TEK Instruction Manual

Part No. 070-3782-00
Product Group 20

TSG7
SMPTE COLOR BARS GENERATOR MODULE

Please Check for CHANGE INFORMATION at the Rear of This Manual

First Printing JUN 1981
Revised JUL 1987

Tektronix
COMMITTED TO EXCELLENCE

Printed in U.S.A. Specification and price change privileges are reserved.

TABLE OF CONTENTS

PREFACE

This manual is divided into two parts for safety purposes. Part I should be used by both operating and service personnel. The Safety Summary should be reviewed before operating or servicing the instrument. Part II contains service instructions that can lead to exposure of personnel to hazardous voltages. The service instructions are intended for use by qualified service personnel only.

PART I
OPERATORS INFORMATION

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

TABLE OF CONTENTS (cont)

LIST OF ILLUSTRATIONS

NOTE

The following illustrations are located in the foldout section at the rear of this manual.

LIST OF TABLES

OPERATORS SAFETY SUMMARY

The general safety information in this part of the summary is for both operating and servicing personnel. Specific warnings and cautions will be found throughout the manual where they apply, 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.

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.

SYMBOLS

In This Manual

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

As Marked on Equipment

DANGER — High voltage.

Protective ground (earth) terminal.

ATTENTION — refer to manual.

Grounding the Product

This product is grounded through the grounding conductor of the 1410 mainframe power cord. To avoid electrical shock, plug the power cord into a properly wired receptacle before connecting to the product input or output terminals. A protective ground connection by way of the grounding conductor in the power module power cord is essential for safe operation.

Danger Arising From Loss of Ground

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

Do Not Operate in Explosive Atmospheres

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

Do Not Remove Covers or Panels

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

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.

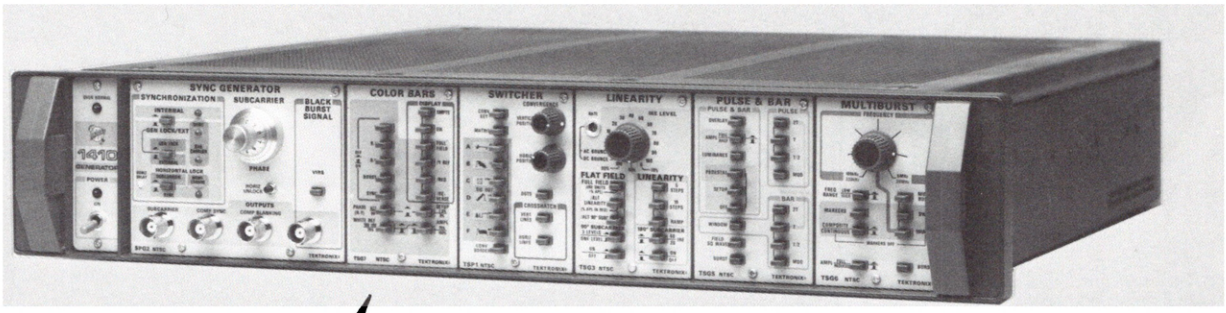
Use Care When Servicing With Power On

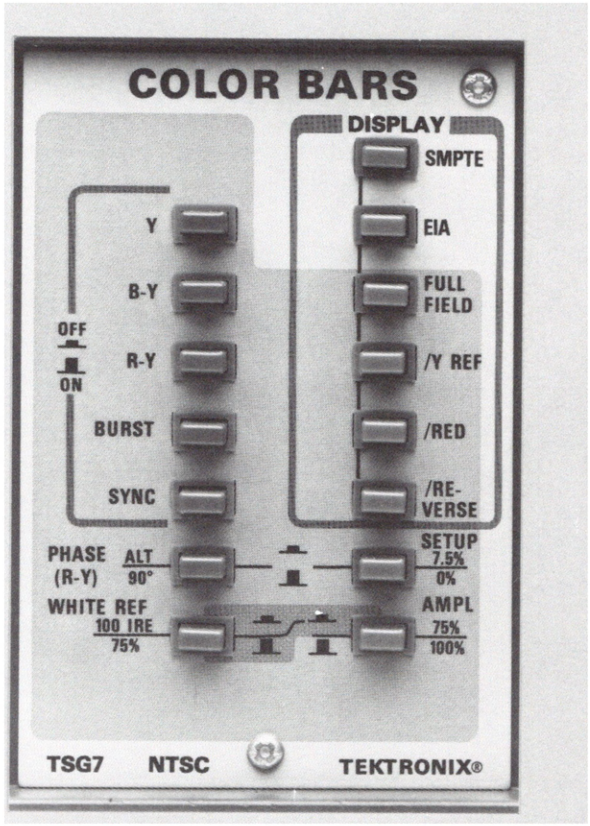
Dangerous voltages may exist at several points in this product. To avoid personal injury, do not touch exposed connections and components while power is on.

