B	7D	R4224	2B	7D	U4255	3G	5E
J4240	3L	3C	R4265	2C	6G	U4260	5F	5G
J4241	3J	3C				U4265A	3F	6G
J4242	3N	3C	U4207	7C	6F	U4265B	4F	6G
J4243	1S	2C	U4207	9C	6F	U4265C	2C	6G
J4256	9G	4G	U4225	2B	7D	U4265D	1B	6G
J4330	7J	4G	U4235	4B	6E	U4275	3E	6F
			U4240A	4D	4E	U4280	8F	4F
P4256	10H	4G	U4240B	9F	4E			
			U4240C	4D	4E			
Q4201	9B	7F	U4245	3B	6E			

Partial A20 also shown on diagram 21.

CHASSIS MOUNTED PARTS

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
P500	1A	CHASSIS	P4210	1A	CHASSIS	W4210	6A	CHASSIS
P502	7A	CHASSIS						
P4207	7A	CHASSIS	W4207	9A	CHASSIS			

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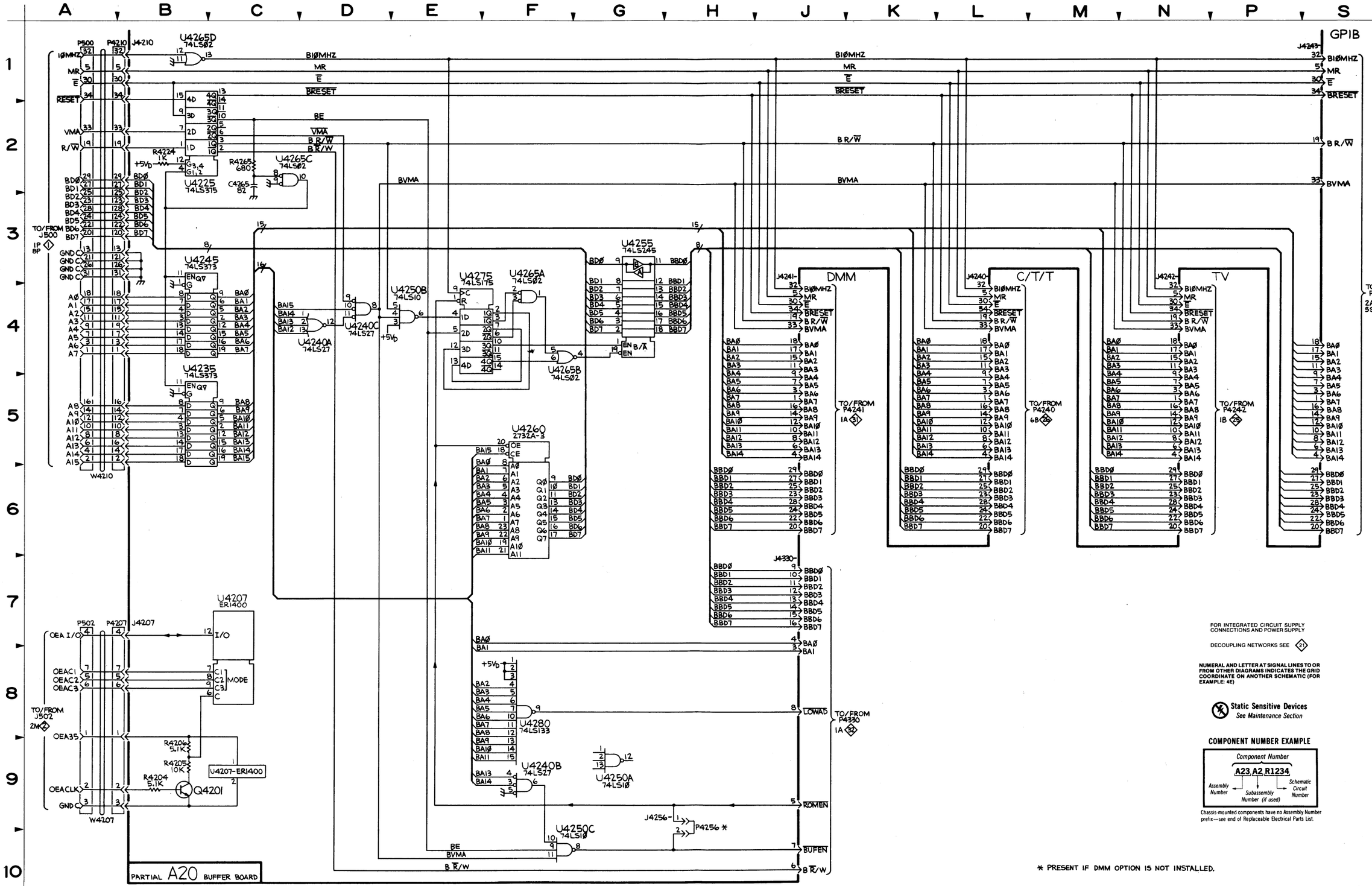

2445/2465 OPTION 05 (TELEVISION OPTION)

4630-10

FOR INTEGRATED CIRCUIT SUPPLY CONNECTIONS AND POWER SUPPLY

DECOUPLING NETWORKS SEE 21

NUMERAL AND LETTER AT SIGNAL LINES TO OR FROM OTHER DIAGRAMS INDICATES THE GRID COORDINATE ON ANOTHER SCHEMATIC (FOR EXAMPLE: 4E)

Static Sensitive Devices
See Maintenance Section

COMPONENT NUMBER EXAMPLE

Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.

* PRESENT IF DMM OPTION IS NOT INSTALLED.

BUFFER BOARD DIGITAL DISTRIBUTION 20

CHASSIS MOUNTED PARTS

CIRCUIT NUMBER	SCHEM NUMBER	SCHEM LOCATION	CIRCUIT NUMBER	SCHEM NUMBER	SCHEM LOCATION
P100	21	3A	P4234	21	5B
P101	21	6A	P4236	21	6B
P102	21	4A	P4258	21	1P
P103	21	3A	P651(B)	21	1S
P104	21	5A			
P109	21	3A	W4203	21	9S
P500	20	1A	W4207	20	9A
P502	20	7A	W4210	20	6A
P602	21	8S	W4228	21	3B
P4203	21	8P	W4230	21	3A
P4207	20	7A	W4232	21	5B
P4210	20	1A	W4234	21	6B
P4228	21	3B	W4236	21	7B
P4230	21	3B			
P4232	21	4B			

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BUFFER BOARD ANALOG AND POWER DISTRIBUTIONS 21

ASSEMBLY A20

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
C4215	9C	6E	J4236	6B	1E	R4203	5D	4B
C4224	9C	6E	J4238	5P	2E	R4207	4C	4A
C4240	9C	6F	J4240	7J	3C	R4208	4C	4A
C4241	9C	6F	J4241	7F	3C	R4210	3C	1B
C4255	9C	6G	J4242	7L	3C			
C4260	9C	5F	J4243	6P	2C	U4225	9D	7D
C4270	9C	4E	J4258	1P	6G	U4235	9D	6E
C4280	10B	3A	J4330	7F	4G	U4240	9E	4E
			J651(B)	1B	4G	U4245	9D	6E
J4203	8P	5G				U4250	9E	5E
J4220	5L	3A	P203	9B	4C	U4255	9D	5E
J4221	5J	3B	P303	8B	5F	U4260	9C	5G
J4228	3B	1C				U4265	9E	6G
J4230	3B	1C	R4200	4B	1B	U4275	9D	6F
J4232	4B	1D	R4201	4C	1C	U4280	9D	4F
J4234	5B	1D	R4202	5D	4B			

Partial A20 also shown on diagram 20.

CHASSIS MOUNTED PARTS

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
P100	3A	CHASSIS	P4228	3B	CHASSIS	W4203	9S	CHASSIS
P101	6A	CHASSIS	P4230	3B	CHASSIS	W4228	3B	CHASSIS
P102	4A	CHASSIS	P4232	4B	CHASSIS	W4230	3A	CHASSIS
P103	3A	CHASSIS	P4234	5B	CHASSIS	W4232	5B	CHASSIS
P104	5A	CHASSIS	P4236	6B	CHASSIS	W4234	6B	CHASSIS
P109	3A	CHASSIS	P4258	1P	CHASSIS	W4236	7B	CHASSIS
P602	8S	CHASSIS	P651(B)	1S	CHASSIS	W4258	3S	CHASSIS
P4203	8P	CHASSIS						

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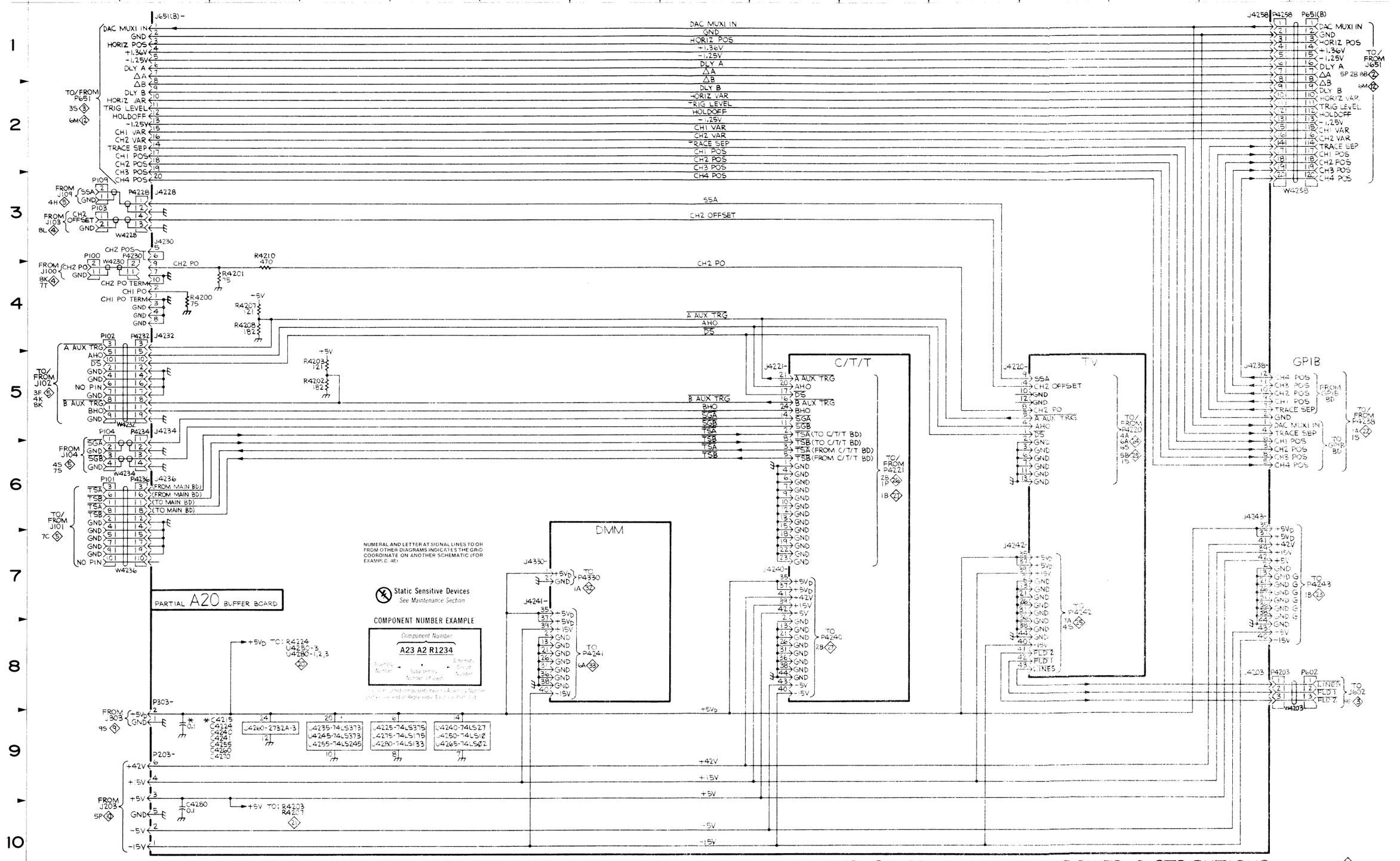

