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TSG21
PAL-M COLOR BAR TEST SIGNAL GENERATOR MODULE

INSTRUCTION MANUAL

Tektronix, Inc.
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Beaverton, Oregon 97077

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Product Group 20

Serial Number _____

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WARNING

THE FOLLOWING SERVICING INSTRUCTIONS ARE FOR USE BY QUALIFIED PERSONNEL ONLY. TO AVOID PERSONAL INJURY, DO NOT PERFORM ANY SERVICING OTHER THAN THAT CONTAINED IN OPERATING INSTRUCTIONS UNLESS YOU ARE QUALIFIED TO DO SO. REFER TO OPERATORS SAFETY SUMMARY AND SERVICE SAFETY SUMMARY PRIOR TO PERFORMING ANY SERVICE.

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OPERATORS SAFETY SUMMARY

The general safety information in this part of the summary is for both operating and service personnel. Specific warnings and cautions will be found throughout the manual where they apply, but may 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 marking, or a hazard to property including the equipment itself.

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

SAFETY CONSIDERATIONS

Symbols In This Manual

This symbol indicates where applicable cautionary or other information is to be found.

Symbols As Marked On Equipment


DANGER—High Voltage.


Protective ground (earth) terminal.


ATTENTION—Refer to manual.

Power Source

This product is intended to operate in a mainframe whose power source will not apply more than 250 V rms between the supply conductors of the mainframe 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 connected to the mainframe. To avoid electrical shock, plug the power cord into a properly wired receptacle before connecting to the mainframe input terminals. A protective ground connection by way of the grounding conductor in the mainframe 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 nobs 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.

For detailed information on power cords and connectors, see the Accessories section.

Refer power cord and connector changes to qualified service personnel.

Use the Proper Fuse

To avoid fire hazard, use only a fuse of the proper 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 atmosphere of explosive gases unless it has been specifically certified for such operation.

Do Not Remove Covers or Panels

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

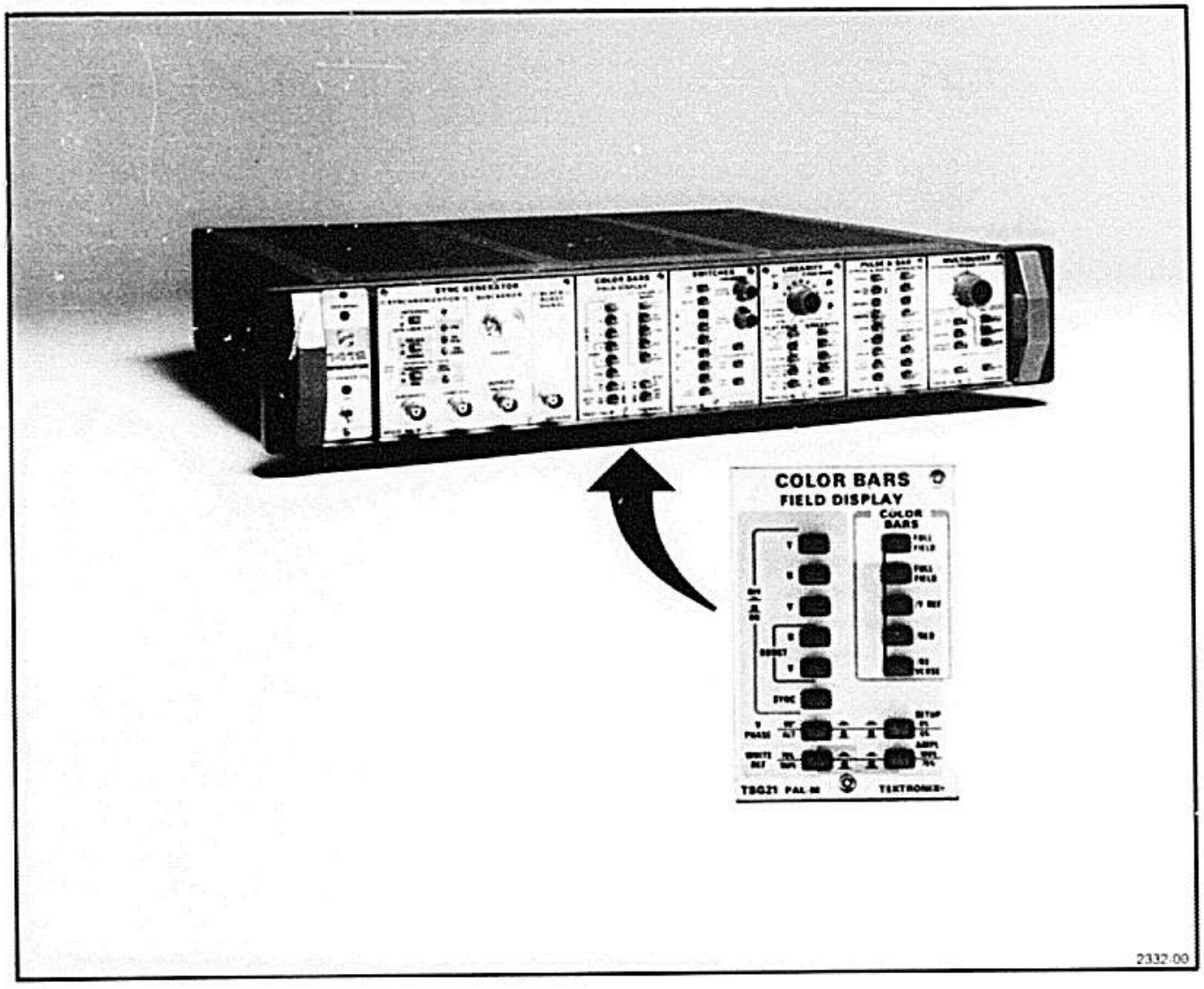


Fig. 1-1. The TSG21 PAL Color Bar Test Signal Generator.

PART I
OPERATOR'S INFORMATION

OPERATING INSTRUCTIONS

DESCRIPTION

The TSG21 PAL Color Bars Test Signal Generator module consists of two circuit boards and a shield board that plug into the 1412 mainframe Interface board, plus a front panel. The generator is designed for use as part of a modular television test signal generator system. Typically, a 1412 mainframe, an SPG22 Sync Pulse Generator, a TSG21, and a TSG23 Linearity Test Signal Generator might comprise such a system. Pin connectors on the bottom edge of each board mate with vertical pins on the Interface board. The shield is mounted between the circuit boards.

The TSG21 provides composite video test signals including full field color bars in fixed and alterable formats, and split-field signals consisting of color bars for 3/4 or 1/2 of the field followed by luminance reference, red chrominance, or color bars in reverse sequence. Color bar amplitude may be 100% or 75%, and a 5% set-up level may be added to the 75% bars. The white bar may be 100% or 75% of peak white. By means of internal programming, qualified service personnel may change the split-field timing, the bar sequence, and the split-field color.

FRONT PANEL SWITCH FUNCTIONS

FIELD DISPLAY Functions

1. Y—Luminance selector. Press button to remove lumuninance.
2. U—0° chrominance selector. Press button to remove U chrominance.
3. V—90° chrominance selector. Press button to remove V chrominance.
4. BURST U and V—Color burst selector. Press U or V button to remove U or V component of color burst.
5. SYNC—Composite sync selector. Press button to remove composite sync.

COLOR BARS Functions

The five COLOR BARS switches are self-canceling. The Fixed FULL FIELD switch overrides all others on the TSG21 panel, providing standard color bars when pressed in, no matter what other combinations have been selected.

6. Fixed FULL FIELD—Selects full field color bars in a sequence of white, yellow, cyan, green, magenta, red, blue and black, with 75% amplitude, 5% set-up level, and 100% white reference, color bars signal sequence can be changed by internal programming.
7. Alterable FULL FIELD—Same display as Fixed FULL FIELD except with selectable amplitude, pedestal, and white reference levels; and removable signal components.

8. /Y REF—Selects a split-field display of color bars in the same sequence as FULL FIELD, followed by the luminance portion of the color bars for the remainder of the field. The split can be 1/2 or 3/4 field as selected by internal programming in the SPG21, SPG22, or SPG23.

9. /RED—Selects a split-field display of color bars as in /Y REF, followed by red chrominance. (Same phase and amplitude, at the same luminance level as the red bar.) Colors other than red available by internal programming. Remotely switchable to white.

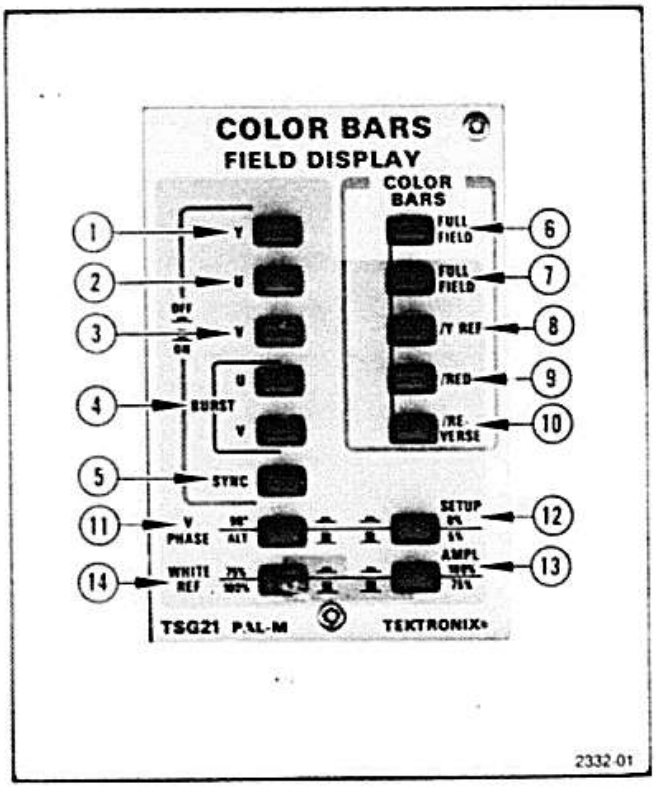


Fig. 1-2. TSG21 Front Panel Controls.

10. /REVERSE—Selects a split-field display of color bars as in /Y REF, followed by color bars in a reverse sequence.

11. VPHASE—Selects either of two conditions for the V chrominance component of the color bar signal: one, (ALT), the V chrominance component alternates between 90° and 270° at a line rate; two, (90°), the V chrominance component is locked in the 90° axis.

12. SETUP—Deletes or adds a 5% setup level to the output signal. With the switch in the "out" position, the 5% setup level is added to the output signal and bar amplitudes are reduced to maintain the peak level at 700 mV.

13. AMPL—Selects 100% or 75% bars amplitude. The "in" position selects 100% bar amplitude. The "out" position selects 75 % bar amplitude, and also enables the WHITE REF switch.

14. WHITE REF—Selects 100% or 75% white reference only when 75% amplitude is selected.

TEST SIGNAL INFORMATION

The TSG21 test signals and their general applications are described in the following paragraphs. Table 1-1 lists the signals available in the alterable color bar modes, and the AMPL and WHITE REF switch settings required to generate them.

Table 1-1
SELECTING COLOR BAR TEST SIGNALS

TEST SIGNAL	WHITE REF 75% IN 100% OUT	AMPL 100% IN 75% OUT	SETUP 0% IN 5% OUT	FIG
100/0/75/5 (100% Bars) (75% Reference)	OUT	OUT	OUT	1-3
75/0/75/0 (75% Bars) (75% Reference)	IN	OUT	IN	1-4
100/0/100/0 (100% Bars) (100% Reference)	NO EFFECT	IN	IN	1-5

NOTE

In the Fixed FULL FIELD mode, the 100/0/75/5 signal (standard PAL-M color bars) is selected regardless of the other switch settings.

These color bar signals may be used for making phase and gain adjustments of color monitors, or for verifying overall acuracy of the decoding function.

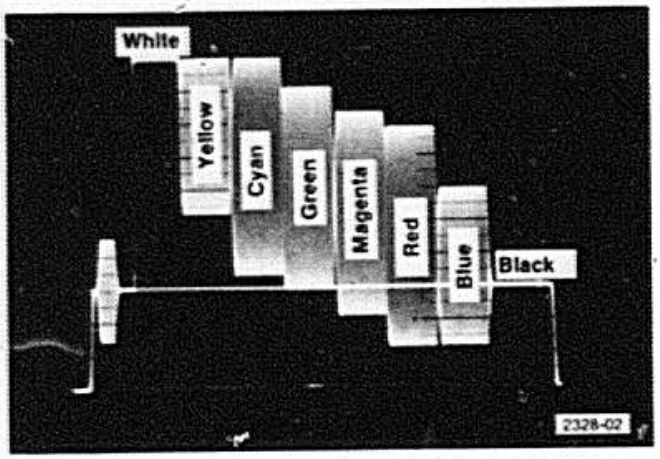


Fig. 1-3. 100/0/75/5 Color Bars.

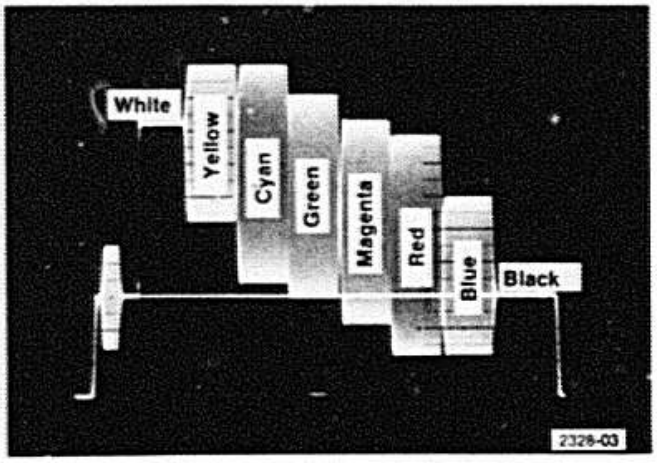


Fig. 1-4. 75/0/75/0 (75%) Color Bars.

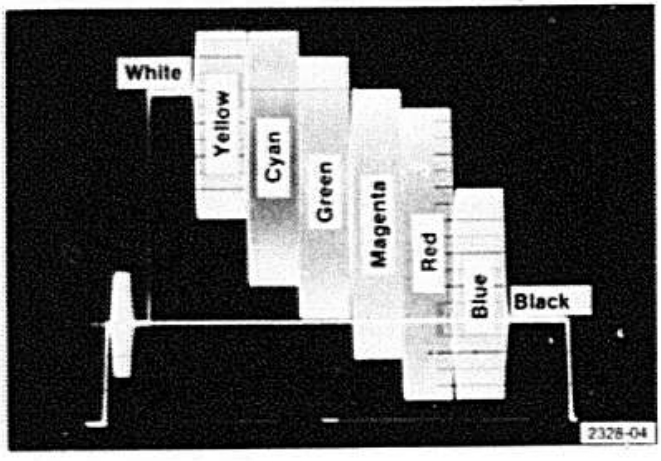


Fig. 1-5. 100/0/100/0 (100%) Color Bars.

Several references and relationships make the various color bar signals useful for quick checks on a waveform monitor for nonlinear distortions. In all of the signals, the positive-peak levels of the yellow and cyan color bars are equal; and the negative-peak levels of the red and blue bars are equal. In standard PAL-M bars, the positive-peak level of the yellow and cyan bars is the same as peak white; and the negative-peak level of the green bar is at the blanking level. In the 95% bars signal, the negative-peak level of the red and blue bars is at the blanking level. Deviation from the reference levels may be an indication of differential gain distortion, U-V gain error, chrominance-luminance gain error, or harmonic distortion.

Qualified service personnel, using Section 3 of this manual, may alter the TSG21 to produce color bars with a different bar sequence. These signals exhibit severe transitions of chrominance phase and luminance amplitudes. They are useful in testing for nonlinear distortions.

Split-Field Y Reference Signal

This signal consists of color bars in the upper portion of the field, followed by the corresponding luminance signal in the lower portion of the field (see Fig. 1-6). This signal is especially useful for checking color balance, tracking, and chrominance-luminance delay of color picture monitors.

Split-Field Red Signal

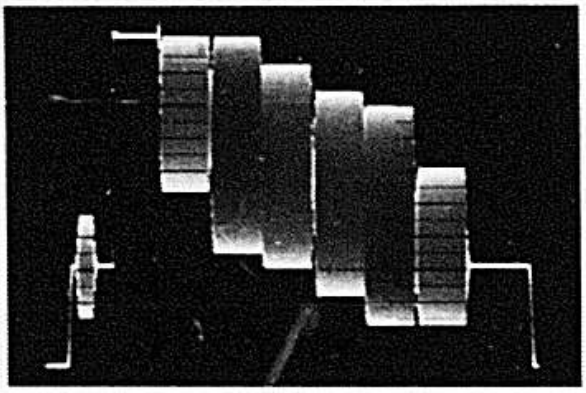
Color bars are in the top portion of the field, followed by red in the lower portion (see Fig. 1-7). Chrominance noise and VTR head-banding are readily seen in the red portion.

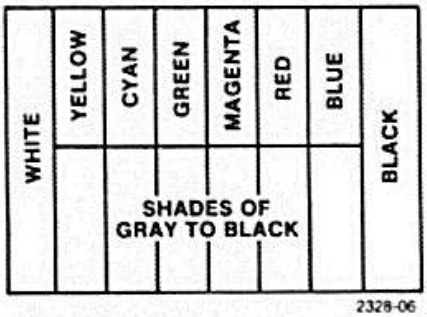
Color of the lower portion may be changed to white by connecting the appropriate pin of the 1412 REMOTE connector, J41, to a logic low level (0 V). The all-white portion is useful in adjusting decoder balance in color picture monitors.

In addition, qualified service personnel may change the color of the lower portion to any bar color (see Section 3).

Split-Field Reverse Signal

Color bars are in the top portion of the field, followed by color bars in reverse sequence in the lower portion (see Fig. 1-8). This signal is useful in checking color tracking of color picture monitors, observing chrominance-to-luminance delay, and velocity modulation in video tape recorders.





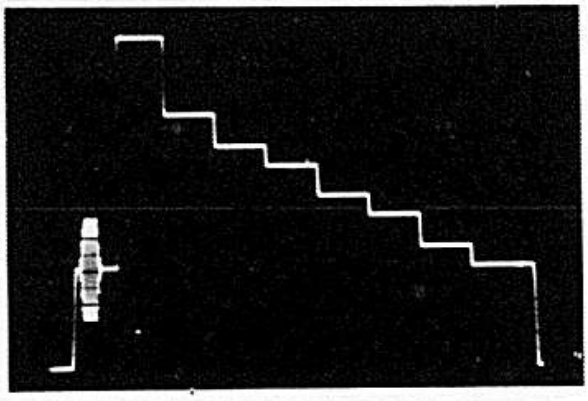
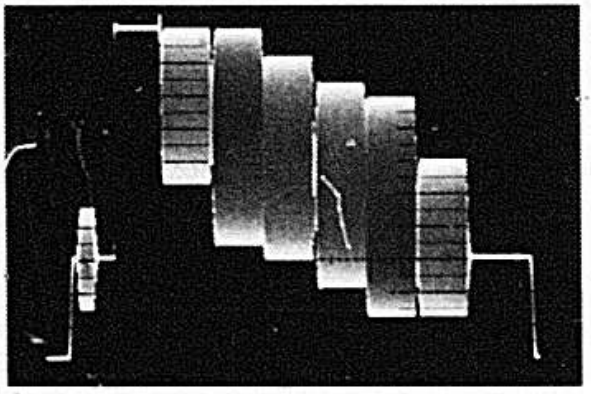
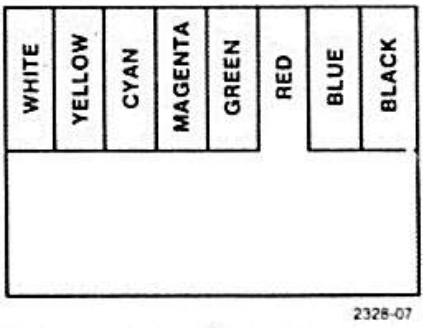


Fig. 1-6. Split-Field Y Reference.





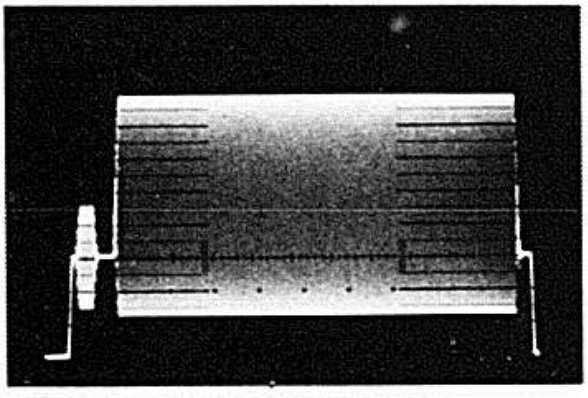
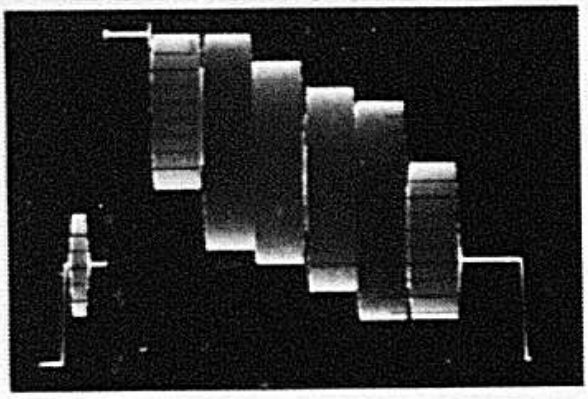


Fig. 1-7. Split-Field Red.



BLACK	WHITE
BLUE	YELLOW
RED	CYAN
MAGENTA	GREEN
GREEN	MAGENTA
CYAN	RED
YELLOW	BLUE
WHITE	BLACK

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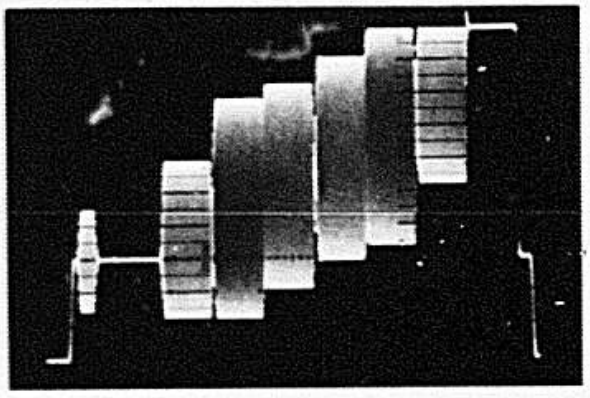


Fig. 1-8. Split-Field Reverse.

SPECIFICATIONS AND PERFORMANCE CHECK

SPECIFICATIONS

The following electrical characteristics are valid only if the instrument has been calibrated at an ambient temperature between +20°C and +30°C, and the instrument is operating at an ambient temperature betwen 0°C and +50°C. The instrument must have a warmup period of at least 30 minutes before checking the specification.

Items listed in the Performance Requirement column of the Electrical Characteristics are verified by completing the Performance Check in this manual. Items listed in the Supplemental Information column are not verified in this manual; they are either explanatory notes or performance characteristics for which no limits are specified. However, some items listed in the Supplemental Information column are indirectly verified by checking related Performance Requirement data.

ELECTRICAL CHARACTERISTICS

Characteristics	Performance Requirement				Supplemental Information
Color Bar Signals Luminance Component Accuracy	Within 1.5 mV or 1% of level, whichever is greater, measured from blanking level.				
Chrominance Component Accuracy Absolute Amplitudes Relative Amplitudes	±3%. Within 1% of red bar, or 1 mV plus p-p residual subcarrier, whichever is greater.				
Bar Amplitudes 100% Amplitude Color Bars, 0% Setup 100% White Reference	**Luminance (mV)**	**Chrominance (mV p-p)**	**U (mV p-p)**	**V (mV p-p)**	
Peak White	700.0	2.5 or less			
White	700.0	2.5 or less			
Yellow	620.2	627.3	611.5	140.0	
Cyan	490.7	885.1	206.4	860.7	
Green	410.9	826.8	405.1	720.7	
Magenta	289.1	826.8	405.1	720.7	
Red	209.3	885.1	206.4	860.7	
Blue	79.8	627.3	611.5	140.0	
Black	0.0	2.5 or less			

ELECTRICAL SPECIFICATION (cont)

Characteristics	Performance Requirement				Supplemental Information
75% Amplitude Color Bars, 0% Setup 75% White Reference	**Luminance (mV)**	**Chrominance (mV p-p)**	**U (mV p-p)**	**V (mV p-p)**	
Peak White	700.0	2.5 or less			
White	525.0	2.5 or less			
Yellow	465.2	470.5	458.6	105.0	
Cyan	368.0	663.8	154.8	645.5	
Green	308.2	620.1	303.9	540.5	
Magenta	216.8	620.1	303.9	540.5	
Red	157.0	663.8	154.8	645.5	
Blue	59.9	470.5	458.6	105.0	
Black	0.0	2.5 or less			
100% Amplitude Color Bars, 5% Setup 100% White Reference	**Luminance (mV)**	**Chrominance (mV p-p)**	**U (mV p-p)**	**V (mV p-p)**	
Peak White	700.0	2.5 or less			
White	700.0	2.5 or less			
Yellow	625.9	582.5	567.8	130.0	
Cyan	505.7	821.9	191.6	799.2	
Green	431.6	767.7	376.2	699.2	
Magenta	318.5	767.7	376.2	699.2	
Red	244.4	821.9	191.6	799.2	
Blue	124.1	582.5	567.8	130.0	
Black	50.0	2.5 or less			
75% Amplitude Color Bars, 5% Setup 75% White Reference	**Luminance (mV)**	**Chrominance (mV p-p)**	**U (mV p-p)**	**V (mV p-p)**	
Peak White	700.0	2.5 or less			
White	537.5	2.5 or less			
Yellow	481.9	436.9	425.9	97.5	
Cyan	391.7	616.4	143.7	599.4	
Green	336.2	575.8	282.2	501.9	
Magenta	251.3	575.8	282.2	501.9	
Red	195.8	616.4	143.7	599.4	
Blue	105.6	436.9	425.9	97.5	
Black	50.0	2.5 or less			
Bar Width	6.6 μs ±330 ns.				See SPG manual.
Luminance Risetime	125 ns ±20 ns.				
Chrominance-Luminance Delay	20 ns or less.				
Chrominance Risetime	400 ns ±60 ns.				
U, V Quadrature Error					0.5° or less.
V Axis Phase Switch/Error	0.5° or less.				
Aberrations					20 mV p-p or less.
Residual Subcarrier	2.5 mV or less.				
Spurious Subcarrier End of H Blanking Elsewhere	32 mV or less.				2.5 mV or less.

ELECTRICAL SPECIFICATION (cont)

Characteristics	Performance Requirement	Supplemental Information
Other Noise		
During Sync, end of H Blanking and start of White Bar	32 mV or less.	
Elsewhere		2.5 mV or less.
Split Field Displays		Split is 1/2-1/2 or 3/4-1/4, selectable in SPG.
Fixed Full Field Display and VITS		
Amplitude		75%
Setup		5%
White Reference		100%
Composite Video		
Amplitude		
Sync	−300 mV ±3 mV from blanking.	
Burst		
Absolute	300 mV ±9 mV.	
Relative U and V Components	Alternate bursts are equal within 2%. Equal within 1%.	
Blanking Level	0 V ±50 mV.	
Timing		
Line Blanking Interval		11.1 μs ±250 ns.
Front Porch		1.4 μs or greater.
Sync Risetime	125 ns ±20 ns.	
Sync HAD*		4.8 μs ±200 ns.
Breezeway		1 μs typical.
Burst Delay		5.8 μs ±100 ns (21 cycles of subcarrier).
Burst Risetime	400 ns ±60 ns.	
Burst Envelope HAD*	2.52 μs ±280 ns.	See SPG Manual.
Line Period	63.5 μs.	See SPG Manual.
Field Period	16.68 ms.	See SPG Manual.
Burst Phase	+135° and −135° on successive lines.	
Angle Between Bursts	90° ±1°.	
Return Loss	30 dB or greater, to 5 MHz.	
Isolation		40 dB or greater.

*HAD = Half Amplitude Duration.

ENVIRONMENTAL CHARACTERISTICS

Characteristic	Performance Requirement	Characteristic	Performance Requirement
Temperature		Altitude	
Storage	−40°C to +65°C	Storage	To 50,000 feet.
Operating	0°C to +50°C	Operating	To 15,000 feet.

PERFORMANCE CHECK PROCEDURE

Introduction

The procedure in this section serves as a guide to perform the performance check steps. Limits, tolerances, and waveforms appearing in this procedure are not instrument specifications except as listed under the Performance Requirement column of the Specification.

The TSG21 front-panel control names in the text are capitalized; for example, SYNC. Control and connector names on test equipment and internal controls in the TSG21 module under test have only the first letter capitalized; for example test oscilloscope Time/Div., or 1482 Mag control, except when they are used as generic terms.

A short-form procedure is provided to aid in checking calibration of the TSG21. It may be used as a calibration guide by the experienced calibrator, or as a record of calibration, since the step numbers correspond to those in the complete performance check procedure.

TEST EQUIPMENT

The capabilities of the test equipment described in the following list are the minimum required to calibrate the instrument. Test equipment used in preparing these procedures are given in each example. If alternative equipment is used, it must meet or exceed the listed requirements.

1. Waveform Monitor. Capable of viewing line rate and field rate signals, with a magnifier to measure risetime and pulse duration. A TEKTRONIX 1482 MOD W5F Waveform Monitor is used in this procedure with a Video Amplitude Calibration Fixture.

2. Test Oscilloscope. Bandwidth, DC to 30 MHz; minimum deflection factor, 1 mV/div; two input channels with provisions for independent or differential operation. For example: a TEKTRONIX 7603 Oscilloscope with 7A13, 7A18, and 7B53A plug-in units.

3. Sine Wave Generator. Minimum output, 500 mV; frequency range, 50 kHz and variable from 1 MHz to 5 MHz. For example: a TEKTRONIX SG 503 in a Tektronix TM 500 Series Mainframe.

4. Spectrum Analyzer (optional). Capable of measuring the harmonics or color subcarrier to −40 dB of the fundamental. For example: a TEKTRONIX 1401A or 7L12.

5. Return Loss Bridge. Tektronix Part No. 015-1049-00.

6. Vectorscope. For example: a TEKTRONIX 522A.

7. 75 Ω Cable (Two required). Tektronix Part No. 012-0074-00.

8. 75 Ω End-Line Termination. Tektronix Part No. 011-0102-00.

9. 75 Ω In-Line Terminator. Tektronix Part No. 011-0103-00.

10. 50 Ω to 75 Ω Minimum Loss Attenuator. Tektronix Part No. 011-0057-00.

11. 75 Ω 10X Attenuator. Tektronix Part No. 011-0061-00.

12. Video Amplitude Calibration Fixture. Tektronix Part No. 067-0916-00.

Making Measurements with the Video Amplitude Calibration Fixture (VAC)

The signal to be measured must be connected to the 1482R Video Input A and terminated in 75 Ω with the precision 75 Ω Termination (011-0102-00 supplied with the VAC). The output of the VAC connects to Video Input B and is unterminated. Set the 1482R as follows:

DC Restorer	Off
Oper/Cal	Oper
Input	A-B

To check luminance amplitudes with a given tolerance, adjust the VAC Variable control while observing the waveform monitor display. When the level being measured overlays the blanking level, read the amplitude directly from the VAC front-panel Output in mV readout.

To check chrominance amplitudes, a different setup is used. The signal to be measured must be connected to the 1482R Video Input A through a Subcarrier Harmonic Rejection Filter (015-0407-00 supplied with the VAC).

Because the Harmonic Rejection Filter has 0.6% pass band loss, a 0.6% Attenuator (011-0134-00 supplied with the VAC) should be connected in series with the VAC Output to the 1482R Video Input B.

Peak-to-peak chrominance amplitudes are checked for tolerance by adjusting the VAC Variable control until the peaks of the chrominance packet being measured just meet.

To adjust a signal level, use the VAC Output as a reference. First, set the VAC Output to a desired level using the VAC Preset Level push buttons, or manually setting the lever switches. Then for luminance signals, adjust the proper control such that the luminance level overlays the blanking level. For chrominance signals, adjust the proper control until the peaks of the chrominance packets just

SHORT FORM PERFORMANCE CHECK PROCEDURE

Step	Parameter	Requirement
1.	Residual Subcarrier	2.5 mV or less
2.	Luminance Gain (Sync)	−300 mV ±3 mV
3.	Dc Level	0 V ±50 mV
4.	Sync Shaping, Risetime	t_r = 125 ns ±20 ns Symmetry from top to bottom, and minimum aberrations.
5.	Luminance Shaping, Risetime	t_r = 125 ns ±20 ns Symmetry from top to bottom, and minimum aberrations.
6.	Color Bar Luminance (75/0)	1% or 1.5 mV
	Black	0 mV
	Blue	59.9 mV ±1.5 mV
	Red	157.0 mV ±1.6 mV
	Magenta	216.8 mV ±2.2 mV
	Green	308.2 mV ±3.1 mV
	Cyan	368.0 mV ±3.7 mV
	Yellow	465.2 mV ±4.7 mV
	White (75%)	525.0 mV ±5.3 mV
	100% White Ref	
	White (100%)	700.0 mV ±7.0 mV

SHORT FORM PERFORMANCE CHECK PROCEDURE (cont)

Step	Parameter	Requirement
	100/0	
	White	700.0 mV ±7.0 mV
	Yellow	620.2 mV ±6.2 mV
	Cyan	490.7 mV ±4.9 mV
	Green	410.9 mV ±4.1 mV
	Magenta	289.1 mV ±2.9 mV
	Red	209.3 mV ±2.1 mV
	Blue	79.8 mV ±8.0 mV
	Black	0 mV
	100/5	
	Black	50 mV
	Blue	124.1 mV ±1.4 mV
	Red	244.4 mV ±2.4 mV
	Magenta	318.5 mV ±3.2 mV
	Green	431.6 mV ±4.3 mV
	Cyan	505.7 mV ±5.0 mV
	Yellow	625.9 mV ±6.2 mV
	White	700.0 mV ±7.0 mV
7.	U and V Drive Filters	32 mV or less spurious subcarrier, and good burst shaping.
8.	Chrominance Bandpass Filter	Straight lines between vectors, null at green-magenta transition, and minimum harmonics.
9.	Luminance-to-Chrominance Delay	20 ns or less between chrominance and luminance.
10.	V Phase Switcher	0.5° or less phase error.
11.	Quadrature Phase	Minimum differences in amplitudes on consecutive lines.
12.	75/0 Total Chrominance Amplitudes	3% total, 1% relative.
	Blue, Yellow	470.5 mV ±14.1 mV
	Red, Cyan	663.8 mV ±19.9 mV
	Green, Magenta	620.1 mV ±18.6 mV
	White, Black	2.5 mV or less
13.	75/0 U and V Chrominance Amplitudes	3% total, 1% relative.

SHORT FORM PERFORMANCE CHECK PROCEDURE (cont)

Step	Parameter	Requirement
	U	
	Red	154.8 mV ±4.6 mV
	Green	303.9 mV ±9.1 mV
	White	2.1 mV or less
	Blue	458.6 mV ±13.8 mV
	Yellow	458.6 mV ±13.8 mV
	Magenta	303.9 mV ±9.1 mV
	Cyan	154.8 mV ±4.6 mV
	V	
	Blue	105.0 mV ±3.1 mV
	Green	540.5 mV ±16.2 mV
	White	2.5 mV or less
	Red	645.5 mV ±19.4 mV
	Cyan	645.5 mV ±19.4 mV
	Magenta	540.5 mV ±16.2 mV
	Yellow	105.0 mV ±3.1 mV
14.	100/0 Chrominance Amplitudes	3% total, 1% relative
	Total	
	Blue, Yellow	627.3 mV ±18.8 mV
	Green, Magenta	826.8 mV ±24.8 mV
	Red, Cyan	885.1 mV ±26.6 mV
	U	
	Red, Cyan	206.4 mV ±6.2 mV
	Green, Magenta	405.1 mV ±12.2 mV
	Blue, Yellow	611.5 mV ±18.3 mV
	V	
	Blue, Yellow	140.0 mV ±4.2 mV
	Green, Magenta	720.7 mV ±21.6 mV
	Red, Cyan	860.7 mV ±25.8 mV
15.	U and V Bursts	3% total, 1% relative
	U Burst	212.1 mV ±6.4 mV
	V Burst	212.1 mV ±6.4 mV
	Total Burst	300 mV ±9.0 mV
	Burst Risetime	400 ns ±60 ns
	Bursts on consecutive lines	2% relative
	Burst Phase	
	+V	+135° ±1°
	−V	−135° ±1°

SHORT FORM PERFORMANCE CHECK PROCEDURE (cont)

Step	Parameter	Requirement
16.	Chrominance Risetime	400 ns ±60 ns
17.	Subcarrier Phase	Matches rear-panel Subcarrier.
18.	Return Loss	30 dB or greater to 5 MHz.