Disconect power from the 1410 mainframe before removing protective panels, soldering, or replacing components.

Power Source

This unit receives operating voltages from the power supply in the 1410 mainframe. The grounding conductor in the 1410 power cord provides protective ground connection and is essential for safe operation.





3782-00

TSG7 SMPTE Color Bars Generator.

PART I
OPERATORS INFORMATION

OPERATING INSTRUCTIONS

DESCRIPTION

The TSG7 is the SMPTE Color Bars Generator for the 1410 NTSC Generator. It provides SMPTE (Society of Motion Picture and Television Engineers), EIA (Electronics Industries Association), and an alterable full field color bars signal. The TSG7 is designed to work with any of the NTSC series of SPG (Sync Pulse Generator) modules. The completed generator may consist of as many as six TSG (Test Signal Generator) modules and one SPG module.

The TSG7 provides composite full field and split field color bars signals. Two of the split field color bars signals are of a fixed format: the SMPTE and EIA signals. The SMPTE signal is made up of seven color bars and −I,W,Q,B of the EIA signals plus Chroma Set and Black Set signals. (Signals are covered in specific detail later in this section.)

The remaining split field signals and the full field color bars signals offer a number of selectable features. The split field may include reverse color bars, red reference, or a luminance reference. In all signals, except SMPTE and EIA, the 100% saturated color bars are available in either 75% or 100% amplitudes with either 0% or 7.5% setup levels. A white reference of either 75 or 100 IRE may also be selected.

Other split field combinations may also be programmed by altering certain internal jumpers. Any internal reconfiguring should only be undertaken by qualified service personnel.

Display

There are six possible color bars displays, of which four allow the operator to modify the basic display. Only the SMPTE and EIA color bars signals are of fixed format and cannot have one or more parameters altered by other TSG7 front-panel function switches. A particular signal is selected by pressing one of the DISPLAY push button switches.

The following description of front-panel switch functions is designed to be used with Fig. 1-1.

(1) SMPTE

The SMPTE color bars signal consists of four signal elements. The first two-thirds of the field contains the seven-bar standard color bars signal (identical to the EIA color bars), the next one-twelfth of the field contains the Chroma Set signal (Reverse Blue Bars), the final one-fourth of the field contains a signal that combines the standard −I,W,Q,B signal with a Black Set signal. The selection of SMPTE signal disables all other TSG7 front-panel switching. The SMPTE signal is discussed in greater detail later in this section.

(2) EIA

The EIA color bars signal consists of two signal elements. The first three-fourths of the field contains the seven-bar color bars signal, the remainder of the field contains the −I,W,Q,B signal with a Black Set signal. The selection of EIA signal disables all other TSG7 front-panel switching. The EIA signal is discussed in greater detail later in this section.

(3) FULL FIELD

The FULL FIELD color bars, unless internally altered, consist of a sequence of gray, yellow, cyan, green, magenta, red, blue, and black vertical color stripes. The FULL FIELD signal may be altered by selecting signal parameters with other front-panel push button switches. Note that if no DISPLAY push buttons are pressed, the full field bars will be displayed and the other front-panel push buttons will be active.

(4) /Y REF

This signal consists of a split field that presents the eight color bars in the upper part of the display and a gray scale in the lower part. The display can be divided either 75/25 or 50/50; the field division is dependent on the setting of an internal plug jumper.

(5) /RED

The upper portion of this signal is the eight color bars signal, while the lower portion is red chrominance and luminance that is identical to the red color bar. The display can be divided either 75/25 or 50/50; the field division is dependent on the setting of an internal plug jumper.

(6) /REVERSE

This signal has the eight color bars in the upper portion of the display and a reverse sequence of color bars in the lower portion. This signal is either 75/25 or 50/50 depending on the position of an internal jumper.