ANALOG CIRCUITRY 24

ASSEMBLY A25

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
C5331	2D	1C	P4220	6A	1B	R5622	1G	3A	R5850	6L	4D
C5419	6C	2A	P4220	7S	1B	R5623	3E	3B	R5851	5K	4D
C5540	6B	2C				R5624	3E	3B	R5852	4K	4D
C5543	7H	2C	Q5442	7F	2C	R5626	2D	3B	R5853	6L	4D
C5545	7F	3C	Q5512	1F	2A	R5627	1F	3B	R5864	2L	4E
C5612	2F	3A	Q5515	1F	2A	R5628	2C	3B	R5868	4L	4E
C5613	5H	3A	Q5518	4H	3A	R5629	5B	3B			
C5625	3D	3B	Q5528	2D	2B	R5652	1S	3D	U5310	4H	2A
C5627	2C	3B	Q5530	5C	2B	R5656	5N	3D	U5410	3H	2A
C5630	6A	3B	Q5625	3E	3B	R5657	4N	3D	U5427A	4E	2B
C5631	5D	3B	Q5735	4S	3C	R5720	3G	3B	U5427B	4F	2B
C5639	2B	3B	Q5736	8G	3C	R5722	5F	3B	U5427C	6E	2B
C5640	7F	3C	Q5860	4L	4E	R5723	5F	4B	U5427D	2D	2B
C5651	4P	3D				R5725	8C	4B	U5427E	6E	2B
C5720	5G	4B	R5319	4G	1A	R5729	8F	4B	U5436	5C	2C
C5724	4F	4B	R5322	5D	1B	R5732	2C	3C	U5456A	1P	2D
C5726	5F	4B	R5329	5D	1B	R5733	8C	3C	U5456B	2P	2D
C5728	8F	4B	R5330	3C	1B	R5735	3G	4C	U5636A	7G	3C
C5734	3F	4C	R5333	5B	1C	R5736	2G	4C	U5636B	5B	3C
C5740	4S	3C	R5334	4D	1C	R5737	5F	4C	U5636C	4E	3C
C5755	7B	4D	R5335	4D	1C	R5738	3F	4C	U5636D	7G	3C
C5773	2K	4F	R5336	5D	1C	R5739	2H	4C	U5645A	5N	3C
C5775	4M	4F	R5421	6C	2B	R5750	4M	3D	U5645B	6N	3C
C5830	2H	4B	R5422	4H	2B	R5752	4M	3D	U5712A	5G	4A
C5848	5K	4C	R5423	4D	2B	R5754	6B	4D	U5712B	10E	4A
C5853	6L	4D	R5424	5D	2B	R5755	4L	4D	U5712C	9E	4A
C5865	4L	4E	R5429	6E	2B	R5771	2K	4F	U5712D	8C	4A
			R5432	2C	2B	R5810	5G	4A	U5712E	8B	4A
CR5522	3F	2A	R5433	5A	2C	R5811	5G	4A	U5728A	4S	3B
CR5526	3E	2B	R5434	4B	2C	R5812	9E	4A	U5728B	2J	3B
CR5623	3E	3B	R5443	3P	2C	R5813	9C	4A	U5728C	3H	3B
CR5641	5E	3C	R5444	4P	2C	R5820	9E	4A	U5728D	8D	3B
CR5653	2S	3D	R5445	4S	2C	R5822	10B	4B	U5728E	7D	3B
CR5655	3S	3D	R5519	5H	2A	R5823	5G	4B	U5755	6E	4D
CR5721	3H	3B	R5523	4H	2B	R5824	4G	4B	U5756A	1N	3D
CR5735	3G	4C	R5524	1E	2B	R5825	9C	4B	U5756B	4P	3D
CR5751	4M	3D	R5525	3F	2B	R5826	9C	4B	U5838A	5M	4C
CR5772	2K	4F	R5540	4B	2C	R5827	7C	4B	U5838B	3J	4C
CR5774	2J	4F	R5541	4B	2C	R5828	7D	4B	U5838C	4J	4C
CR5776	4M	4F	R5542	8G	2C	R5829	2G	4B	U5845	3K	4D
CR5823	4G	4B	R5544	7G	3C	R5830	2J	4C	U5855	7E	4D
CR5825	2H	4B	R5556	6M	2D	R5831	9G	4C			
CR5831	3H	4C	R5557	5P	3D	R5832	3J	4C	VR5420	6D	2B
CR5867	4M	4E	R5610	4F	3A	R5833	8D	4C	VR5866	4M	4E
			R5611	1G	3A	R5834	8D	4C			
P4220	4A	1B	R5612	1E	3A	R5847	5J	4C			

Partial A25 also shown on diagram 25.

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WAVEFORMS

SYNC PICKOFF COMPARATOR

FIXED GAIN AMPLIFIER WITH BACK PORCH CLAMP

VARIABLE GAIN AMPLIFIER

PULSE STRETCHER, EQUALIZING PULSE REMOVER, AND AUTO BASELINE GENERATOR

SYNC-TIP CLAMP AND AUTOMATIC GAIN CONTROL

BACK-PORCH CLAMP

VERTICAL BACK PORCH CLAMP

BACK PORCH CLAMP SWITCHING

PHASE LOCKED LOOP

VERTICAL SYNC

FIELD SYNC GENERATOR

DELAYED HORIZONTAL CLOCK

FOR INTEGRATED CIRCUIT SUPPLY CONNECTIONS AND POWER SUPPLY DECOUPLING NETWORKS SEE 25

NUMERAL AND LETTER AT SIGNAL LINES TO OR FROM OTHER DIAGRAMS INDICATES THE GRID COORDINATES ON ANOTHER SCHEMATIC (FOR EXAMPLE: 4E)

Static Sensitive Devices
See Maintenance Section

COMPONENT NUMBER EXAMPLE

Component Number: A23,A2,R1234
Assembly Number; Subassembly Number (if used); Schematic Circuit Number

Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.

PARTIAL A25 TELEVISION OPTION BOARD

A25—TV BOARD

CIRCUIT NUMBER	SCHEM NUMBER	CIRCUIT NUMBER	SCHEM NUMBER	CIRCUIT NUMBER	SCHEM NUMBER	CIRCUIT NUMBER	SCHEM NUMBER
C5331	24	Q5530	24	R5756	25	U5636	24
C5374	25	Q5625	24	R5760	25	U5636	24
C5419	24	Q5735	24	R5771	24	U5636	24
C5458	25	Q5736	24	R5810	24	U5636	25
C5465	25	Q5860	24	R5811	24	U5645	24
C5490	25	R5319	24	R5812	24	U5645	24
C5540	24	R5322	24	R5813	24	U5645	25
C5543	24	R5329	24	R5820	24	U5680	25
C5545	24	R5330	24	R5822	24	U5680	25
C5612	24	R5333	24	R5823	24	U5680	25
C5613	24	R5334	24	R5824	24	U5680	25
C5625	24	R5335	24	R5825	24	U5712	24
C5627	24	R5336	24	R5826	24	U5712	24
C5630	24	R5370	25	R5827	24	U5712	24
C5631	24	R5371	25	R5828	24	U5712	24
C5633	25	R5421	24	R5829	24	U5712	24
C5639	24	R5422	24	R5830	24	U5712	25
C5640	24	R5423	24	R5831	24	U5728	24
C5651	24	R5424	24	R5832	24	U5728	24
C5690	25	R5429	24	R5833	24	U5728	24
C5720	24	R5432	24	R5834	24	U5728	24
C5724	24	R5433	24	R5847	24	U5728	24
C5726	24	R5434	24	R5850	24	U5728	25
C5728	24	R5443	24	R5851	24	U5755	24
C5731	25	R5444	24	R5852	24	U5755	25
C5734	24	R5445	24	R5853	24	U5756	24
C5740	24	R5519	24	R5864	24	U5756	24
C5755	24	R5523	24	R5868	24	U5756	25
C5757	25	R5524	24	R5891	25	U5764	25
C5770	25	R5525	24	U5310	24	U5764	25
C5773	24	R5540	24	U5310	25	U5770	25
C5775	24	R5541	24	U5315	25	U5770	25
C5810	25	R5542	24	U5380	25	U5770	25
C5830	24	R5544	24	U5380	25	U5770	25
C5848	24	R5556	24	U5390	25	U5770	25
C5853	24	R5557	24	U5390	25	U5770	25
C5865	24	R5610	24	U5390	25	U5770	25
CR5522	24	R5611	24	U5390	25	U5775	25
CR5526	24	R5612	24	U5390	25	U5775	25
CR5623	24	R5622	24	U5410	24	U5775	25
CR5641	24	R5623	24	U5410	25	U5775	25
CR5653	24	R5624	24	U5427	24	U5775	25
CR5655	24	R5626	24	U5427	24	U5790	25
CR5721	24	R5627	24	U5427	24	U5790	25
CR5735	24	R5628	24	U5427	24	U5790	25
CR5751	24	R5629	24	U5427	24	U5790	25
CR5772	24	R5632	25	U5436	24	U5790	25
CR5774	24	R5652	24	U5456	24	U5838	24
CR5776	24	R5656	24	U5456	24	U5838	24
CR5823	24	R5657	24	U5456	25	U5838	24
CR5825	24	R5720	24	U5459	25	U5838	25
CR5831	24	R5722	24	U5459	25	U5845	24
CR5867	24	R5723	24	U5565	25	U5845	25
P4220	24	R5725	24	U5565	25	U5855	24
P4220	24	R5729	24	U5575	25	U5855	25
P4220	24	R5730	25	U5575	25	U5880	25
P4220	25	R5732	24	U5580	25	U5880	25
P4220	25	R5733	24	U5580	25	U5880	25
P4242	25	R5735	24	U5580	25	U5880	25
P4242	25	R5736	24	U5580	25	U5880	25
P4242	25	R5737	24	U5580	25	U5890	25
Q5370	25	R5738	24	U5580	25	U5890	25
Q5442	24	R5739	24	U5580	25	U5890	25
Q5512	24	R5750	24	U5590	25	U5890	25
Q5515	24	R5752	24	U5590	25	U5890	25
Q5518	24	R5754	24	U5590	25	VR5420	24
Q5528	24	R5755	24	U5636	24	VR5866	24