PROCEDURE

Preliminary

Before starting this procedure, the TSG21 should be installed in a 1412 Generator mainframe, along with an appropriate SPG unit.

The system and all test equipment to be used in the procedure should be allowed a 20 minute warmup period before starting the procedure.

1. Check Residual Subcarrier Amplitude

a. Connect the TSG21 output, via a 75-Ω cable and an in-line 75-Ω terminator, to the test oscilloscope vertical input. Set the oscilloscope deflection factor to 5 mV/div and set the input for ac coupling.

b. Set the TSG21 Y, U, and V pushbuttons to their off positions, and set the V PHASE switch to ALT.

c. CHECK—residual subcarrier for 2.5 mV or less amplitude.

2. Check Luminance Gain (Sync)

a. Connect the Color Bars rear-panel Module Output to the 1482 Waveform Monitor CH A input, and terminate the other loop-through input connector in 75 Ω.

b. Set the 1482 Response to Flat, Input to A Dc Cpl'd, Volts Full Scale to 0.2, Display to 10 μs/div, and push in the Cal and Oper switches.

c. Push in the TSG21 Alterable FULL FIELD COLOR BARS pushbuttons.

d. CHECK—luminance gain, using the Video Amplitude Calibration Fixture to match the sync tip with blanking level. The amplitude should read 300 mV ±3 mV.

3. Check Dc Level

a. Use the same equipment hookup as described in parts a, b, and c of Step 2.

b. Set the 1482 Volts Full Scale to 1.0, Display to 10 μs/div, and push in the Oper switch. Set the DC Restorer to OFF, temporarily remove the cable from the 1482 CH A Input. Position the trace to the graticule blanking level line (0.3), and reconnect the cable to the 1482 CH A Input.

c. CHECK—blanking level for 0 V ±50 mV.

4. Check Sync Shaping and Risetime

a. Connect the TSG21 output to the test oscilloscope vertical input, via a 75-Ω cable and an in-line 75-Ω terminator. Set the test oscilloscope sweep rate to view the sync pulse, and the vertical to a setting that gives several divisions of vertical deflection.

b. CHECK—the sync pulse for symmetry from top to bottom, and minimum aberrations.

c. CHECK—risetime of the sync pulse for 125 ns ±20 ns.

5. Check Luminance Shaping and Risetime

a. Use the same equipment setup as described in part a of Step 5, except set the TSG21 Y switch to ON and the U and V switches to OFF, providing a display of luminance only.

b. CHECK—color bar luminance step edges for symmetry from top to bottom, and minimum aberrations.

c. CHECK—risetime of the leading edge of the white bar for 125 ns ±20 ns.

6. Check Color Bar Luminance Amplitudes

a. Use the same equipment hookup as described in Step 2, parts a, b and c.

b. Push in the U and V pushbuttons, leaving the Y pushbutton out (in the ON position), providing a luminance color bar display only. Set the luminance AMPL pushbutton for 75/0 and the WHITE REF to 75%.

c. CHECK—luminance levels (75/0) as listed in Table 2-1, using the Video Amplitude Calibration Fixture to match each luminance bar with blanking level.

Table 2-1
75% LUMINANCE LEVELS

Luminance Bar	Amplitude (mV)	Tolerance (±mV)
Black	0	—
Blue	59.9	1.5
Red	157.0	1.6
Magenta	216.8	2.2
Green	308.2	3.1
Cyan	368.0	3.7
Yellow	465.2	4.7
White (75/0)	525.0	5.3

d. Set the WHITE REF pushbutton to 100%.

e. CHECK—that the white luminance bar (100/0) is 700.0 mV ±7 mV.

f. Set the AMPL pushbutton for 100/0.

g. CHECK—luminance levels (100/0/100/0) as listed in Table 2-2, using the Video Amplitude Calibration Fixture to match each luminance bar with blanking level.

Table 2-2
100/0 LUMINANCE LEVELS

Luminance Bar	Amplitude (mV)	Tolerance (±mV)
White	700.0	7.0
Yellow	620.2	6.2
Cyan	490.7	4.9
Green	410.9	4.1
Magenta	289.1	2.9
Red	209.3	2.1
Blue	79.8	1.5
Black	0	—

h. Set the AMPL pushbutton for 100/5.

i. CHECK—luminance levels (100/0/100/5) as listed in Table 2-3, using the Video Amplitude Calibration Fixture to match each luminance bar with blanking level.

Table 2-3
100/5 LUMINANCE LEVELS

Luminance Bar	Amplitude (mV)	Tolerance (±mV)
Black	50	0.5
Blue	124.1	1.2
Red	244.4	2.4
Magenta	318.5	3.2
Green	431.6	4.3
Cyan	505.7	5.0
Yellow	625.9	6.2
White	700.0	7.0

7. Check U and V Drive Filters

a. Use the same equipment hookup as described in part a, b, and c of Step 2.

b. Set the Y pushbutton to the OFF position, and check that U and V pushbuttons are also pressed in.

c. CHECK—for good shaping of the burst envelope. See Fig. 2-1.

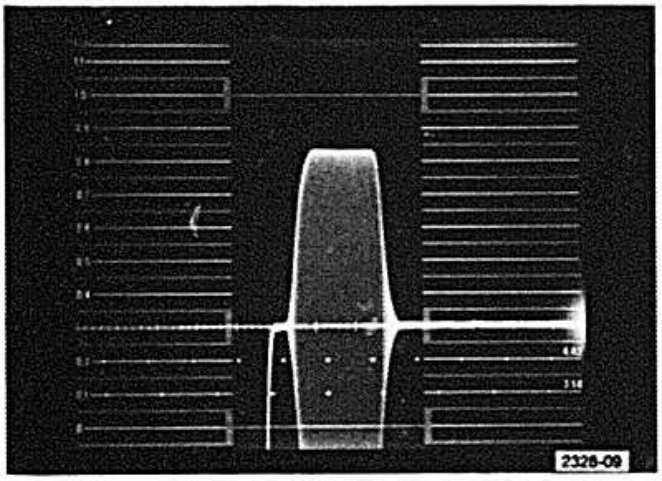


Fig. 2-1. Proper Shaping of the U Burst Envelope.

d. CHECK—for spurious subcarrier at the end of line blanking (white bar start), using the Video Amplitude Calibrator to check peak-to-peak amplitude. Amplitude should be 32 mV or less.

8. Check Chrominance Bandpass Filter Response

a. Connect the Color Bars rear-panel Module Output to the 1482 Waveform Monitor CH A input. Connect a 75-Ω cable from the other CH A loop-through input to the 522A Vectorscope CH A input, and terminate the other loop-through input in 75 Ω.

b. Set the TSG21 Y pushbutton to the OFF position.

c. Set the waveform monitor controls so that two consecutive lines overlay. Set the vectorscope controls to display the color bar vectors.

d. CHECK—for straight lines connecting the dots on the vectorscope display, similar to that shown in Fig 2-2.

e. CHECK—for a null at the green-magenta transition of the color bar display on the waveform monitor, similar to that shown in Fig. 2-3.

f. OPTIONAL CHECK—using a spectrum analyzer, check that the third (and higher) harmonics are 30 dB or greater down from the chrominance subcarrier fundamental, as illustrated in Fig. 2-4.

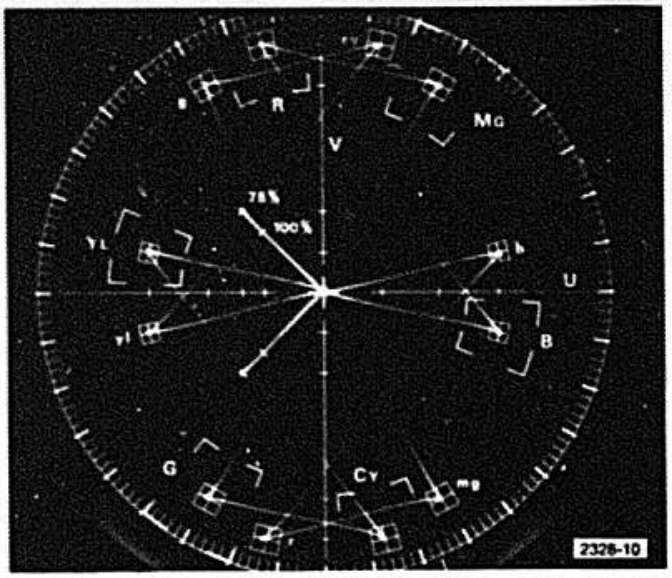


Fig. 2-2. Chrominance Bandpass Filter vectorscope display.

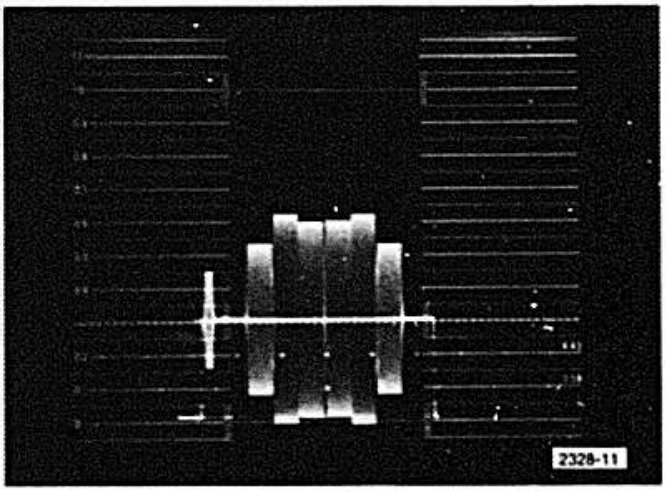


Fig. 2-3. Two consecutive lines overlayed.

9. Check Luminance-to-Chrominance Delay

a. Connect the Color Bars rear-panel Module Output to the 1482 Waveform Monitor CH A input. Terminate the other loop-through input in 75 Ω.

b. Set the TSG21 Y pushbutton to the ON position, and set COLOR BARS for the /REVERSE mode.

c. CHECK—for minimum subcarrier at the green-magenta transitions as shown in Fig. 2-5.

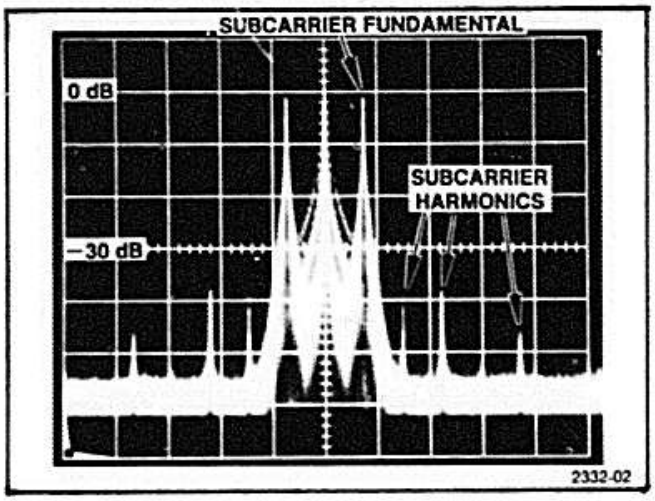


Fig. 2-4. Chrominance Bandpass Filter spectrum analyzer display.

10. Check Phase Switcher

a. Connect the Color Bars rear-panel Module Output to the 522A Vectorscope CH A input. Terminate the other loop-through input in 75 Ω.

b. Set the TSG21 U pushbutton to the OFF position.

c. Set the vectorscope controls to display the alternating V axis vectors.

d. CHECK—phase error between alternating V axis vectors for 0.5° or less (see Fig. 2-6). Use the vectorscope Calibrated Phase dial to measure any error.

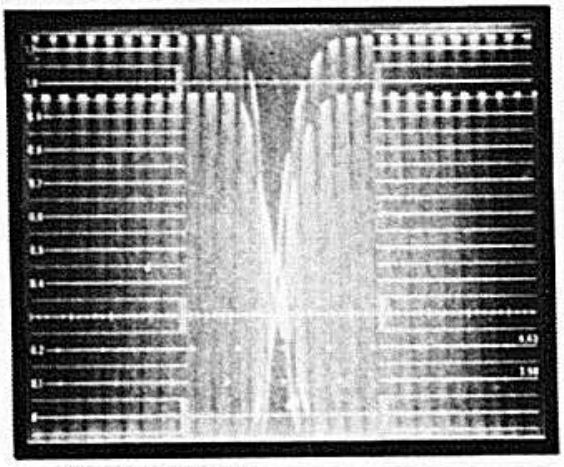
11. Check Quadrature Phase

a. Connect the Color Bars rear-panel Module Output to the 1482 Waveform Monitor CH A input. Terminate the other loop-through input in 75 Ω.

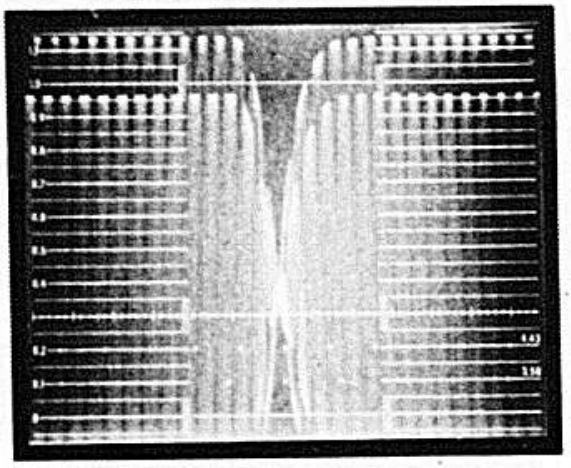
c. CHECK—overlay of consecutive lines on the waveform monitor for minimum differences in amplitudes, as shown in Fig. 2-7.

12. Check 75/0 Chrominance Amplitudes

a. Use the same equipment hookup as described in part a of Step 12.

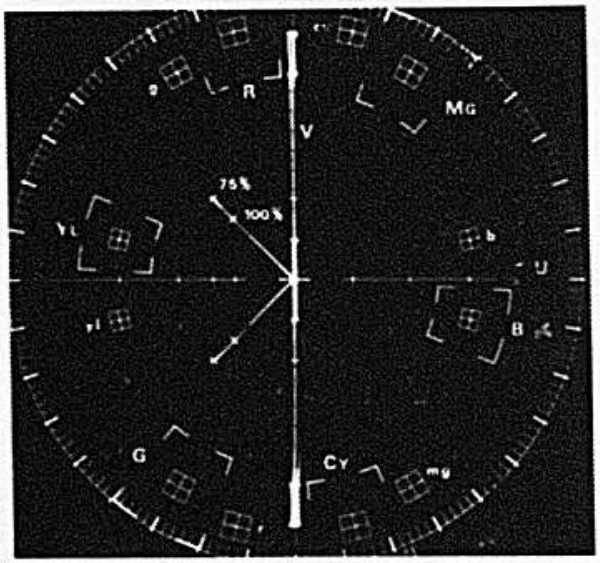


a. Delay misadjusted.

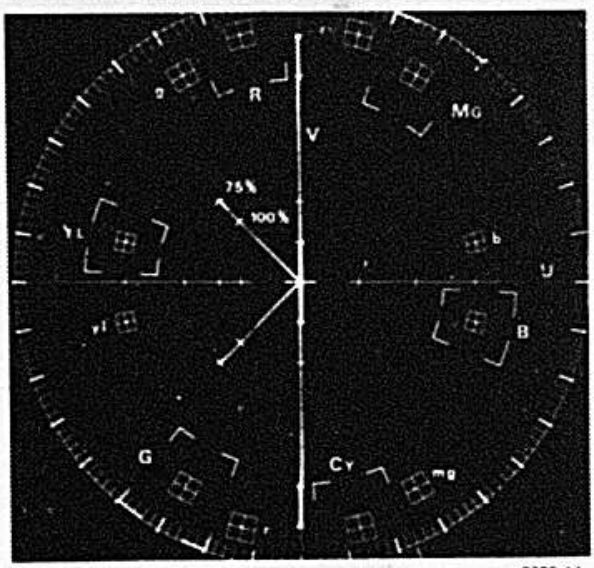


b. Delay properly adjusted. 2328-13

Fig. 2-5. Luminance-to-Chrominance Delay waveform monitor display.



a. V Axis Switcher misadjusted.



b. V Axis Switcher properly adjusted. 2328-14

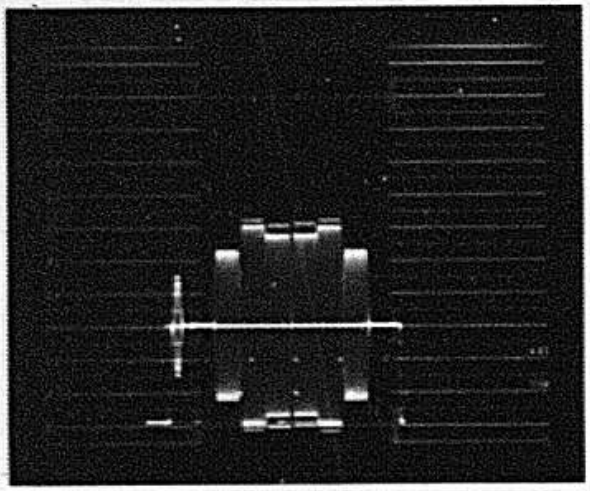
Fig. 2-6. V Axis Phase Switcher vectorscope display.

b. Set the TSG21 for 75/0 color bars, and set the Y pushbutton to the OFF position.

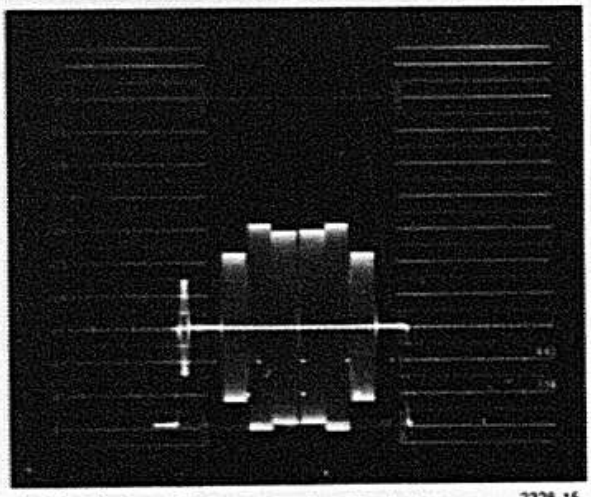
c. CHECK—that color bar amplitudes are within 3% of their absolute amplitudes, as listed in Table 2-4. Use the Video Amplitude Calibration Fixture to make the measurements. Fig. 2-8 shows an example of measuring chrominance with the Calibration Fixture.

Table 2-4
75/0 TOTAL CHROMINANCE AMPLITUDES

Color Bar	Absolute Amplitude (mV p-p)	Tolerance Range
Blue, Yellow	470.5	456.4—484.6
Red, Cyan	663.8	643.9—683.7
Green, Magenta	620.1	601.5—638.7
White, Black	0	2.5 mV or less



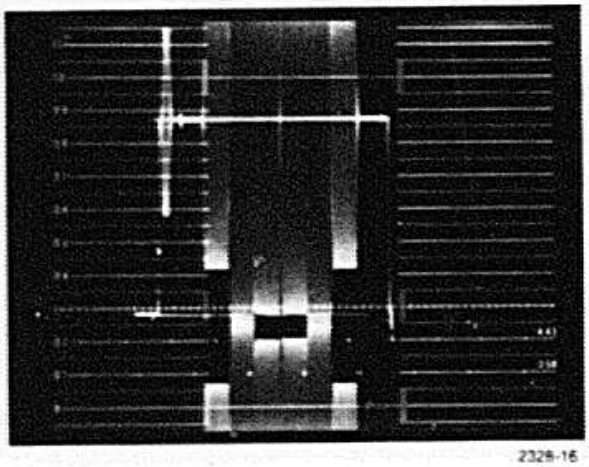
a. Quadrature Phase misadjusted.



b. Quadrature Phase properly adjusted.

2328-15

Fig. 2-7. Quadrature Phase waveform monitor display.



2328-16

Fig. 2-8. Waveform monitor display showing the red color bar peaks just overlaying.

d. CHECK—that relative amplitudes of the color bars are within 1% of each other. To check this, take the measured value of the Red color bar, and apply to the formula:

$$\frac{\text{Measured Value}}{\text{Absolute Amplitude}} \times 100\% = \%\ \text{Red relative amplitude.}$$

EXAMPLE: Assume that the Red color bar measured 670.6 mV.

$$\frac{\text{Measured Red}}{\text{Absolute Red}} \times 100\% = \frac{670.6\ \text{mV}}{663.8\ \text{mV}} \times 100\% = 101\%$$

The Red color bar in this example is 1% above the absolute amplitude.

Repeat this step for each remaining color bar listed in Table 2-4. All other amplitudes should be within 1% of the Red relative amplitude.

EXAMPLE: Assume that the Blue color bar measures 482.3 mV.

$$\frac{\text{Measured Blue}}{\text{Absolute Blue}} \times 100\% = \frac{482.3\ \text{mV}}{470.5\ \text{mV}} \times 100\% = 102.5\%$$

Although this is less than 3% above the Blue's absolute value, it is greater than 1% from the Red relative amplitude of 101% in the previous example. The color bar amplitudes in these examples would require adjustment to be within the specified limits.

13. Check 75/0 U and V Chrominance Amplitudes

a. Use the same equipment hookup as described in part a of Step 12.

b. Set the TSG21 V pushbutton to the OFF position.

c. CHECK—that the U chrominance amplitudes are within 3% of their absolute amplitudes as listed in Table 2-5.

d. CHECK—that the U chrominance relative amplitudes are within 1% of the Red bar relative amplitude, or 1 mV plus p-p residual subcarrier, whichever is greater. Use the same technique as described in part d of Step 13.

Table 2-5
75/0 U CHROMINANCE AMPLITUDES

Color Bar	Absolute Amplitude (mV p-p)	Tolerance Range
Red, Cyan	154.8	150.2—159.4
Green, Magenta	303.9	294.7—312.9
Blue, Yellow	458.6	444.8—472.4

e. Set the TSG21 U pushbutton to OFF, and the V button to ON.

f. CHECK—that the V chrominance amplitudes are within 3% of their absolute amplitudes as listed in Table 2-6.

g. CHECK—that the V chrominance relative amplitudes are within 1% of the Red bar relative amplitude, or 1 mV plus p-p residual subcarrier, whichever is greater. Use the same technique as described in part d of Step 13.

Table 2-6
75/0 V CHROMINANCE AMPLITUDES

Color Bar	Absolute Amplitude (mV p-p)	Tolerance Range
Blue, Yellow	105.0	101.8—108.1
Green, Magenta	540.5	524.3—556.7
Red, Cyan	645.5	626.1—664.9

h. Set the TSG21 U and V pushbuttons to their ON positions.

14. Check 100/0 Chrominance Amplitudes

a. Use the same equipment hookup as described in part a of Step 12.

b. Set the TSG21 for the 100/0 chrominance mode (100% chrominance bars).

c. CHECK—that the total 100/0 chrominance amplitudes are within 3% of their absolute amplitudes, as listed in Table 2-7.

Table 2-7
100/0 TOTAL CHROMINANCE AMPLITUDES

Color Bar	Absolute Amplitude (mV p-p)	Tolerance Range
Blue, Yellow	627.3	608.5—646.1
Green, Magenta	826.8	802.0—851.6
Red, Cyan	885.1	858.5—911.7

d. CHECK—that relative amplitudes of the color bars are within 1% of the Red bar relative amplitude, or 1 mV plus p-p residual subcarrier, whichever is greater. Use the same technique as described in part d of Step 13.

e. Set the TSG21 V pushbutton to the OFF position.

f. CHECK—that the 100/0 U chrominance amplitudes are within 3% of their absolute amplitudes, as listed in Table 2-8.

Table 2-8
100/0 U CHROMINANCE AMPLITUDES

Color Bar	Absolute Amplitude (mV p-p)	Tolerance Range
Red, Cyan	206.4	200.2—212.6
Green, Magenta	405.1	392.9—417.3
Blue, Yellow	611.5	593.2—629.8

g. CHECK—that the relative amplitudes of the color bars are within 1% of the Red bar relative amplitude, or 1 mV plus p-p residual subcarrier, whichever is greater. Use the same technique as described in part d of Step 13.

h. Set the TSG21 V pushbutton to ON, and the U pushbutton OFF.

i. CHECK—that the 100/0 V chrominance amplitudes are with 3% of their absolute amplitudes, as listed in Table 2-9.

Table 2-9
100/0 V CHROMINANCE AMPLITUDES

Color Bar	Absolute Amplitude (mV p-p)	Tolerance Range
Blue, Yellow	140.0	135.8—144.2
Green, Magenta	720.7	648.6—742.3
Red, Cyan	860.7	834.9—886.5

j. CHECK—that the relative amplitudes of the color bars are within 1% of the Red bar relative amplitude, or 1 mV plus p-p residual subcarrier, whichever is greater. Use the same technique as described in part d of Step 13.

15. Check U and V Bursts

a. Use the same equipment hookup as described in part a of Step 12.

b. Set the TSG21 BURST V pushbutton to OFF.

c. CHECK—U burst amplitude for 212.1 mV p-p ±3% (205.7—218.5 mV p-p). Use the Video Amplitude Calibration Fixture to make the measurement. Note the actual value.

d. Set the TSG21 BURST U pushbutton to OFF, and the BURST V pushbutton to ON.

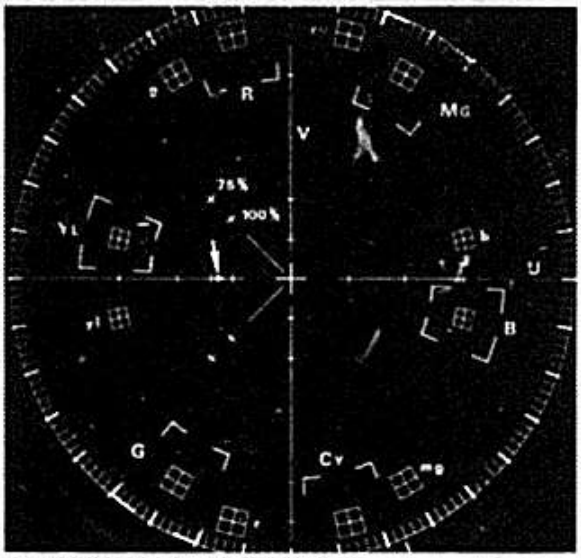
e. CHECK—that the V burst amplitude is between 205.7 and 218.5 mV p-p and is within 1% of the U burst amplitude.

f. Set the TSG21 BURST V and BURST U pushbuttons to ON.

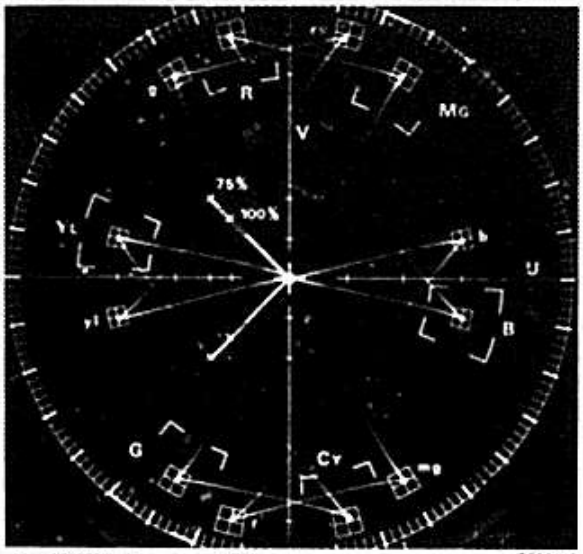
d. Disconnect the 75-Ω cable where it attaches to the 10X attenuator that is connected to the 1412 Subcarrier J21 connector. Connect this same cable to the TSG21 rear-panel output connector, so that this signal is applied to CH A of the vectorscope.

e. CHECK—that the burst vectors are at 135° and 225° (see Fig. 2-9).

ADD (g) check-that total burst amplitude is 300 mV p-p ± 3% (291.0 – 309.0 mV p-p).
(h) CHECK - that burst risetime, as measured between the 10% and 90% points of the positive peak is 400 ns ± 40ns.
(i) Set the waveform monitor controls to overlay two consecutive lines.
(j) CHECK - that burst amplitudes on consecutive lines are within 20% of each other (294.0 – 306.0 mV p-p).



a. Subcarrier phase set to 180°.



b. TSG11 phase matching the subcarrier phase. 2328-17

Fig. 2-9. Subcarrier Phase adjustment illustration.

18. Check Return Loss

a. Set up the Return Loss Bridge, sine wave generator, and differential amplifier plug-in unit to measure return loss of the TSG21. (The Instruction Manual provided with the Return Loss Bridge gives detailed instructions on the proper procedure.)

b. Set the sine wave generator for 500 mV output amplitude, and vary the frequency from 50 kHz to 5 MHz.

16. a.-e.
17. a-e
18. a-e

* Disc ch info 02/1183

c. CHECK—the returned amplitude for 16 mV or less (return loss is 30 dB or greater to 5 MHz).

g. CHECK—that total burst amplitude for 300 mV p-p ±3% (291.0—309.0 mV p-p).

h. CHECK—that burst risetime, as measured between the 10% and 90% points of the positive peak, is between 400 ns ±60 ns.

i. Set the waveform monitor controls to overlay two consecutive lines.

j. CHECK—that burst amplitudes on consecutive lines are within 2% of each other (294.0—306.0 mV p-p).

16. Check Chrominance Risetime

a. Use the same equipment hookup as described in part a of Step 12.

b. Set the TSG21 U and V COLOR BARS pushbuttons to ON, and the Y pushbutton to OFF. Display the positive peak start of the magenta bar.

c. CHECK—risetime of the magenta bar for 400 ns ±60 ns.

17. Check Subcarrier Phase

a. Connect the 1412 rear-panel Subcarrier output J20 signal to the 522A Vectorscope Ext CW 0 Ref input connector, and terminate in 75 Ω.

Connect the other 1412 rear-panel Subcarrier output J21 signal through a 10X attenuator and 75-Ω cable (in that order) to the vectorscope CH A input connector. Terminate the other CH A loop-through connector in 75 Ω.

b. Set the SPG22 to the Internal mode of operation.

c. Set the 522A Vectorscope controls as follows:

Ch A, Full Field, A0, and Vector PAL buttons pressed in. CH A Gain control set to Cal, and 0 Ref switch set to Ext. Rotate the CH A Phase control to position the subcarrier vector at 180°. (See Fig. 2-9.)

NOTE

Do not move the 522A Vectorscope CH A Phase control until completing this step.

WARNING

THE FOLLOWING SERVICING INSTRUCTIONS ARE FOR USE BY QUALIFIED PERSONNEL ONLY. TO AVOID PERSONAL INJURY, DO NOT PERFORM ANY SERVICING OTHER THAN THAT CONTAINED IN OPERATING INSTRUCTIONS UNLESS YOU ARE QUALIFIED TO DO SO. REFER TO OPERATORS SAFETY SUMMARY AND SERVICE SAFETY SUMMARY PRIOR TO PERFORMING ANY SERVICE.

SERVICING 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 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 in a mainframe whose power source will not apply more than 250 V rms between the supply conductors of the mainframe 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.

WARNING

THE FOLLOWING SERVICING INSTRUCTIONS ARE FOR USE BY QUALIFIED PERSONNEL ONLY. TO AVOID PERSONAL INJURY, DO NOT PERFORM ANY SERVICING OTHER THAN THAT CONTAINED IN OPERATING INSTRUCTIONS UNLESS YOU ARE QUALIFIED TO DO SO.

PART II
SERVICE INFORMATION

INSTALLATION

INSTALLING IN THE MAINFRAME

Use the following steps to install the TSG21 module in the 1412 mainframe.

WARNING

Disconnect power from the mainframe before installation.

1. Remove the top cover from the mainframe. Remove the plastic spacer bars over the plug-in modules.

2. Select an available module location for installation of the TSG21. Remove the blank front panel from this location. See Fig. 3-1.

3. Position the shield board over the four pins between rows of circuit board pins at the selected location on the mainframe Interface board. Seat the shield firmly on the Interface board.

4. Position the Color Bar Output board, A31-2, over the middle row of mainframe interface pins at the selected location, for example, P59 at location 2. Use the plastic guide for proper pin alignment. Seat the board firmly on the Interface board.

5. Position the Color Bar Logic board, A30-2, over the row of pins adjacent to the shield. Align the board pins using the plastic guides, and seat firmly on the Interface board.

6. Attach the plastic pushbutton extenders to the board pushbuttons shafts.

7. Position the TSG21 front panel in front of the extenders, and secure it to the 1412 mainframe front casting with the screws provided.

8. Connect the appropriate coaxial cable from the 1412 Module Output connector to the output pins of the A31-2 Color Bar Output board. Cables are color coded to match location designations shown in Fig. 3-1.

9. Unless installing other modules, perform the installation checkout, then replace the plastic spacer bar and the 1412 top cover.

Reverse the installation steps to remove the module.

INSTALLATION CHECKOUT

After installing the module in the 1412 mainframe, the Performance Check in Section 2 of this instruction manual should be performed to determine if the module is operating within specified limits. Adjusting the module according to the Calibration Procedure in Section 4 should bring the module within specification.

OPERATING MODULE SELECTION

VITS

A Vertical Interval Test Signal (VITS) may be enabled on a specific line during the vertical interval. The TSG21 front-panel switches except BURST U and V, have no effect on the VITS.

VITS may be enabled by either an internal or external VITS Key signal that goes to a TTL low (0 V) during the unblanking time of the desired VITS television line. Fig. 3-2 shows an example of the VITS Key signal and the color bar VITS.

An internal VITS Key signal may be obtained from a Black Burst Generator module in the 1412 SPG22. Use the Installation section of the appropriate Black Burst Generator instruction manual to determine the VITS line programming for specific module locations of the TSG21. The internal VITS Key does not allow field selection. VITS will be enabled on both fields.

If field selection is desired, an external VITS Key (i.e., from a switcher) may be connected to the 1412 REMOTE connector, J41. Table 3-1 shows the correct pin number on J41 for each module location the TSG21 may be installed in.

Remote Fixed FULL FIELD Mode Selection

A TTL low (0 V) on interface pin 57 at the TSG21's location produces the same effect as pressing the Fixed FULL FIELD switch. The Standard 75% PAL-M Color Bar signal (100/0/75/5) is generated, and the front-panel switches have no effect.

The interface pin may be accessed through the 1412 REMOTE connector, J41, as shown in Table 3-1.

Remote Split Field Color Bars/White Mode Selection

A TTL low (0 V) on interface pin 56 at the TSG21's location changes the lower field color to white when the /RED button is engaged. Interface pin 56 is accessible through the 1412 REMOTE connector, J41, as shown in Table 3-1.

Color Bar Sequence

Color Bar sequence may be altered by jumper connectors, as shown in Fig. 3-3. The wires in the jumper block on P227, P225, and P226 determine the sequence of the chrominance signal. The wires in the jumper block on P217, P215, and P216 determine the sequence of the luminance signal. Both the chrominance and luminance circuits required identical changes.