NOTE

There is another position to the internal signal division jumper, that allows a full-field Y, RED, or Reverse Color Bars signal when /Y REF, /RED, or /REVERSE is selected.

Amplitude and Phase References

(7) SETUP

Selects the black reference level, either 7.5% (IRE) above the blanking level, or 0% (blanking level).

(8) AMPL

Selects either 100%, or 75% amplitude color bars. The WHITE REF is active in the 75% position only.

(9) WHITE REF

Selects a 100 IRE white reference when 75% amplitude color bars are used. If the push button switch is in the out position, the white reference will be 75 IRE (75%) with 0% setup, and 77 IRE with 7.5% setup.

(10) PHASE (R−Y)

When selected, the phase of the R−Y chrominance signal is alternated between 90° and 270° at line or field rate. Selection of rate is controlled by the location of a resistor on the Color Bars Output Circuit Board (A31).

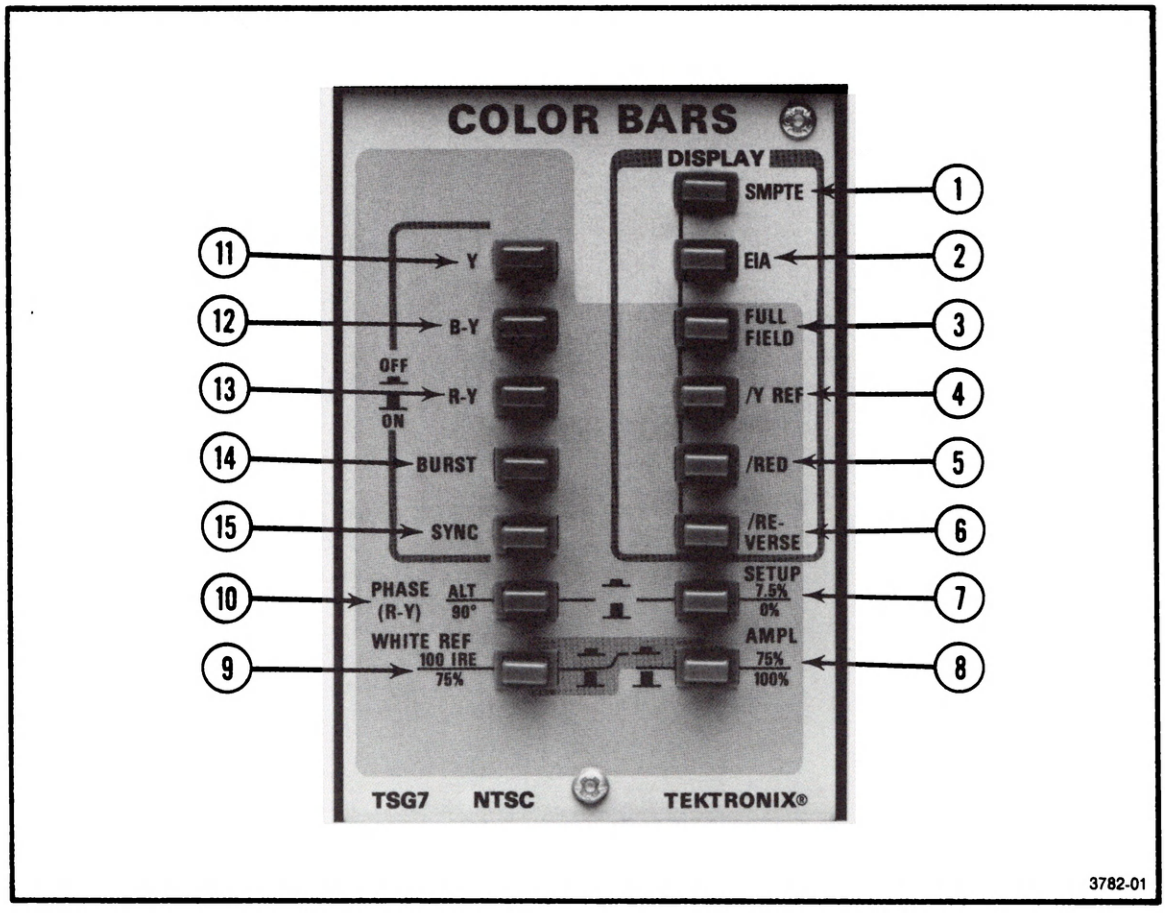


Fig. 1-1. TSG7 front-panel controls.