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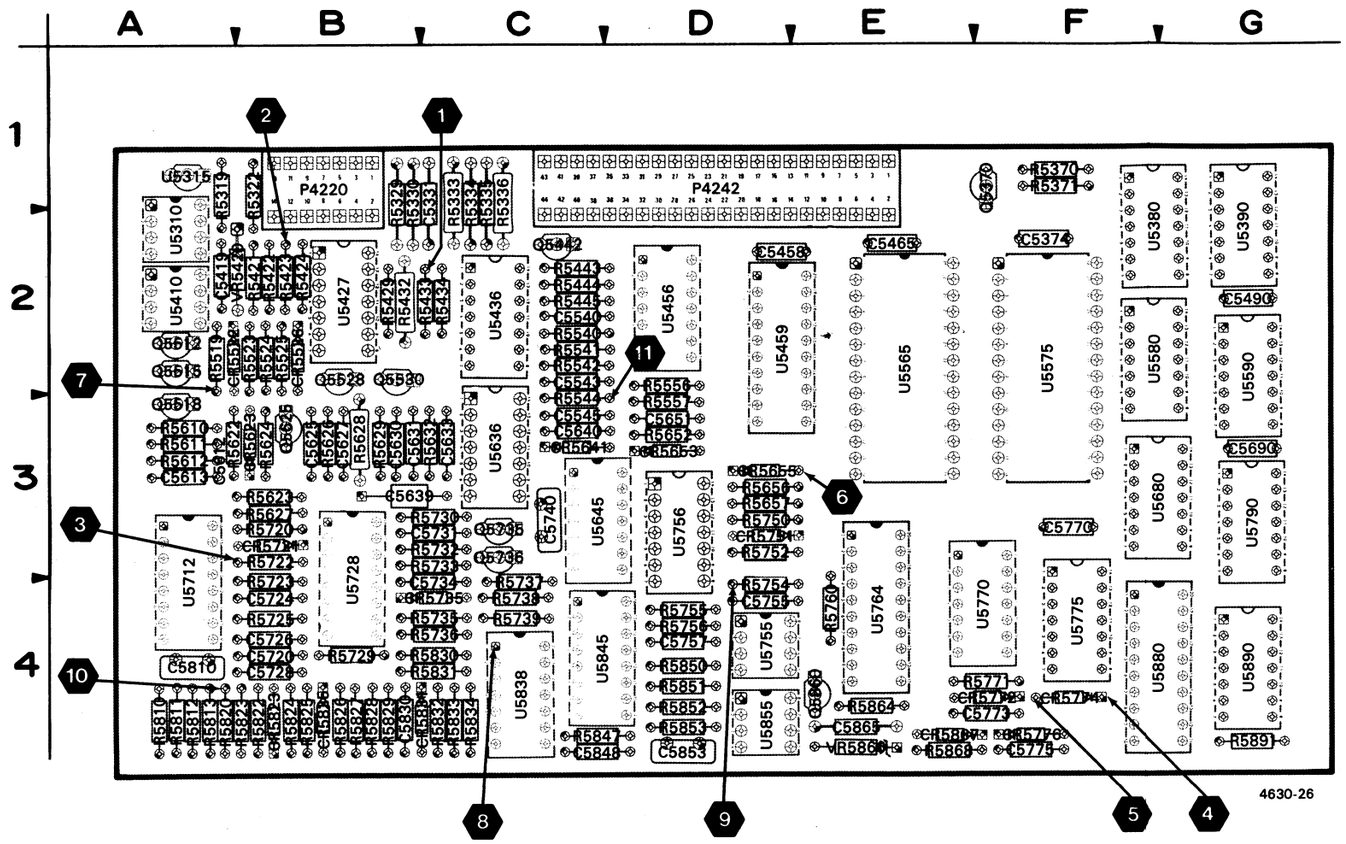
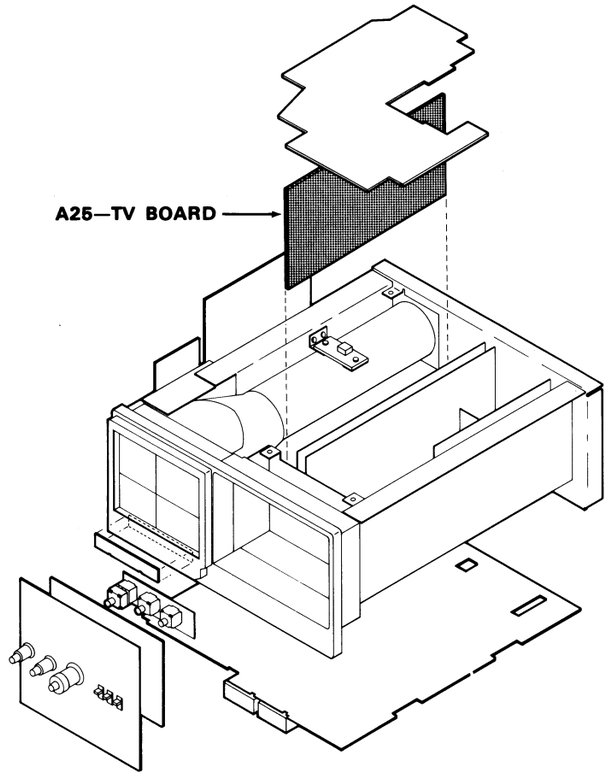
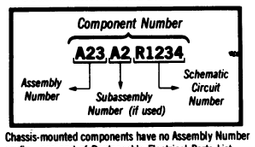


Figure 7-5. A25—TV board.



Static Sensitive Devices
See Maintenance Section

COMPONENT NUMBER EXAMPLE



Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.

DIGITAL CIRCUITRY AND POWER DISTRIBUTION

ASSEMBLY A25

CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEM LOCATION	BOARD LOCATION
C5374	7B	2F	U5390B	3C	2G	U5764	4J	4E
C5458	7B	2D	U5390C	2C	2G	U5764	7D	4E
C5465	7B	2E	U5390D	2D	2G	U5770A	3H	4F
C5490	7B	2G	U5390	7D	2G	U5770B	4H	4F
C5633	9G	3C	U5410	9H	2A	U5770C	4H	4F
C5690	7B	3G	U5456	9D	2D	U5770D	3K	4F
C5731	9G	3C	U5459	4E	2D	U5770E	2E	4F
C5757	9E	4D	U5459	7D	2D	U5770F	3K	4F
C5770	7B	3F	U5565	4G	2E	U5770	8D	4F
C5810	10B	4A	U5565	7C	2E	U5775A	3L	4F
			U5575	1K	2F	U5775B	4L	4F
P4220	1S	1B	U5575	7F	2F	U5775C	3L	4F
P4220	5A	1B	U5580A	1D	2F	U5775D	2L	4F
P4242	1A	1D	U5580B	2P	2F	U5775	8D	4F
P4242	4S	1D	U5580C	3B	2F	U5790A	3E	3G
P4242	7A	1D	U5580D	3M	2F	U5790B	2N	3G
			U5580E	2C	2F	U5790C	2C	3G
Q5370	2P	1F	U5580F	6M	2F	U5790D	3M	3G
			U5580	7D	2F	U5790	8D	3G
R5370	2P	1F	U5590A	3N	2G	U5838	9D	4C
R5371	1P	1F	U5590B	2P	2G	U5845	9D	4D
R5632	9G	3C	U5590	7D	2G	U5855	9H	4D
R5730	9G	3C	U5636	9G	3C	U5880A	3J	4G
R5756	9D	4D	U5645	9D	3C	U5880B	3J	4G
R5760	6J	4E	U5680A	3H	3G	U5880C	3J	4G
R5891	4J	4G	U5680B	3H	3G	U5880D	2D	4G
			U5680C	1E	3G	U5880	7D	4G
U5310	9H	2A	U5680	7D	3G	U5890A	3G	4G
U5315	8C	1A	U5712	9J	4A	U5890B	3K	4G
U5380	2C	2F	U5728	9J	3B	U5890C	4K	4G
U5380	7E	2F	U5755	9H	4D	U5890D	4L	4G
U5390A	3B	2G	U5756	9D	3D	U5890	8D	4G

Partial A25 also shown on diagram 24.

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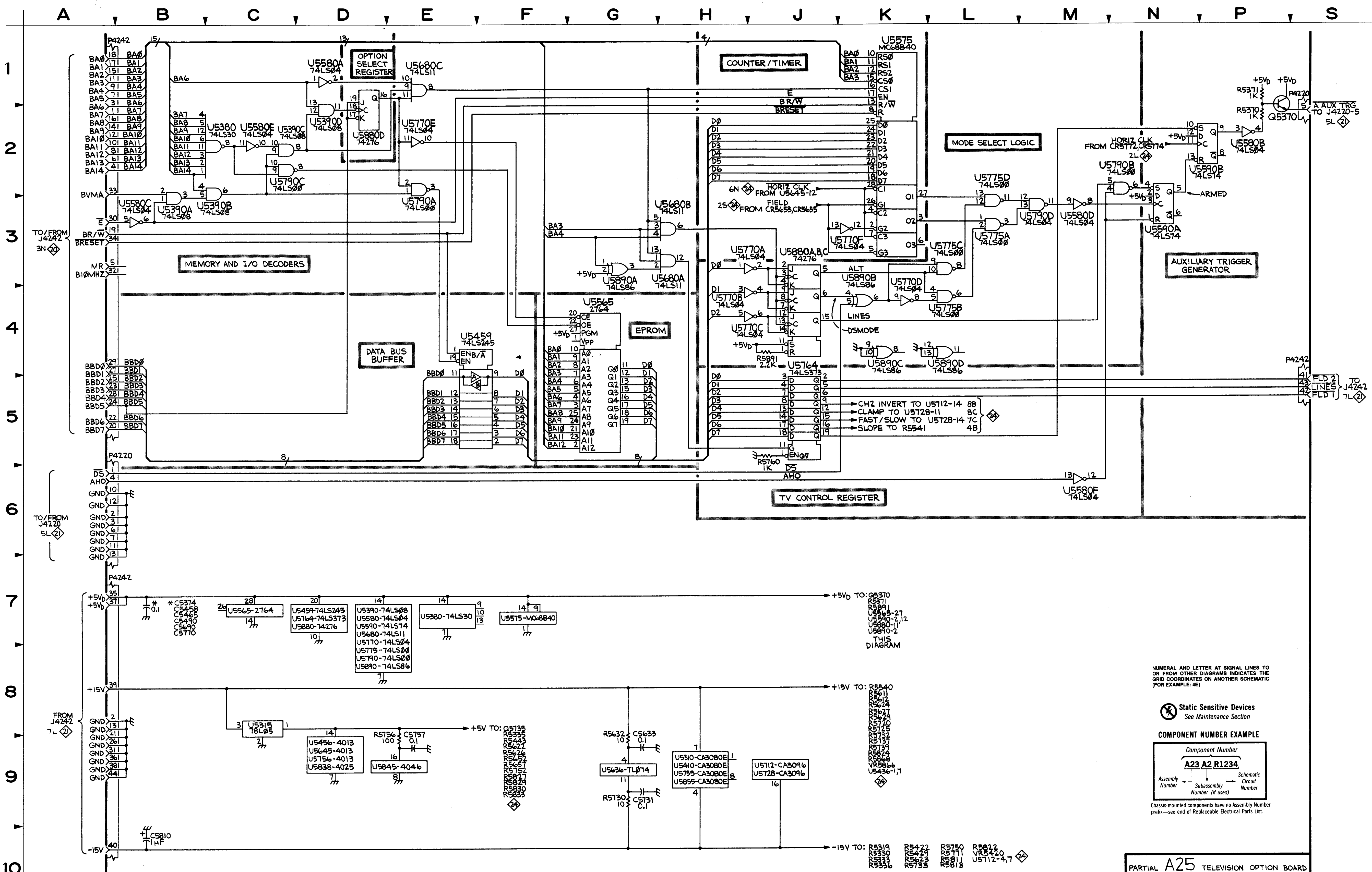

2445/2465 OPTION 05(TELEVISION OPTION)

4630-13

DIGITAL CIRCUITRY AND POWER DISTRIBUTION

TEST WAVEFORM SETUP INFORMATION

The numbered waveforms below were obtained at the test points indicated on the schematic diagram. The waveforms are representative of signals that may be expected at the associated points when the following setup conditions are observed. Any changes from the given setup conditions required to produce a given waveform are noted with that waveform illustration.