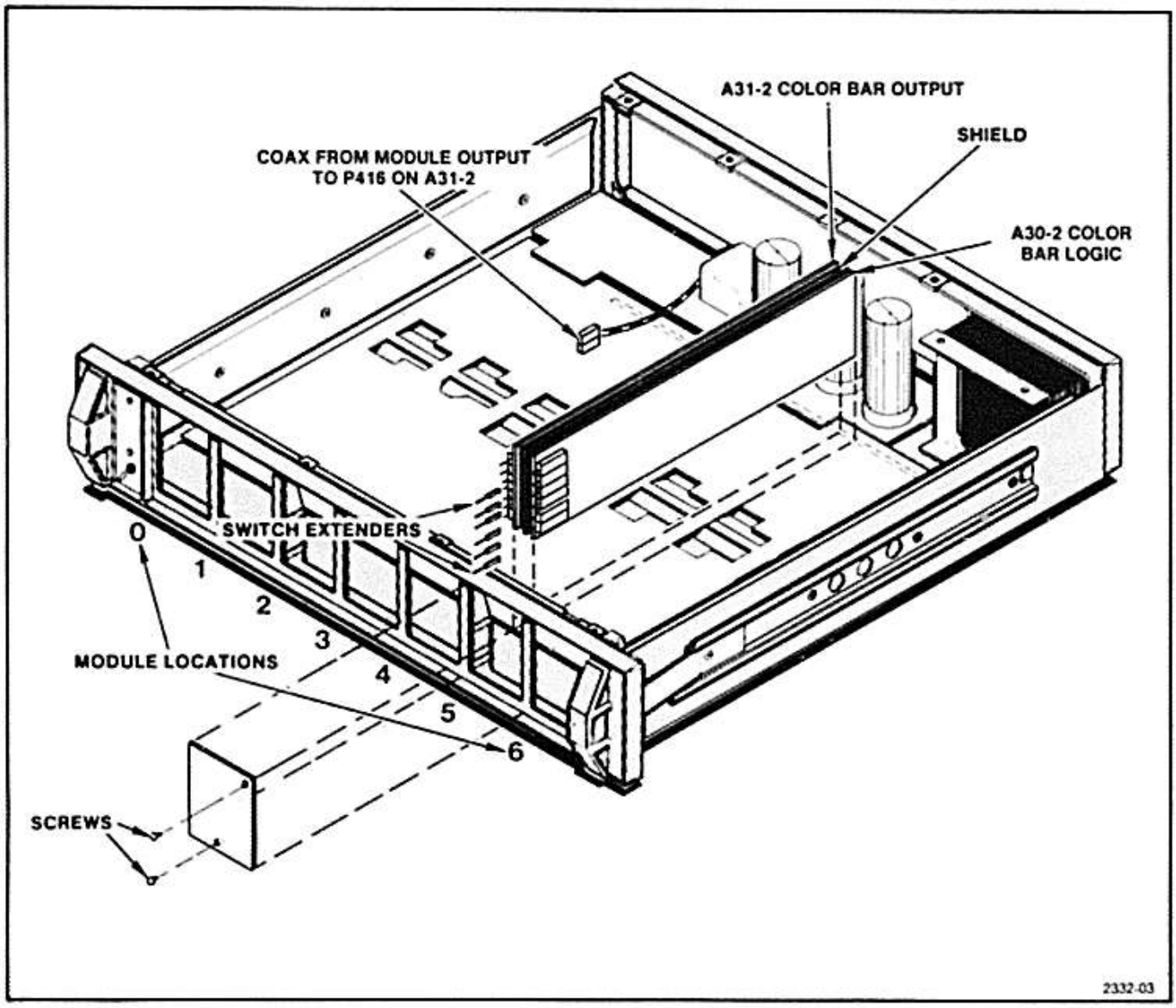


Fig. 3-1. Installing the module circuit boards in the mainframe.

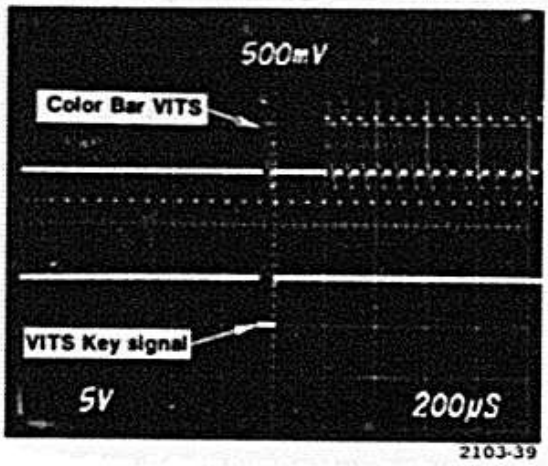


Fig. 3-2. VITS Key signal and Color Bar VITS.

Table 3-1

J41 PIN ASSIGNMENTS FOR REMOTE OPERATION OF THE TSG21

MODULE LOCATION	J41 REMOTE PIN NUMBER		
	VITS Key	Fixed FULL FIELD	WHITE
1	24	18	17
2	23	15	14
3	22	12	11
4	21	9	8
5	20	6	5
6	19	3	2

To change the configuration of a jumper, remove it from the board, pry one side out from the top with a fingernail or small screwdriver, and relocate the wires according to Fig. 3-3.

Color bars with a white, cyan, magenta, blue, yellow, green, red, and black sequence offer the largest phase transitions for the chrominance signal. The white, magenta, yellow, red, cyan, blue, green, and black sequence offers the largest luminance transitions.

Split Field Color Selection

The solid color (lower) portion of the split field COLOR BARS RED signal may be changed to any bar color. Wire straps at W205, W206, W207, and W209 must be resoldered as shown in Fig. 3-4.

Split Field Timing Selection

In the split field modes, the field may be split for equal size portions or for the upper portion to be 3/4 of the field and the lower portion 1/4 of the field. These splits are controlled by a jumper in the SPG module, and are factory set for the 1/2—1/2 mode. See the Installation section of the appropriate SPG instruction manual for the jumper location.

Other Straps

W146 and W230 alter signal parameters for use in the PAL System. They should not be moved from factory wired positions for normal use in the TSG21.

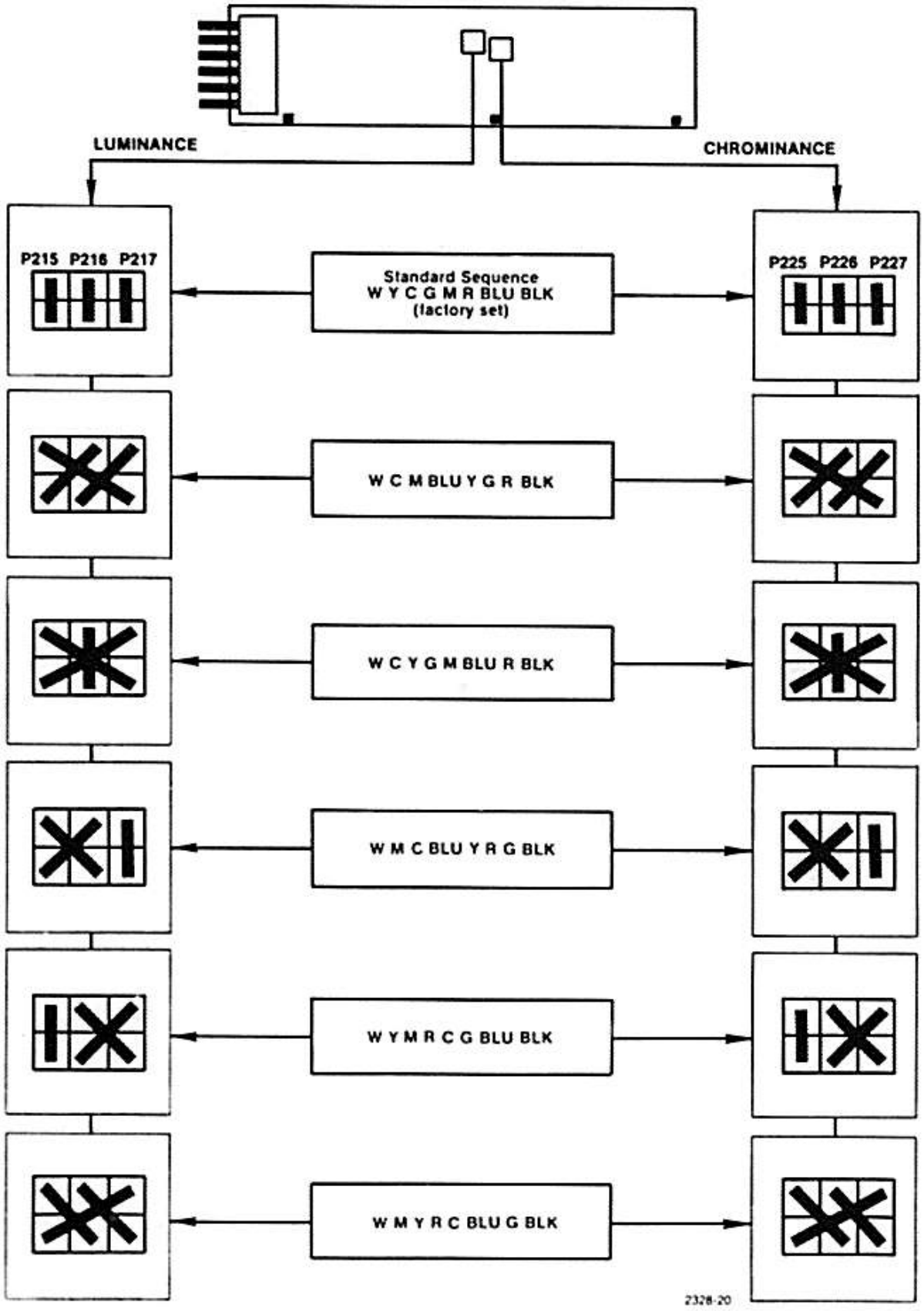


Fig. 3-3. Programming the Color Bar Logic board for altered Color Bar Sequence.

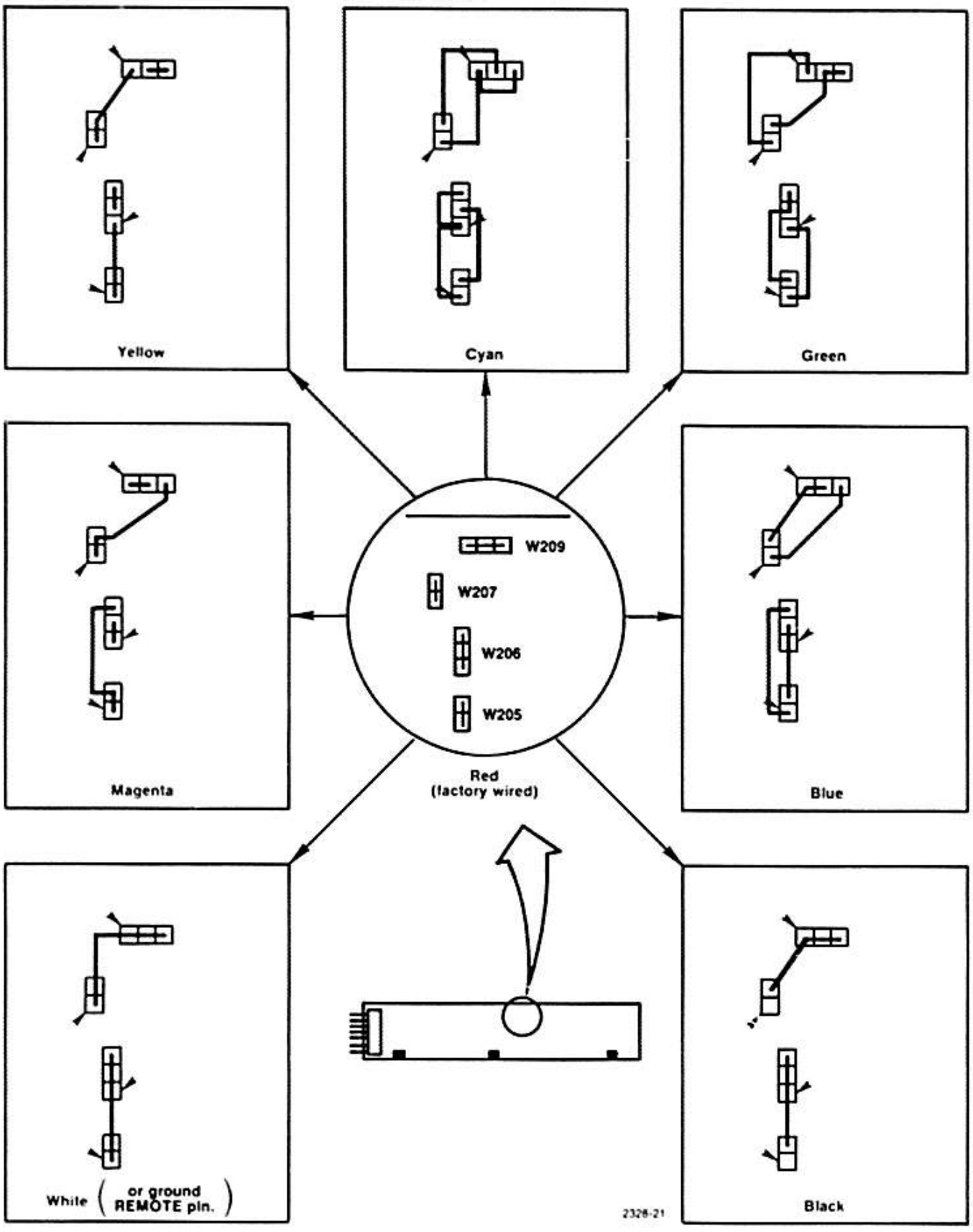


Fig. 3-4. Split Field Color Selection on the Color Bar Logic board.

CALIBRATION PROCEDURE

Introduction

The procedure in this section serves as a guide to perform the calibration steps. Limits, tolerances, and waveforms appearing in this procedure are not instrument specifications except as listed in Section 2, Specification.

The TSG21 front-panel control names in the text are capitalized; for example SYNC. Control and connector names on test equipment and internal controls in the TSG21 module under test have only the first letter capitalized; for example, test oscilloscope, Time/Div., or 1482R Mag control, except when they are used as generic terms.

A short form procedure is provided to aid in checking calibration of the TSG21. It may be used as a calibration guide by the experienced calibrator, or as a record of calibration, since the step numbers correspond to those in the complete calibration procedure.

TEST EQUIPMENT

The capabilities of the test equipment described in the following list are the minimum required to calibrate the instrument. Test equipment used in preparing these procedures is given in each example. If alternative equipment is used, it must meet or exceed the listed requirements.

1. Waveform Monitor. Capable of viewing line rate and field rate signals, with a magnifier to measure risetime and pulse duration. A TEKTRONIX 1482R MOD W5F Waveform Monitor is used in this procedure with a special calibration fixture.

2. Test Oscilloscope. Bandwidth, dc to 30 MHz; minimum deflection, 1mV/div; two input channels with provisions for independent or differential operation. For example: a TEKTRONIX 7603 Oscilloscope with 7A13, 7A18, and 7B53 plug-in units.

3. Sine Wave Generator. Minimum output, 500 mV; frequency range, 50 kHz and variable from 1 MHz to 5 MHz. For example: a TEKTRONIX SG 503 in a Tektronix TM 500 Series Mainframe.

4. Chopped Voltage Reference. Tektronix Part No. 067-0916-00 Video Amplitude Calibration Fixture.

5. Spectrum Analyzer (optional). Capable of measuring the harmonics or color subcarrier to −40 dB of the fundamental. For example: a TEKTRONIX 1401A or 7L12.

6. Return Loss Bridge. Tektronix Part No. 015-1049-00.

7. Vectorscope. For example: a TEKTRONIX 522A.

8. 75 Ω Cable (Two required). Tektronix Part No. 012-0074-00.

9. 75 Ω End-Line Termination. Tektronix Part No. 011-0102-00.

10. 75 Ω In-Line Terminator. Tektronix Part No. 011-0103-00.

11. 50 Ω to 75 Ω Minimum Loss Attenuator. Tektronix Part No. 011-0057-00.

12. 75 Ω 10X Attenuator. Tektronix Part No. 011-0061-00.

13. Extender Circuit Board. Tektronix Part No. 670-4441-00. Supplied as an accessory with the 1412 Mainframe.

Making Measurements with the Video Amplitude Calibration Fixture (VAC)

The signal to be measured must be connected to the 1482R Video Input A and terminated in 75 Ω with the precision 75 Ω Termination (011-0102-00 supplied with the VAC). The output of the VAC connects to Video Input B and is unterminated. Set the 1482R as follows:

DC Restorer	Off
Oper/Cal	Oper
Input	A-B

To check luminance amplitudes with a given tolerance, adjust the VAC Variable control while observing the waveform monitor display. When the level being measured overlays the blanking level, read the amplitude directly from the VAC front-panel Output in mV readout.

To check chrominance amplitudes, a different setup is used. The signal to be measured must be connected to the 1482R Video Input A through a Subcarrier Harmonic Rejection Filter (015-0407-00 supplied with the VAC).

Because the Harmonic Rejection Filter has 0.6% pass band loss, a 0.6% Attenuator (011-0134-00 supplied with the VAC) should be connected in series with the VAC Output to the 1482R Video Input B.

Peak-to-peak chrominance amplitudes are checked for tolerance by adjusting the VAC Variable control until the peaks of the chrominance packet being measured just meet.

To adjust a signal level, use the VAC Output as a reference. First, set the VAC Output to a desired level using the VAC Preset Level push buttons, or manually setting the lever switches. Then for luminance signals, adjust the proper control such that the luminance level overlays the blanking level. For chrominance signals, adjust the proper control until the peaks of the chrominance packets just meet.

To adjust a signal level, use the calibration fixture as a reference. First, set the Amplitude dial to the desired level. Then, for luminance signals, adjust the required control so the luminance level overlays the blanking level. For chrominance, adjust for the peaks to just meet.

SHORT FORM CALIBRATION PROCEDURE

Step	Parameter	Requirement	Adjust
1.	Residual Subcarrier	2.5 mV or less	R402, R403, C371, C373
2.	Luminance Gain (Sync)	−300 mV ±3 mV	R449
3.	Dc Level	0 V ±50 mV	R459
4.	Setup Level	50 mV ±1.5 mV	Check
5.	Sync Shaping, Risetime	t_r = 125 ns ±20 ns Symmetry from top to bottom, and minimum aberrations.	L464, L467
6.	Luminance Shaping, Risetime	t_r = 125 ns ±20 ns Symmetry from top to bottom, and minimum aberrations.	L484, L487
7.	Color Bar Luminance 75/0	1% or 1.5 mV	
	Black	0 mV	Check
	Blue	59.9 mV ±1.5 mV	R296
	Red	157.0 mV ±1.6 mV	R298
	Magenta	216.8 mV ±2.2 mV	Check
	Green	308.2 mV ±3.1 mV	R298
	Cyan	368.0 mV ±3.7 mV	Check
	Yellow	465.2 mV ±4.7 mV	Check
	White (75%)	525.0 mV ±5.3 mV	Check
	100% White Ref		
	White (100%)	700.0 mV ±7.0 mV	R276
	100/0		
	White	700.0 mV ±7.0 mV	Check
	Yellow	620.2 mV ±6.2 mV	Check
	Cyan	490.7 mV ±4.9 mV	Check
	Green	410.9 mV ±4.1 mV	Check
	Magenta	289.1 mV ±2.9 mV	Check
	Red	209.3 mV ±2.1 mV	Check
	Blue	79.8 mV ±8.0 mV	Check
	Black	0 mV	Check

SHORT FORM CALIBRATION PROCEDURE (cont)

Step	Parameter	Requirement	Adjust
	100/5		
	Black	50 mV	Check
	Blue	124.1 mV ±1.2 mV	Check
	Red	244.4 mV ±2.4 mV	Check
	Magenta	318.5 mV ±3.2 mV	Check
	Green	431.6 mV ±4.3 mV	Check
	Cyan	505.7 mV ±5.1 mV	Check
	Yellow	625.1 mV ±6.2 mV	Check
	White	700.0 mV ±7.0 mV	Check
	75/5		
	White	537.5 mV ±5.4 mV	Check
	Yellow	481.9 mV ±4.8 mV	Check
	Cyan	391.7 mV ±3.9 mV	Check
	Green	336.2 mV ±3.4 mV	Check
	Magenta	251.3 mV ±2.5 mV	Check
	Red	195.8 mV ±2.0 mV	Check
	Blue	105.6 mV ±1.1 mV	Check
	Black	50.0 mV ±0.5 mV	Check
8	U and V Drive Filters	32 mV or less spurious subcarrier, and good burst shaping.	L444, L424, L432, L452
9	Chrominance Bandpass Filter	Straight lines between vectors, null at green-magenta transition, and minimum harmonics.	L357, L367
10	Luminance-to-Chrominance Delay	20 ns or less between luminance and chrominance.	R149
11	V Phase Switcher	0.5° or less phase error.	C351
12	Quadrature Phase	Minimum differences in amplitudes on consecutive lines.	L363
13	Chrominance Gain	300 mV ±3 mV Burst	R378
14	75/0 Total Chrominance Amplitudes	3% total, 1% relative.	
	Blue, Yellow	470.5 mV ±14.1 mV	Check
	Red, Cyan	663.8 mV ±19.9 mV	Check
	Green, Magenta	620.1 mV ±18.6 mV	Check
	White, Black	2.5 mV or less	Check
15	75/0 U and V Chrominance Amplitudes	3% total, 1% relative.	
	U		
	Red	154.8 mV ±4.6 mV	R248
	Green	303.9 mV ±9.1 mV	R238
	White	Chrominance null	R228
	Blue	458.6 mV ±13.8 mV	Check
	Yellow	458.6 mV ±13.8 mV	Check
	Magenta	303.9 mV ±9.1 mV	Check
	Cyan	154.8 mV ±4.6 mV	Check

SHORT FORM CALIBRATION PROCEDURE (cont)

Step	Parameter	Requirement	Adjust
	V		
	Blue	105.0 mV ±3.1 mV	R259
	Green	540.5 mV ±16.2 mV	R268
	White	Chrominance null	R258
	Red	645.5 mV ±19.4 mV	Check
	Cyan	645.5 mV ±19.4 mV	Check
	Magenta	540.5 mV ±16.2 mV	Check
	Yellow	105.0 mV ±3.1 mV	Check
16.	100/0 Chrominance Amplitudes	3% total, 1% relative	
	Total		
	Blue, Yellow	627.3 mV ±18.8 mV	Check
	Green, Magenta	826.8 mV ±24.8 mV	Check
	Red, Cyan	885.1 mV ±26.6 mV	Check
	U		
	Red, Cyan	206.4 mV ±6.2 mV	Check
	Green, Magenta	405.1 mV ±12.2 mV	Check
	Blue, Yellow	611.5 mV ±18.3 mV	Check
	V		
	Blue, Yellow	140.0 mV ±4.2 mV	Check
	Green, Magenta	720.7 mV ±21.6 mV	Check
	Red, Cyan	860.7 mV ±25.8 mV	Check
17.	U and V Bursts	3% total, 1% relative	
	U Burst	212.1 mV ±6.4 mV	R239
	V Burst	212.1 mV ±6.4 mV	R249
	Total Burst	300 mV ±9.0 mV	Check
	Burst Risetime	400 ns ±60 ns	Check
	Burst on consecutive lines	2% relative	Check
	Burst Phase		
	+V	+135° ±1°	Check
	−V	−135° ±1°	Check
18.	Chrominance Risetime	400 ns ±60 ns	Check
19.	Subcarrier Phase	Matches rear-panel Subcarrier	L317, C318
20.	Isolation	40 dB or greater	Check
21.	Return Loss	30 dB or greater	Check

PROCEDURE

Preliminary

Mount the Color Bar Output board on the Extender board to gain access to the adjustments. Use care in aligning pins and connectors. All adjustments on the Color Bar Logic board may be reached from above, not requiring use of the Extender board.

The system and all test equipment to be used in the procedure should be allowed a 20 minute warmup period before starting the procedure.

1. Check/Adjust Residual Subcarrier Amplitude

a. Connect the TSG21 output, via a 75-Ω cable and an in-line 75-Ω terminator, to the test oscilloscope vertical input. Set the oscilloscope deflection factor to 5 mV/div and set the input for ac coupling.

b. Set the TSG21 Y, U, and V pushbuttons to OFF, and set the V PHASE switch to ALT.

c. CHECK—residual subcarrier for 2.5 mV or less amplitude.

d. ADJUST—R402, R403, C371, and C373 (Res Subc) for minimum residual subcarrier. Several adjustments may be required because of interaction.

2. Check/Adjust Luminance Gain

a. Connect the TSG21 output to the 1482 Waveform Monitor CH A input, and terminate the other CH A loop-through input connector in 75 Ω. The Video Amplitude Calibration Fixture should be connected to the 1482 CH B input.

b. Set the 1482 Response to Flat, Input to A-B Volts Full Scale to 1.0, Display to 10 μs/div, and DC Restore to OFF.

c. Push in the TSG21 Alterable FULL FIELD COLOR BARS pushbutton.

d. CHECK—luminance gain, using the Video Amplitude Calibration Fixture to match the sync tip with blanking level. The amplitude should read 300 mV ±3 mV.

e. ADJUST—R449 (Lum Gain) for sync to blanking amplitude of 300 mV.

3. Check/Adjust Dc Level

a. Use the same equipment hookup as described in parts a, b and c of Step 2, except the calibration fixture is not connected to CH B input, and the Input switch is set to A Dc Cpl'd.

b. Set the 1482 Volts Full Scale to 1.0, Display to 10 μs/div, and push in the Oper switch. Set the DC Restorer to Off, and temporarily remove the cable from the 1482 Ch A Input. Position the trace to the graticule blanking level line (0.3), and reconnect the cable to the 1482 CH A Input.

c. CHECK—blanking level for 0 V ±50 mV.

d. ADJUST—R459 (Dc Level) for a blanking level of 0 V.

e. INTERACTION—Because of interaction between the Lum Gain (R449) and Dc Level (R459) adjustments, repeat Steps 2 and 3.

4. Check Setup Level

a. Use the same equipment setup as described in Step 2.

b. Set the TSG21 AMPL to 100/5 mode. Press in the Y, U, and V pushbuttons (OFF).

c. CHECK—for a pedestal level of 50 mV ±1.5 mV from blanking.

5. Check/Adjust Sync Shaping and Risetime

a. Connect the TSG21 output to the test oscilloscope vertical input, via a 75-Ω cable and an in-line 75-Ω terminator. Set the test oscilloscope triggering and sweep rate to view the sync pulse, and the vertical to a setting that gives several divisions of vertical deflection.

b. CHECK—the sync pulse for symmetry from top to bottom, and minimum aberrations.

c. CHECK—risetime of the sync pulse (between 10% and 90% points on the leading edge) for 125 ns ±20 ns.

d. ADJUST—L484 and L487 (125 ns Filter) for best shaping.

6. Check/Adjust Luminance Shaping and Risetime

a. Use the same equipment setup as described in part a of Step 5, except set the TSG21 Y switch to ON and the U and V switches to OFF, providing a display of luminance only.

b. CHECK—color bar luminance step edges for symmetry from top to bottom, and minimum aberrations.

c. CHECK—risetime of the leading edge of the white bar for 125 ns ± 20 ns.

d. ADJUST—L484 and L487 (125 ns Filter) for best shaping if necessary.

7. Check/Adjust Color Bar Luminance Amplitudes

a. Use the same equipment hookup as described in Step 2.

b. Push in the TSG21 U and V pushbuttons, leaving the Y pushbutton out (in the ON position), providing a luminance color bar display only. Set the luminance AMPL pushbutton for 75%, the WHITE REF to 75%, and SETUP to 0%.

c. CHECK/ADJUST—luminance levels as listed in Table 4-1, using the Video Amplitude Calibration Fixture to match each luminance bar with blanking level.

d. Set the TSG21 WHITE REF to 100%.

e. CHECK—that the white luminance bar (100% and 0% setup) is 700.0 mV ± 7 mV.

f. ADJUST—R276 (100% White) for a white level of 700.0 mV.

g. Set the TSG21 AMPL pushbutton for 100.0.

h. CHECK—luminance levels 100% as listed in Table 4-2, using the Video Amplitude Calibration Fixture to match each luminance bar with blanking level.

i. Set the TSG21 AMPL pushbuttons for 100/5.

j. CHECK—luminance levels (100/0/100/5) as listed in Table 4-3, using the Video Amplitude Calibration Fixture to match each luminance bar with blanking level.

k. CHECK—Luminance levels (100/0/75/5) as listed in Table 4-4, using the Video Amplitude Calibration Fixture to match each luminance bar level with the blanking level.

Table 4-1
75% LUMINANCE LEVELS

Luminance Bar	Amplitude (mV)	Tolerance (±mV)	Check/ Adjust
Black	0	—	Check
Blue	59.9	1.5	R296 (B_y)
Red	157.0	1.6	R286 (R_y)
Magenta	216.8	2.2	Check
Green	308.2	3.1	R298 (G_y)
Cyan	368.0	3.7	Check
Yellow	465.2	4.7	Check
White (75.0)	525.0	5.3	Check

Table 4-2
100% LUMINANCE LEVELS

Luminance Bar	Amplitude (mV)	Tolerance (±mV)
White	700.0	7.0
Yellow	620.2	6.2
Cyan	490.7	4.9
Green	410.9	4.1
Magenta	289.1	2.9
Red	209.3	2.1
Blue	79.8	1.5
Black	0	—

Table 4-3
100/0/100/5 LUMINANCE LEVELS

Luminance Bar	Amplitude (mV)	Tolerance (±mV)
Black	50	0.5
Blue	124.1	1.2
Red	244.4	2.4
Magenta	318.5	3.2
Green	431.6	4.3
Cyan	505.7	5.1
Yellow	625.9	6.2
White	700.0	7.0

Table 4-4
100/0/75/5 LUMINANCE LEVELS

Luminance Bar	Amplitude (mV)	Tolerance (±mV)
White	537.5	5.4
Yellow	481.9	4.8
Cyan	391.7	3.9
Green	336.2	3.4
Magenta	251.3	2.5
Red	195.8	2.0
Blue	105.6	1.1
Black	50.0	0.5

8. Check/Adjust U and V Drive Filters

a. Use the same equipment hookup as described in Step 2, except the calibration fixture is not connected to Ch B and the Input switch is set to A Dc Cpl'd.

b. Set the TSG21 Y pushbutton to OFF, the BURST U to ON, the BURST V to OFF, and release the 100/25 pushbutton. Check that the COLOR BARS U and V pushbuttons are also pressed in.

c. CHECK—for good shaping of the burst envelope. See Fig. 4-1.

d. CHECK—for spurious subcarrier at the end of line blanking (white bar start), using the Amplitude dial of the Calibration Fixture to check peak-to-peak amplitude. Amplitude should be 32 mV or less.

e. ADJUST—L444 (−U) for best shaping of the U burst envelope.

f. Set the TSG21 BURST V switch to ON and the BURST U to OFF.

g. ADJUST—L432 (+V) for best shaping of the V burst envelope.

h. Set the TSG21 BURST U and BURST V and the COLOR BARS U and V pushbuttons to the ON position.

i. ADJUST—L424 (+U) and L452 (−V) for minimum spurious subcarrier at the end of line blanking.

j. ADJUST—L424 (+U), L444 (−U), L432 (+V), and L452 (−V) slightly to optimize the burst shaping and to minimize the spurious subcarrier at the end of line blanking.

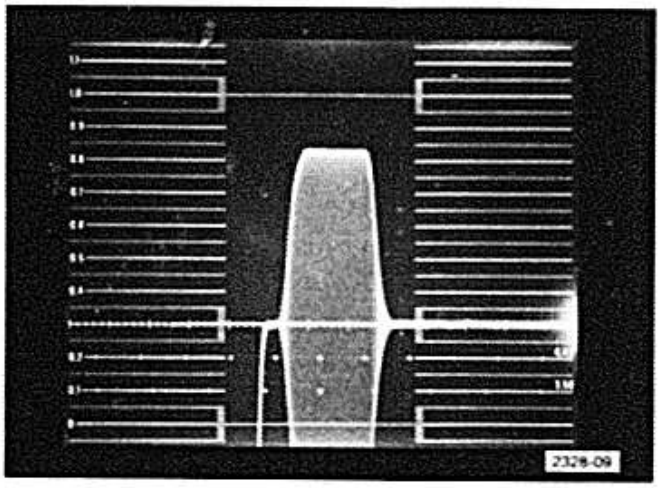


Fig. 4-1. Proper Shaping of the U Burst Envelope.

9. Check/Adjust Chrominance Bandpass Filter Response

a. Connect the TSG21 output to the 1482 Waveform Monitor CH A input. Connect a 75-Ω cable from the other Ch A loop-through input to the 522A Vectorscope CH A input, and terminate the other vectorscope CH A loop-through input in 75 Ω.

NOTE

If a spectrum analyzer is available, do not terminate the other loop-through input of the vectorscope. Instead, connect a 75-Ω cable to loop-through connector, terminate the far end of the cable with a 50-to-75 Ω minimum loss attenuator (75 Ω end at the cable), and connect to the 50-Ω input of the spectrum analyzer.

b. Set the TSG21 Y pushbutton to the OFF position.

c. Set the waveform monitor controls so that two consecutive lines overlay. Set the vectorscope controls to display the color bar vectors.

d. CHECK—for straight lines connecting the dots on the vectorscope display, similar to that shown in Fig. 4-2.

e. CHECK—for a null at the green-magenta transition of the color bar display on the waveform monitor, similar to that shown in Fig. 4-3.

f. OPTIONAL CHECK—using a spectrum analyzer, check that the third (and higher) harmonics are 30 dB or greater down from the chrominance subcarrier fundamental, as illustrated in Fig. 4-4.

g. ADJUST—L357 and L367 (Chrominance Bandpass) to optimize for minimum harmonics, best straight lines between vectors, and a null at the green-magenta transition.

NOTE

Only slight readjustment from the factory setting should be necessary. No more than a slight readjustment should be attempted without the use of a spectrum analyzer.

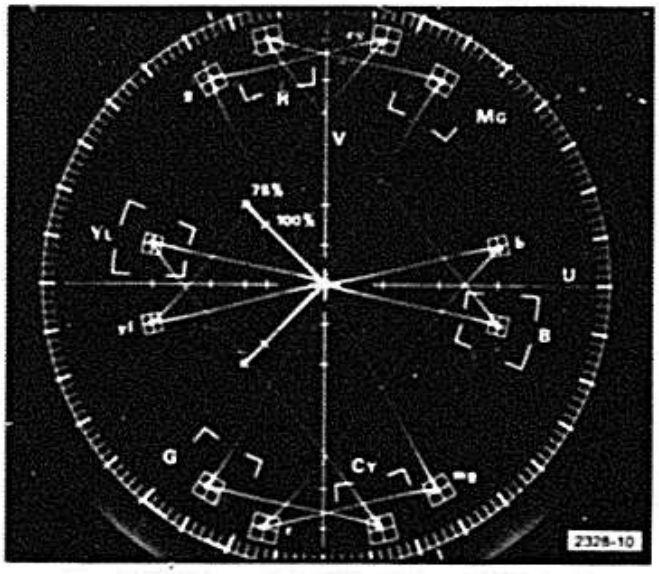


Fig. 4-3. Chrominance Bandpass Filter waveform monitor display.

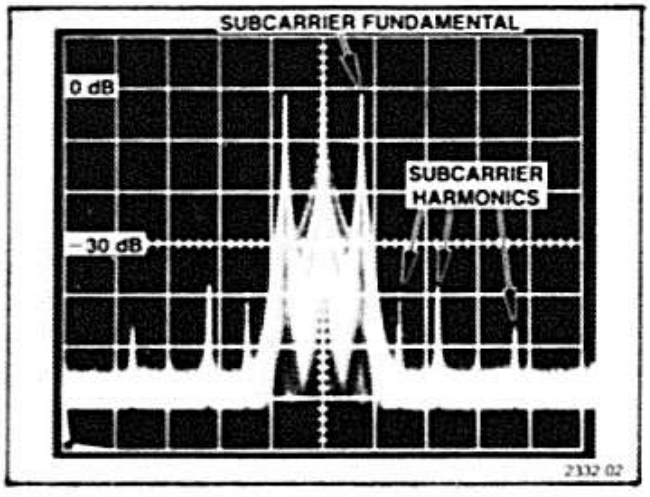


Fig. 4-2. Chrominance Bandpass Filter vectorscope display.

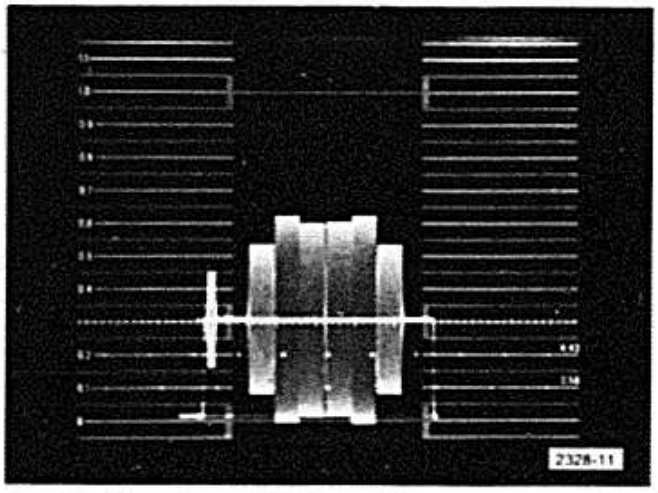


Fig. 4-4. Chrominance Bandpass Filter spectrum analyzer display.

10. Adjust Luminance-to-Chrominance Delay

a. Connect the TSG21 output to the waveform monitor CH A input. Terminate the other CH A loop-through input in 75 Ω.

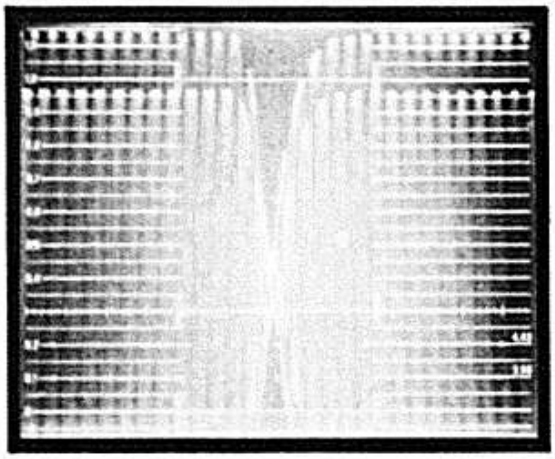
b. Set the TSG21 Y pushbutton to the ON position, and set COLOR BARS for the /REVERSE mode.

c. ADJUST—R149 (Y Delay) for minimum subcarrier at the green-magenta transitions (see Fig. 4-5).

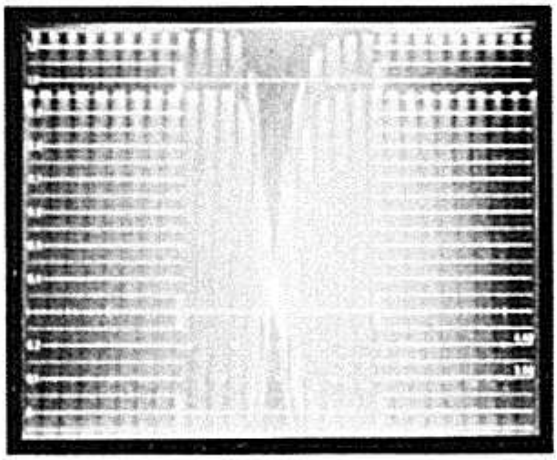
11. Check/Adjust V Phase Switcher

a. Connect the TSG21 output to the vectorscope CH A input. Terminate the other CH A loop-through input in 75 Ω.

b. Set the TSG21 COLOR BARS U pushbutton to OFF.



a. Delay misadjusted.



b. Delay properly adjusted. 2328-13

Fig. 4-5. Luminance-to-Chrominance Delay waveform monitor display.

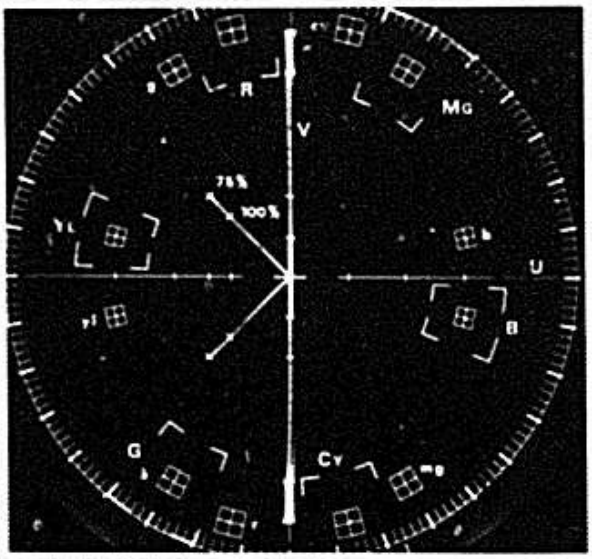
c. Set the vectorscope controls to display the alternating V axis vectors.

d. CHECK—phase error between alternating V axis vectors for 0.5° or less (see Fig. 4-6). Use the vectorscope Calibrated Phase dial to measure any error.

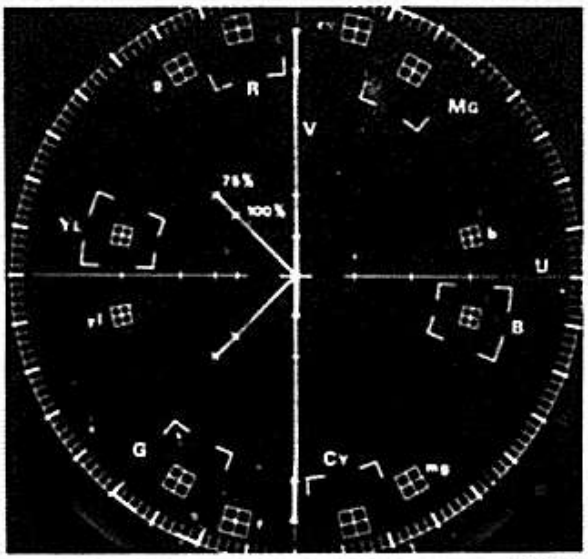
e. ADJUST—C351 (V0) for minimum phase error of the V axis vectors (see Fig. 4-6a).

NOTE

At this point, residual subcarrier (Step 1) should be rechecked, and adjusted if necessary.



a. V Axis Switcher misadjusted.



b. V Axis Switcher properly adjusted. 2328-14

Fig. 4-6. V Axis Phase Switcher vectorscope display.

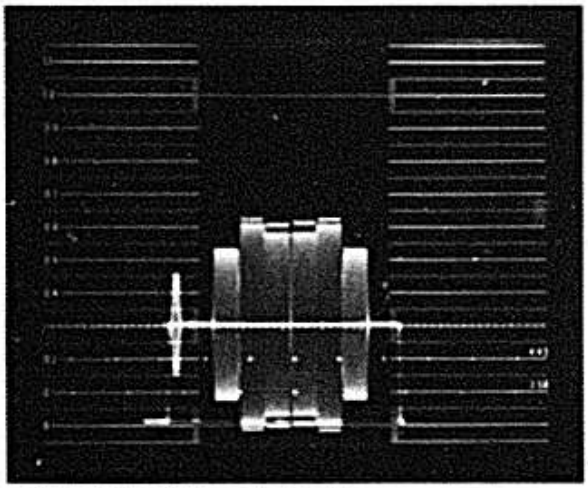
12. Check/Adjust Quadrature Phase

a. Connect the TSG 21 output to the waveform monitor CH A input. Terminate the other CH A loop-through input in 75 Ω.

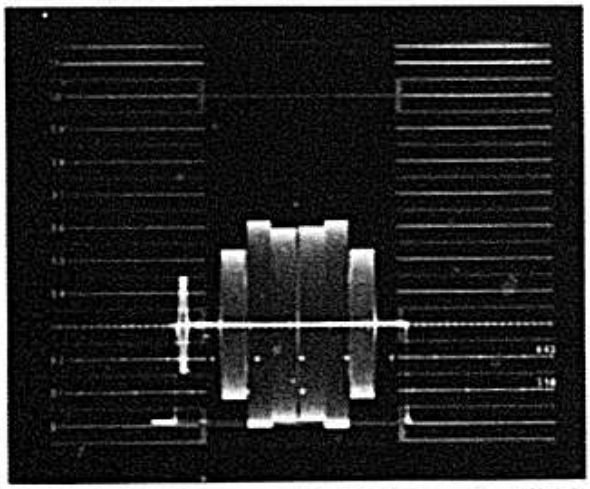
b. Set the TSG21 Y pushbutton to OFF, and the U pushbutton to ON.

c. CHECK—overlay of consecutive lines on the waveform monitor for minimum differences in amplitudes as shown in Fig. 4-7.

d. ADJUST—L363 (Quad Phase) for minimum differences in amplitudes (see Fig 4-7a).



a. Quadrature Phase misadjusted.



b. Quadrature Phase properly adjusted.

2328-15

Fig. 4-7. Quadrature Phase waveform monitor display.

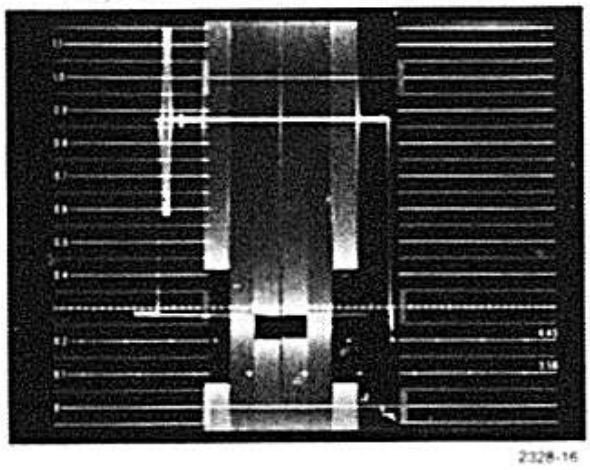
13. Preadjust Chrominance Gain

a. Use the same equipment hookup as described in part a of Step 12, and connect the Video Amplitude Calibration Fixture to the waveform monitor CH B Input. Set the 1482 DC Restorer to OFF, and Input switch to A-B. See Fig. 4-8 for an example of measuring chrominance with the Calibration Fixture.

b. CHECK—burst amplitude for 300 mV ± 9 mV.

c. PRESET—R239 (Burst U) and R249 (Burst V) to midrange.

d. ADJUST—R379 (Chrominance Gain) for a burst amplitude of 300 mV.



2328-16

Fig. 4-8. Waveform monitor display showing the red color bar peaks just overlaying.

14. Check 75/0 Chrominance Amplitudes

a. Use the same equipment hookup as described in part a of Step 13.

b. Set the TSG21 for 75/0 color bars, and set the Y pushbutton to the OFF position.

c. CHECK—that color bar amplitudes are within 3% of their absolute amplitudes, as listed in Table 4-5.

Table 4-5
75/0 TOTAL CHROMINANCE AMPLITUDES

Color Bar	Absolute Amplitude (mV p-p)	Tolerance Range
Blue, Yellow	470.5	456.4—484.6
Red, Cyan	663.8	643.9—683.7
Green, Magenta	620.1	601.5—638.7
White, Black	0	2.5 mV or less

d. CHECK—that relative amplitudes of the color bars are within 1% of each other. To check this, take the measured value of the Red color bar, and apply to the formula:

$$\frac{\text{Measured Value}}{\text{Absolute Amplitude}} \times 100\% = \%\ \text{Red relative amplitude.}$$

EXAMPLE: Assume that the Red color bar measured 670.6 mV.

$$\frac{\text{Measured Red}}{\text{Absolute Red}} \times 100\% = \frac{670.6\ \text{mV}}{663.8\ \text{mV}} \times 100\% = 101\%$$

The Red color bar in this example is 1% above the absolute amplitude.

Repeat this step for each remaining color bar listed in Table 4-5. All other amplitudes should be within 1% of the Red relative amplitude.

EXAMPLE: Assume that the Blue color bar measures 482.3 mV.

$$\frac{\text{Measured Blue}}{\text{Absolute Blue}} \times 100\% = \frac{482.3\ \text{mV}}{470.5\ \text{mV}} \times 100\% = 102.5\%$$

Although this is less than 3% above the Blue's absolute value, it is greater than 1% from the Red relative amplitude of 101% in the previous example. The color bar amplitudes in these examples would require adjustment to be within the specified limits.

15. Check/Adjust 75/0 U and V Chrominance Amplitudes

a. Use the same equipment hookup as described in part a of Step 13.

b. Set the TSG21 COLOR BARS V pushbutton to the OFF position.

c. CHECK—that the U chrominance amplitudes are within 3% of their absolute amplitudes as listed in Table 4-6.

Table 4-6
75/0 U CHROMINANCE AMPLITUDES

Color Bar	Absolute Amplitude (mV p-p)	Tolerance Range
Red, Cyan	154.8	150.2—159.4
Green, Magenta	303.9	294.8—313.0
Blue, Yellow	458.6	444.8—472.4

d. CHECK—that the U chrominance relative amplitudes are within 1% of the Red bar relative amplitude, or 1 mV plus p-p residual subcarrier, whichever is greater. Use the same technique as described in part d of Step 14.

e. ADJUST—U chrominance amplitudes as shown in Table 4-7.

Table 4-7
75/0 U CHROMINANCE ADJUSTMENTS

Color Bar	Amplitude (mV p-p)	Adjust
Red	154.8	R248 (R_U)
Green	303.9	R238 (G_U)
White	Adjust for chrominance null on the white bar.	R228 (B_U)
Blue	444.8—472.4	Check
Yellow	444.8—472.4	Check
Magenta	294.8—313.0	Check
Cyan	150.2—159.4	Check

f. Set the TSG21 U pushbutton to OFF, and the V pushbutton to ON.

g. CHECK—that the V chrominance amplitudes are within 3% of their absolute amplitudes as listed in Table 4-8.

h. CHECK—that the V chrominance relative amplitudes are within 1% of the Red bar relative amplitude, or 1 mV plus p-p residual subcarrier, whichever is greater. Use the same technique as described in part d of Step 14.

Table 4-8
75/0 V CHROMINANCE AMPLITUDES

Color Bar	Absolute Amplitude (mV p-p)	Tolerance Range
Blue, Yellow	105.0	101.8—108.1
Green, Magenta	540.5	524.3—556.7
Red, Cyan	645.5	626.1—664.9

i. ADJUST—V chrominance amplitudes as shown in Table 4-9.

Table 4-9
75/0 CHROMINANCE ADJUSTMENTS

Color Bar	Amplitude (mV p-p)	Adjust
Blue	105.0	R259 (B_V)
Green	540.5	R268 (G_V)
White	Adjust for chrominance null on the white bar.	R258 (R_V)
Red	626.1—664.9	Check
Cyan	626.1—664.9	Check
Magenta	524.3—556.7	Check
Yellow	101.8—108.1	Check

j. Set the TSG21 U and V chrominance switches to ON.

k. RECHECK—total chrominance amplitudes in the 75/0 mode, as listed in Table 4-5 of Step 14.

16. Check 100/0 Chrominance Amplitudes

a. Use the same equipment hookup as described in part a of Step 13.

b. Set the TSG21 for the 100/0 chrominance mode (100% chrominance bars).

c. CHECK—that the total 100/0 chrominance amplitudes are within 3% of their absolute amplitudes, as listed in Table 4-10.

Table 4-10
100/0 TOTAL CHROMINANCE AMPLITUDES

Color Bar	Absolute Amplitude (mV p-p)	Tolerance Range
Blue, Yellow	627.3	608.5—646.1
Green, Magenta	826.8	802.0—851.6
Red, Cyan	885.1	858.5—911.7

d. CHECK—that relative amplitudes of the color bars are within 1% of the Red bar relative amplitude, or 1 mV plus p-p residual subcarrier, whichever is greater. Use the same technique as described in part d of Step 14.

e. Set the TSG21 COLOR BARS V pushbutton to the OFF position.

f. CHECK—that the 100/0 U chrominance amplitudes are within 3% of their absolute amplitudes, as listed in Table 4-11.

Table 4-11
100/0 U CHROMINANCE AMPLITUDES

Color Bar	Absolute Amplitude (mV p-p)	Tolerance Range
Red, Cyan	206.4	200.2—212.6
Green, Magenta	405.1	392.9—417.3
Blue, Yellow	611.5	593.2—629.8

g. CHECK—that the relative amplitudes of the color bars are within 1% of the Red bar relative amplitude, or 1 mV plus p-p residual subcarrier, whichever is greater. Use the same technique as described in part d of Step 14.

h. Set the TSG21 V pushbutton to ON, and the U pushbutton OFF.

i. CHECK—that the 100/0 V chrominance amplitudes are with 3% of their absolute amplitudes, as listed in Table 4-12.

Table 4-12
100/0 V CHROMINANCE AMPLITUDES

Color Bar	Absolute Amplitude (mV p-p)	Tolerance Range
Blue, Yellow	140.0	135.8—144.2
Green, Magenta	720.7	648.6—742.3
Red, Cyan	860.7	834.9—886.5

j. CHECK—that the relative amplitudes of the color bars are within 1% of the Red bar relative amplitude, or 1 mV plus p-p residual subcarrier, whichever is greater. Use the same technique as described in part d of Step 14.

17. Check/Adjust U and V Bursts

a. Use the same equipment hookup as described in part a of Step 13.

b. Set the TSG21 BURST V pushbutton to OFF.

c. CHECK—U burst amplitude for 212.1 mV p-p ±3% (205.7—218.5 mV p-p). Use the Video Amplitude Calibration Fixture to make the measurement. Note the actual value.

d. ADJUST—R239 (Burst U) for a U burst amplitude of 212.1 mV p-p.

e. Set the TSG21 BURST U pushbutton to OFF, and the BURST V pushbutton to ON.

f. CHECK—that the V burst amplitude is between 205.7 and 218.5 mV p-p and is within 1% of the U burst amplitude.

g. ADJUST—R249 (Burst V) for the V burst amplitude to match the U burst amplitude (212.1 mV p-p).

h. Set the TSG21 BURST V and BURST U pushbuttons to ON.

i. CHECK—total burst amplitude for 300 mV p-p ±3% (291.0—309.0 mV p-p).

j. CHECK—that burst risetime, as measured between the 10% and 90% points of the positive peak, is between 340 ns and 460 ns.

k. Set the waveform monitor controls to overlay two consecutive lines.

l. CHECK—that burst amplitudes on consecutive lines are within 2% of each other (294.0—306.0 mV p-p).

18. Check Chrominance Risetime

a. Connect the TSG21 output to the test oscilloscope vertical input via a 75-Ω cable and an in-line 75-Ω terminator. Set the test oscilloscope triggering and sweep rate to view the green-magenta transition, and the vertical to a setting that gives several divisions of vertical deflection of the positive portion of the magenta bar.

b. Place a jumper on pins 1 and 2 of P281 on the Sync Lock board (A21-2) in the SPG22 module.

c. Set the TSG21 U and V COLOR BARS pushbuttons to ON, and the Y pushbutton to OFF. Display the positive peak start of the magenta bar.

d. CHECK—risetime of the magenta bar for 400 ns ±60 ns.

19. Check/Adjust Subcarrier Phase

a. Connect the 1412 rear-panel Subcarrier output J20 signal to the 522A Vectorscope Ext CW ϕ Ref input connector, and terminate in 75 Ω.

Connect the other 1412 rear-panel Subcarrier output J21 signal through a 10X attenuator and 75-Ω cable (in that order) to the vectorscope CH A input connector. Terminate the other CH A loop-through connector in 75 Ω.

b. Set the SPG21 to the Internal mode of operation.

c. Set the 522A Vectorscope controls as follows:

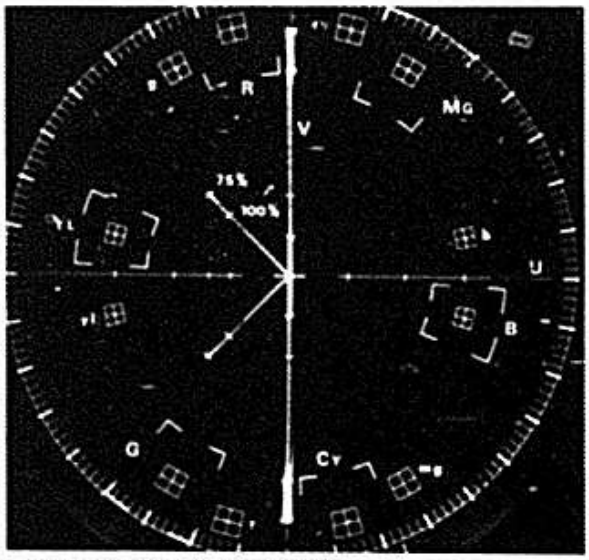
Ch A, Full Field, Aϕ, and Vector PAL buttons pressed in. CH A Gain control set to Cal, and ϕ Ref switch set to Ext. Rotate the CH A Phase control to position the subcarrier vector at 180°. (See Fig. 4-9a.)

NOTE

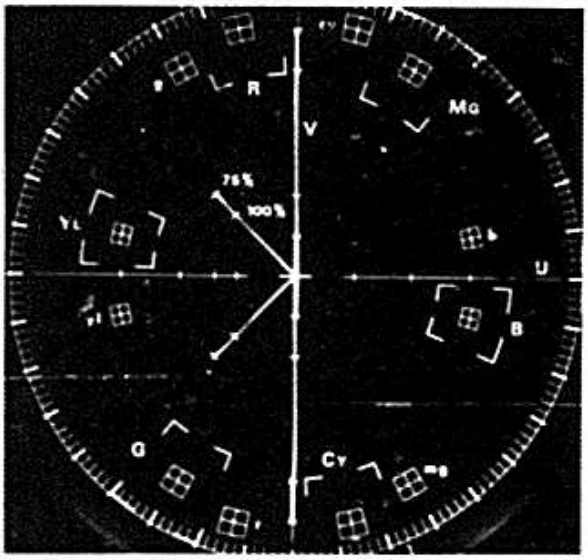
Do not move the 522A Vectorscope CH A Phase control until completing this step.

d. Disconnect the 75-Ω cable where it attaches to the 10X attenuator that is connected to the 1412 Subcarrier J21 connector. Connect this same cable to the TSG21 rear-panel output connector, so that this signal is applied to CH A of the vectorscope.

e. CHECK—that the burst vectors are at 135° and 225° (see Fig. 4-9b).



a. V Axis Switcher misadjusted.



b. V Axis Switcher properly adjusted. 2328-14

Fig. 4-9. Subcarrier Phase adjustment illustration.

f. ADJUST—L317 and C318 (Subc Phase) to position the burst vectors at 135° and 225°.

NOTE

Use C318 as a coarse adjustment, and L317 as a fine adjustment.

20. Check Isolation

a. Connect the TSG21 output to the test oscilloscope vertical input, via a 75-Ω cable and a 75-Ω end-line terminator.

b. Set the TSG21 for Fixed FULL FIELD COLOR BARS.

c. Set the test oscilloscope controls to provide one or two full lines of video, with the deflection factor set to provide a full graticule height of display.

d. To check passive isolation, short the unused output pins of P416.

e. CHECK—that the TSG21 output signal changes amplitude 1% or less (40 dB or greater isolation).

f. To check active isolation, remove the short, and apply a properly-terminated 3.58 MHz sine wave signal (from the sine-wave generator) at the unused output pins of P416. Vary the amplitude between 0.5 V and 4 V.

g. CHECK—that 1% or less of the 3.58 MHz sine wave is added to the TSG21 signal (40 dB or greater isolation).

21. Check Return Loss

a. Set up the Return Loss Bridge, sine wave generator, and differential amplifier plug-in unit to measure return loss of the TSG21. (The Instruction Manual provided with the Return Loss Bridge gives detailed instructions on the proper procedure.)

b. Set the sine wave generator for 500 mV output amplitude, and vary the frequency from 50 kHz to 5 MHz.

c. CHECK—the returned signal amplitude for 16 mV or less (return loss is 30 dB or greater).

THEORY OF OPERATION

This section begins with a Block Diagram Description of the TSG21. Illustrated signal paths and circuit relationships provide an overview of instrument operation.

The Circuit Description portion of this section provides a detailed discussion of the circuit diagram. The diagram is segmented with gray-tint blocks according to circuit function. Circuit block titles correspond to those listed in this section and the Block Diagram.

The Block Diagram and circuit diagram are located on foldout pages at the rear of the manual. Pull out the appropriate diagram when reading this discussion.

BLOCK DIAGRAM DESCRIPTION

Blocks are outlined on the schematic diagrams, and their names index the circuit description. Figure 5-1 shows a simplified block diagram for use with the Block Diagram Description, in conjunction with the foldout Block Diagram in Section 8.

Switching, Timing, and Logic

Timing from the SPG module, and commands from the front-panel switches and the 1412 REMOTE connector are used in this block to develop timing and control signals for the Color Bar test signal. They control the chrominance and luminance (Y) bar counters, and the chrominance and luminance drive sections.

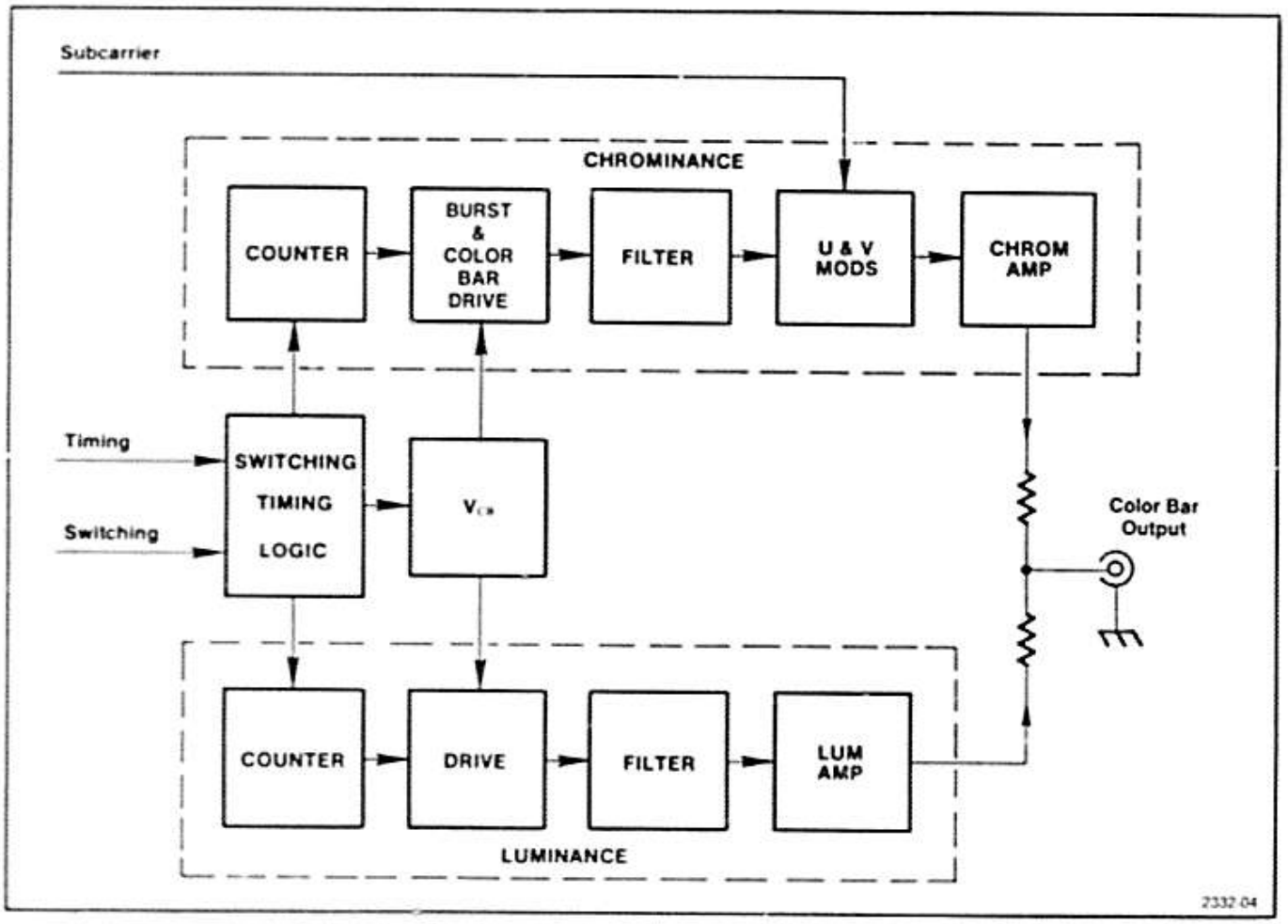


Fig. 5-1. Simplified Block Diagram of the TSG21.

Color Bar Voltages (V_{CB})

This block acts as a voltage supply for the Luminance and Chrominance Drive blocks. V_{CB} is set at 10.14 V for 75% amplitude color bars, and 13.50 V when 100% bars are selected.

Chrominance

The chrominance and luminance portions of the color bar signal are generated separately, and summed at the module output. Phase and amplitude of the chrominance signal are determined by vector addition of the inputs to the U and V balanced modulators.

The Chrominance Counter generates the red, green, and blue timing for the U and V Chrominance Drive circuits. The Chrominance Drive circuits are current switches that supply signal inputs to the balanced modulators. The + and − U and V filters shape the modulating signals.

The Subcarrier Limiter and Shaper provides subcarrier, with constant amplitude and fixed symmetry, to the U Modulator and the Quad Phase circuit. The Quad Phase circuit shifts the subcarrier 90° to drive the V Modulator. The V Phase Switch selects whether the subcarrier will be accepted at the + or − subcarrier input of the V Modulator. The V Phase Switch will switch on alternate lines, for normal Phase Alternate Line (PAL) operation; but may be selected for only + V operation.

The U and V Modulators combine the modulating signals with the subcarrier inputs to provide outputs of proper phase and amplitude. The Modulators drive the Chrominance Bandpass Filter which reduces harmonics. The Chrominance Output Amplifier sets the overall gain of the chrominance signal, and provides a low impedance output.

Luminance

The Luminance Counter is similar to the Chrominance Counter, except the clock input is delayed to compensate for delay in the chrominance circuits. This ensures proper coincidence of the luminance and chrominance signals at the output.

The Luminance Counter and Logic circuits control the Luminance Drive circuits. The Luminance Filter shapes the drive signals for 125 ns risetime. The shaped signals drive the Luminance Output Amplifier. Finally, luminance and chrominance are summed at the Module Output. The output is capable of driving two 75 Ω loads.

CIRCUIT DESCRIPTION

Color Bar Logic ◇1

Switching, Timing, and Logic

Logic gates develop and route timing signals for the rest of the module. In addition, front-panel switch settings and remote jack (J41) conditions are converted to logic commands.

Fixed FULL FIELD: The COLOR BARS switches (S103, S104, S105, S106, and S107) mechanically cancel each other. When S107 is engaged, a high level at the output of U146D inhibits all other front-panel switches. A low on the appropriate pin of the Remote jack (J41), or pin 57 of the Interconnect board at the TSG21's location, will produce the same effect. The fixed FULL FIELD signal is standard PAL-M color bars.

Alterable FULL FIELD: S106 has no electrical connections, but serves to mechanically cancel S103, S104, S105, and S107. Assuming that any external fixed FULL FIELD control is high (inactive), a low level at the output of U146D enables the rest of the front-panel switches to alter the output signal of the TSG21 module.

U and V BURST: Engaging S304 or S303 inhibits burst pulses at the output of U192A or U192B respectively. The output of U192A turns on CR242, inhibiting U Burst drive; the output of U192B turns on CR252, inhibiting V Burst drive.

U and V (Chrominance): Engaging S306 or S305 inhibits blanking at the outputs of U212C or U212B, respectively. The output of U212C turns on CR234, CR245, and CR237, inhibiting U chrominance drive; the output of U212B turns on CR267, CR256, and CR265, inhibiting V chrominance drive.

Y (Luminance): When S307 is engaged, the output of U194B goes low, and a high at the output of U146C produces highs at all of U199's data inputs. The counter outputs are thus held high, and luminance is turned off.

SYNC: When S302 is engaged, the output of U194C is forced low, and the composite sync signal at the pin 11 input of U194C is inhibited.

Split Field Color Bars: In the split field modes, the 1/2 V or 3/4 V signal (depending on the position of P144 in the SPG module) is gated by U126C, U126A, or U126D to drive certain gates and counters. The 3/4 V signal from the SPG

module ends at the end of line 622. Set-rest flip-flop U164A-U126B delays the trailing edge of the 3/4 V signal to the middle of line 623. This ensures that the half-line at 623 does not revert to color bars in any one of the split field modes.

NOTE

The remainder of this circuit description will assume that the 1/2 V signal is chosen.

COLOR BARS/Y REF: When S105 is engaged, U126D, U124A, and U184B gate the 1/2 V signal to drive U212C and U212B together with chrominance blanking. The outputs of U212C and U212B enable the U and V chrominance drives during the first half of the field, and disable the chrominance drives during the last half of the field.

COLOR BARS/RED: When S104 is engaged, U126C gates the 1/2 V signal to drive U194A, U144C, U194B, and U146C. The B-Data inputs at U196 and U199 are driven high during the first half of the field, and held low during the last half of the field. Thus, U196 and U199 red outputs are held low (active) while the rest of the outputs are held high (inactive) during the last half of the field.

The solid color portion (lower portion) of the COLOR BARS/RED signal may be changed to any bar color. Wire straps at W205, W206, W207, and W209 must be resoldered. (This is shown in Fig. 3-4 of the Installation section.)

The solid color portion of the COLOR BARS/RED signal may be externally selected for white. The appropriate pin of the remote connector, J41, or pin 56 of the interconnect board at the TSG21's location must be grounded while S104 is engaged. Under this condition, all the counter data inputs are driven low for the last half of the field, and all of the counter outputs are low (active).

COLOR BARS/REVERSE: When S103 is engaged, U126A gates the 1/2 V signal to drive the Up/Dn inputs of U196 and U199, and the data inputs of U186. The 1/2 V signal tells the chrominance and luminance counters to count up (low input) during the first half of the field, and to count down (high input) during the last half of the field. U186 enables the chrominance and luminance counters to count from the first rising edge of the color bar timing signal during the first half of the field, and from the second rising edge during the last half of the field. This is required because in the reverse sequence, the first color bar is black (all outputs are high). Thus, the counters are not enabled until the second rising edge of the color bar timing signal.

Miscellaneous Logic: The following describes further switching, timing, and logic functions.

Color Bar Timing: Color bar (CB) timing from the SPG module is used to drive the chrominance and luminance counters, and to form chrominance blanking. U166A delays the CB timing signal to the luminance counter, U199, and to U186. This compensates for inherent delay in the chrominance circuits. Y Delay, R159, adjusts the amount of delay to exactly match chrominance and luminance timing at the module output.

If the video disable line from the SPG module goes high, U182B will inhibit the CB timing signal.

Chrominance Blanking: Blanking for chrominance is developed by U166B and associated gates. See Fig. 5-2.

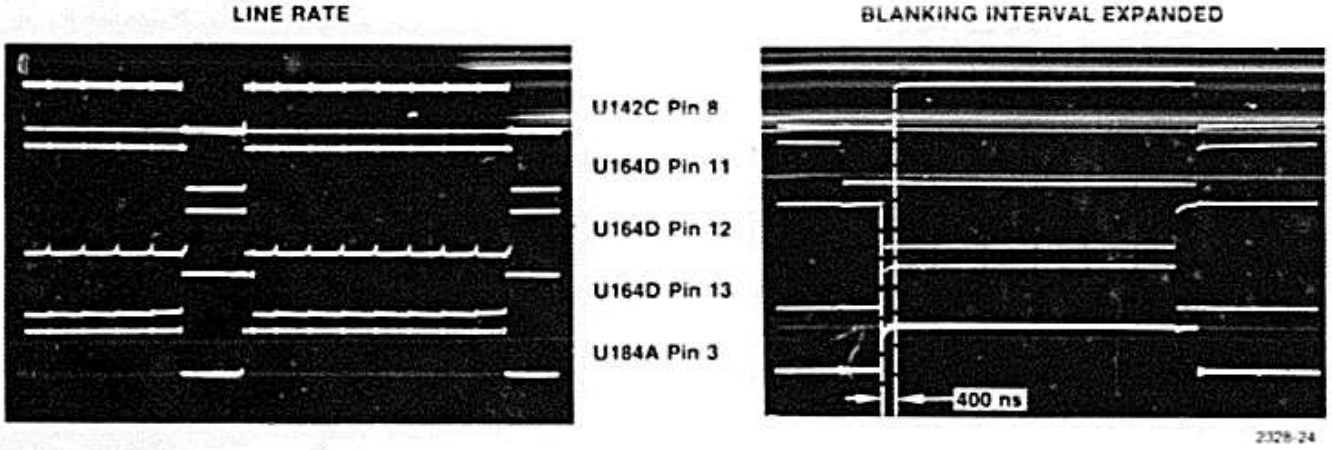


Fig. 5-2. Chrominance Blanking generation.