2445/2465 OPTION 05 SETUP

Connect a 100 IRE unit composite video signal (NTSC or PAL) to the CH 2 input using a 75 Ω bnc cable and a 75 Ω termination. Set initial front-panel controls as follows:

Vertical

CH 2 POSITION	Midrange
MODE	
CH 1, CH 3, and CH 4	Off (button out)
CH 2	On (button in)
CH 2 Input Coupling	1 MΩ DC
CH 2 VOLTS/DIV	0.2 V
CH 2 VAR	In detent

Horizontal

POSITION	Midrange
X10 MAG	Off (button out)
A SEC/DIV	10 μs (knobs locked)
SEC/DIV VAR	In detent
ΔV and Δt	Displays off

Trigger

MODE	AUTO
SOURCE	CH 2
COUPLING	LINES
HOLDOFF	MIN (Fully CCW)
SLOPE	-

TEST OSCILLOSCOPE SETUP

Using a X10 probe with the test oscilloscope, set its Trigger Slope, Trigger Level, Volts/Div, and Time/Div ranges as required to obtain the indicated displays.

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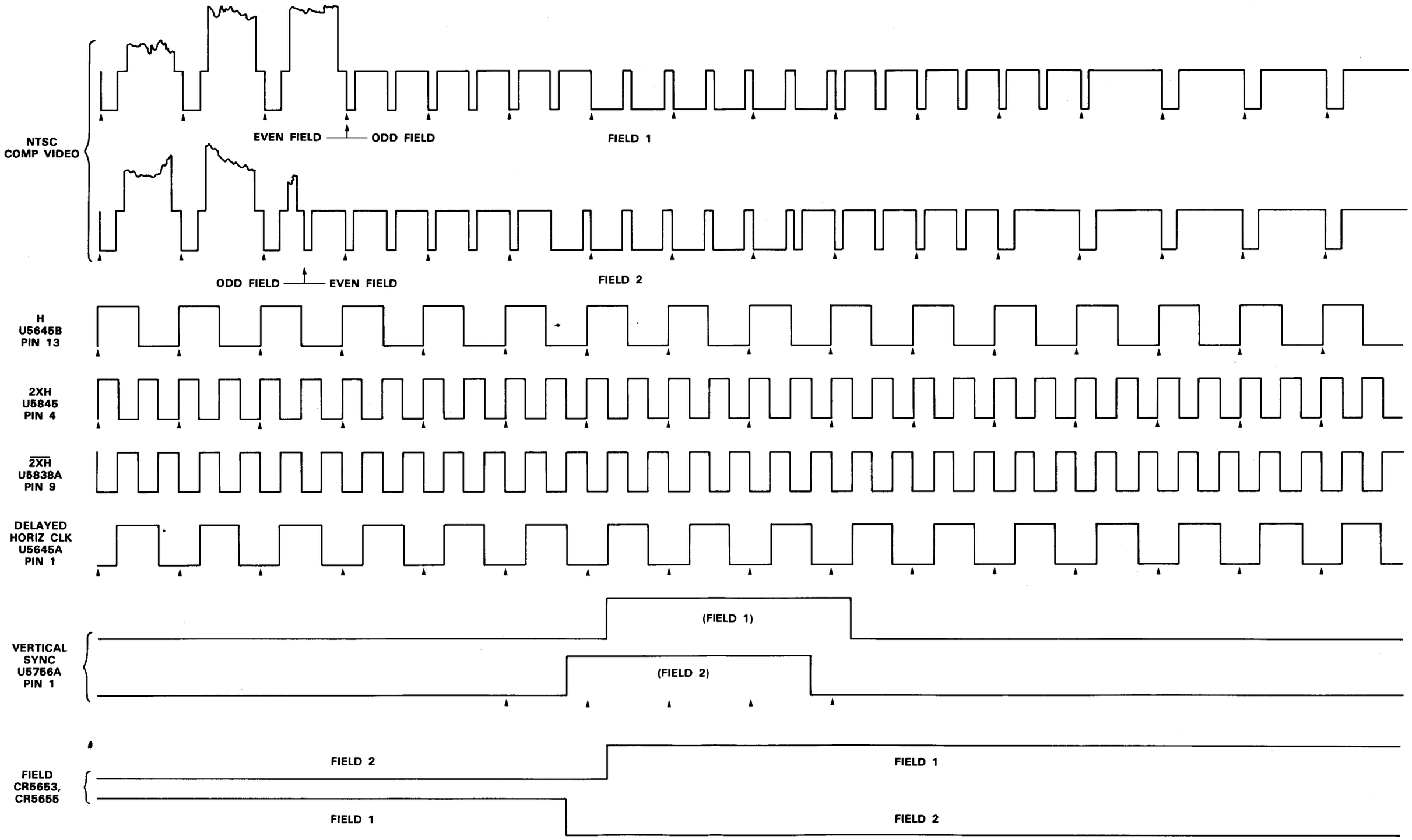

4630-03

Figure 7-6. TV Option timing diagram.

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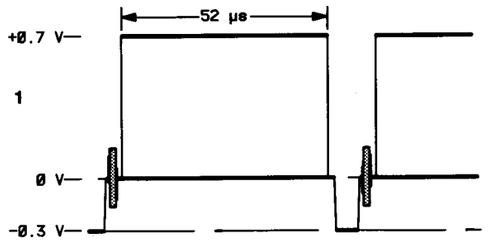
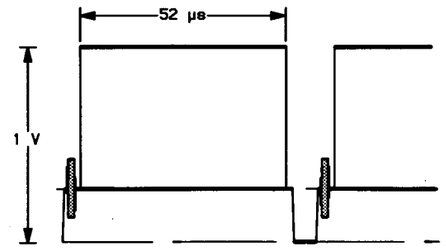
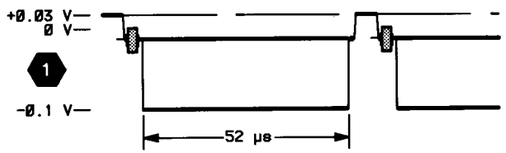
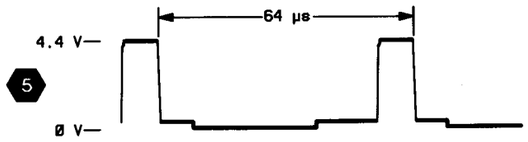
INPUT SIGNAL WHILE OBSERVING WAVEFORMS 1 THROUGH 8.

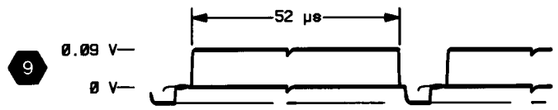


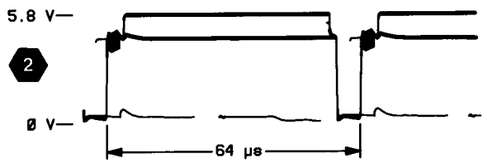
INPUT SIGNAL WHILE OBSERVING WAVEFORMS 9 THROUGH 11. CONNECT A FIELD SQUARE WAVE FROM A TV GENERATOR TO THE CH 2 INPUT. SET CH 2 INPUT COUPLING TO TV CLAMP.

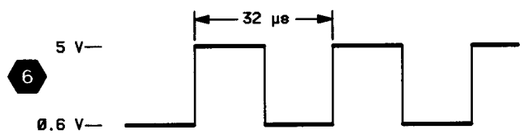


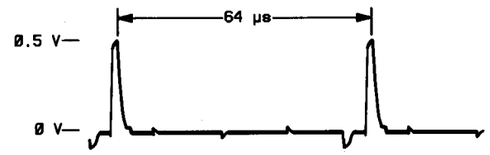


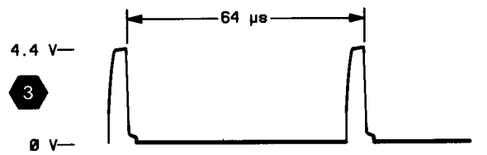


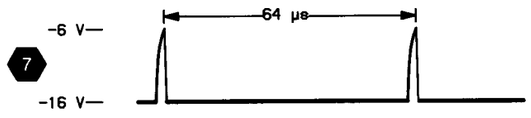


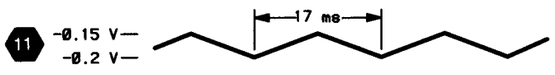


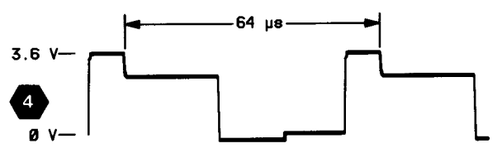


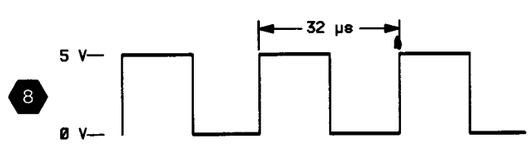












A AND B SEC/DIV 5 ms.

4638-52

J100 A1 TO A20

Pin	Line Name	Schem
1	CH1 PO TERM	4
2	CH1 PO	4
3	GND	4
4	GND	4
5	CH2 POS	4
6	CH2 POS	4
7	GND	4
8	GND	4
9	CH2 PO	4
10	CH2 PO TERM	4

P100 A1 TO A20

Pin	Line Name	Schem
1	GND	21
2	CH2 PO	21

J/P101 A1 TO A20

Pin	Line Name	Schem
1	$\overline{TSA}$	5,21
2	GND	5,21
3	$\overline{TSA}$	5,21
4	GND	5,21
5	GND	5,21
6	$\overline{TSB}$	5,21
7	GND	5,21
8	$\overline{TSB}$	5,21
9	GND	5,21
10	NO PIN	5,21

J/P102 A1 TO A20

Pin	Line Name	Schem
1	BHO	5,21
2	GND	5,21
3	$\overline{A\ AUX\ TRG}$	5,21
4	GND	5,21
5	AHO	5,21
6	NO PIN	5,21
7	GND	5,21
8	$\overline{B\ AUX\ TRG}$	5,21
9	GND	5,21
10	$\overline{DS}$	5,21

J/P500 A5 TO A20

Pin	Line Name	Schem
1	A7	1,20
2	A15	1,20
3	A6	1,20
4	A14	1,20
5	MR	1,20
6	A13	1,20
7	A5	1,20
8	A12	1,20
9	A4	1,20
10	A11	1,20
11	A3	1,20
12	A10	1,20
13	GND C	1,20
14	A9	1,20
15	A2	1,20
16	A8	1,20
17	A1	1,20
18	A0	1,20
19	$R/\overline{W}$	1,20
20	BD7	1,20
21	GND C	1,20
22	BD6	1,20
23	BD3	1,20
24	BD5	1,20
25	BD2	1,20
26	GND C	1,20
27	BD1	1,20
28	BD4	1,20
29	BD0	1,20
30	$\overline{E}$	1,20
31	GND C	1,20
32	10MHz	1,20
33	VMA	1,20
34	$\overline{RESET}$	1,20

J/P502 A5 TO A20

Pin	Line Name	Schem
1	OEA35	2,20
2	OEACLK	2,20
3	GND C	2,20
4	OEAI/O	2,20
5	OEAC2	2,20
6	OEAC3	2,20
7	OEAC1	2,20

J651(B)/P651/W651 A6 TO A20

Pin	Line Name	Schem
1	DAC MUX1 IN	3,21
2	GND	12,21
3	HORIZ POS	3,21
4	+1.36V	3,21
5	-1.25V	3,21
6	DLY A	3,21
7	△A	3,21
8	△B	3,21
9	DLY B	3,21
10	HORIZ VAR	3,21
11	TRIG LEVEL	3,21
12	HOLDOFF	3,21
13	-1.25V	3,21
14	TRACE SEP	3,21
15	CH1 VAR	3,21
16	CH2 VAR	3,21
17	CH1 POS	3,21
18	CH2 POS	3,21
19	CH3 POS	3,21
20	CH4 POS	3,21

J651/P651(B) A20 TO A5

Pin	Line Name	Schem
1	DAC MUX1 IN	2,21
2	GND	12,21
3	HORIZ POS	2,21
4	+1.36V	2,21
5	-1.25V	2,21
6	DLY A	2,21
7	△A	2,21
8	△B	2,21
9	DLY B	2,21
10	HORIZ VAR	2,21
11	TRIG LEVEL	2,21
12	HOLDOFF	2,21
13	-1.25V	2,21
14	TRACE SEP	2,21
15	CH1 VAR	2,21
16	CH2 VAR	2,21
17	CH1 POS	2,21
18	CH2 POS	2,21
19	CH3 POS	2,21
20	CH4 POS	2,21

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J/P/W4207		A5 TO A20
Pin	Line Name	Schem
1	OEA35	20
2	OEACLK	20
3	GND C	20
4	OEAI/O	20
5	OEAC2	20
6	OEAC3	20
7	OEAC1	20

J/P4220		A20 TO A25
Pin	Line Name	Schem
1	$\overline{DS}$	21,25
2	GND	21,25
3	GND	21,25
4	AHO	21,25
5	$\overline{A\ AUX\ TRG}$	21,25
6	GND	21,25
7	GND	21,25
8	CH2 PO	21,24
9	SSA	21,24
10	GND	21,25
11	GND	21,25
12	GND	21,25
13	GND	21,25
14	CH2 OFFSET	21,24

J4230		A1 TO A20
Pin	Line Name	Schem
1	CH1 PO TERM (GND)	21
2	CH1 PO	21
3	GND	21
4	GND	21
5	CH2 POS	21
6	CH2 POS	21
7	GND	21
8	GND	21
9	CH2 PO	21
10	CH2 PO TERM (GND)	21

J/P/W4210		A5 TO A20
Pin	Line Name	Schem
1	A7	20
2	A15	20
3	A6	20
4	A14	20
5	MR	20
6	A13	20
7	A5	20
8	A12	20
9	A4	20
10	A11	20
11	A3	20
12	A10	20
13	GND C	20
14	A9	20
15	A2	20
16	A8	20
17	A1	20
18	A0	20
19	R/$\overline{W}$	20
20	BD7	20
21	GND C	20
22	BD6	20
23	BD3	20
24	BD5	20
25	BD2	20
26	GND C	20
27	BD1	20
28	BD4	20
29	BD0	20
30	$\overline{E}$	20
31	GND C	20
32	10MHz	20
33	VMA	20
34	$\overline{RESET}$	20

J/P4221		A20 TO A27
Pin	Line Name	Schem
1	GND	21,27
2	$\overline{TSA}$	21,26
3	$\overline{TSA}$	21,26
4	GND	21,27
5	$\overline{TSB}$	21,26
6	GND	21,27
7	GND	21,27
8	$\overline{TSB}$	21,26
9	GND	21,27
10	GND	21,27
11	$\overline{SGB}$	21,26
12	GND	21,27
13	GND	21,27
14	$\overline{SGA}$	21,26
15	GND	21,27
16	$\overline{B\ AUX\ TRG}$	21,26
17	$\overline{DS}$	21,26
18	GND	21,27
19	GND	21,27
20	AHO	21,26
21	$\overline{A\ AUX\ TRG}$	21,26
22	GND	21,27
23	GND	21,27
24	BHO	21,26

P4230		A1 TO A20
Pin	Line Name	Schem
1	GND	21
2	CH2 PO	21

J/P/W4232		A20 TO A1
Pin	Line Name	Schem
1	BHO	21
2	GND	21
3	$\overline{A\ AUX\ TRG}$	21
4	GND	21
5	AHO	21
6	GND	21
7	GND	21
8	$\overline{B\ AUX\ TRG}$	21
9	GND	21
10	$\overline{DS}$	21

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J/P/W4236		A1 TO A20
Pin	Line Name	Schem
1	$\overline{\text{TSA}}$	21
2	GND	21
3	$\overline{\text{TSA}}$	21
4	GND	21
5	GND	21
6	$\overline{\text{TSB}}$	21
7	GND	21
8	$\overline{\text{TSB}}$	21
9	GND	21
10	NO PIN	21

J/P4240		A20 TO A27
Pin	Line Name	Schem
1	BA7	20,26
2	GND	21,27
3	BA6	20,26
4	BA14	20,26
5	MR	20,26
6	BA13	20,26
7	BA5	20,26
8	BA12	20,26
9	BA4	20,26
10	BA11	20,26
11	BA3	20,26
12	BA10	20,26
13	GND	21,27
14	BA9	20,26
15	BA2	20,26
16	BA8	20,26
17	BA1	20,26
18	BA0	20,26
19	BR/$\overline{\text{W}}$	20,26
20	BBD7	20,26
21	GND	21,27
22	BBD6	20,26
23	BBD3	20,26
24	BBD5	20,26
25	BBD2	20,26
26	GND	21,27
27	BBD1	20,26
28	BBD4	20,26
29	BBD0	20,26
30	$\overline{\text{E}}$	20,26
31	GND	21,27
32	B10MHz	20,26
33	BVMA	20,26
34	$\overline{\text{BRESET}}$	20,26
35	$+5V_D$	21,27
36	GND	21,27
37	$+5V_D$	21,27
38	GND	21,27
39	+15V	21,27
40	-15V	21,27
41	+42V	21,27
42	+5V	21,27
43	-5V	21,27
44	GND	21,27

J/P/W4241		A20 TO A29
Pin	Line Name	Schem
1	BA7	20,31
2	GND	21,33
3	BA6	20,31
4	BA14	20,31
5	MR	20,31
6	BA13	20,31
7	BA5	20,31
8	BA12	20,31
9	BA4	20,31
10	BA11	20,31
11	BA3	20,31
12	BA10	20,31
13	GND	21,33
14	BA9	20,31
15	BA2	20,31
16	BA8	20,31
17	BA1	20,31
18	BA0	20,31
19	BR/$\overline{\text{W}}$	20,31
20	BBD7	20,31
21	GND	21,33
22	BBD6	20,31
23	BBD3	20,31
24	BBD5	20,31
25	BBD2	20,31
26	GND	21,33
27	BBD1	20,31
28	BBD4	20,31
29	BBD0	20,31
30	$\overline{\text{E}}$	20,31
31	GND	21,33
32	B10MHz	20,31
33	BVMA	20,31
34	$\overline{\text{BRESET}}$	20,31
35	$+5V_D$	21,33
36	GND	21,33
37	$+5V_D$	21,33
38	GND	21,33
39	+15V	21,33
40	-15V	21,33

J/P4238		A20 TO A23
Pin	Line Name	Schem
1	DAC MUX1 IN	21,22
2	GND	21,22
3	CH2 POS	21,22
4	TRACE SEP	21,22
5	CH4 POS	21,22
6	CH1 POS	21,22
7	TRACE SEP	21,22
8	CH3 POS	21,22
9	CH1 POS	21,22
10	CH2 POS	21,22
11	CH3 POS	21,22
12	CH4 POS	21,22

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J/P4242		A20 TO A25
Pin	Line Name	Schem
1	BA7	20,25
2	GND	21,25
3	BA6	20,25
4	BA14	20,25
5	MR	20,25
6	BA13	20,25
7	BA5	20,25
8	BA12	20,25
9	BA4	20,25
10	BA11	20,25
11	BA3	20,25
12	BA10	20,25
13	GND	21,25
14	BA9	20,25
15	BA2	20,25
16	BA8	20,25
17	BA1	20,25
18	BA0	20,25
19	BR/$\overline{W}$	20,25
20	BBD7	20,25
21	GND	21,25
22	BBD6	20,25
23	BBD3	20,25
24	BBD5	20,25
25	BBD2	20,25
26	GND	21,25
27	BBD1	20,25
28	BBD4	20,25
29	BBD0	20,25
30	$\overline{E}$	20,25
31	GND	21,25
32	B10MHz	20,25
33	BVMA	20,25
34	$\overline{BRESET}$	20,25
35	+5V$_D$	21,25
36	GND	21,25
37	+5V$_D$	21,25
38	GND	21,25
39	+15V	21,25
40	-15V	21,25
41	$\overline{FLD2}$	21,25
42	$\overline{FLD1}$	21,25
43	$\overline{LINES}$	21,25
44	GND	21,25

J/P4243		A20 TO A23
Pin	Line Name	Schem
1	BA7	20,22
2	GND	21,23
3	BA6	20,22
4	BA14	20,22
5	MR	20,22
6	BA13	20,22
7	BA5	20,22
8	BA12	20,22
9	BA4	20,22
10	BA11	20,22
11	BA3	20,22
12	BA10	20,22
13	GND G	21,23
14	BA9	20,22
15	BA2	20,22
16	BA8	20,22
17	BA1	20,22
18	BA0	20,22
19	BR/$\overline{W}$	20,22
20	BBD7	20,22
21	GND G	21,23
22	BBD6	20,22
23	BBD3	20,22
24	BBD5	20,22
25	BBD2	20,22
26	GND G	21,23
27	BBD1	20,22
28	BBD4	20,22
29	BBD0	20,22
30	$\overline{E}$	20,22
31	GND G	21,23
32	B10MHz	20,22
33	BVMA	20,22
34	$\overline{BRESET}$	20,22
35	+5V$_D$	21,23
36	GND G	21,23
37	+5V$_D$	21,23
38	GND G	21,23
39	+15V	21,23
40	-15V	21,23
41	+42V	21,23
42	+5V	21,23
43	-5V	21,23
44	GND	21,23

J/P/W4258		A20 TO A5
Pin	Line Name	Schem
1	DAC MUX1 IN	21
2	GND	21
3	HORIZ POS	21
4	+1.36V	21
5	-1.25V	21
6	DLY A	21
7	$\triangle$A	21
8	$\triangle$B	21
9	DLY B	21
10	HORIZ VAR	21
11	TRIG LEVEL	21
12	HOLDOFF	21
13	-1.25V	21
14	TRACE SEP	21
15	CH1 VAR	21
16	CH2 VAR	21
17	CH1 POS	21
18	CH2 POS	21
19	CH3 POS	21
20	CH4 POS	21

J/P4330		A20 TO A30
Pin	Line Name	Schem
1	+5V$_D$	21,32
2	GND	21,32
3	BA1	20,32
4	BA0	20,32
5	$\overline{ROMEN}$	20,32
6	B$\overline{R}$/W	20,32
7	$\overline{BUFEN}$	20,32
8	$\overline{LOWAD}$	20,32
9	BBD0	20,32
10	BBD1	20,32
11	BBD2	20,32
12	BBD3	20,32
13	BBD4	20,32
14	BBD5	20,32
15	BBD6	20,32
16	BBD7	20,32

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J/P4800 A23 TO GPIB CONNECTOR

Pin	Line Name	Schem
1	DIO1	22
2	DIO5	22
3	DIO2	22
4	DIO6	22
5	DIO3	22
6	DIO7	22
7	DIO4	22
8	DIO8	22
9	EOI	22
10	REN	22
11	DAV	22
12	GND G	22
13	NRFD	22
14	GND G	22
15	NDAC	22
16	GND G	22
17	IFC	22
18	GND G	22
19	SRQ	22
20	GND G	22
21	ATN	22
22	GND G	22
23	GND	22
24	GND G	22