U166B and U164D effectively remove the timing pulses from the CB timing signal, leaving the blanking portion. Composite blanking is produced at U142C by combining vertical blanking from U144A and D with horizontal blanking from U142A. The outputs of U142C and U164D combine in U184A to produce the chrominance blanking signal. Its trailing edge is the same as for luminance blanking, but its leading edge occurs about 400 ns sooner.

Luminance Blanking: Blanking for the luminance signal is generated by combining horizontal blanking and modified vertical blanking. If a VITS Key signal is present, it will be gated in during the vertical blanking interval by U144A. The rising edge of vertical blanking is delayed by R133 and C134. This compensates for inherent delay in the chrominance circuits, ensuring that chrominance and luminance are blanked simultaneously at the end of half line 623. CR133 discharges C134 at the falling edge of vertical blanking.

U142D combines horizontal blanking and the modified vertical blanking. Luminance blanking drives the red, green, and blue luminance drive circuits; U212D for 100% white bar logic, and U124B and C for 25% pedestal logic.

A high on the video disable line will override luminance blanking at U142A.

25% Pedestal Blanking: In the 100/25 mode, a 25% pedestal is added to the 75% luminance signal. The pedestal is on for all color bars except black. U214C gates the red, green, and blue logic signals from the chrominance counter, U196, producing a high during the black bar and blanking time. R233 and C230 delay the rising edge of the signal to ensure that the pedestal is on until chrominance ends. CR231 discharges C230 at the falling edge of the signal, preventing delay at the start of the white bar.

U124B combines luminance blanking and the delayed black bar signal, creating the seven bar wide pedestal signal.

When S101A is engaged, U124D's output goes low, except when controlled by U162A in the fixed FULL FIELD mode or during an ITS line. If U124D's output is low, the pedestal blanking signal will pass through U124C to CR272 and the pedestal drive circuit.

100% White Bar Logic: The 100% white bar drive circuit is activated during the white bar time when the WHITE REF switch, S300, is in the 100% position, and 75% color bars are selected (S100 and S101 are both out). S300, through S100A, S101B, and U214B places a low level at pin 12 of U212D. This enables composite luminance blanking to pass through U212D. CR275, CR277, and CR278 for a diode OR gate that combines luminance blanking with luminance red, green, and blue timing from the luminance counter, U199. Thus, current flows through Q282 only during white bar time.

Video Disable: When pin 32 of the Interconnect Board goes high, all signal components are turned off. A high from buffer U182A inhibits the color bar timing signal at U182B, inhibits the horizontal blanking signal at U142A, and gates off sync at U182C.

Chrominance Disable: A high on the chroma disable line, pin 31, overrides a series of OR gates, finally pulling the outputs of U212C and U212B high to shut off the U and V chrominance drive circuits.

VITS Key: U144A allows a VITS Key signal to cancel vertical blanking at VITS time. A high at U144B's output ensures that the Y, U, and V switches do not affect the VITS signal. U and V burst components, however, may be turned off. In the VITS and fixed FULL FIELD modes, the output of U162A also has the following effects; U214B ensures that white reference will be 100%, U192D and U124D turn off the 25% pedestal, and Q148 selects the fixed V_{CB} voltage for 75% bar amplitude.

Chrominance and Luminance Counters

U196 generates the chrominance timing signals, and U199 generates the luminance timing signals. Both counters are synchronous up/down counters. The chrominance counter is clocked by the color bar timing signal. The luminance counter is clocked by a delayed color bar timing signal to compensate for chrominance delay. A high on the video disable line will inhibit the color bar timing signal to both counters. See Fig. 5-3.

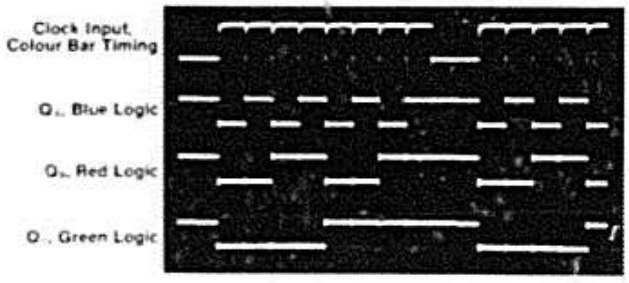


Fig. 5-3. Counter logic.

In the FULL FIELD modes, the counters are loaded by composite sync timing. A low during sync time presets the counter outputs to the logic levels at the data inputs (high). U186 is loaded during composite sync time, then counts eight clock pulses before changing states, inhibiting the counters after eight color bars have been produced. The up/down inputs are low, causing the counters to count up. The blue, red, and green timing outputs feed the chrominance and luminance drive circuits to produce color bar drive currents in a sequence of white, yellow, cyan, green, magenta, red, blue, and black.

In the COLOR BARS/RED mode, the load inputs are held low during the second half of the field, and the B data inputs are held high. Therefore, the counters are inhibited, and only the red chrominance and luminance drive circuits are enabled during the seond half field. If the /White remote line is held low in this mode, all data inputs will be low, and all drive circuits enabled, producing a white second half field. Any other bar color may be selected for the solid color portion of the field (when remote /White is not enabled), by rewiring W205 and W206 at the chrominance counter data inputs, and W207 and W209 at the luminance counter data inputs.

In the COLOR BARS/REVERSE mode, U186's data inputs, and U196 and U199's up/down inputs are held high during the second half field. This causes U196 and U199 to be enabled to count from the second rising edge of the color bar timing signal, and reverses the direction of counting during this time. The result is color bars in reverse sequence during the second half field.

When the Y switch is engaged, the load input of the luminance counter, U199, is held low, causing all of the signal outputs to follow the data inputs (go high). This shuts off the luminance drive circuits.

Chrominance Drive

The chrominance drive circuits are switched by digital timing signals to create analog signal currents that are used to modulate the subcarrier signal in the U and V Modulator stages. See Fig. 5-4.

Burst currents are developed by Q254 (V burst) and Q244 (U burst). During burst time CR252 and CR242 are off, and Q254 and Q244 pass the currents developed by their emitter resistors and the −15 volts supply. The current through Q254 goes to the +V Filter and modulator input. The signal through Q244 goes to the −U Filter and modulator input. The circuits are adjusted to produce equal amplitude signals, so that when combined at the modulator output and amplified by the Chrominance Output Amplifier, the signals will produce a vector sum, giving the total burst amplitude at a phase of +135°. When the V Modulator is switched, burst phase becomes −135°.

The output of the chrominance counter drives the U and V chrominance switching transistors. The ±U color bar drive is developed by Q234 (blue), Q245 (red), and Q235 (green); the ±V color bar drive is developed by Q265 (blue), Q255 (red), and Q264 (green). The transistors are also switched by chrominance blanking and U and V chrominance switch logic from U212C and U212B. Current is generated in these circuits similarly to the burst drive circuits, except that the color bar voltage (V_{CB}) connected to the emitter resistors is switchable to select different amplitudes.

Color bar sequence may be altered by rewiring the chrominance counter outputs in the jumper block containing P227, P225, and P226. A similar rewiring must be done with the luminance counter outputs in the block containing P217, P215, and P216. See the Installation Section (3) and Fig. 3-3 for further details.

Q291 provides the +0.6 V bias voltage for the chrominance and luminance drive transistors.

Luminance Drive

The luminance counter drives Q293 (blue), Q283 (red), Q292 (green), and Q282 (100% white) luminance drive transistors. (See Fig. 5-5.) The blue, red, and green drives are disabled during blanking time by luminance blanking through CR295, CR285, and CR297. Color bar sequence may be altered by changing the wiring of the jumpers in the block containing P217, P215, and P216. A similar rewiring is required for the chrominance counter outputs. See Fig. 3-3 in Section 3, Installation, for further details.

The 100% white bar drive is enabled in the 100/0/75/0 mode to add extra current during the white bar time.

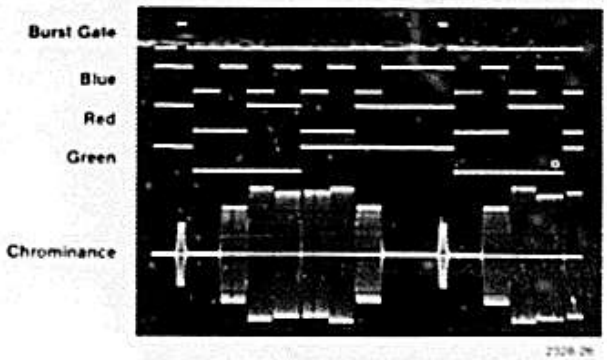


Fig. 5-4. Chrominance Drive generation.

Amplitude of the color bar luminance is set by the values of the emitter resistor and the color bar voltages (V_{CB}).

5% pedestal current is added to the color bar luminance signal by Q281 in the 100/5 mode.

The outputs of Q293, Q283, Q292, Q282, and Q281 are summed, and drive the 115 ns filter shown on diagram 2.

Composite sync turns off Q280 during sync time. Current is switched through Q280 at all other times to set the sync-to-blanking amplitude.

V_{CB} (Color Bar Voltage)

This circuit acts as a voltage supply for the chrominance and luminance drive circuits. Changing the V_{CB} voltage changes the current through the drive transistors proportionally.

The voltage at one of two resistor-divider strings is connected to the voltage follower circuit, U179-Q189. Q148 controls the set of CMOS switches in U169. When Q148 is on (VITS, fixed FULL FIELD, or 100/5 modes), the voltage at divider R158-R159 is connected through switch A to drive the voltage follower. Switch C connects −15 V to the control input of switch B, turning that switch off.

When Q148 is off, switch A and C are shut off; switch B connects the voltage from divider R120-R123-R121 to the follower input. The voltage at this divider is selectable for 100% (100/0) or 75% (75/0) color bars by S100B.

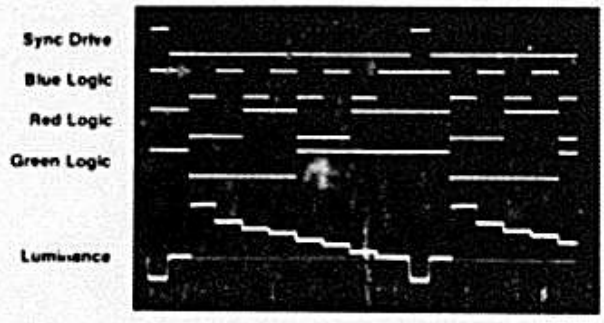


Fig. 5-5. Luminance Drive generation.

Color Bar Output ◇2

Subcarrier Limiter and Shaper

This circuit provides subcarrier drive to the modulators with fixed amplitude and symmetry.

Emitter follower Q314 isolates the subcarrier from its source. L317 and C318 adjust the phase of the TSG21 output to match the phase of the 1412 Subcarrier output. The averaging action of the self-bias circuit at Q337's emitter ensures symmetry at the collector. CR327 rectifies the negative peaks of the subcarrier signal, and C329 stores the charge to bias Q337. Paraphase amplifier, Q338 and Q348, limits the subcarrier amplitude. The outputs of the paraphase amplifier are integrated across C335 and C345, creating triangular-wave signals that drive push-pull amplifier Q345 and Q344. The push-pull amplifier delivers subcarrier through T355 to the U Modulator and the Quad Phase circuits.

Quad Phase

L363, C353, and C363 form a phase-shift filter that is adjusted to delay the subcarrier 90°. This provides subcarrier input to U382, the V Modulator, that is 90° delayed with respect to the phase of the subcarrier input of U384, the U Modulator.

0°–180° Phase Shifter

The 0°-180° phase shifter switches the 90° subcarriers 180° between opposite inputs of the V modulator at a line rate. The output signal's V subcarrier phase thus alternates between 90° and 270° on alternate lines.

When the V PHASE switch, S301, is in the ALT position, CR312 is off, and Q331 is on. H/2 switches Q333, and the collectors of Q342 and Q341 are 180° out of phase. V subcarrier phase alternates at the H/2 rate. C351 balances the circuit for exactly 180° phase shift.

When the V PHASE switch is in the 90° position, CR312 conducts, and Q331 is off. Q333 is biased so that the H/2 signal at its base has no effect. Consequently, V subcarrier phase is 90° on all lines.

U and V Filters

The ±U and ±V Filters are identical and each consists of an LC Pi network. Each filter limits the upper frequency of its drive signal to approximately 2 MHz, thus preventing the U or V signal components from exceeding the 3.58 MHz

subcarrier frequency. The filters are adjusted for best shaping of the color bar chrominance signal.

U and V Modulators

Amplitude modulation of the subcarrier is accomplished in the doubly-balanced modulators, U364 and U382. Referring to Fig. 5-6, the upper four transistors, Q1 through Q4, operate in a switching mode at subcarrier rate, while Q5 and Q6 operate in a linear mode. Normally, the collector currents for Q5 and Q6 are balanced, resulting in no net subcarrier output. During burst and chrominance time, these transistors are unbalanced. Their unbalanced collector currents are switched by Q1 through Q4, resulting in a burst and chrominance output. The modulator outputs are summed and coupled to the bandpass filter through T375.

Bandpass Filter

The Bandpass Filter passes a 1.5 MHz band, centered at 3.58 MHz, and couples the modulator outputs to the chrominance output amplifier. The filter is adjusted to provide minimum harmonic amplitude, and best amplitude, shaping, and overlay of the chrominance packets.

Chrominance Output Amplifier

The chrominance signal from the Bandpass Filter is ac coupled to an operational amplifier, Q386, Q387, Q397, and Q398. The gain of the amplifier is adjusted by R379. The output is near zero impedance, allowing the amplifier to function as a near-perfect voltage source with the source impedance determined by the resistors connected to the module outputs. The chrominance output is summed with the luminance output (another zero impedance amplifier) so the 150 Ω resistors in series with each output appear in parallel with each other, giving a 75 Ω impedance at the module outputs. See Fig. 5-7.

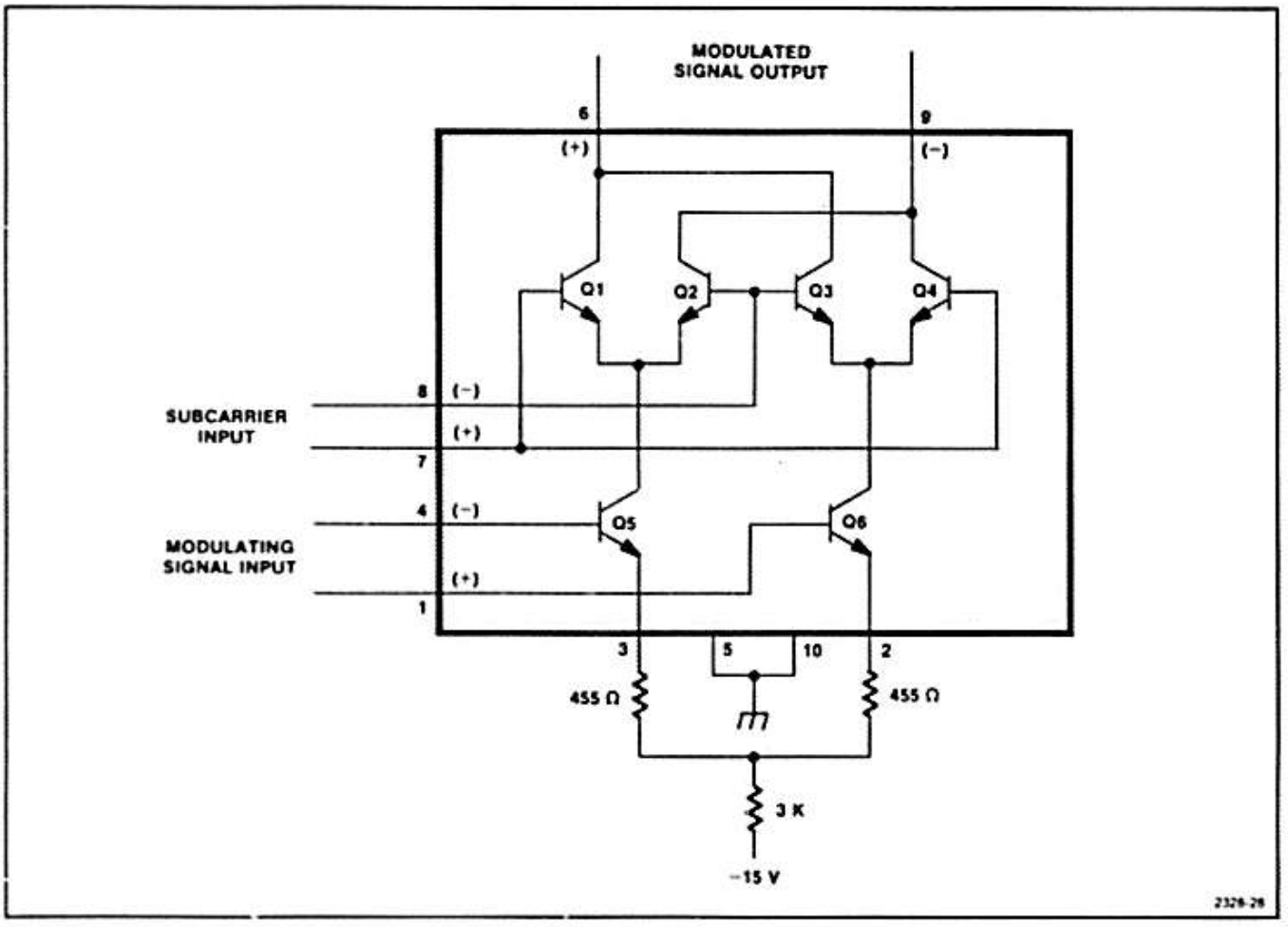


Fig. 5-6. Modulator operation.

125 ns Filter

This filter sets the rise time of the luminance and composite sync signals. The output of the filter is dc-coupled to the luminance output amplifier.

Luminance Output Amplifier

Luminance current from the 115 ns filter is amplified by operational amplifer Q446, Q427, Q436, and Q426. Gain of the amplifier is adjusted by R449. R459 (DC Level), provides another current input to the amplifier, and is used to adjust the blanking level to zero volts. The amplifier output is summed with the chrominance signal at the module output.

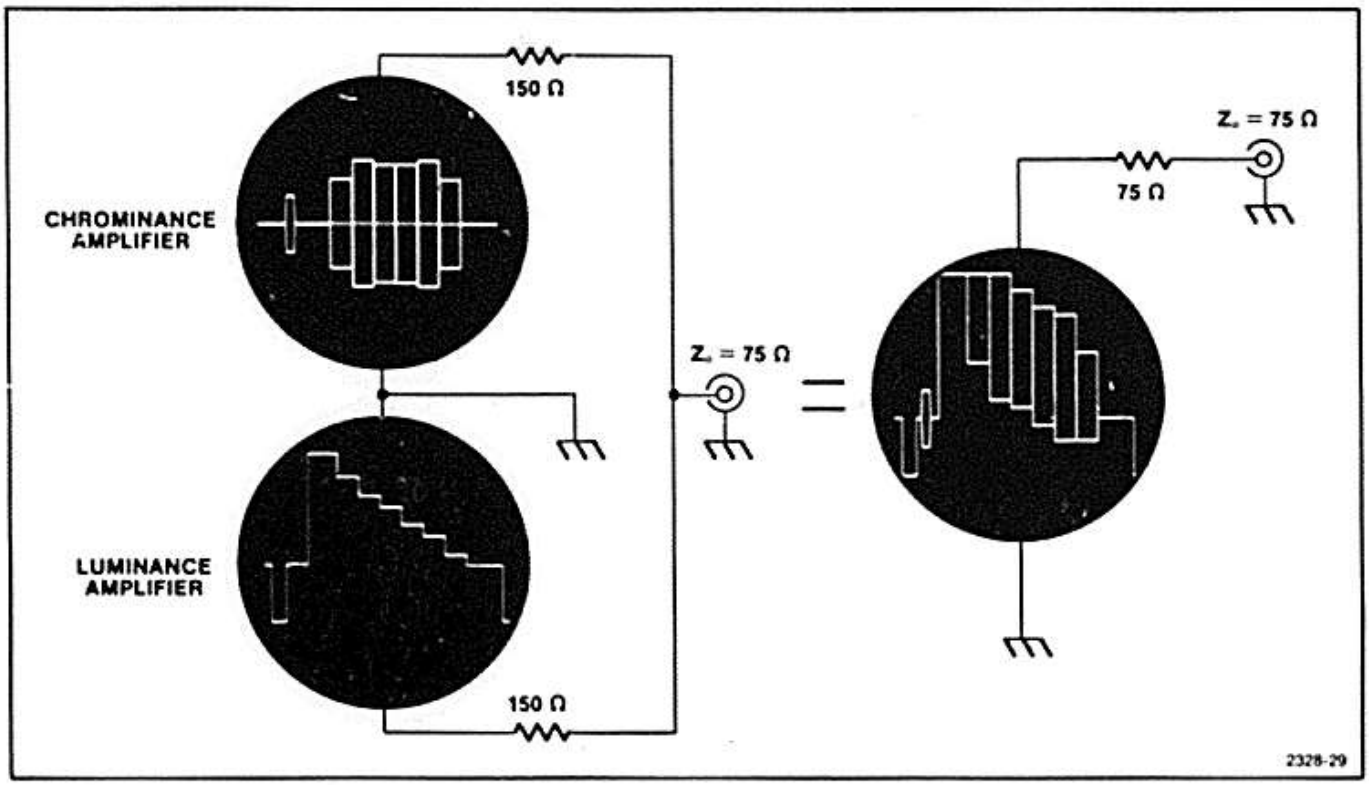


Fig. 5-7. Chrominance and Luminance Output Amplifiers.

MAINTENANCE

This section is divided into three parts: Maintenance, Troubleshooting, and Repair.

Maintenance includes inspection, cleaning, and recalibration. Troubleshooting contains information for isolating a trouble to a component. Repair includes procedures for removing and replacing components.

MAINTENANCE

A regular schedule of maintenance can improve instrument reliability. How often the maintenance is performed should be determined by the severity of the operating environment.

Cleaning

Dust accumulating on the circuit boards acts as an insulating blanket, preventing efficient heat dissipation, and possibly causing overheating and component breakdown. A layer of dust can also provide an electrical conduction path, especially under high humidity conditions. Remove the power cord before cleaning the module.

CAUTION

Avoid the use of chemical cleaning agents that might damage the plastics used in this instrument. Avoid chemicals that contain benzene, toluene, xylene, or similar solvents.

The best way to remove heavy accumulations of dust is to blow it off with a dry, low-velocity air jet. Remaining dust can be removed with a small brush followed by a soft cloth dampened in a mild detergent and water solution. A cotton-tipped applicator is useful in tight places.

Visual Inspection

Visually inspect the circuit board or boards during the preventive maintenance routine for such defects as broken connectors, loose or disconnected pin connectors, improperly seated transistors and integrated circuits, and damaged components. Make sure that the boards are properly seated on the 1412 Mainframe Interface pins. Boards with shields should be parallel to each other and held firmly by the plastic clips provided for this purpose.

The corrective procedure for most visible defects is obvious; however, care must be taken to determine and correct the cause of heat-damaged components. Heat damage is sometimes an indication of trouble elsewhere in the instrument.

Multi-Pin Connectors

Board output signals are fed to the rear-panel connectors through coaxial cable and multi-pin connectors. The connector holder has identification numbers that identify terminal connectors No. 2 and up. A triangular key symbol is also located on the circuit board to identify pin No. 1 (see Fig. 6-1) so that the connector can be properly oriented.

Transistor and Integrated Circuit Checks

Periodic transistor and integrated circuit checks are not recommended. The best performance check for these devices is actual operation of the instrument. Performance of the circuit is thoroughly checked during the performance check or calibration procedure. Any sub-standard transistors or integrated circuits will usually be detected at that time.

Recalibration

The length of time between recalibration depends on the amount of use the circuitry receives, the nature of the environment, and the change in performance when some components are replaced.

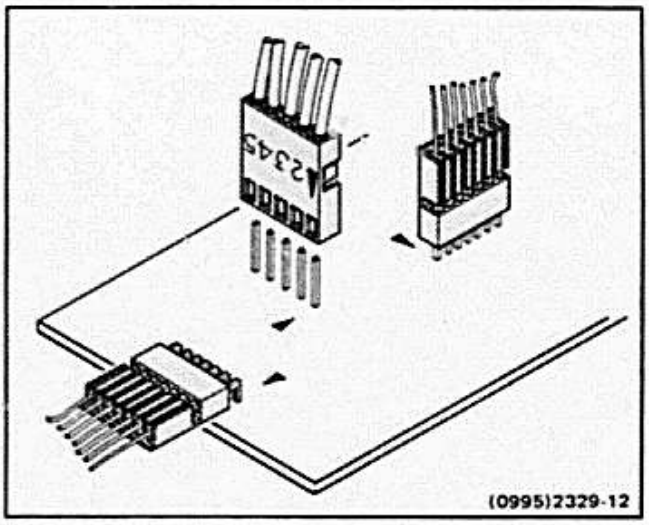


Fig. 6-1. Multiple pin connector holders.

In general, a partial recalibration is necessary if the components replaced affect the board calibration. Complete recalibration is recommended if the board or boards are not operating to their full capability. To ensure correct and accurate operation, performance should be checked at regular intervals; for example after 1,000 hours of operation if used continuously, or every six months if used infrequently.

A Performance Check Procedure is given in Section 2, and a Calibration Procedure is given in Section 4.

TROUBLESHOOTING

Information contained here may be used as a guide in locating circuit failures. The schematic diagrams, circuit description, and calibration sections should be referred to for fast, efficient location and repair of defects.

Diagrams

Circuit diagrams are shown on the foldout pages in Section 8. The circuit number and electrical value of each component are shown on the diagrams. Important waveforms are also shown.

Circuit Boards

The circuit boards are outlined in black on the schematic diagrams. Circuit board illustrations are provided on the back of the foldout pages that precede the relevant diagrams. The assembly number assigned to each circuit board is an abbreviated method for identifying the board.

When troubleshooting circuit boards in the instrument, the use of an extender board facilitates access to the board connections and components. This will save time in looking for faults. Carefully align the board pin connectors to ensure good contact.

Circuit numbers are assigned on a grid system to facilitate component location. Low numbers start at the lower-front corner of the board increasing to the rear and top.

Transistor and Integrated Circuit Lead Configurations

Figure 6-2 illustrates the lead configurations for the socket-mounted transistors and integrated circuits (IC) used on the circuit board.

IC Diagrams

Positive logic functions of the IC's are shown in Section 8 of this manual.

Troubleshooting Equipment

The following test equipment is useful for troubleshooting the module circuit boards.

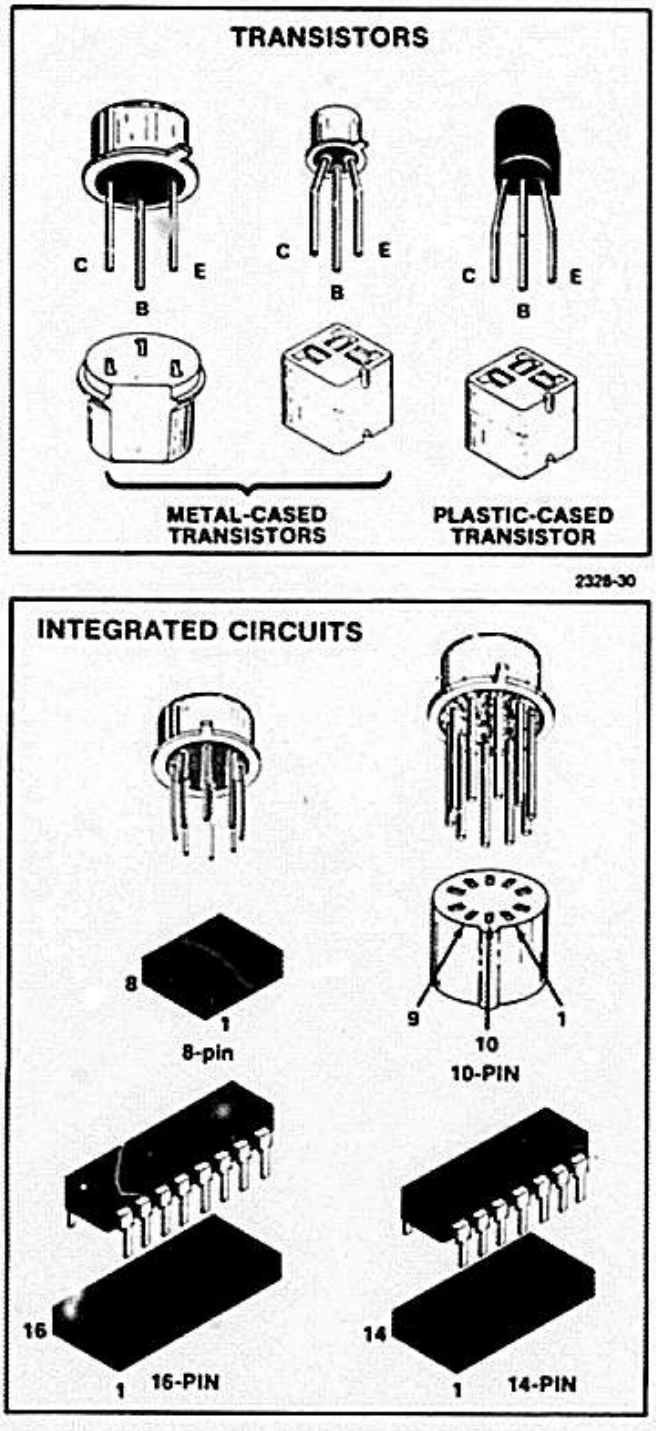


Fig. 6-2. Semiconductor basing illustrations.

1. Test Oscilloscope. For viewing waveforms at various test points in the circuit. Frequency response; dc to at least 10 MHz. It should be equipped with a 10X probe.

2. DVM and Ohmmeter. For measuring dc voltages and resistances accurately. The ohmmeter is also required for checking continuity.

3. Semiconductor Tester. Some means of testing the transistors and diodes is helpful. A transistor-curve tracer such as the TEKTRONIX Type 577 will give the most complete information.

Troubleshooting Procedure

This procedure starts with simple, but sometimes taken-for-granted problem areas and proceeds to detailed troubleshooting.

1. Check Control Settings. Incorrect control settings or wrong internal jumper positions can indicate a trouble that does not exist. If there is any question about the correct function or operation of any control or jumper, refer to the Operating Instructions or Installation section.

2. Check Associated Boards. Before troubleshooting a board, check that the A20-2 Sync Timing board is operating properly and supplying the correct signals to the Mainframe Interface board. Make sure that other boards on the Interface board are not defective. Check that the test oscilloscope probe, if used, is not defective.

3. Isolate Trouble to a Circuit. Symptoms will often identify the circuit in which the trouble is located. Incorrect operation of all circuits often means trouble in the power supply section of the Mainframe. Consider this possibility if voltages are incorrect. Make sure that all board pin connectors are making good contact before proceeding with trouble isolation.

4. Visual Check. Visually check the portion of the board in which the trouble is suspected. Some troubles can be located by checking for unsoldered connections, broken wires, loosely-seated transistors, loose-fitting connectors, damaged components, or damaged circuit boards.

5. Check Voltages and Waveforms. Often the defective component or stage can be located by checking for the correct voltage or waveform in the circuit. Typical waveforms are given near the diagrams. To obtain operating conditions similar to those used to take these waveforms, refer to the instructions at the start of the Diagrams section.

CAUTION

Due to component density on the circuit boards, special care should be exercised when using meter leads and tips. Accidental shorts can cause abnormal voltages or transients that can damage components.

6. Check Individual Components. After the trouble has been isolated to one circuit or stage, the next step is to isolate the trouble to one component or part. Components that are soldered in place are best checked by disconnecting one end to isolate the measurement from the effects of surrounding circuitry. The following methods are provided for checking individual electrical components in the module.

a. Transistors. The best check of transistor operation is actual performance under operating conditions. If a transistor is suspected of being defective, it can be checked by substituting a new component or one which has been checked previously. However, be sure that the circuit conditions are not such that a replacement transistor might also be damaged. If substitute transistors are not available, use a dynamic tester (such as the TEKTRONIX Type 577) to check the transistor.

b. Integrated Circuits. Integrated circuits should not be replaced unless they are actually defective. The best method for checking these devices is by direct substitution with a new component or one which is known to be good. Be sure that circuit conditions are not such that a replacement component might be damaged.

c. Diodes. A diode can be checked for an open or shorted condition by measuring the resistance between terminals. Use an ohmmeter (set to the 1 kΩ scale to keep from damaging the diode) for measuring the diode resistance. The resistance should be very high in one direction and very low when the ohmmeter leads are reversed.

d. Resistors. Resistors can be checked with an ohmmeter: check the Replaceable Electrical Parts list for the tolerance of the resistors used in the instrument. Resistors normally do not need to be replaced unless the measured value varies widely from the specified value.

e. Inductors and Switch Contacts. Check for an open circuit (that should normally be closed) by checking continuity with an ohmmeter.

f. Capacitors. A leaky or shorted capacitor can best be detected by checking the resistance with an ohmmeter on the highest scale. Do not exceed the voltage rating of the capacitor. An open capacitor can best be detected with a capacitance meter or by checking whether the capacitor passes ac signals.

REPAIR

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

Location Guide for Replacing Parts

The exploded-view drawings associated with the Replaceable Mechanical Parts list (located at the rear of the manual) are helpful in the removal or disassembly of individual components or subassemblies. Circuit board illustrations are provided on the backs of foldout pages in the Diagrams section of this manual.

Pushbutton Switch Replacement

Before removing a pushbutton switch, disengage the pushbutton actuating arm so that it does not project beyond the rear of the switch. Next, carefully pry back the plastic retainer clip at the rear of the switch with the tip of a small screwdriver. See Fig. 6-3. Remove by lifting the switch body up and back from the front retainer clip.

Reverse the removal procedure to install the replacement switch.

Circuit Board Replacement

If a circuit board is damaged beyond repair, the entire assembly, including all components, can be replaced. Tektronix part numbers are given in the Replaceable Electrical Parts list.

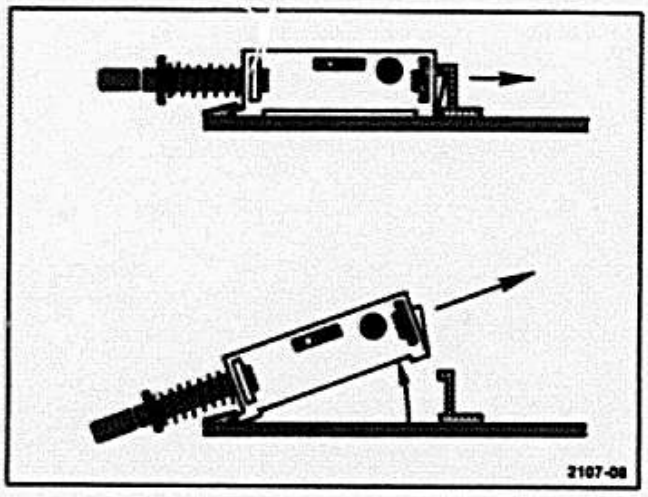


Fig. 6-3. Pushbutton switch replacement.

Circuit Board Removal.

1. Disconnect the multi-pin connectors from the board. Note the order of these connectors so they can be correctly replaced. Disconnect any other connectors that are used for interconnection with other circuits.

2. Disengage the front-panel knobs by pulling them straight out from the front panel until the board controls are free. Remove the plastic retainers from top of boards.

3. Grasp the board at both ends and pull straight up from the Interface board.

4. To replace the board, reverse the order of removal. Use the mating plastic guides to align the board pin connectors. Match the triangle key symbol on the multi-pin connectors to the same symbol on the board.

Interconnecting Pins. To replace a pin which is mounted on a circuit board, first disconnect any pin connectors. Then, unsolder the damaged pin and pull it out of the board with a pair of pliers. Be careful not to damage the wiring on the board with too much heat. Ream out the hole in the circuit board with a 0.031-inch drill. Remove the ferrule from the new interconnecting pin and press the new pin into the hole in the circuit board. Position the pin in the same manner as the old pin. If the old pin was bent at an angle to mate with a connector, bend the new pin to match the associated pins.

NOTE

A pin replacement kit including necessary tools, instructions, and replacement pins is available from Tektronix, Inc. Order Tektronix Part No. 040-0542-00.

Transistors and ICs

Transistors and ICs should not be replaced unless they are actually defective. If removed from their sockets during routine maintenance, return them to their original sockets. Unnecessary replacement or transposing of semiconductors may affect the calibration of the board.

CAUTION

The POWER switch must be turned off before removing or replacing semiconductors.

Any replacement component should be of the original type or a direct replacement. Cut and shape the leads to conform with the component being replaced. After a component is replaced, check the operation and calibration of associated circuits.

An extracting tool should be used to remove the 14- and 16-pin integrated circuits to prevent damage to the pins. This tool is available from Tektronix, Inc. Order Tektronix Part No. 003-0619-00. If an extracting tool is not available, use care to avoid damaging the pins. Pull slowly and evenly on both ends of the IC. Try to avoid having one end of the IC disengage from the socket before the other end.

SERVICING ILLUSTRATIONS

Information contained in this section serves as an aid to the service technician who performs the calibration, maintenance, and troubleshooting procedures. Included are illustrations showing the adjustment and jumper locations for each circuit board.

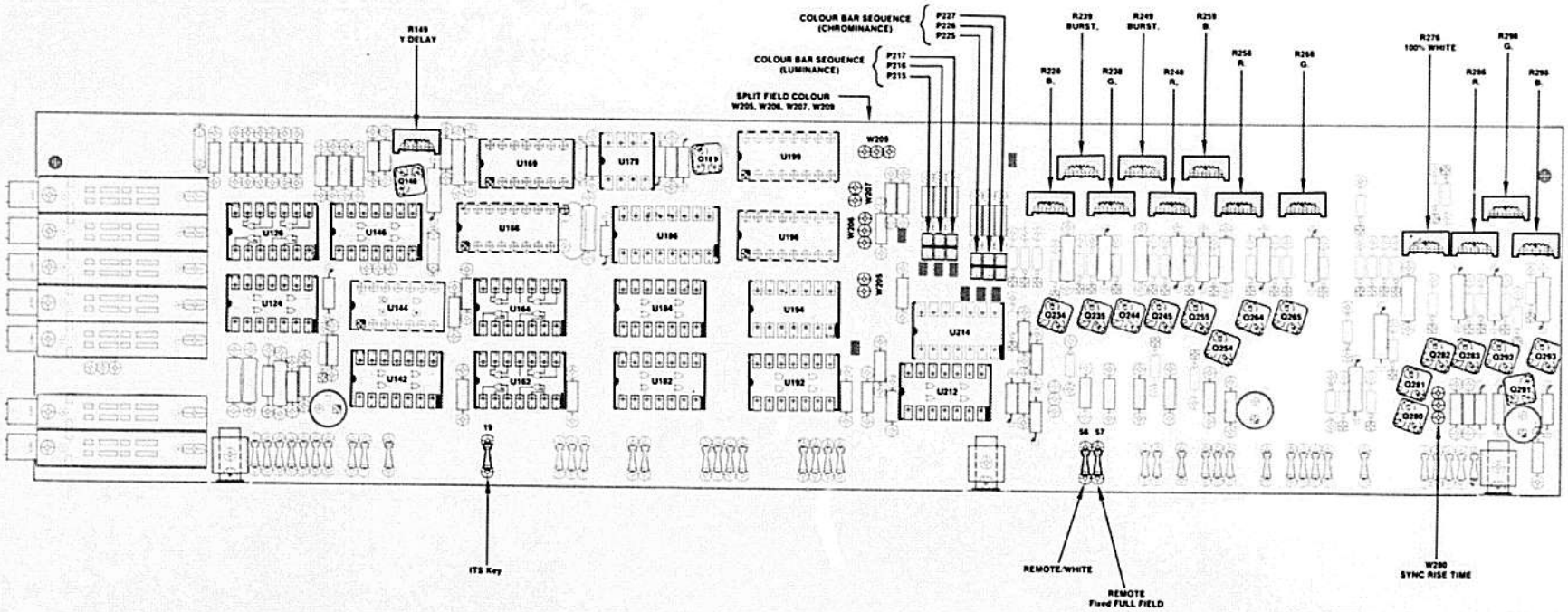


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FIG. 8-1. A30-1 COLOUR BAR LOGIC BOARD ADJUSTMENTS AND JUMPER LOCATIONS.

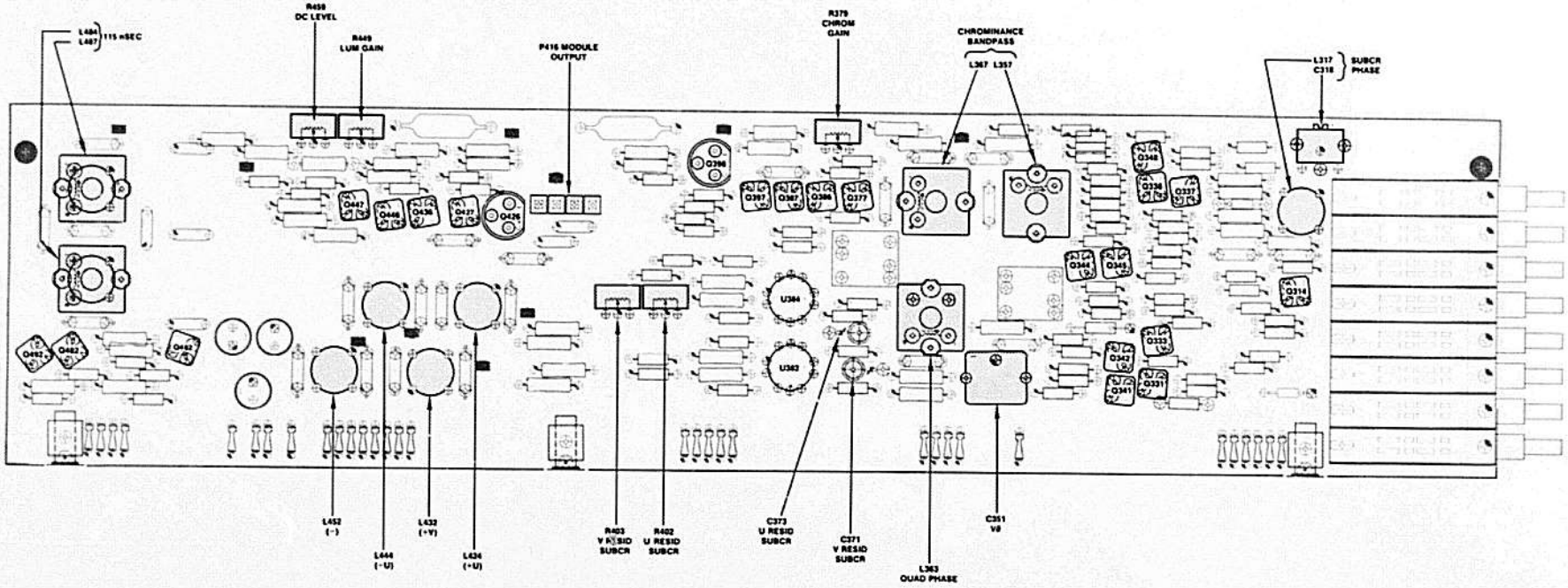


FIG. 8-2. A31-1 COLOUR BAR OUTPUT ADJUSTMENT LOCATIONS.

DIAGRAMS AND CIRCUIT BOARD ILLUSTRATIONS

This section of the manual contains block and schematic diagrams with waveforms and etched circuit board illustrations.

Symbols

Symbols used on the diagrams are based on ANSI Y32.2-1970 and IEEE No. 315 March 1971. Logic symbology is based on ANSI Y32.14-1973 (IEEE Std. 91-1973). Logic symbols depict the logic function performed and may differ from the manufacturer's data.

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).

Semiconductor Types

Refer to the Electrical Parts List.

Reference Designators

The following letters are used as reference designators to identify components or assemblies on Tektronix, Inc. schematic diagrams.

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

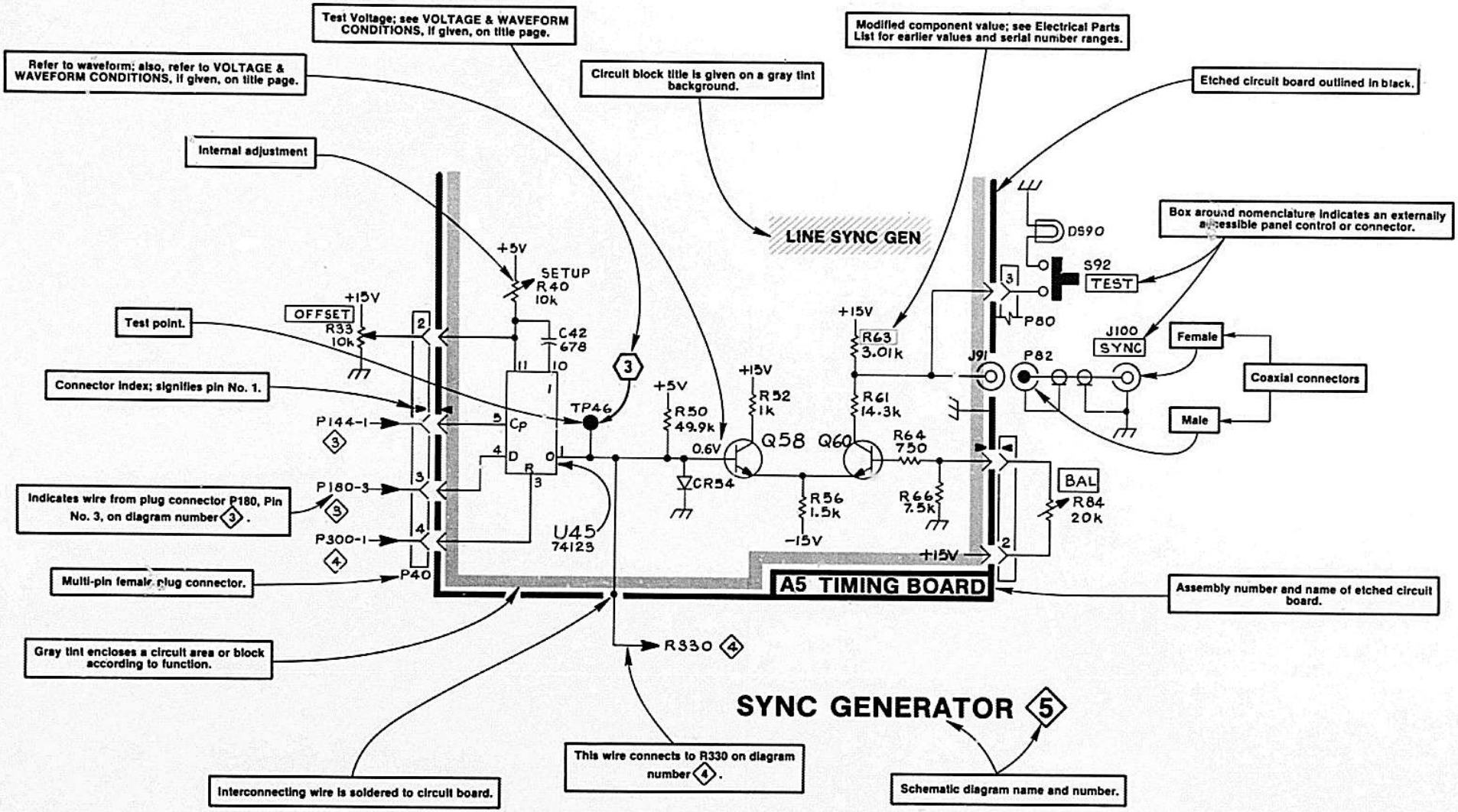
Partial Schematic Diagram With Explanations

The partial diagram at the left is an example of the various symbols and other information provided on Tektronix, Inc. diagrams.

Transformer Wiring

A two-letter abbreviation color code is used to identify wires without terminal connection labels.

Bk	Black
Br	Brown
Rd	Red
Or	Orange
Yl	Yellow
G	Green
Bl	Blue
Vi	Violet
Gy	Gray
W	White

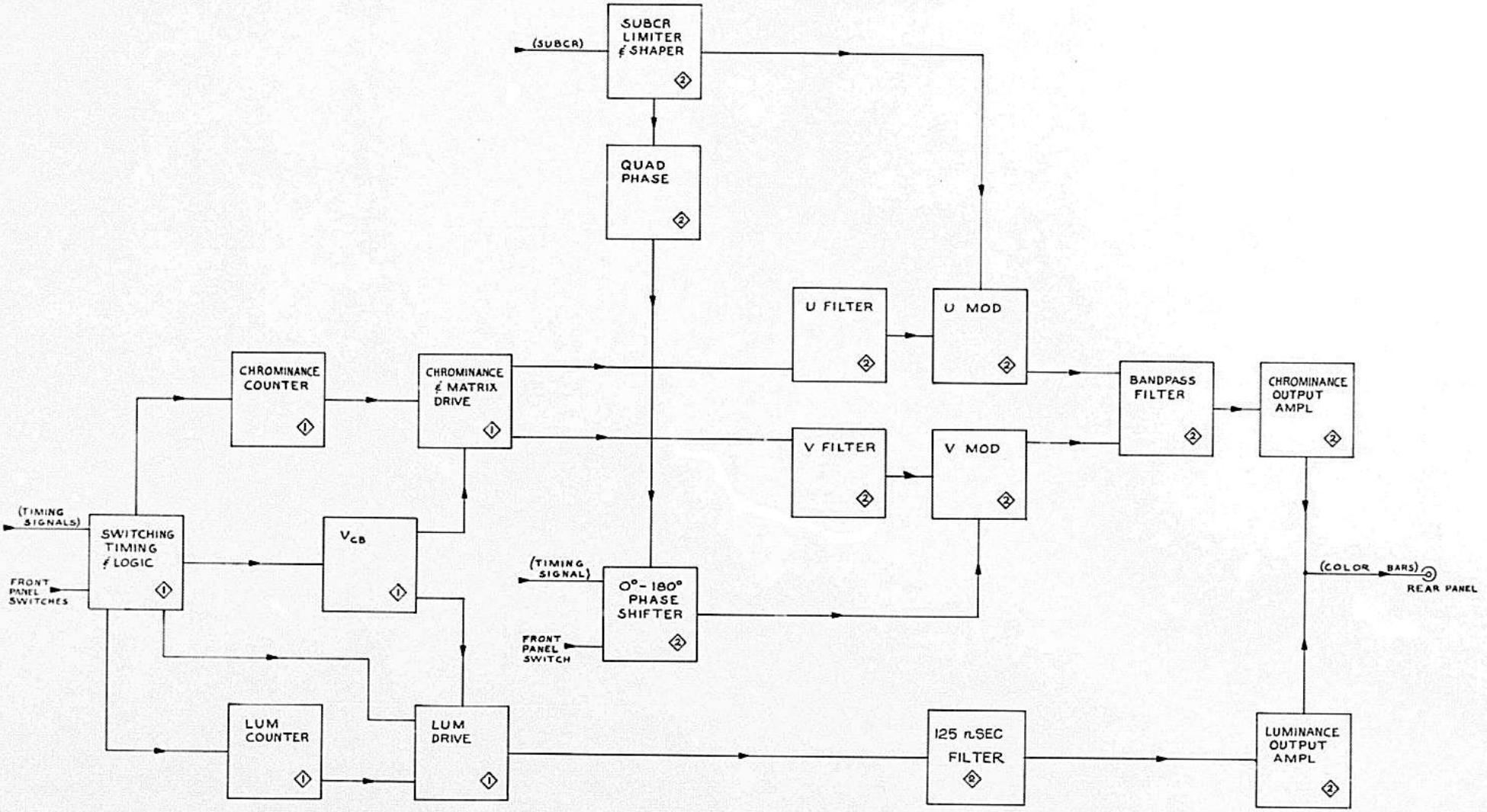


SCHEMATIC EXAMPLE

2324-33

WAVEFORM CONDITIONS

All waveforms were taken with the front panel fixed FULL FIELD pushbutton engaged ; and the Waveform Monitor controls set to Flat Response, Dc Cpl'd, 1 V/Div, Dc Restorer Off, and 10 μs/Div.



TSG21

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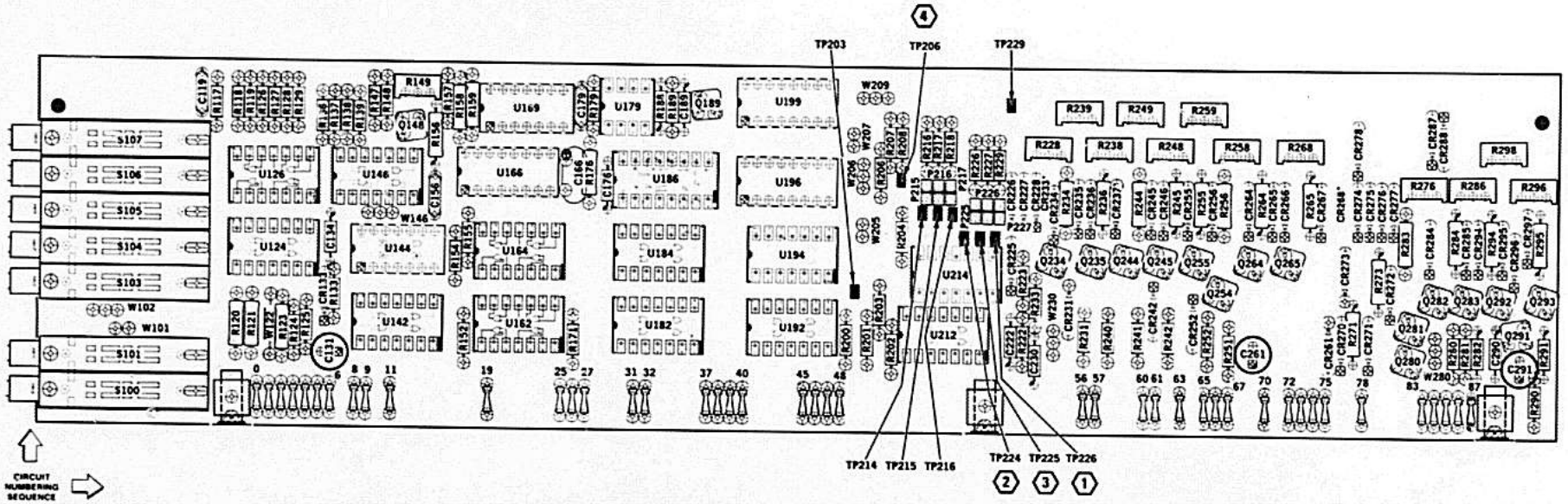
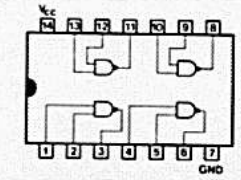
BLOCK DIAGRAM

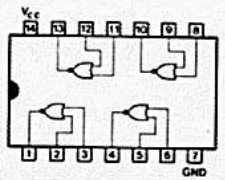


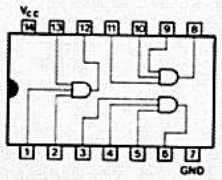
A30-2 COLOUR BAR LOGIC CIRCUIT BOARD

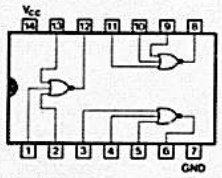
2332-08

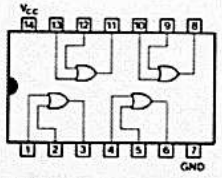
Static Sensitive Devices
See Maintenance Section

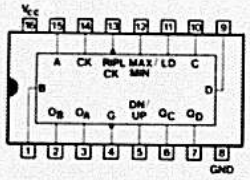


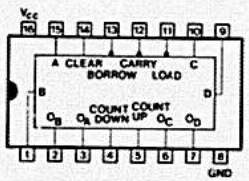


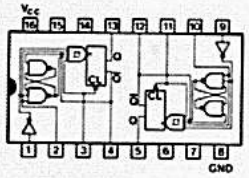


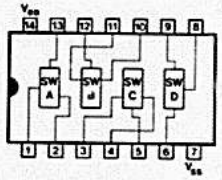


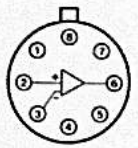






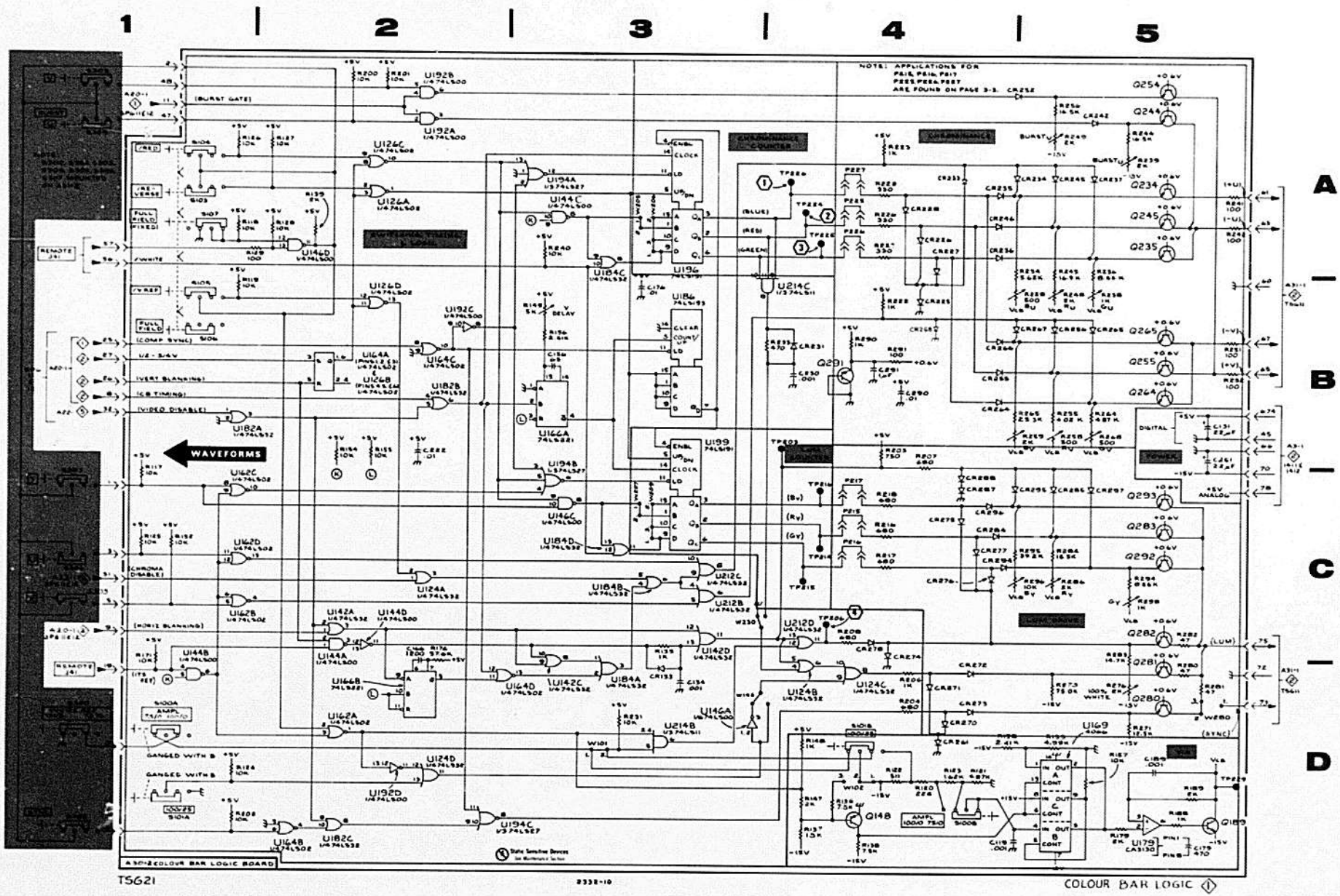




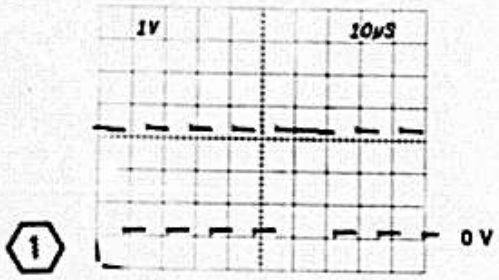


COLOR BAR LOGIC
PARTS LOCATING CHART

C119	D4	P215	C4	R171	D1	R286	C5	U146D	A2
C131	B5	P216	C4	R176	D2	R290	B4	U162A	D2
C134	D3	P217	C4	R179	D5	R291	B4	U162B	C1
C156	B3	P225	A4	R188	D5	R294	C5	U162C	C1
C166	D2	P226	A4	R189	D5	R295	C5	U162D	C1
C176	B3	P227	A4	R200	A2	R296	C5	U164A	B2
C179	D5			R201	A2	R298	C5	U164B	D2
C189	D5	Q148	D4	R202	D1			U164C	B2
C222	B2	Q189	D5	R203	B4	S100A	D1	U169D	D3
C230	B4	Q234	D5	R204	D4	S100B	D4	U166A	B3
C261	B5	Q235	A5	R206	D4	S101A	D1	U166B	D2
C290	B4	Q244	A5	R207	B4	S101B	D4	U169	D5
C291	B4	Q245	A5	R208	C4	S103	A1	U179	D5
		Q254	A5	R216	C4	S104	A1	U182A	B1
CR133	D3	Q255	B5	R217	C4	S105	B1	U182B	B2
CR225	B4	Q264	B5	R218	C4	S106	B1	U182C	D2
CR226	A4	Q265	B5	R222	B4	S107	A1	U184A	D3
CR227	A4	Q280	D5	R223	A4	S300	D1	U184B	C3
CR228	A4	Q281	D5	R226	A4	S302	D1	U184C	A3
CR231	B4	Q282	C5	R227	A4	S303	A1	U184D	C3
CR233	A4	Q283	C5	R228	B5	S304	A1	U186	B3
CR234	A5	Q291	B4	R229	A4	S305	C1	U192A	A2
CR235	A4	Q292	C5	R231	D3	S306	C1	U192B	A2
CR236	A4	Q293	C5	R233	B4	S307	C1	U192C	B2
CR237	A5			R234	A5			U192D	D2
CR242	A5	R117	C1	R236	A5	TP203	B4	U194A	A3
CR245	A5	R118	A1	R238	B5	TP206	C4	U194B	C3
CR246	A4	R119	B1	R239	A5	TP214	C4	U194C	D2
CR252	A4	R120	D4	R240	A3	TP215	C4	U196	A3
CR255	B4	R121	D4	R241	A5	TP216	C4	U199	B3
CR256	B5	R123	D4	R242	A5	TP224	A4	U212B	C3
CR261	B4	R124	D1	R244	A5	TP225	A4	U212C	C3
CR264	B4	R125	C1	R245	A5	TP226	A4	U212D	C4
CR265	B5	R126	A1	R248	B5	TP229	D5	U214B	D3
CR266	B4	R127	A2	R249	A5			U214C	B4
CR267	B5	R128	A2	R251	B5	U124A	C2		
CR268	B4	R129	A1	R252	B5	U124B	D4	W101	D3
CR270	D4	R133	C3	R255	B5	U124C	D4	W102	D4
CR271	D4	R136	D4	R256	A5	U124D	D2	W122	D4
CR272	D4	R137	D4	R258	B5	U126A	A2	W146	D3
CR273	D4	R138	D4	R259	B5	U126B	B2	W205	A3
CR274	C4	R139	A2	R264	B5	U126C	A2	W206	A3
CR275	C4	R147	D4	R265	B5	U126D	B2	W207	C3
CR276	C4	R148	D4	R268	B5	U142A	C2	W209	C3
CR277	C4	R149	B3	R271	D5	U142C	D3	W230	C3
CR278	C4	R152	C1	R273	D5	U142D	C3	W280	D5
CR284	C4	R154	B2	R276	D5	U144A	C2		
CR285	C5	R155	B2	R280	D5	U144B	D1		
CR287	C4	R156	B3	R281	D5	U144C	A3		
CR288	C4	R157	D5	R282	C5	U144D	C2		
CR294	C4	R158	D4	R283	C5	U146A	D3		
CR295	C5	R159	D5	R284	C5	U146C	C3		
CR296	C4								
CR297	C5								



① WAVEFORMS



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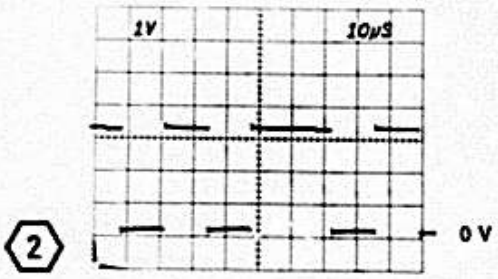

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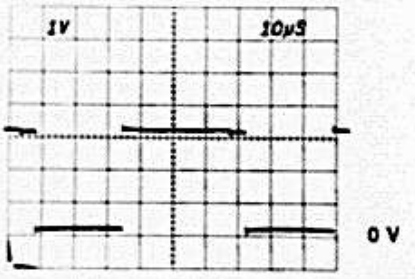

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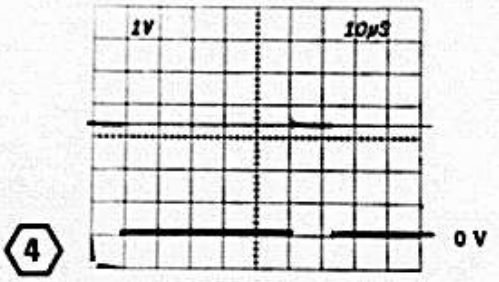

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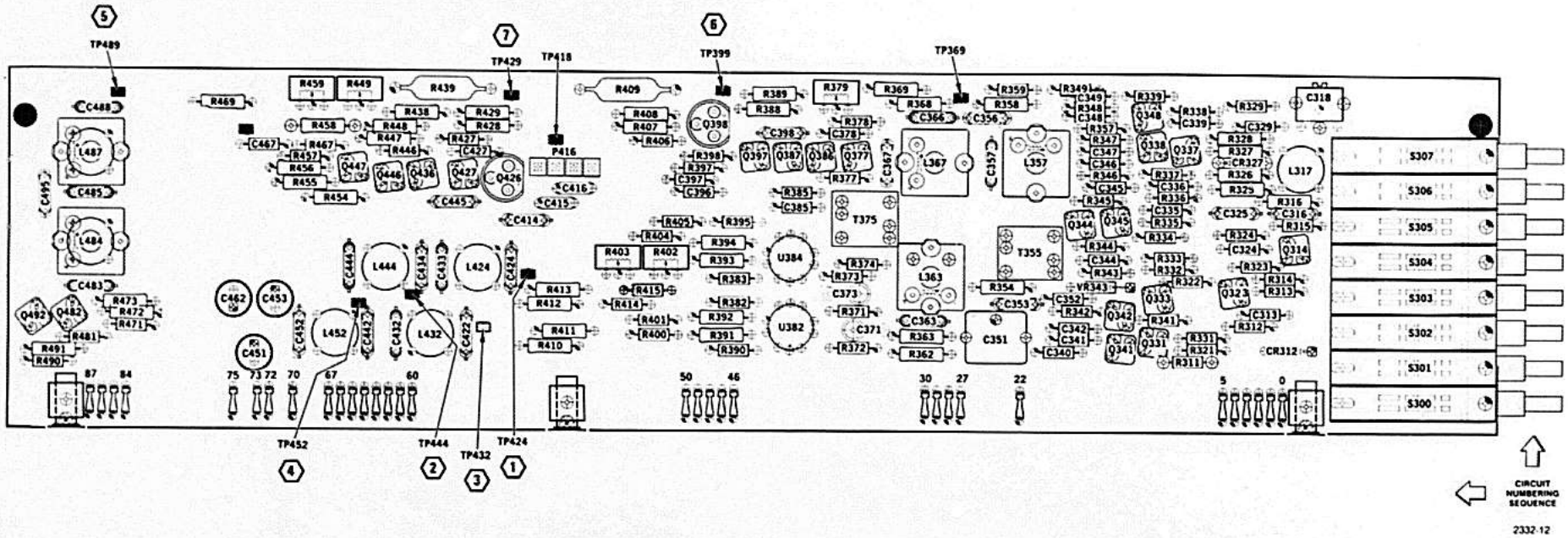
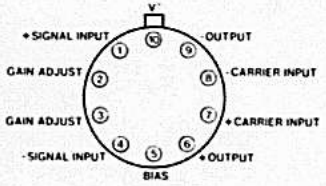
2332-09



A31-2 COLOUR BAR OUTPUT CIRCUIT BOARD

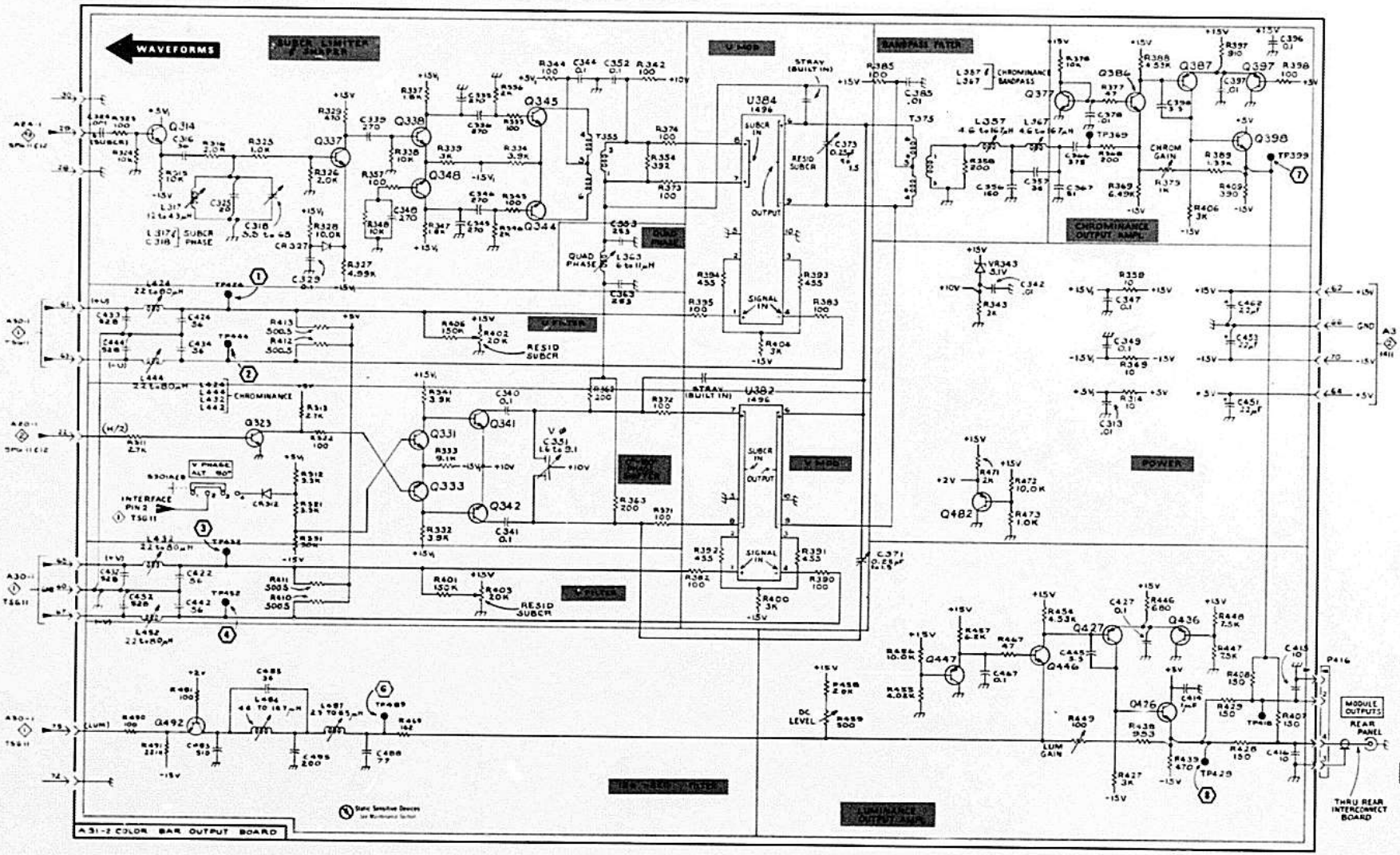
Static Sensitive Devices
See Maintenance Section