J/P5290 A20 TO A29

Pin	Line Name	Schem
1	BA7	31
2	GND	33
3	BA6	31
4	BA14	31
5	MR	31
6	BA13	31
7	BA5	31
8	BA12	31
9	BA4	31
10	BA11	31
11	BA3	31
12	BA10	31
13	GND	33
14	BA9	31
15	BA2	31
16	BA8	31
17	BA1	31
18	BA0	31
19	BR/$\overline{W}$	31
20	BBD7	31
21	GND	33
22	BBD6	31
23	BBD3	31
24	BBD5	31
25	BBD2	31
26	GND	33
27	BBD1	31
28	BBD4	31
29	BBD0	31
30	$\overline{E}$	31
31	GND	33
32	B10MHz	31
33	BVMA	31
34	$\overline{\text{BRESET}}$	31
35	$+5V_D$	33
36	GND	33
37	$+5V_D$	33
38	GND	33
39	+15V	33
40	-15V	33

J/P/W5990 A27 TO WORD RECOGNIZER CONNECTOR

Pin	Line Name	Schem
1	$\overline{\text{WORD}}$	26,28
2	WDATA	26,28
3	WCLOCK	26,28
4	GND	26,28
5	$+5V_W$	26,28
6	DATA RETURN	26,28

J/P/W6370 WORD RECOGNIZER CONNECTOR TO A32

Pin	Line Name	Schem
1	$\overline{\text{WORD}}$	28
2	WDATA	28
3	WCLOCK	28
4	GND	28
5	$+5V_W$	28
6	DATA RETURN	28
7	GND	28

J/P6380 A32 TO A33

Pin	Line Name	Schem
1	$+5V_W$	28
2	WCLOCK	28
3	SYNCH	28
4	GATED CLOCK	28
5	GND	28

J/P6385 A32 TO A33

Pin	Line Name	Schem
1	GND	28
2	$\overline{\text{LOW BYTE EQUAL}}$	28
3	SERIAL DATA	28
4	GATED Q	28
5	Q DONT CARE	28
6	DATA RETURN	28

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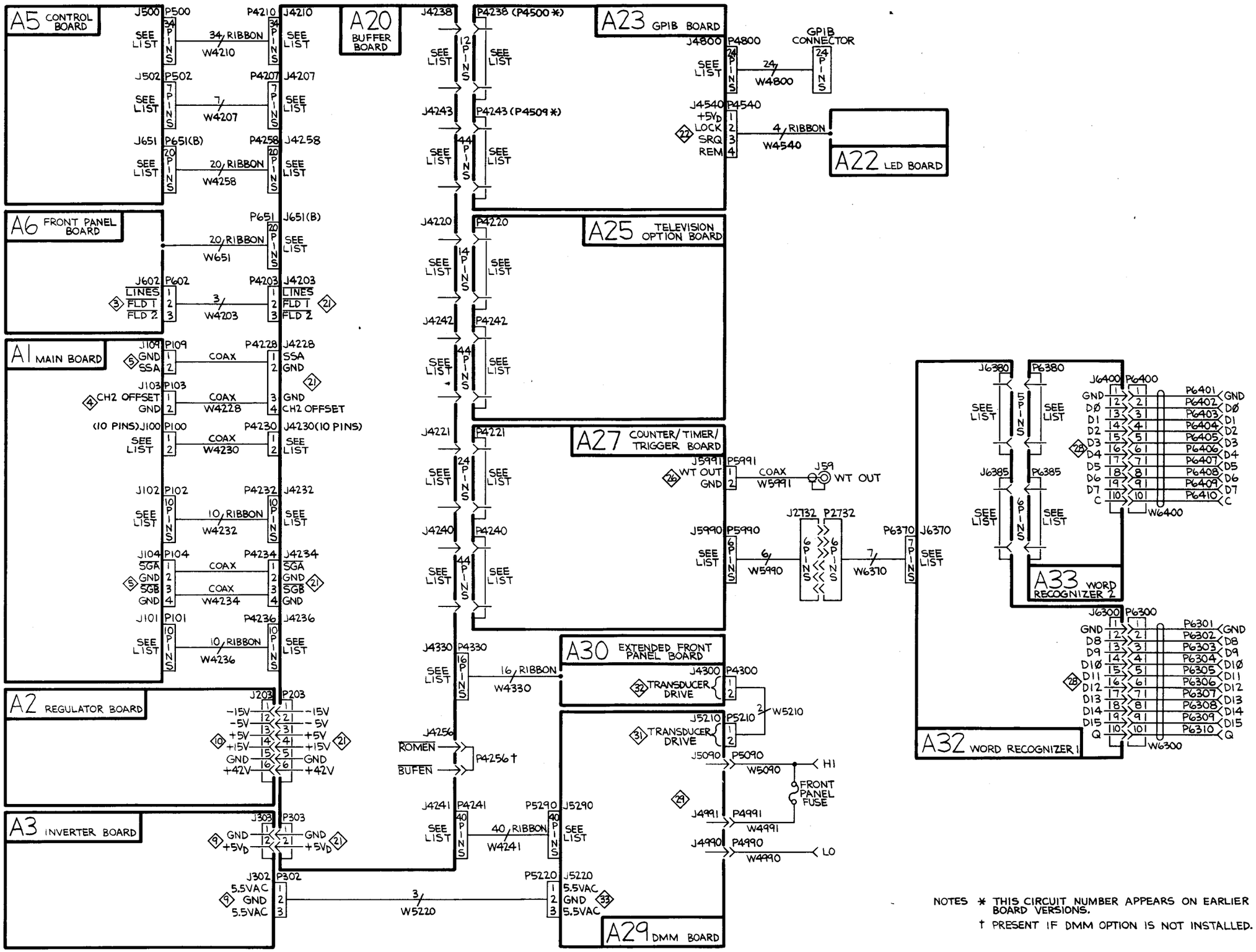

NOTES * THIS CIRCUIT NUMBER APPEARS ON EARLIER BOARD VERSIONS.

† PRESENT IF DMM OPTION IS NOT INSTALLED.

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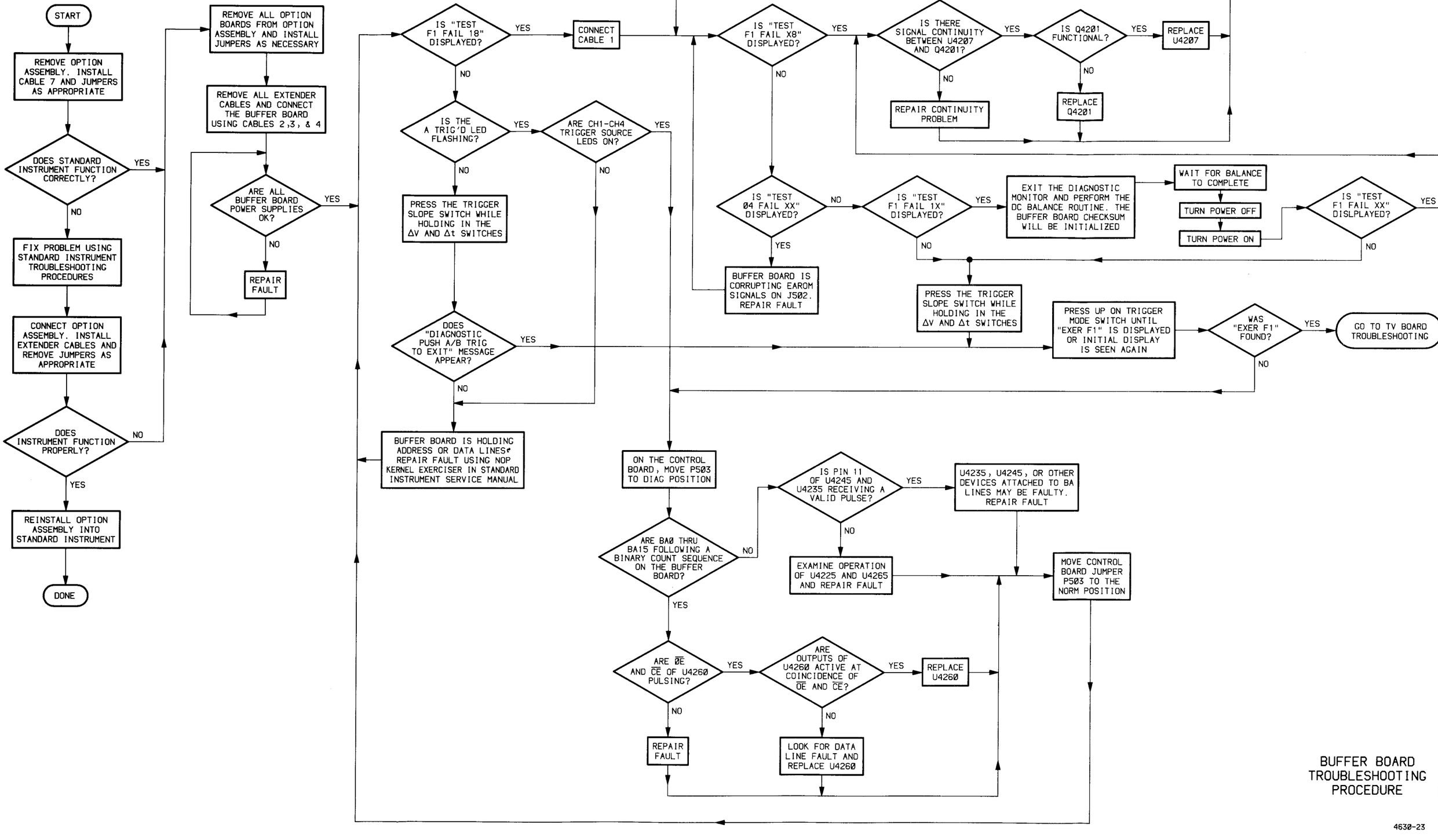

BUFFER BOARD TROUBLESHOOTING PROCEDURE

INITIAL TROUBLESHOOTING SETUP

The input signal during the troubleshooting that follows is a composite video signal. Set initial front-panel controls as follows:

Vertical

CH 2 POSITION	Midrange
MODE	
CH 1, CH 3, and CH 4	Off (button out)
CH 2	On (button in)
CH 2 Input Coupling	1 MΩ DC
CH 2 VOLTS/DIV	0.5 V
CH 2 VAR	In detent

Horizontal

POSITION	Midrange
X10 MAG	Off (button out)
A SEC/DIV	10 μs (knobs locked)
SEC/DIV VAR	In detent
ΔV and Δt	Displays off

Trigger

MODE	AUTO
SOURCE	CH 2
COUPLING	LINES for lines troubleshooting, FLD1 line 1 for field troubleshooting
HOLDOFF	MIN (Fully CCW)
SLOPE	+ for + sync, - for - sync

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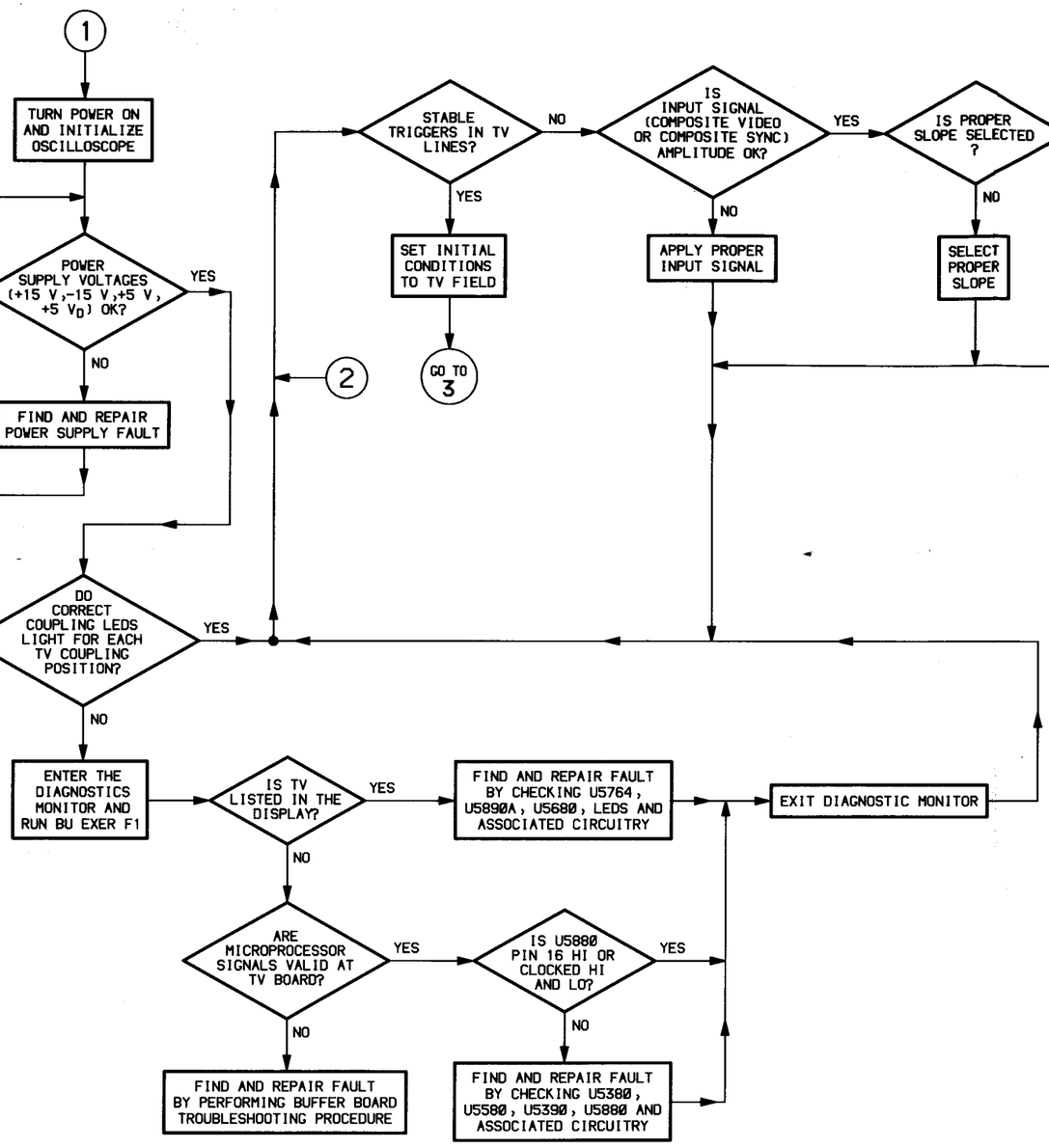

TV OPTION TROUBLESHOOTING PROCEDURE

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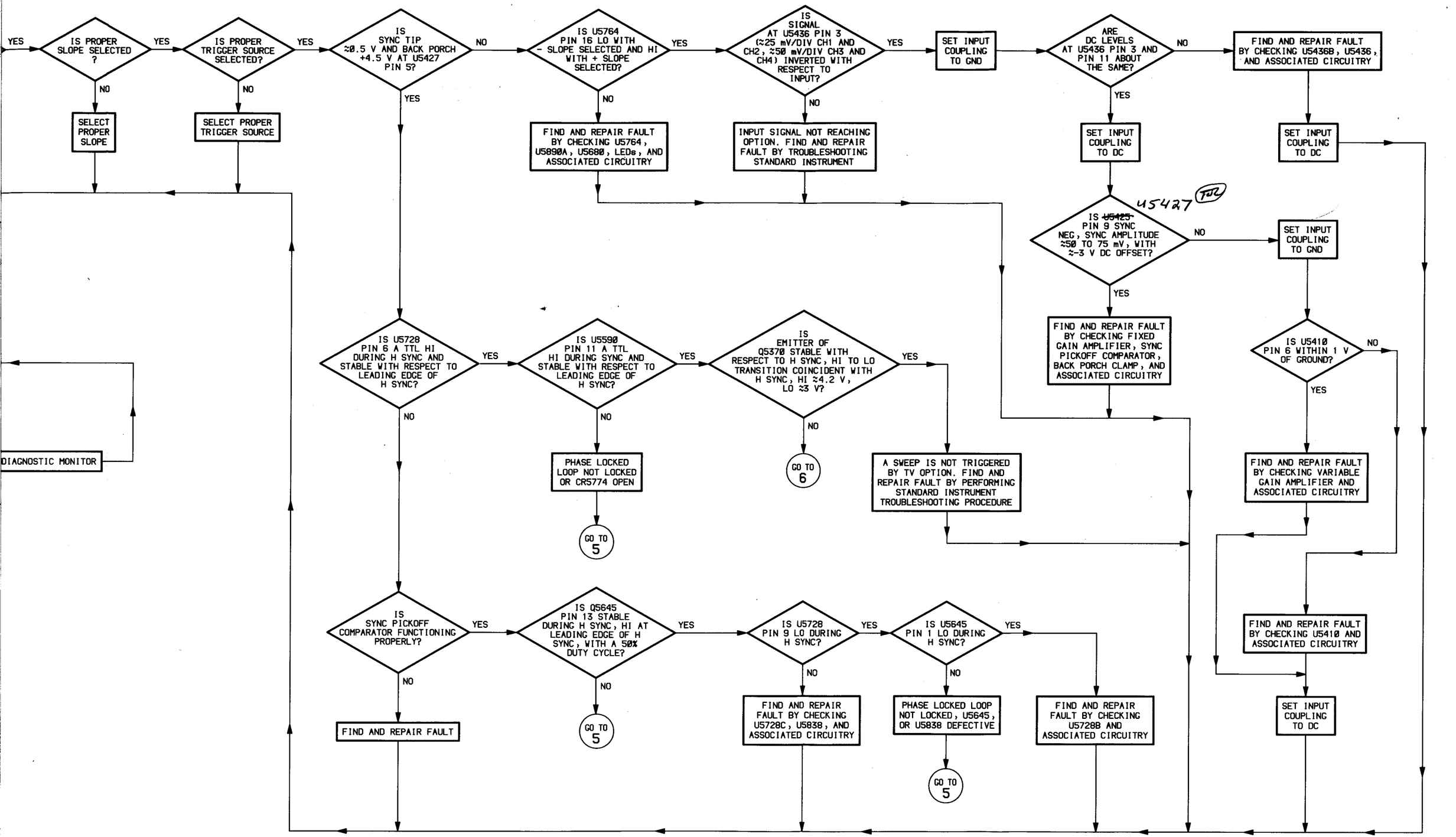

4638-20

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3

IS TRIGGER IN TV FIELD STABLE?
YES
NO
IS LINE COUNTING CORRECT?
NO
YES
GO TO 4
IS CORRECT PROTOCOL SELECTED?
NO
SELECT CORRECT PROTOCOL
YES
ARE HORIZ CLK AND FIELD STABLE AT U5575?
YES
FIND AND REPAIR FAULT BY CHECKING U5575 AND ASSOCIATED CIRCUITRY
NO

IS U5645 PIN 12 STABLE WITH RESPECT TO H SYNC, LO DURING H SYNC, 50% DUTY CYCLE, AND TRANSITION COINCIDENT WITH H SYNC?
YES
NO
GO TO 5
DOES INPUT SIGNAL USE INTERLACED SCAN?
NO
YES
DO U5756 PIN 12 TRANSITIONS COINCIDE WITH V SYNC?
YES
NO
FIND AND REPAIR FAULT BY CHECKING U5756 AND ASSOCIATED CIRCUITRY
DOES U5756 PIN 12 TOGGLE?
NO
YES
IS U5456 PIN 12 HI DURING FIELD 1 AND LO DURING FIELD 2?
YES
NO
FIND AND REPAIR FAULT BY CHECKING U5556, U5728A, Q5735, AND ASSOCIATED CIRCUITRY
DOES U5756 PIN 1 TOGGLE AT FIELD RATE?
YES
NO
IS U5770 PIN 13 HI DURING FIELD 1 AND LO DURING FIELD 2?
YES
NO
FIND AND REPAIR FAULT BY CHECKING U5770, CR5655, CR5653, AND ASSOCIATED CIRCUITRY
DOES U5770 PIN 13 TOGGLE AT FIELD RATE?
YES
NO

IS TRIGGER UNSTABLE IN ALL FIELD COUPLING POSITIONS?
YES
SET TRIGGER COUPLING TO FLD 1 LINE NO. 20
NO
IS TRIGGER STABLE IN FLD 1?
NO
YES
IS TRIGGER STABLE IN FLD 2?
NO
SET TRIGGER COUPLING TO FLD 2 LINE NO. 20
YES
SET TRIGGER COUPLING TO ALT FLD LINE NO.20

IS U5575 PIN 27 STABLE?
NO
ARE HORIZ CLK AND FIELD STABLE AT U5575?
NO
YES
IS U5790 PIN 5 LO?
YES
NO
FIND AND REPAIR FAULT BY CHECKING U5770C, U5880C, AND ASSOCIATED CIRCUITRY
IS U5790B PIN 6 HI?
YES
FIND AND REPAIR FAUL BY CHECKING U5775A, U5775D, U5790D, U5580 AND ASSOCIATED CIRCUIT
IS U5575 PIN 3 STABLE?
YES
FIND AND REPAIR FAULT BY CHECKING U5775A, U5790D AND ASSOCIATED CIRCUITRY
NO

IS U5880 PIN 5 HI?
YES
NO
SET INPUT COUPLING TO GND
IS U5880B PIN 6 LO?
YES
NO
FIND AND REPAIR FAULT BY CHECKING U5880A, U5770A, AND ASSOCIATED CIRCUITRY
IS U5890B PIN 5 HI?
YES
NO
REPAIR FAULT BY PERFORMING DS PORTION OF STANDARD INSTRUMENT TROUBLESHOOTING
DO U5890B, U5770D, U5775B, AND U5775C FUNCTION PROPERLY?
YES
NO
REPAIR FAULT
SET LINE NO. TO 1
IS U5880B PIN 6 HI?
YES
NO
FIND AND REPAIR FAULT BY CHECKING U5880B, U5770B, AND ASSOCIATED CIRCUITRY
CONNECT A 60 Hz SQUARE WAVE (LO ≈3.0 V AND HI ≈4.2 V) TO J4220 PIN 5
IS U5890B PIN 5 A STABLE TTL SIGNAL?
NO
REPAIR FAULT BY PERFORM DS PORTION OF STANDAR INSTRUMENT TROUBLESHOOT