MC1496G

COLOR BAR OUTPUT PARTS LOCATING CHART

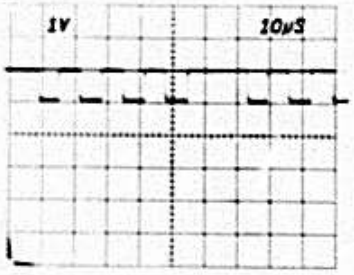
C313	B5
C316	A1
C318	A1
C324	A1
C325	A2
C329	B2
C335	A2
C336	A2
C339	A2
C340	B2
C341	C2
C342	B4
C344	A3
C345	B2
C346	A2
C347	B5
C348	A2
C349	B5
C351	C3
C352	A3
C353	B3
C356	A4
C357	A4
C363	B3
C366	A4
C367	A4
C371	C4
C373	A4
C378	A5
C385	A4
C396	A4
C397	A5
C398	A5
C414	D5
C415	D5
C416	D5
C422	C1
C424	B1
C427	C5
C432	C1
C433	B1
C434	B1
C442	C1
C444	B1
C445	C5
C451	B5
C452	C1
C453	B5
C462	B5
C467	D4
C483	D1
C485	D2
C488	D2
C455	D2
CR312	C2
CR327	B2
L317	A1
L357	A4
L363	B3
L367	A4
L424	B1
L432	C1
L444	B1
L452	C1
L484	D2
L487	D2
P416	D5
Q314	A1
Q331	C2
Q333	C2
Q337	A2
Q338	A2
Q341	B2
Q342	C2
Q344	A3
Q345	A3
Q348	A2
Q377	A4
Q386	A5
Q387	A5
Q397	A5
Q398	A5
Q426	D5
Q427	C5
Q436	C5
Q446	D4
Q447	D4
Q482	C4
Q492	D1
R311	C1
R312	C2
R313	B2
R314	B5
R315	A1
R316	A1
R321	C2
R322	C2
R323	A1
R324	A1
R325	A2
R326	A2
R327	B2
R328	B2
R329	A2
R331	C2
R332	C2
R333	C2
R334	A3
R335	A3
R336	A2
R337	A2
R338	A2
R339	A2
R341	B2
R342	A3
R343	B4
R344	A3
R345	A3
R346	B2
R347	B2
R348	B2
R349	B5
R354	A3
R357	A2
R358	A4
R359	B5
R362	B3
R363	C3
R368	A5
R369	A5
R371	C3
R372	B3
R373	A3
R374	A3
R377	A5
R378	A4
R379	A5
R382	C3
R383	B4
R385	A4
R388	A5
R389	A5
R390	C4
R391	C4
R392	C3
R393	B4
R394	B3
R395	B3
R397	A5
R398	A5
R400	C3
R401	C2
R402	B2
R403	C2
R404	B3
R405	B2
R406	A5
R407	D5
R408	D5
R409	A5
R410	C2
R411	C2
R412	B2
R413	B2
R427	D5
R428	D5
R429	D5
R438	D5
R439	D5
R446	C5
R447	C5
R448	C5
R449	D5
R454	C4
R455	D4
R456	C4
R457	C4
R458	D4
R459	D4
R467	C4
R469	D2
R471	C4
R472	C4
R473	C4
R481	D1
R490	D1
R491	D1
S301A	C1
S301B	C1
T375	A4
T355	A3
TP369	A5
TP399	A5
TP418	D5
TP424	B2
TP429	D5
TP432	C2
TP444	B2
TP452	C2
TP489	D2
U382	B3
U384	A3
VR343	B4



TSG21

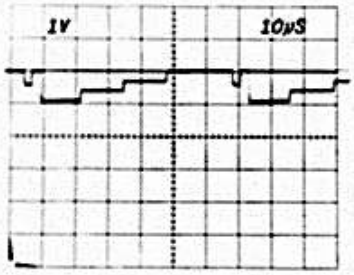
COLOR BAR OUTPUT ②

2 WAVEFORMS



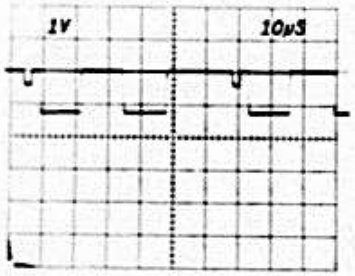
1 0 V

(+U)



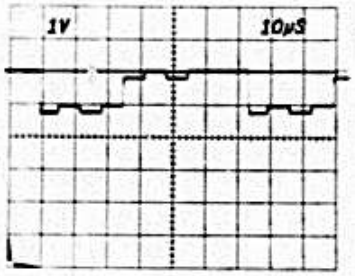
2 0 V

(−U)



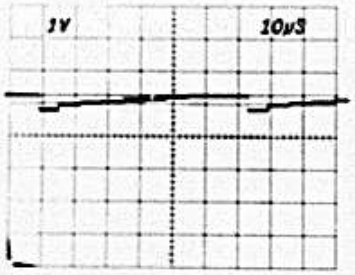
3 0 V

(+V)



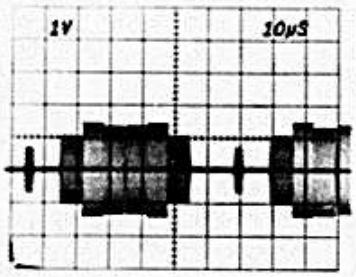
4 0 V

(−V)

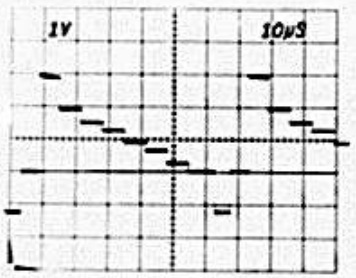


5 0 V

115 ns



6 0 V



7 0 V

2332-13

REPLACEABLE ELECTRICAL 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.

LIST OF ASSEMBLIES

A list of assemblies can be found at the beginning of the Electrical Parts List. The assemblies are listed in numerical order. When the complete component number of a part is known, this list will identify the assembly in which the part is located.

CROSS INDEX-MFR. CODE NUMBER TO MANUFACTURER

The Mfr. Code Number to Manufacturer index for the Electrical Parts List is located immediately after this page. The Cross Index provides codes, names and addresses of manufacturers of components listed in the Electrical Parts List.

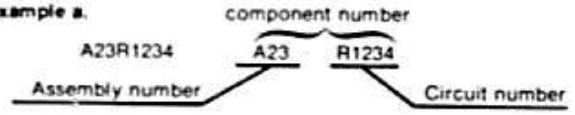
ABBREVIATIONS

Abbreviations conform to American National Standard Y1.1.

COMPONENT NUMBER (column one of the Electrical Parts List)

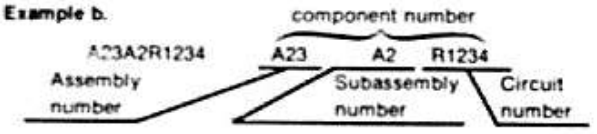
A numbering method has been used to identify assemblies, subassemblies and parts. Examples of this numbering method and typical expansions are illustrated by the following:

Example a.



Read: Resistor 1234 of Assembly 23

Example b.



Read: Resistor 1234 of Subassembly 2 of Assembly 23

Only the circuit number will appear on the diagrams and circuit board illustrations. Each diagram and circuit board illustration is clearly marked with the assembly number. Assembly numbers are also marked on the mechanical exploded views located in the Mechanical Parts List. The component number is obtained by adding the assembly number prefix to the circuit number.

The Electrical Parts List is divided and arranged by assemblies in numerical sequence (e.g., assembly A1 with its subassemblies and parts, precedes assembly A2 with its subassemblies and parts).

Chassis-mounted parts have no assembly number prefix and are located at the end of the Electrical Parts List.

TEKTRONIX PART NO. (column two of the Electrical Parts List)

Indicates part number to be used when ordering replacement part from Tektronix.

SERIAL/MODEL NO. (columns three and four of the Electrical Parts List)

Column three (3) indicates the serial number at which the part was first used. Column four (4) indicates the serial number at which the part was removed. No serial number entered indicates part is good for all serial numbers.

NAME & DESCRIPTION (column five of the Electrical Parts List)

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.

MFR. CODE (column six of the Electrical Parts List)

Indicates the code number of the actual manufacturer of the part. (Code to name and address cross reference can be found immediately after this page.)

MFR. PART NUMBER (column seven of the Electrical Parts List)

Indicates actual manufacturers part number.

CROSS INDEX—MFR. CODE NUMBER TO MANUFACTURER

Mfr Code	Manufacturer	Address	City, State, Zip
00853	SANGAMO ELECTRIC CO., S. CAROLINA DIV.	P O BOX 128	PICKENS, SC 29671
01121	ALLEN-BRADLEY COMPANY	1201 2ND STREET SOUTH	MILWAUKEE, WI 53204
01295	TEXAS INSTRUMENTS, INC., SEMICONDUCTOR GROUP	P O BOX 5012, 13500 N CENTRAL EXPRESSWAY	DALLAS, TX 75222
02735	RCA CORPORATION, SOLID STATE DIVISION	ROUTE 202	SOMERVILLE, NY 08876
03508	GENERAL ELECTRIC COMPANY, SEMI-CONDUCTOR PRODUCTS DEPARTMENT	ELECTRONICS PARK	SYRACUSE, NY 13201
04222	AVX CERAMICS, DIVISION OF AVX CORP.	P O BOX 867, 19TH AVE. SOUTH	MYRTLE BEACH, SC 29577
04713	MOTOROLA, INC., SEMICONDUCTOR PROD. DIV.	5005 E MCDOWELL RD,PO BOX 20923	PHOENIX, AZ 85036
07263	FAIRCHILD SEMICONDUCTOR, A DIV. OF FAIRCHILD CAMERA AND INSTRUMENT CORP.	464 ELLIS STREET	MOUNTAIN VIEW, CA 94042
09023	CORNELL-DUBILIER ELECTRONIC DIVISION FEDERAL PACIFIC ELECTRIC CO.	2652 DALRYMPLE ST.	SANFORD, NC 27330
22526	BERG ELECTRONICS, INC.	YOUK EXPRESSWAY	NEW CUMBERLAND, PA 17070
24546	CORNING GLASS WORKS, ELECTRONIC COMPONENTS DIVISION	550 HIGH STREET	BRADFORD, PA 16701
27014	NATIONAL SEMICONDUCTOR CORP.	2900 SEMICONDUCTOR DR.	SANTA CLARA, CA 95051
32997	BOURNS, INC., TRIMPOT PRODUCTS DIV.	1200 COLUMBIA AVE.	RIVERSIDE, CA 92507
34430	MONSANTO COMMERCIAL PRODUCT, CO. FABRICATOR PRODUCTS DIV.	BOX 3790, 611 EAST CERRITOS AVE.	ANAHEIM, CA 92803
52769	SPRAGUE GOODMAN ELEC., INC.	134 FULTON AVENUE	GARDEN CITY PARK, NY 11040
56289	SPRAGUE ELECTRIC CO.	87 MARSHALL ST.	NORTH ADAMS, MA 01247
59660	TUSONIX INC.	2155 N FORBES BLVD	TUCSON, AZ 85705
72982	ERIE TECHNOLOGICAL PRODUCTS, INC.	644 W. 12TH ST.	ERIE, PA 16512
73138	BECKMAN INSTRUMENTS, INC., HELIPOT DIV.	2500 HARBOR BLVD.	FULLERTON, CA 92634
74970	JOHNSON, E. F., CO.	299 10TH AVE. S. W.	WASECA, MN 56093
80009	TEKTRONIX, INC.	P O BOX 500	BEAVERTON, OR 97077
91637	DALE ELECTRONICS, INC.	P. O. BOX 609	COLUMBUS, NE 68601

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A100	670-4459-00			CKT BOARD ASSY:SHIELD	80009	670-4459-00
A30-2	670-4920-01			CKT BOARD ASSY:COLOR BAR LOGIC	80009	670-4920-01
A31-2	670-4921-00			CKT BOARD ASSY:COLOR BAR OUTPUT	80009	670-4921-00
C119	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	59660	0831610Y5P0102D
C131	290-0745-00			CAP.,FXD,ELCTLT:22UF,+50-10%,25V	56289	502D225
C134	281-0812-00			CAP.,FXD,CER DI:1000PF,10%,100V	72982	8035D9AADX7R102K
C156	283-0634-00			CAP.,FXD,MICA D:65PF,1%,100V	00853	D151E650F0
C166	283-0623-00			CAP.,FXD,MICA D:1200PF,1%,100V	00853	D191F122F0
C176	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	04222	SA201C103KAA
C179	283-0597-00			CAP.,FXD,MICA D:470PF,10%,300V	00853	D153E471K0
C189	281-0812-00			CAP.,FXD,CER DI:1000PF,10%,100V	72982	8035D9AADX7R102K
C222	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	04222	SA201C103KAA
C230	281-0812-00			CAP.,FXD,CER DI:1000PF,10%,100V	72982	8035D9AADX7R102K
C261	290-0745-00			CAP.,FXD,ELCTLT:22UF,+50-10%,25V	56289	502D225
C290	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	04222	SA201C103KAA
C291	290-0534-00			CAP.,FXD,ELCTLT:1UF,20%,35V	56289	196D105X0035HA1
C313	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	04222	SA201C103KAA
C316	283-0636-00			CAP.,FXD,MICA D:36PF,1.4%,100V	00853	D155E360G0
C318	281-0226-00			CAP.,VAR,PLSTC:5.5-65PF,100V	52769	GXD38000
C324	281-0812-00			CAP.,FXD,CER DI:1000PF,10%,100V	72982	8035D9AADX7R102K
C325	283-0637-00			CAP.,FXD,MICA D:20PF,2.5%,100V	00853	D151E200D0
C329	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	59660	SA205E104MAA
C335	281-0791-00			CAP.,FXD,CER DI:270PF,10%,100V	72982	8035D2AADX5R271K
C336	281-0791-00			CAP.,FXD,CER DI:270PF,10%,100V	72982	8035D2AADX5R271K
C339	281-0791-00			CAP.,FXD,CER DI:270PF,10%,100V	72982	8035D2AADX5R271K
C340	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	59660	SA205E104MAA
C341	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	59660	SA205E104MAA
C342	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	04222	SA201C103KAA
C344	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	59660	SA205E104MAA
C345	281-0791-00			CAP.,FXD,CER DI:270PF,10%,100V	72982	8035D2AADX5R271K
C346	281-0791-00			CAP.,FXD,CER DI:270PF,10%,100V	72982	8035D2AADX5R271K
C347	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	59660	SA205E104MAA
C348	281-0791-00			CAP.,FXD,CER DI:270PF,10%,100V	72982	8035D2AADX5R271K
C349	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	59660	SA205E104MAA
C351	281-0116-00			CAP.,VAR,AIR DI:1.5-9.1PF,530V	74970	189-0754-075
C352	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	59660	SA205E104MAA
C353	283-0598-00			CAP.,FXD,MICA D:253PF,5%,300V	09023	CD15EC(253)J03
C356	283-0640-00			CAP.,FXD,MICA D:160PF,1%,100V	00853	D151E161F0
C357	283-0636-00			CAP.,FXD,MICA D:36PF,1.4%,100V	00853	D155E360G0
C363	283-0598-00			CAP.,FXD,MICA D:253PF,5%,300V	09023	CD15EC(253)J03
C366	283-0670-00			CAP.,FXD,MICA D:375PF,1%,500V	00853	D155F3750F0
C367	283-0635-00			CAP.,FXD,MICA D:51PF,1%,100V	00853	D151E510F0
C371	281-0064-00			CAP.,VAR,PLSTC:0.25-1.5PF,600V	74970	273-0001-101
C373	281-0064-00			CAP.,VAR,PLSTC:0.25-1.5PF,600V	74970	273-0001-101
C378	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	04222	SA201C103KAA
C385	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	04222	SA201C103KAA
C396	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	59660	SA205E104MAA
C397	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	04222	SA201C103KAA
C398	281-0534-00			CAP.,FXD,CER DI:3.3PF,+/-0.25PF,500V	04222	7001-1316
C409	308-0252-00			RES.,FXD,WW:390 OHM,5%,3W	91637	CW2B-B390R0J
C414	283-0177-00			CAP.,FXD,CER DI:1UF,+80-20%,25V	56289	273C5
C415	283-0648-00			CAP.,FXD,MICA D:10PF,5%,100V	00853	D151C100D0
C416	283-0648-00			CAP.,FXD,MICA D:10PF,5%,100V	00853	D151C100D0
C422	283-0639-00			CAP.,FXD,MICA D:56PF,1%,100V	00853	D151E560F0
C424	283-0639-00			CAP.,FXD,MICA D:56PF,1%,100V	00853	D151E560F0
C427	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	59660	SA205E104MAA
C432	283-0596-00			CAP.,FXD,MICA D:528PF,1%,300V	00853	D153F5280F0

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
C433	283-0596-00			CAP.,FXD,MICA D:528PF,1%,300V	00853	D153F5280F0
C434	283-0639-00			CAP.,FXD,MICA D:56PF,1%,100V	00853	D151E560F0
C439	308-0426-00			RES.,FXD,WW:470 OHM,5%,3W	91637	CW2B-470R0J
C442	283-0639-00			CAP.,FXD,MICA D:56PF,1%,100V	00853	D151E560F0
C444	283-0596-00			CAP.,FXD,MICA D:528PF,1%,300V	00853	D153F5280F0
C445	281-0534-00			CAP.,FXD,CER DI:3.3PF,+/-0.25PF,500V	04222	7001-1316
C451	290-0745-00			CAP.,FXD,ELCTLT:22UF,+50-10%,25V	56289	502D225
C452	283-0596-00			CAP.,FXD,MICA D:528PF,1%,300V	00853	D153F5280F0
C453	290-0745-00			CAP.,FXD,ELCTLT:22UF,+50-10%,25V	56289	502D225
C462	290-0745-00			CAP.,FXD,ELCTLT:22UF,+50-10%,25V	56289	502D225
C467	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	59660	SA205E104MAA
C483	283-0660-00			CAP.,FXD,MICA D:510PF,2%,500V	00853	D155F511G0
C485	283-0636-00			CAP.,FXD,MICA D:36PF,1.4%,100V	00853	D155E360G0
C488	283-0633-00			CAP.,FXD,MICA D:77PF,1%,100V	00853	D151E770F0
C495	283-0672-00			CAP.,FXD,MICA D:200PF,1%,500V	00853	D155F2010F0
CR133	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR225	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR226	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR227	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR228	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR231	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR233	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR234	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR235	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR236	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR237	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR242	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR245	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR246	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR252	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR255	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR256	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR261	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR264	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR265	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR266	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR267	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR268	150-1000-00			LT EMITTING DIO:RED,650NM,40MA MAX	34430	MV-50
CR270	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR271	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR272	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR273	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR274	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR275	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR276	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR277	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR278	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR284	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR285	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR287	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR288	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR294	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR295	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR296	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR297	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR312	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR327	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
L317	114-0280-00			COIL,RF:12-43UH,CORE 276-0568-00	80009	114-0280-00
L357	114-0278-00			COIL,RF:4.6-16.7UH,CORE 276-0568-00	80009	114-0278-00
L363	114-0257-00			COIL,RF:VARIABLE,6-11UH	80009	114-0257-00
L367	114-0278-00			COIL,RF:4.6-16.7UH,CORE 276-0568-00	80009	114-0278-00
L424	114-0310-00			COIL,RFUH	80009	114-0310-00
L432	114-0310-00			COIL,RFUH	80009	114-0310-00
L444	114-0310-00			COIL,RFUH	80009	114-0310-00
L452	114-0310-00			COIL,RFUH	80009	114-0310-00
L484	114-0278-00			COIL,RF:4.6-16.7UH,CORE 276-0568-00	80009	114-0278-00
L487	114-0308-00			COIL,RF:2.9-6.5UH	80009	114-0308-00
P215	131-0608-00			TERMINAL,PIN:0.365 L X 0.025 PH BRZ GOLD	22526	47357
P216	131-0608-00			TERMINAL,PIN:0.365 L X 0.025 PH BRZ GOLD	22526	47357
P217	131-0608-00			TERMINAL,PIN:0.365 L X 0.025 PH BRZ GOLD	22526	47357
P225	131-0608-00			TERMINAL,PIN:0.365 L X 0.025 PH BRZ GOLD	22526	47357
P226	131-0608-00			TERMINAL,PIN:0.365 L X 0.025 PH BRZ GOLD	22526	47357
P227	131-0608-00			TERMINAL,PIN:0.365 L X 0.025 PH BRZ GOLD	22526	47357
P416	131-0589-00			TERMINAL,PIN:0.46 L X 0.025 SQ	22526	48283-029
Q148	151-0220-00			TRANSISTOR:SILICON,PNP	07263	S036228
Q189	151-0207-00			TRANSISTOR:SILICON,NPN	03508	X32D6191
Q234	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS6521	04713	SPS8801
Q235	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS6521	04713	SPS8801
Q244	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS6521	04713	SPS8801
Q245	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS6521	04713	SPS8801
Q254	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS6521	04713	SPS8801
Q255	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS6521	04713	SPS8801
Q264	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS6521	04713	SPS8801
Q265	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS6521	04713	SPS8801
Q280	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS6521	04713	SPS8801
Q281	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS6521	04713	SPS8801
Q282	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS6521	04713	SPS8801
Q283	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS6521	04713	SPS8801
Q291	151-0220-00			TRANSISTOR:SILICON,PNP	07263	S036228
Q292	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS6521	04713	SPS8801
Q293	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS6521	04713	SPS8801
Q314	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
Q323	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS6521	04713	SPS8801
Q331	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
Q333	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
Q337	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
Q338	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
Q341	151-0225-00			TRANSISTOR:SILICON,NPN	07263	S39291
Q342	151-0225-00			TRANSISTOR:SILICON,NPN	07263	S39291
Q344	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
Q345	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
Q348	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
Q377	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
Q386	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
Q387	151-0220-00			TRANSISTOR:SILICON,PNP	07263	S036228
Q397	151-0220-00			TRANSISTOR:SILICON,PNP	07263	S036228
Q398	151-0103-00			TRANSISTOR:SILICON,NPN	80009	151-0103-00
Q426	151-0103-00			TRANSISTOR:SILICON,NPN	80009	151-0103-00
Q427	151-0220-00			TRANSISTOR:SILICON,PNP	07263	S036228
Q436	151-0220-00			TRANSISTOR:SILICON,PNP	07263	S036228
Q446	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
Q447	151-0220-00			TRANSISTOR:SILICON,PNP	07263	S036228
Q482	151-0220-00			TRANSISTOR:SILICON,PNP	07263	S036228

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
Q492	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS6521	04713	SPS8801
R117	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R118	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R119	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R120	321-0131-00			RES.,FXD,FILM:226 OHM,1%,0.125W	91637	MFF1816G226R0F
R121	321-0259-03			RES.,FXD,FILM:4.87K OHM,0.25%,0.125W	91637	MFF1816D48700C
R122	321-0165-00			RES.,FXD,FILM:511 OHM,1%,0.125W	91637	MFF1816G511R0F
R123	321-0213-03			RES.,FXD,FILM:1.62K OHM,0.25%,0.125W	91637	MFF1816D16200C
R124	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R125	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R126	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R127	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R128	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R129	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R133	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R136	315-0752-00			RES.,FXD,CMPSN:7.5K OHM,5%,0.25W	01121	CB7525
R137	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R138	315-0752-00			RES.,FXD,CMPSN:7.5K OHM,5%,0.25W	01121	CB7525
R139	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R147	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R148	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R149	311-1917-00			RES.,VAR,NONWIR:TRMR,5K OHM,10%,0.5W	73138	72-198-0
R152	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R154	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R155	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R156	321-0233-00			RES.,FXD,FILM:2.61K OHM,1%,0.125W	91637	MFF1816G26100F
R157	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R158	321-0830-03			RES.,FXD,FILM:2.41K OHM,0.25%,0.125W	91637	MFF1816D24100C
R159	321-0260-03			RES.,FXD,FILM:4.99K OHM,0.25%,0.125W	24546	NC55C4991C
R171	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R176	321-0362-00			RES.,FXD,FILM:57.6K OHM,1%,0.125W	91637	MFF1816G57601F
R179	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R188	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R189	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R200	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R201	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R202	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R203	315-0751-00			RES.,FXD,CMPSN:750 OHM,5%,0.25W	01121	CB7515
R204	315-0681-00			RES.,FXD,CMPSN:680 OHM,5%,0.25W	01121	CB6815
R206	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R207	315-0681-00			RES.,FXD,CMPSN:680 OHM,5%,0.25W	01121	CB6815
R208	315-0681-00			RES.,FXD,CMPSN:680 OHM,5%,0.25W	01121	CB6815
R216	315-0681-00			RES.,FXD,CMPSN:680 OHM,5%,0.25W	01121	CB6815
R217	315-0681-00			RES.,FXD,CMPSN:680 OHM,5%,0.25W	01121	CB6815
R218	315-0681-00			RES.,FXD,CMPSN:680 OHM,5%,0.25W	01121	CB6815
R222	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R223	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R226	315-0331-00			RES.,FXD,CMPSN:330 OHM,5%,0.25W	01121	CB3315
R227	315-0331-00			RES.,FXD,CMPSN:330 OHM,5%,0.25W	01121	CB3315
R228	311-1248-00			RES.,VAR,NONWIR:500 OHM,10%,0.50W	73138	72-23-0
R229	315-0331-00			RES.,FXD,CMPSN:330 OHM,5%,0.25W	01121	CB3315
R231	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R233	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R234	321-0265-00			RES.,FXD,FILM:5.62K OHM,1%,0.125W	91637	MFF1816G56200F
R236	321-0283-00			RES.,FXD,FILM:8.66K OHM,1%,0.125W	91637	MFF1816G86600F
R238	311-1237-00			RES.,VAR,NONWIR:1K OHM,10%,0.50W	32997	3386X-T07-102

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R239	311-1918-00			RES.,VAR,NONWIR:2K OHM,10%,0.50W	73138	72-199-0
R240	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R241	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R242	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R244	321-0310-00			RES.,FXD,FILM:16.5K OHM,1%,0.125W	91637	MFF1816G16501F
R245	321-0311-00			RES.,FXD,FILM:16.9K OHM,1%,0.125W	91637	MFF1816G16901F
R248	311-1918-00			RES.,VAR,NONWIR:2K OHM,10%,0.50W	73138	72-199-0
R249	311-1918-00			RES.,VAR,NONWIR:2K OHM,10%,0.50W	73138	72-199-0
R251	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R252	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R255	321-0251-00			RES.,FXD,FILM:4.02K OHM,1%,0.125W	91637	MFF1816G40200F
R256	321-0310-00			RES.,FXD,FILM:16.5K OHM,1%,0.125W	91637	MFF1816G16501F
R258	311-1248-00			RES.,VAR,NONWIR:500 OHM,10%,0.50W	73138	72-23-0
R259	311-1918-00			RES.,VAR,NONWIR:2K OHM,10%,0.50W	73138	72-199-0
R264	321-0259-03			RES.,FXD,FILM:4.87K OHM,0.25%,0.125W	91637	MFF1816D48700C
R265	321-0328-00			RES.,FXD,FILM:25.5K OHM,1%,0.125W	91637	MFF1816G25501F
R268	311-1248-00			RES.,VAR,NONWIR:500 OHM,10%,0.50W	73138	72-23-0
R271	321-0631-03			RES.,FXD,FILM:12.5K OHM,0.25W,0.125W	91637	MFF1816D12501C
R273	321-0373-03			RES.,FXD,FILM:75K OHM,0.25%,0.125W	91637	MFF1816D75001C
R276	311-1918-00			RES.,VAR,NONWIR:2K OHM,10%,0.50W	73138	72-199-0
R280	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R281	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R282	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R283	321-0305-00			RES.,FXD,FILM:14.7K OHM,1%,0.125W	91637	MFF1816G14701F
R284	321-0310-00			RES.,FXD,FILM:16.5K OHM,1%,0.125W	91637	MFF1816G16501F
R286	311-1918-00			RES.,VAR,NONWIR:2K OHM,10%,0.50W	73138	72-199-0
R290	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R291	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R294	321-0283-00			RES.,FXD,FILM:8.66K OHM,1%,0.125W	91637	MFF1816G86600F
R295	321-0346-00			RES.,FXD,FILM:39.2K OHM,1%,0.125W	91637	MFF1816G39201F
R296	311-1245-00			RES.,VAR,NONWIR:10K OHM,10%,0.50W	73138	72-28-0
R298	311-1237-00			RES.,VAR,NONWIR:1K OHM,10%,0.50W	32997	3386X-T07-102
R311	315-0272-00			RES.,FXD,CMPSN:2.7K OHM,5%,0.25W	01121	CB2725
R312	315-0332-00			RES.,FXD,CMPSN:3.3K OHM,5%,0.25W	01121	CB3325
R313	315-0272-00			RES.,FXD,CMPSN:2.7K OHM,5%,0.25W	01121	CB2725
R314	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R315	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R316	321-0222-00			RES.,FXD,FILM:2K OHM,1%,0.125W	91637	MFF1816G20000F
R321	315-0332-00			RES.,FXD,CMPSN:3.3K OHM,5%,0.25W	01121	CB3325
R322	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R323	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R324	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R325	321-0193-00			RES.,FXD,FILM:1K OHM,1%,0.125W	91637	MFF1816G10000F
R326	321-0222-00			RES.,FXD,FILM:2K OHM,1%,0.125W	91637	MFF1816G20000F
R327	321-0260-00			RES.,FXD,FILM:4.99K OHM,1%,0.125W	91637	MFF1816G49900F
R328	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R329	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R331	315-0303-00			RES.,FXD,CMPSN:30K OHM,5%,0.25W	01121	CB3035
R332	315-0392-00			RES.,FXD,CMPSN:3.9K OHM,5%,0.25W	01121	CB3925
R333	315-0912-00			RES.,FXD,CMPSN:9.1K OHM,5%,0.25W	01121	CB9125
R334	315-0392-00			RES.,FXD,CMPSN:3.9K OHM,5%,0.25W	01121	CB3925
R335	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R336	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R337	315-0182-00			RES.,FXD,CMPSN:1.8K OHM,5%,0.25W	01121	CB1825
R338	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R339	315-0302-00			RES.,FXD,CMPSN:3K OHM,5%,0.25W	01121	CB3025
R341	315-0392-00			RES.,FXD,CMPSN:3.9K OHM,5%,0.25W	01121	CB3925

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R342	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R343	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R344	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R345	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R346	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R347	315-0182-00			RES.,FXD,CMPSN:1.8K OHM,5%,0.25W	01121	CB1825
R348	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R349	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R354	321-0154-00			RES.,FXD,FILM:392 OHM,1%,0.125W	91637	MFF1816G392ROF
R357	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R358	321-0126-00			RES.,FXD,FILM:200 OHM,1%,0.125W	91637	MFF1816G200ROF
R359	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R362	321-0126-00			RES.,FXD,FILM:200 OHM,1%,0.125W	91637	MFF1816G200ROF
R363	321-0126-00			RES.,FXD,FILM:200 OHM,1%,0.125W	91637	MFF1816G200ROF
R368	321-0126-00			RES.,FXD,FILM:200 OHM,1%,0.125W	91637	MFF1816G200ROF
R369	321-0271-00			RES.,FXD,FILM:6.49K OHM,1%,0.125W	91637	MFF1816G64900F
R371	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R372	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R373	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R374	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R377	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R378	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R379	311-1237-00			RES.,VAR,NONWIR:1K OHM,10%,0.50W	32997	3386X-T07-102
R382	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R383	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R385	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R388	321-0256-00			RES.,FXD,FILM:4.53K OHM,1%,0.125W	91637	MFF1816G45300F
R389	321-0205-00			RES.,FXD,FILM:1.33K OHM,1%,0.125W	91637	MFF1816G13300F
R390	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R391	321-0812-07			RES.,FXD,FILM:455 OHM,0.1%,0.125W	91637	MFF1816C455R0B
R392	321-0812-07			RES.,FXD,FILM:455 OHM,0.1%,0.125W	91637	MFF1816C455R0B
R393	321-0812-07			RES.,FXD,FILM:455 OHM,0.1%,0.125W	91637	MFF1816C455R0B
R394	321-0812-07			RES.,FXD,FILM:455 OHM,0.1%,0.125W	91637	MFF1816C455R0B
R395	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R397	315-0911-00			RES.,FXD,CMPSN:910 OHM,5%,0.25W	01121	CB9115
R398	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R400	315-0302-00			RES.,FXD,CMPSN:3K OHM,5%,0.25W	01121	CB3025
R401	315-0154-00			RES.,FXD,CMPSN:150K OHM,5%,0.25W	01121	CB1545
R402	311-1198-00			RES.,VAR,NONWIR:20K OHM,20%,0.5W	73138	72-29-0
R403	311-1198-00			RES.,VAR,NONWIR:20K OHM,20%,0.5W	73138	72-29-0
R404	315-0302-00			RES.,FXD,CMPSN:3K OHM,5%,0.25W	01121	CB3025
R405	315-0154-00			RES.,FXD,CMPSN:150K OHM,5%,0.25W	01121	CB1545
R406	315-0302-00			RES.,FXD,CMPSN:3K OHM,5%,0.25W	01121	CB3025
R407	321-0114-03			RES.,FXD,FILM:150 OHM,0.25%,0.125W	91637	MFF1816D150R0C
R408	321-0114-03			RES.,FXD,FILM:150 OHM,0.25%,0.125W	91637	MFF1816D150R0C
R409	308-0252-00			RES.,FXD,WW:390 OHM,5%,3W	91637	CW2B-B390R0J
R410	321-0961-07			RES.,FXD,FILM:500.5 OHM,0.1%,0.125W	24546	NE55E500R5B
R411	321-0961-07			RES.,FXD,FILM:500.5 OHM,0.1%,0.125W	24546	NE55E500R5B
R412	321-0961-07			RES.,FXD,FILM:500.5 OHM,0.1%,0.125W	24546	NE55E500R5B
R413	321-0961-07			RES.,FXD,FILM:500.5 OHM,0.1%,0.125W	24546	NE55E500R5B
R427	315-0302-00			RES.,FXD,CMPSN:3K OHM,5%,0.25W	01121	CB3025
R428	321-0114-03			RES.,FXD,FILM:150 OHM,0.25%,0.125W	91637	MFF1816D150R0C
R429	321-0114-03			RES.,FXD,FILM:150 OHM,0.25%,0.125W	91637	MFF1816D150R0C
R438	321-0191-00			RES.,FXD,FILM:953 OHM,1%,0.125W	91637	MFF1816G953ROF
R439	308-0426-00			RES.,FXD,WW:470 OHM,5%,3W	91637	CW2B-470R0J
R446	315-0681-00			RES.,FXD,CMPSN:680 OHM,5%,0.25W	01121	CB6815
R447	321-0277-00			RES.,FXD,FILM:7.5K OHM,1%,0.125W	91637	MFF1816G75000F

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R448	321-0277-00			RES.,FXD,FILM:7.5K OHM,1%,0.125W	91637	MFF1816G75000F
R449	311-1244-00			RES.,VAR,NONWIR:100 OHM,10%,0.50W	32997	3386X-T07-101
R454	321-0256-00			RES.,FXD,FILM:4.53K OHM,1%,0.125W	91637	MFF1816G45300F
R455	321-0251-00			RES.,FXD,FILM:4.02K OHM,1%,0.125W	91637	MFF1816G40200F
R456	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R457	315-0622-00			RES.,FXD,CMPSN:6.2K OHM,5%,0.25W	01121	CB6225
R458	321-0222-00			RES.,FXD,FILM:2K OHM,1%,0.125W	91637	MFF1816G20000F
R459	311-1248-00			RES.,VAR,NONWIR:500 OHM,10%,0.50W	73138	72-23-0
R460	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R461	321-0322-00			RES.,FXD,FILM:22.1K OHM,1%,0.125W	91637	MFF1816G22101F
R462	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R467	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R468	321-0117-00			RES.,FXD,FILM:162 OHM,1%,0.125W	91637	MFF1816G162R0F
R469	321-0117-00			RES.,FXD,FILM:162 OHM,1%,0.125W	91637	MFF1816G162R0F
R471	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R472	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R473	321-0193-00			RES.,FXD,FILM:1K OHM,1%,0.125W	91637	MFF1816G10000F
R481	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R490	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R491	321-0322-00			RES.,FXD,FILM:22.1K OHM,1%,0.125W	91637	MFF1816G22101F
S100 S101 S103 S104	263-0010-00			SWITCH PB ASSY:1 PUSH,7.5MM,W/2 CONTACTS	80009	263-0010-00
S105 S106 S107 S301 S302	263-0023-01			SWITCH PB ASSY:5 LATCH,7.5MM,8 CONTACTS	80009	263-0023-01
S303 S304 S305 S306 S307	263-0010-00			SWITCH PB ASSY:1 PUSH,7.5MM,W/2 CONTACTS	80009	263-0010-00
T355	120-1071-00			TRANSFORMER,RF:TOROID,10 TURNS TRIFILAR	80009	120-1071-00
T375	120-1070-00			TRANSFORMER,RF:TOROID,12 TURNS QUADFILAR	80009	120-1070-00
TP203	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
TP206	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
TP214	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
TP215	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
TP216	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
TP224	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
TP225	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
TP226	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
TP229	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
TP369	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
TP399	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
TP418	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
TP424	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
TP429	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
TP432	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
TP444	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
TP452	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
TP468	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
TP489	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00

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U124	156-0479-02			MICROCIRCUIT,DI:QUAD 2-INP ORGATE	01295	SN74LS32NP3
U126	156-0383-00			MICROCIRCUIT,DI:QUAD 2-INPUT NOR GATE	80009	156-0383-00
U142	156-0479-02			MICROCIRCUIT,DI:QUAD 2-INP ORGATE	01295	SN74LS32NP3
U144	156-0382-02			MICROCIRCUIT,DI:QUAD 2-INP NAND GATE	01295	SN74LS00
U146	156-0382-02			MICROCIRCUIT,DI:QUAD 2-INP NAND GATE	01295	SN74LS00
U162	156-0383-00			MICROCIRCUIT,DI:QUAD 2-INPUT NOR GATE	80009	156-0383-00
U164	156-0383-00			MICROCIRCUIT,DI:QUAD 2-INPUT NOR GATE	80009	156-0383-00
U166	156-0733-02			MICROCIRCUIT,DI:DUAL MONOSTABLE MV,SCRN	04713	SN74LS221N/J
U169	156-0644-00			MICROCIRCUIT,DI:QUAD BILATERAL SWITCH	80009	156-0644-00
U179	156-0686-00			MICROCIRCUIT,LI:OPNL AMPL,HIGH IMPEDANCE	02735	CA3130S
U182	156-0479-02			MICROCIRCUIT,DI:QUAD 2-INP ORGATE	01295	SN74LS32NP3
U184	156-0479-02			MICROCIRCUIT,DI:QUAD 2-INP ORGATE	01295	SN74LS32NP3
U186	156-0412-02			MICROCIRCUIT,DI:SYN 4 BIT UP/DOWN CNTR	01295	SN74LS193N3
U192	156-0382-02			MICROCIRCUIT,DI:QUAD 2-INP NAND GATE	01295	SN74LS00
U194	156-0718-02			MICROCIRCUIT,DI:TRIPLE 3-INP NOR GATE	80009	156-0718-02
U196	156-0422-02			MICROCIRCUIT,DI:UP/DOWN SYN BINARY CNTR	01295	SN74LS191
U199	156-0422-02			MICROCIRCUIT,DI:UP/DOWN SYN BINARY CNTR	01295	SN74LS191
U212	156-0479-02			MICROCIRCUIT,DI:QUAD 2-INP ORGATE	01295	SN74LS32NP3
U214	156-0481-02			MICROCIRCUIT,DI:TRIPLE 3 INP & GATE	27014	DM74LS11NA+
U382	156-0130-02			MICROCIRCUIT,LI:MODULATOR/DEMODULATOR,SCRN	04713	SC77162CH
U384	156-0130-02			MICROCIRCUIT,LI:MODULATOR/DEMODULATOR,SCRN	04713	SC77162CH
VR343	152-0279-00			SEMICOND DEVICE:ZENER,0.4W,5.1V,5%	04713	SZG35010RL

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.