TV OPTION TROUBLESHOOTING PROCEDURE

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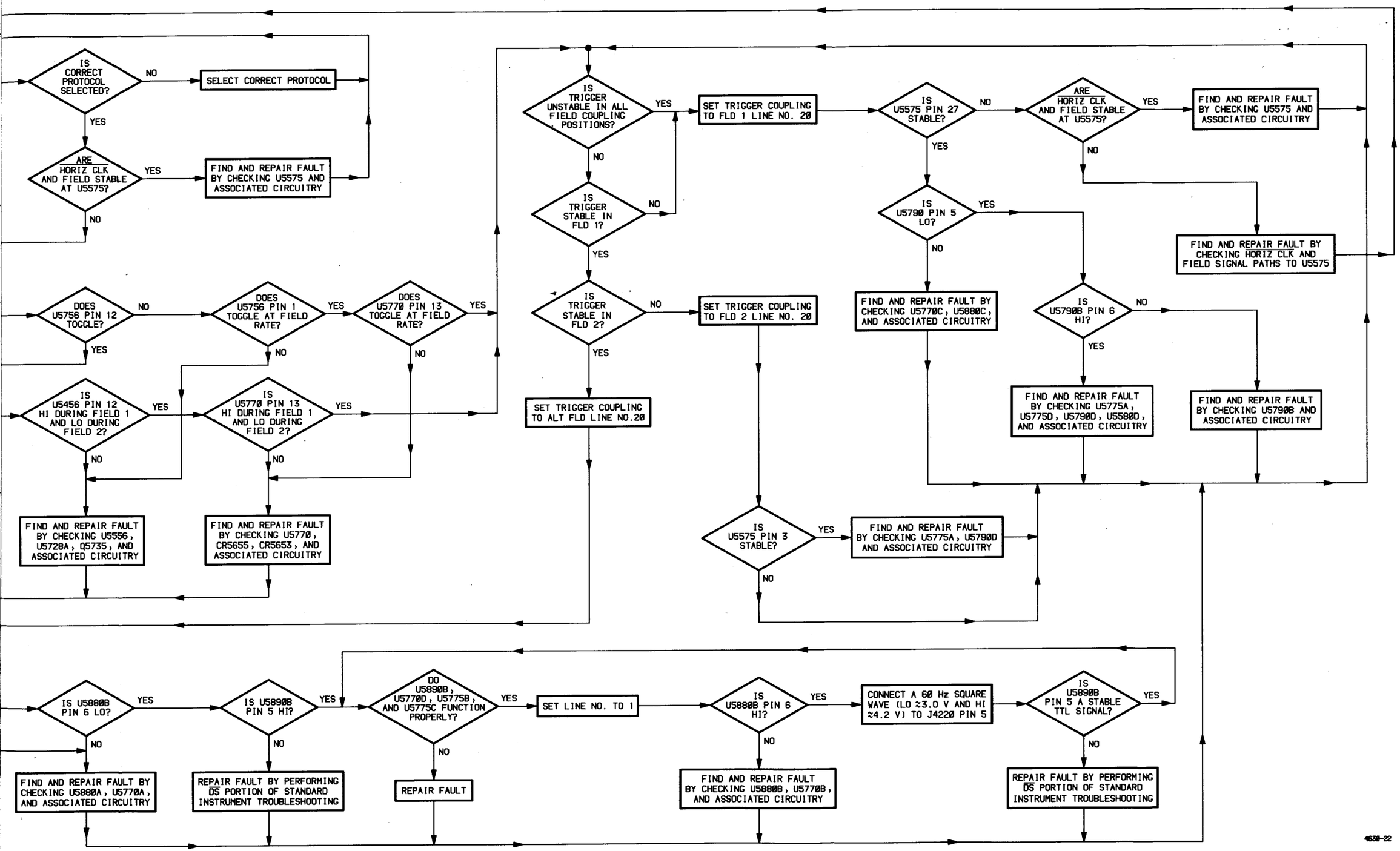

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5

IS U5728 PIN 9 IN SYNC WITH H SYNC AND LO DURING H SYNC?
YES
NO
GO TO 3

IS U5756A PIN 1 HI DURING V SYNC?
NO
YES
IS ANODE OF CR5772 AT H RATE WITH TRANSITION DURING H SYNC?
NO
FIND AND REPAIR FAULT BY CHECKING R5804, CR5772, CR5774, AND ASSOCIATED CIRCUITRY
YES
GO TO 3

CONNECT U5845 PINS 9 AND 8 (GND)

IS FREQUENCY AT U5845 PIN 4 <25 kHz?
YES
NO
FIND AND REPAIR FAULT BY CHECKING U5845, U5838, U5645, AND ASSOCIATED CIRCUITRY

REMOVE SHORT. CONNECT U5845 PINS 9 AND 16 (+5 V)

IS FREQUENCY AT U5845 PIN 4 >150 kHz?
YES
NO

IS U5756 PIN 1 A STATIC LO?
YES
NO
REMOVE SHORT

IS U5838 PIN 6 HI DURING H SYNC?
YES
NO
FIND AND REPAIR FAULT BY CHECKING U5645, U5756, U5845, AND U5838

IS U5756 PIN 4 A STATIC HI?
YES
NO
REMOVE SHORT. FIND AND REPAIR FAULT BY CHECKING U5756 AND ASSOCIATED CIRCUITRY

IS U5845 PIN 1 LO?
YES
NO
REMOVE SHORT. FIND AND REPAIR FAULT BY CHECKING U5845 AND ASSOCIATED CIRCUITRY

REMOVE SHORT. FIND AND REPAIR FAULT BY CHECKING Q5860, U5756, AND ASSOCIATED CIRCUITRY

4

SET THE TRIGGER COUPLING TO TV LINES, AND THE INPUT COUPLING TO TV CLAMP. CONNECT THE INPUT SIGNAL TO CH2

IS DISPLAY STABLE AND WITHOUT TILT?
NO
YES
SELECT CH2 INVERT AND OPPOSITE TRIGGER SLOPE

IS DISPLAY STABLE AND WITHOUT TILT?
NO
YES
DONE

IS PHASE LOCKED LOOP LOCKED?
NO
GO TO 5
YES

IS J4230 PIN 8 25 mV/DIV AND IN PHASE WITH INPUT SIGNAL?
NO
PERFROM STANDARD INSTRUMENT PREAMP TROUBLESHOOTING PROCEDURE
YES

IS U5228 PIN 12 HI WHEN CLAMP IS ON AND LO WHEN CLAMP IS OFF?
NO
FIND AND REPAIR FAULT BY CHECKING DIGITAL CIRCUITRY, U5712, U5728, AND ASSOCIATED CIRCUITRY
YES

IS U5164 PIN 9 LO IN NORMAL AND HI IN CH2 INVERT?
NO
YES

IS U5164 PIN 15 LO WHEN IN 2, 5, 10, 100 mV/DIV, AND 1 V/DIV?
NO
YES
TURN CLAMP ON

IS U5712C ON IN INVERT AND OFF IN NORMAL, AND IS U5712B OFF IN INVERT AND ON IN NORMAL?
NO
FIND AND REPAIR FAULT BY CHECKING U5712, U5755, U5855, AND ASSOCIATED CIRCUITRY
YES

IS GATE OF Q5736 AT -15 V?
NO
FIND AND REPAIR FAULT BY CHECKING U5712, U5728, Q5736, AND ASSOCIATED CIRCUITRY
YES

IS U5728 PIN 15 HI WHEN IN 2,5,10,100 mV/DIV AND 1 V/DIV?
NO
FIND AND REPAIR FAULT BY CHECKING U5728 AND Q5442
YES

DURING BACK PORCH, IS U5755 ENABLED IN NORMAL MODE AND U5855 ENABLED IN INVERT?
NO
FIND AND REPAIR FAULT BY CHECKING U5755, U5855, U5712, AND ASSOCIATED CIRCUITRY
YES

FIND AND REPAIR FAULT BY CHECKING U5636, U5755, U5855, ASSOCIATED CIRCUITRY, CONNECTIONS TO PREAMP, AND THE PREAMP

6

IS U5590B PIN 9 COINCIDENT WITH H SYNC?
NO
YES
FIND AND REPAIR FAULT BY CHECKING U5580B, Q5370, AND ASSOCIATED CIRCUITRY

IS U5590B PIN 10 HI?
YES
NO

IS TV LINES ACTIVE?
YES
NO
SELECT TV LINES

IS U5790B PIN 5 HI?
YES
NO
FIND AND REPAIR FAULT BY CHECKING U5770C, U5880C, AND ASSOCIATED CIRCUITRY

FIND AND REPAIR FAULT BY CHECKING U5764 AND ASSOCIATED CIRCUITRY

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U5845 PINS
8 (GND)

IS FREQUENCY AT U5845 PIN 4 <25 kHz?
YES
NO

REMOVE SHORT. CONNECT U5845 PINS 9 AND 16 (+5 V)

IS FREQUENCY AT U5845 PIN 4 >150 kHz?
YES
NO

IS U5756 PIN 1 A STATIC LO?
YES
NO

REMOVE SHORT

IS U5838 PIN 6 HI DURING H SYNC?
YES
NO

FIND AND REPAIR FAULT BY CHECKING U5645, U5756, Q5860, U5838D, U5845 AND ASSOCIATED CIRCUITRY

REPAIR FAULT
KING R5804,
CR5774, AND
ED CIRCUITRY

FIND AND REPAIR FAULT BY CHECKING U5845, U5838, U5645, AND ASSOCIATED CIRCUITRY

IS U5756 PIN 4 A STATIC HI?
YES
NO

IS U5845 PIN 1 LO?
YES
NO

FIND AND REPAIR FAULT BY CHECKING U5645, U5756, U5845, AND U5838

REMOVE SHORT. FIND AND REPAIR FAULT BY CHECKING U5756 AND ASSOCIATED CIRCUITRY

REMOVE SHORT. FIND AND REPAIR FAULT BY CHECKING U5845 AND ASSOCIATED CIRCUITRY

REMOVE SHORT. FIND AND REPAIR FAULT BY CHECKING Q5860, U5756, AND ASSOCIATED CIRCUITRY

STANDARD
NT PREAMP
SHOOTING
EDURE

D REPAIR
CHECKING
CIRCUITRY,
5728, AND
D CIRCUITRY

IS U5712C ON IN INVERT AND OFF IN NORMAL, AND IS U5712B OFF IN INVERT AND ON IN NORMAL?
NO
YES

FIND AND REPAIR FAULT BY CHECKING U5712, U5755, U5855, AND ASSOCIATED CIRCUITRY

IS GATE OF Q5736 AT -15 V?
NO
YES

FIND AND REPAIR FAULT BY CHECKING U5712, U5728, Q5736, AND ASSOCIATED CIRCUITRY

IS U5728 PIN 15 HI WHEN IN 2,5,10,100 mV/DIV AND 1 V/DIV?
NO
YES

FIND AND REPAIR FAULT BY CHECKING U5728 AND Q5442

DURING BACK PORCH, IS U5755 ENABLED IN NORMAL MODE AND U5855 ENABLED IN INVERT?
NO
YES

FIND AND REPAIR FAULT BY CHECKING U5755, U5855, U5712, AND ASSOCIATED CIRCUITRY

FIND AND REPAIR FAULT BY CHECKING U5636, U5755, U5855, ASSOCIATED CIRCUITRY, CONNECTIONS TO PREAMP, AND THE PREAMP

AMP ON

6

IS U5590B PIN 9 COINCIDENT WITH H SYNC?
NO
YES

FIND AND REPAIR FAULT BY CHECKING U5580B, Q5370, AND ASSOCIATED CIRCUITRY

IS U5590B PIN 10 HI?
YES
NO

IS TV LINES ACTIVE?
YES
NO

SELECT TV LINES

IS U5790B PIN 5 HI?
YES
NO

FIND AND REPAIR FAULT BY CHECKING U5770C, U5880C, AND ASSOCIATED CIRCUITRY

FIND AND REPAIR FAULT BY CHECKING U5764 AND ASSOCIATED CIRCUITRY

IS U5580F PIN 13 HI ONLY DURING HOLDOFF?
NO
YES

FIND AND REPAIR FAULT BY PERFORMING STANDARD INSTRUMENT TROUBLESHOOTING PROCEDURE

IS U5590 PIN 13 SYNCHRONIZED WITH AHO?
NO
YES

FIND AND REPAIR FAULT BY CHECKING U5590A, U5580F, U5790B, AND ASSOCIATED CIRCUITRY

FIND AND REPAIR FAULT BY CHECKING U5590B AND ASSOCIATED CIRCUITRY

GO TO 2

TV OPTION TROUBLESHOOTING PROCEDURE

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