SPECIAL NOTES AND SYMBOLS

X000	Part first added at this serial number
00X	Part removed after this serial number

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.

ITEM NAME

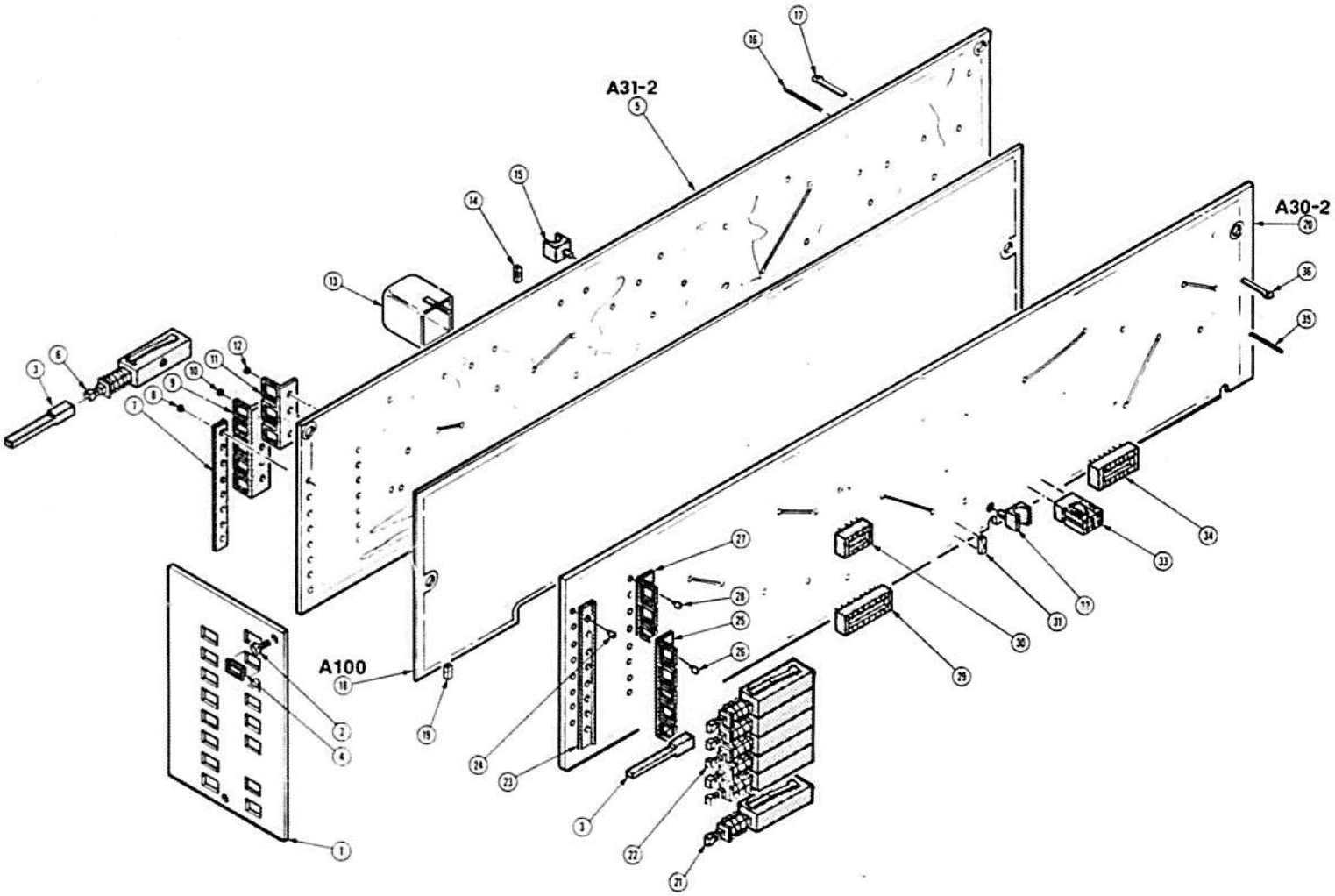
In the Parts List, an Item Name is separated from the description by a colon (:). Because of space limitations, an Item Name may sometimes appear as incomplete. For further Item Name identification, the U.S. Federal Cataloging Handbook H6-1 can be utilized where possible.

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
07707	USM CORP., USM FASTENER DIV.	510 RIVER RD.	SHELTON, CT 06484
22526	BERG ELECTRONICS, INC.	YOUK EXPRESSWAY	NEW CUMBERLAND, PA 17070
71785	TRW, CINCH CONNECTORS	1501 MORSE AVENUE	ELK GROVE VILLAGE, IL 60007
73803	TEXAS INSTRUMENTS, INC., METALLURGICAL MATERIALS DIV.	34 FOREST STREET	ATTLEBORO, MA 02703
80009	TEKTRONIX, INC.	P O BOX 500	BEAVERTON, OR 97077
83385	CENTRAL SCREW CO.	2530 CRESCENT DR.	BROADVIEW, IL 60153



TSG21 PAL-M COLOR BAR GENERATOR MODULE

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	333-2299-00			1		PANEL,FRONT:1412,TSG-21	80009	333-2299-00
						(ATTACHING PARTS)		
-2	213-0277-00			2		SCR,TPG,THD FOR:2-56 X 0.312 INCH,PNH STL	83385	OBD
						- - - * - - -		
-3	366-1691-00			14		PUSH BUTTON:GY,1.2 L	80009	366-1691-00
-4	426-1206-00			14		FRAME,PUSH BTN:MOMENTARY,GRAY PLASTIC	80009	426-1206-00
-5	----- -----			1		CKT BOARD ASSY:COLOR BAR OUTPUT(SEE A31-2 REPL)		
-6	----- -----			8		. SWITCH,PUSH:(SEE A31-2S301,A31-2S302,		
	----- -----			-		. A31-2S303,A31-2S304,A31-2S305,A31-2S306 REPL)		
-7	343-0495-08			1		. CLIP,SWITCH:FRONT,7.5MM X8 UNIT	80009	343-0495-08
						(ATTACHING PARTS)		
-8	210-3033-00			8		. EYELET,METALLIC:0.59 OD X 0.156 INCH LONG	07707	SE-25
						- - - * - - -		
-9	343-0499-14			1		. CLIP,SWITCH:7.5MM X 5 UNIT	80009	343-0499-14
						(ATTACHING PARTS)		
-10	210-3033-00			5		. EYELET,METALLIC:0.59 OD X 0.156 INCH LONG	07707	SE-25
						- - - * - - -		
-11	343-0499-12			1		. CLIP,SWITCH:REAR,7.5MM X 3 UNIT	80009	343-0499-12
						(ATTACHING PARTS)		
-12	210-3033-00			3		. EYELET,METALLIC:0.59 OD X 0.156 INCH LONG	07707	SE-25
						- - - * - - -		
-13	337-1417-00			5		. SHIELD,ELEC:0.55 SQ X 0.685 INCH HIGH	80009	337-1417-00
-14	136-0328-03			32		. SOCKET,PIN TERM:HORIZ,SQ PIN RCPT	22526	47710
-15	214-2440-00			3		. RECEPTACLE,PIN:CIRCUIT CARD	80009	214-2440-00
-16	131-0589-00			4		. TERMINAL,PIN:0.46 L X 0.025 SQ	22526	48283-029
-17	214-0579-00			10		. TERM,TEST POINT:BRS CD PL	80009	214-0579-00
-18	----- -----			1		CKT BOARD ASSY:SHIELD(SEE A100 REPL)		
-19	136-0328-03			4		. SOCKET,PIN TERM:HORIZ,SQ PIN RCPT	22526	47710
-20	----- -----			1		CKT BOARD ASSY:COLOR BAR LOGIC(SEE A30-2 REPL)		
-21	----- -----			2		. SWITCH,PUSH:(SEE A30-2S100,A30-2S101 REPL)		
-22	----- -----			1		. SWITCH,PUSH:(SEE A30-2S103,A30-2S104,		
	----- -----			-		. A30-2S105,A30-2S106,A30-2S107 REPL)		
-23	343-0495-08			1		. CLIP,SWITCH:FRONT,7.5MM X8 UNIT	80009	343-0495-08
						(ATTACHING PARTS)		
-24	210-3033-00			8		. EYELET,METALLIC:0.59 OD X 0.156 INCH LONG	07707	SE-25
						- - - * - - -		
-25	343-0499-14			1		. CLIP,SWITCH:7.5MM X 5 UNIT	80009	343-0499-14
						(ATTACHING PARTS)		
-26	210-3033-00			5		. EYELET,METALLIC:0.59 OD X 0.156 INCH LONG	07707	SE-25
						- - - * - - -		
-27	343-0499-12			1		. CLIP,SWITCH:REAR,7.5MM X 3 UNIT	80009	343-0499-12
						(ATTACHING PARTS)		
-28	210-3033-00			3		. EYELET,METALLIC:0.59 OD X 0.156 INCH LONG	07707	SE-25
						- - - * - - -		
-29	136-0260-02			4		. SKT,PL-IN ELEK:MICROCIRCUIT,16 DIP,LOW CLE	71785	133-51-92-008
-30	136-0514-00			1		. SKT,PL-IN ELEC:MICROCIRCUIT,8 DIP	73803	CS9002-8
-31	136-0328-03			43		. SOCKET,PIN TERM:HORIZ,SQ PIN RCPT	22526	47710
-32	214-2440-00			3		. RECEPTACLE,PIN:CIRCUIT CARD	80009	214-2440-00
-33	198-2864-00			2		. WIRE SET,ELEC:	80009	198-2864-00
-34	136-0269-02			14		. SKT,PL-IN ELEK:MICROCIRCUIT,14 DIP,LOW CLE	73803	CS9002-14
-35	131-0608-00			12		. TERMINAL,PIN:0.365 L X 0.025 PH BRZ GOLD	22526	47357
-36	214-0579-00			9		. TERM,TEST POINT:BRS CD PL	80009	214-0579-00
						STANDARD ACCESSORIES		
	070-2332-00			1		MANUAL,TECH:INSTRUCTION	80009	070-2332-00

MANUAL CHANGE INFORMATION

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

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

A single change may affect several sections. Since the change information sheets are carried in the manual until all changes are permanently entered, some duplication may occur. If no such change pages appear following this page, your manual is correct as printed.

Tektronix
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MANUAL CHANGE INFORMATION

Date: 11/21/83 Change Reference: C2/1183

Product: TSG 21 Manual Part No.: 070-2332-00

DESCRIPTION

Product Group 20

TEXT CHANGE

SECTION 2, SPECIFICATIONS and PERFORMANCE CHECK, PERFORMANCE CHECK PROCEDURE, Page 2-13, Step 15 Check U and V Bursts, following part f.

CHANGE TO READ:

g. CHECK - that total burst amplitude is 300 mV p-p ± 3% (291.0 - 309.0 mV p-p).

h. CHECK - that burst risetime, as measured between the 10% and 90% points of the positive peak is 400 ns ± 60 ns.

i. Set the waveform monitor controls to overlay two consecutive lines.

j. CHECK - that burst amplitudes on consecutive lines are within 2% of each other (294.0 - 306.0 mV p-p).

16. Check Chrominance Risetime

a. Use the same equipment hookup as described in part a of step 12.

b. Set the TSG21 U and V COLOR BARS pushbuttons to ON, and the Y pushbutton to OFF. Display the positive peak start of the magenta bar.

c. CHECK - risetime of the magenta bar for 400 ns ± 60 ns.

17. Check Subcarrier Phase

a. Connect the 1412 rear-panel Subcarrier output J20 signal to the 522A Vectorscope Ext CW Ø Ref input connector, and terminate in 75 ohms.

Connect the other 1412 rear-panel Subcarrier output J21 signal through a 10X attenuator and 75 ohm cable (in that order) to the vectorscope CH A input connector. Terminate the other CH A loop-through connector in 75 ohms.

b. Set the SPG22 to the Internal mode of operation

c. Set the 522A vectorscope controls as follows:

Ch A, Full Field, AØ, and Vector PAL buttons pressed in. CH A Gain control set to Cal, and Ø Ref switch set to Ext. Rotate the CH A Phase control to position the vector at 180°. (See Fig. 2-9)

NOTE

Do not move the 522A Vectorscope CH A Phase control until completing this step.

DESCRIPTION

17. Check Subcarrier Phase (cont.)

d. Disconnect the 75 ohm cable where it attaches to the 10X attenuator that is connected to the 1412 Subcarrier J21 connector. Connect this same cable to the TSG21 rear-panel output connector, so that this signal is applied to CH A of the vectorscope.

e. CHECK - that the burst vectors are at 135° and 225° (see Fig. 2-9).

18. Check Return Loss

a. Set up the Return Loss Bridge, sine wave generator, and differential amplifier plug-in unit to measure return loss of the TSG21. (The Instruction Manual provided with the Return Loss Bridge gives detailed instructions on the proper procedure.)

b. Set the sine wave generator for 500 mV output amplitude, and vary the frequency from 50 kHz to 5 MHz.

c. CHECK - the returned amplitude for 16 mV or less (return loss is 30 dB or greater to 5 MHz).

TEK SUPPLEMENTAL MANUAL

Part No. 070-4910-00
Product Group 20

TSG21
PAL-M COLOUR BAR GENERATOR MODULE
SUPPLEMENTAL MANUAL

Please Check for
CHANGE INFORMATION
at the Rear of This Manual

First Printing SEP 1983

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PART I—OPERATOR'S INFORMATION

Introduction

The TSG21 for 1412 Option AB is a modified TSG21 PAL-M Color Bars Generator Module. It is specially calibrated so that the 75% amplitude bars (0.0% setup) have chrominance amplitude specifications that far exceed those of the standard TSG21 module. Consequently, this manual supplement is concerned with providing revised specification and calibration information.

Unless specifically modified or replaced by material supplied in this manual, material in the original TSG21 Instruction Manual applies to the TSG21 for 1412 Option AB.

NOTE

Table 1 outlines the new electrical specifications which supersede corresponding specifications in Table 2-1 in the original TSG21 Instruction Manual.

Table 1
Revised Electrical Specifications

Characteristic	Performance Requirement				Supplemental Information	Perf. Ck. Step No.
Chrominance Component Accuracy						
Absolute Amplitudes	Within 0.7% for 75% amplitude with ~~7.5%~~ 0.0% setup. All other bar amplitudes within 3% (all subcarrier components).					
Relative Amplitudes	Within 0.5% for 75% amplitude with 0.0% setup. All other bar amplitudes within 1% (all subcarrier components).					
Bar Amplitudes (75/0)	**Lum mV**	**Chrom mV (p-p)**	**R-Y mV (p-p)**	**B-Y mV (p-p)**		
White	700.0	0.5 or less	0	0		
Black	0.0	0.5 or less	0	0		
Chrominance Quadrature Error	0.1° or less.					13

PERFORMANCE CHECK

The TSG21 for 1412 Option AB has very precisely calibrated 75/0 color bar chrominance amplitudes. Because of the precise nature of these calibrated amplitudes, and because the procedure involves internal connections which can be hazardous to non-qualified personnel, this portion of the Performance Check should be performed by qualified service personnel only.

The original performance check steps 12 and 13 can be applied to check for extreme errors in the TSG21 for 1412 Option AB 75/0 chrominance amplitudes (to the specifications of the standard TSG21 75/0 chrominance amplitude tolerances). This procedure cannot be extended to provide the accuracy and precision needed to verify the Option AB specifications. This requires the Calibration Procedure steps 14 and 15 provided in Part II of this supplement.

The superceded Performance Check steps from the original TSG21 Instruction Manual are listed in Table 2, along with the superceding Calibration Procedure steps in this supplement. To use the Calibration Procedure steps as Performance Check steps, ignore the instructions to make adjustments during the procedure.

Table 2
Short Form Performance Check Procedure

ORIGINAL PERF. CK. STEP	OPT. AB CAL. PROC. STEP	PARAMETER	OPTION AB REQUIREMENT
12[a]	15[b]	75/0 Total Chrominance Amplitudes	0.7% Total, 0.5% Relative
		Blue, Yellow	470.5 mV ±3.29 mV
		Red, Cyan	663.8 mV ±4.65 mV
		Green, Magenta	620.1 mV ±4.34 mV
		White, Black	0.5 mV or less
13[a]	14[b]	75/0 V and U Chrominance Amplitudes	0.7% Total, 0.5% Relative
		V	
		Red	154.8 mV ±1.08 mV
		Green	303.8 mV ±2.13 mV
		White	0.5 mV or less
		Blue	458.6 mV ±3.21 mV
		Yellow	458.6 mV ±3.21 mV
		Magenta	303.8 mV ±2.13 mV
		Cyan	154.8 mV ±1.08 mV
		U	
		Blue	105.0 mV ±0.73 mV
		Green	540.5 mV ±3.78 mV
		White	0.5 mV or less
		Red	645.5 mV ±4.51 mV
		Cyan	645.5 mV ±4.51 mV
		Magenta	540.5 mV ±3.78 mV
		Yellow	105.0 mV ±0.73 mV

[a] In original TSG21 Instruction Manual.

[b] In Part II, Service Information, of this supplement.

PART II—SERVICE INFORMATION

WARNING

The following servicing instructions, to the end of this supplement, are for use by qualified personnel only. Do not perform any servicing other than that contained in operating instructions unless you are qualified to do so. Refer to the Operators Safety Summary and Service Safety Summary (in the original TSG21 Instruction Manual) prior to performing any service.

ADDITIONAL TEST EQUIPMENT FOR CALIBRATION PROCEDURE

The test equipment listed here is in addition to the list of test equipment specified in "TEST EQUIPMENT", beginning on page 4-1 of the original TSG21 Instruction Manual.

As noted in the original manual, the capabilities of the test equipment described in the test equipment lists are the minimum required to check the instrument to specification. If alternative equipment is used, it must meet or exceed the listed requirements.

17. Peak-to-Peak Detector.

Amplifier, 015-0408-00; with Detector Head, 015-0413-00.

18. Fluke 5200A (or 5101B) AC Calibration Standard.

Standard or equivalent (HP745A).

19. DM501A or equivalent.

20. 75 Ω 1/4% Resistor.

Tektronix Part No. 321-0085-03.

21. Locally constructed BCD color bar selection box.

(see Fig. 1 for schematic and part numbers)

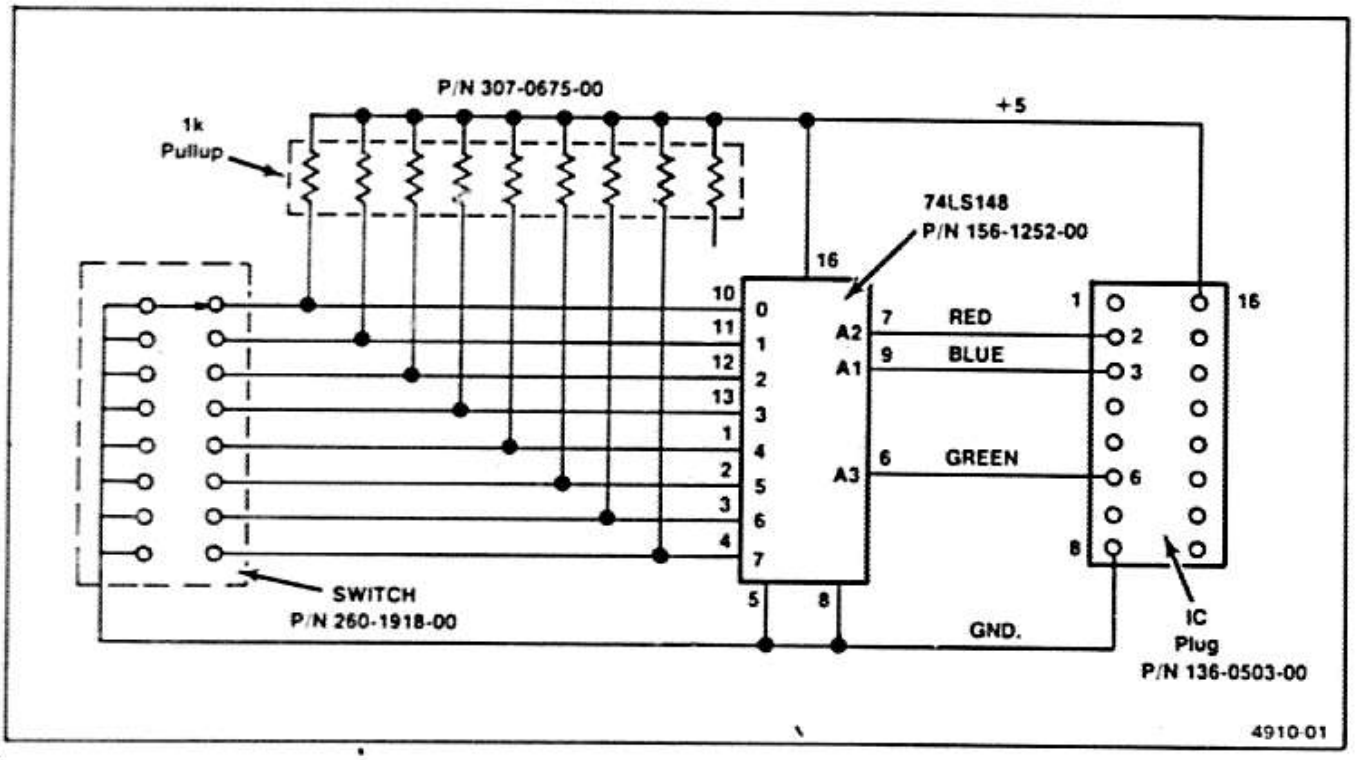

Fig. 1. Schematic Diagram For BCD Switch Box.

CALIBRATION PROCEDURE

The following procedure replaces Calibration Procedure steps 14 and 15 beginning on page 4-10 of the original TSG21 Instruction Manual. These procedures must be performed in sequence with the rest of the Calibration Procedure for proper calibration of the TSG21 module.

14. Adjust 75/0 U and V Chrominance Amplitudes

a. Remove the Color Bar Logic board (A32-2) from the TSG21. Use a jumper wire to tie pin 4 of U184 to ground. Lift pin 10 of U124 from the IC socket. Remove U196 and replace with the plug from the BCD switch box. Replace the Color Bar Logic board.

b. Set the TSG21 front-panel controls as follows:

Y — OFF
U — OFF
V — ON
BURST — OFF
SYNC — OFF
PHASE — 90°
WHITE REF — X
DISPLAY — FULL FIELD
SET UP — 5-%
AMP. — 75%

c. Set the Fluke 5200A controls as follows:

Voltage Error — Off
Vernier — 0
Sense — Ext
Control — Local
Mode — Oper
Freq. — 99.99 kHz
Voltage — See Table 3

d. Connect Fluke 5200A with 75 Ω series resistor as shown in Fig. 2.

e. Set the output voltage of the Fluke 5200A to appropriate p-p voltage level of either Red, Green, or Blue bar (see Table 3).

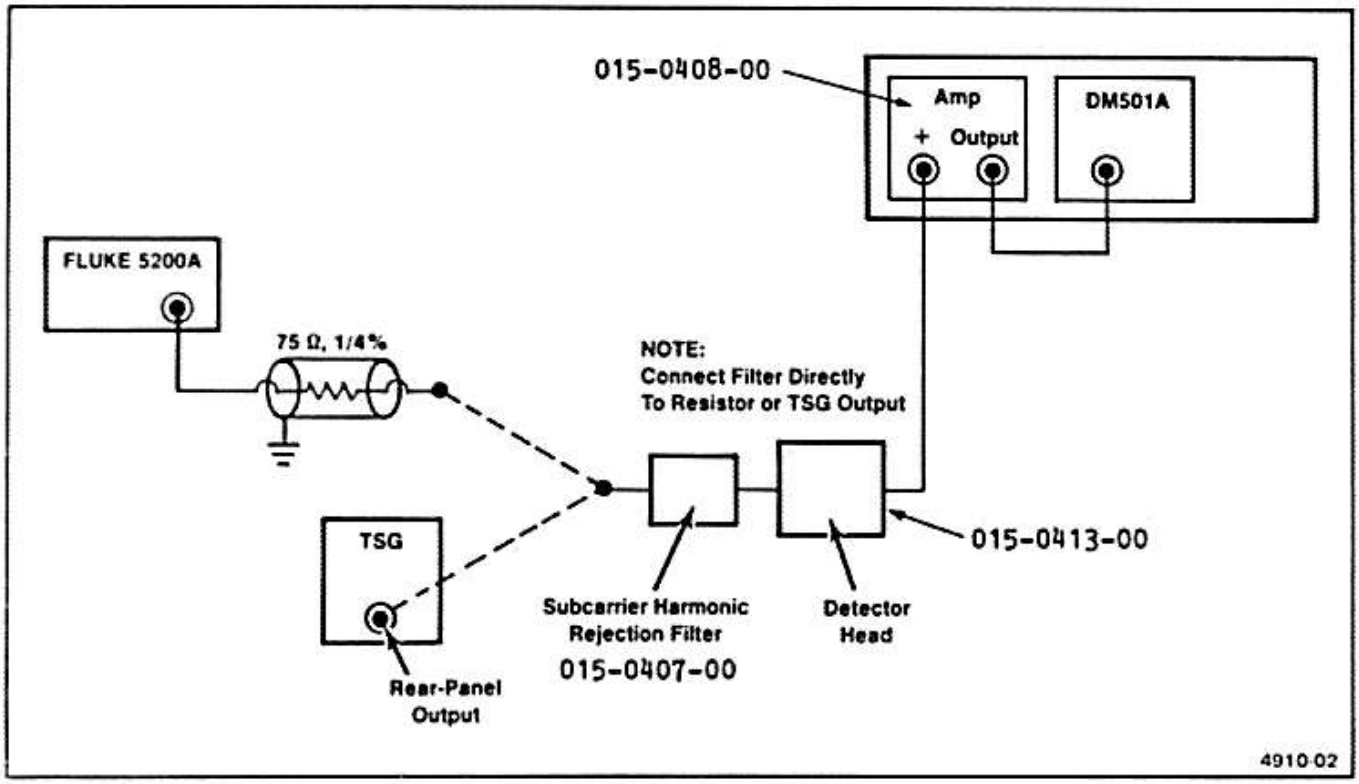

Fig. 2. Equipment Connection For Chrominance Amplitude Measurement.

Table 3
Output Voltage From Fluke 5200A

Bar	V Vrms (mV)	U Vrms (mV)	CHROMA Vrms (mV
Yellow, Blue	69.9[a]	306.25	312.7
Cyan, Red	433.4	103.45	445.5
Green, Magenta	363.4	202.8	416.1

[a]The output from the Fluke 5200A will not be the voltage indicated by its front panel setting in this range. Use the DM501A (Ac setting) to measure and set the output from the 5200A (this is only necessary for the 100 mV range of the 5200A).

f. Adjust the level control on the peak-to-peak detector amplifier to zero the DVM within +100 mV and note the reading on the amplifier.

g. Move the filter and detector head to the output of the TSG21 (see Fig. 2). Do not readjust the p-p detector level control. Set the BCD switch to the appropriate bar (Red, Green, or Blue).

h. CHECK/ADJUST—V chrominance amplitudes (adjust with R258 Red, R268 Green or R259 Blue) so the DVM reading is the same as the reading noted in step f within the voltage range listed in Table 4. Repeat steps g and h until adjustments on Red, Green, and Blue have been completed.

Table 4
Permissible Voltage Change At P-P Detector

BAR	V Vrms (mV)	U Vrms (mV)	CHROMA Vrms (mV)
Yellow, Blue	±0.7	+3.01, −2.6	±3.1
Cyan, Red	+4.3, −3.7	±1.0	±4.4
Green, Magenta	+3.6, −3.1	±2.0	±4.1

i. CHECK—for less than 0.5 mV subcarrier on the white bar (See Fig. 3 for equipment connection diagram, oscilloscope at 1 mV, full bandwidth). If subcarrier amplitude on the white bar is greater than 0.5 mV, recheck equipment and connections and all V chrominance amplitudes (small adjustments of these amplitudes will affect the residual subcarrier amplitude on the white bar).

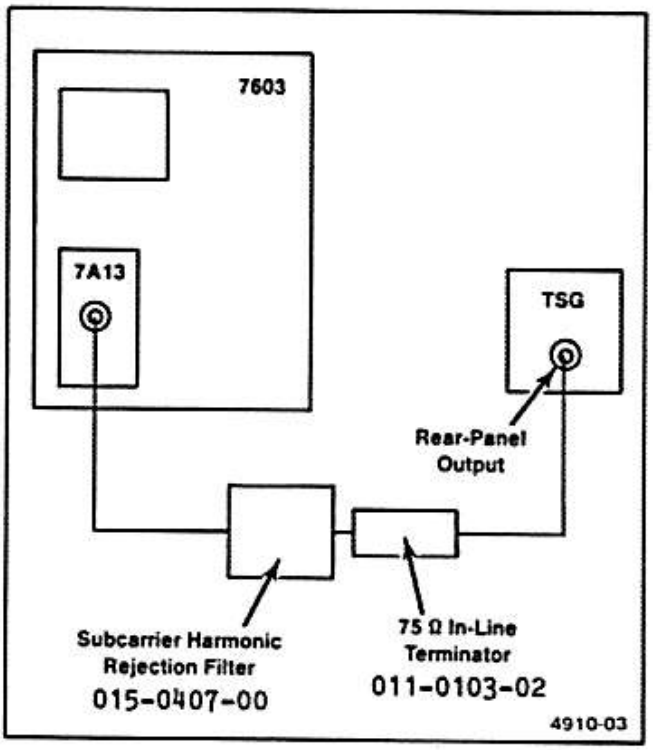

Fig. 3. Equipment Connection For Residual Chrominance Measurement.

j. CHECK—all V chrominance amplitudes by comparing with the output of the Fluke 5200A and referring to the values in Table 4 (use same procedure as in making V chrominance adjustments).

k. Connect the TSG21 output to the Filter, P-P Detector Head and to the Detector Amplifier (see Fig. 1). Select the Red bar with the BCD switch box.

l. Zero the DVM within +100 mV by adjusting the level control on the Detector Amplifier (do not adjust the Fluke 5200A Tolerance Control). Note the DVM reading.

m. Move the filter, P-P Detector and cable to the output of the Fluke 5200A (see Fig. 1). Set the output voltage for the Red U bar (see Table 4).

n. Use the Tolerance Control on the Fluke 5200A to match the DVM reading noted in step l.

o. Check V chroma amplitudes by noting the reading from the Fluke 5200A and comparing it with the output of the TSG21 using the P-P Detector system. See Table 4 and Table 5.

Table 5
Voltage Difference From P-P Detector, Relative To Red

BAR	V Vrms (mV)	U Vrms (mV)	CHROMA Vrms (mV)
Yellow, Blue	±0.5	±2.2	±2.2
Cyan, Red	±3.1	±0.7	±3.2
Green, Magenta	±2.6	±1.4	±2.9

p. Press in the TSG21 V push button and release the U push button. Set the Tolerance Control on the Fluke 5200A to 0%.

q. Adjust U amplitude as indicated in Tables 3 and 4 using the procedure described in steps d through h (R248 Red, R238 Green, R228 Blue).

r. Check for no subcarrier on the white bar using the procedure of step i.

s. Check all U chrominance amplitudes comparing the Fluke 5200A and the TSG21 outputs with the P-P Detector system and referring to Tables 3 and 4 for levels and tolerances.

t. Repeat steps k through o for the U relative to red chroma amplitudes.

15. Check 75/0 Chrominance Amplitudes

a. Release the V push button.

b. Using the P-P Detector system, check the chroma amplitudes by comparing the Fluke 5200A and TSG21 outputs referring to values and tolerances in Tables 3 and 4.

MANUAL CHANGE INFORMATION

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

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

A single change may affect several sections. Since the change information sheets are carried in the manual until all changes are permanently entered, some duplication may occur. If no such change pages appear following this page, your manual is correct as printed.

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MANUAL CHANGE INFORMATION

Date: 9-16-83 Change Reference: C1/983

Product: 1412 Opt. AB Manual Part No.: 070-4910-00

DESCRIPTION

TEXT CHANGE

Page 1, Table 1, "Component Accuracy, Absolute Amplitudes" row, "Performance Requirement" column.

TEXT SHOULD READ:

Within 0.7% for 75% amplitude with 0.0% setup. All other bar amplitudes within 3% (all subcarrier components).