Signal Modification

It is possible to delete certain elements of the full or split field signals, such as burst or sync, by depressing one or more of the following push button switches.

(11) Y (luminance)

Removes the luminance portion of the composite signal.

(12) B−Y (0°/180° chrominance)

Removes the B−Y component of the chrominance signal.

(13) R−Y (90°/270° chrominance)

Removes the R−Y component of the chrominance signal.

(14) BURST

Removes the color burst from the composite output signal.

(15) SYNC

Removes the composite sync signal from the composite output signal.

TEST SIGNAL INFORMATION

The TSG7 test signals and general applications are described in the following paragraphs. Table 1-1 lists the color bars signals available with various settings of front-panel push buttons.

SMPTE and EIA Color Bars Signals

The TSG7 has two color bars of similar makeup. Because it has been in use for a period of time, the EIA Color Bars signal is readily recognizeable and the SMPTE Color Bars signal will be compared to it.

EIA Standard Color Bars Signal

This signal complies with RETMA ENGINEERING COMMITTEE TR-4 on Television Transmitters, "EIA Standard for Encoded Color Bar Signals": RS-189, page 3; Revised RS-189, pages 14538 (3a-4:5/66 and 4a-4:5/66). It is used for adjustment of color monitors and encoders and for making rapid checks of color television transmission systems.

The standard EIA signal consists of two major parts. The first three-fourths of the active scanning lines in each field are divided into seven equal intervals, arranged in descending order of luminance amplitudes as follows: gray, yellow, cyan, green, magenta, red, and blue; see Fig. 1-2. These correspond to saturated colors transmitted at 75% of full amplitude. The remainder of the active scanning lines in each field are used for the transmission of special test information, consisting of a subcarrier signal envelope with a phase corresponding to −I, a reference white pulse, a subcarrier signal envelope with a phase corresponding to +Q, and a reference black interval.

SMPTE Color Bars Signal

There are four basic components to the SMPTE Color Bars Signal, they consist of the seven-bar color bars signal, the −I, white, Q, black signal, a Chroma Set signal, and a Black Set signal. The signal complies with SMPTE Engineering Committee Recommendation ECR 1-1978, "Alignment Color Bar Test Signal for Television Picture Monitors"; whose intent is to standardize the adjustment of chroma gain, chroma phase, and black level monitor controls.

Table 1-1
SELECTING COLOR BARS TEST SIGNALS

Test Signal	White Ref	Ampl	Setup
SMPTE Color Bars	NO EFFECT (77 IRE)	NO EFFECT (75%)	NO EFFECT (75%)
EIA COLOR BARS	NO EFFECT (77 IRE)	NO EFFECT (75%)	NO EFFECT (7.5%)
FULL FIELD COLOR BARS			
75% AMPL, 7.5% SETUP	IN (100 IRE) or OUT (77 IRE)	IN	IN
75% AMPL, 0% SETUP	IN (100 IRE) or OUT (77 IRE)	IN	OUT
100% AMPL, 7.5% SETUP	NO EFFECT (100 IRE)	OUT	IN
100% AMPL, 0% SETUP	NO EFFECT (100 IRE)	OUT	OUT

The SMPTE Color Bars signal, shown in Fig. 1-3, consists of 67% of the field with seven-bar color bars, 8% with the new Chroma Set signal, and the remaining 25% with the combination of the −I, white, Q, black, and the Black Set signal. The seven-bar color bars signal is identical to the one used for the EIA signal, except for the percentage of the field it occupies.

The Chroma Set signal is made up of the color bars, that contain blue, in reverse order. The color bars signal contains blue in every other bar (Blue, Magenta, Cyan, and White). The Color Set signal consists of four color bars, physically separated by black bars. These color bars, that all contain blue, are placed beneath the EIA color bars, that also contain blue, but in reverse order; blue beneath white, magenta beneath cyan, and vise versa. To maintain timing, the color set signal bars are separated by black bars of equal duration.

The −I,W,Q,B signal, used in the SMPTE Color Bars signal, contains a Black Set signal. Its location and duration are identical to those of the red color bar. The signal itself is made up of three black amplitudes, 3.5 IRE, 7.5 IRE, and 11.5 IRE. This provides levels that are 4 IRE above and below the setup level, making it possible to compare small differences in the black level.

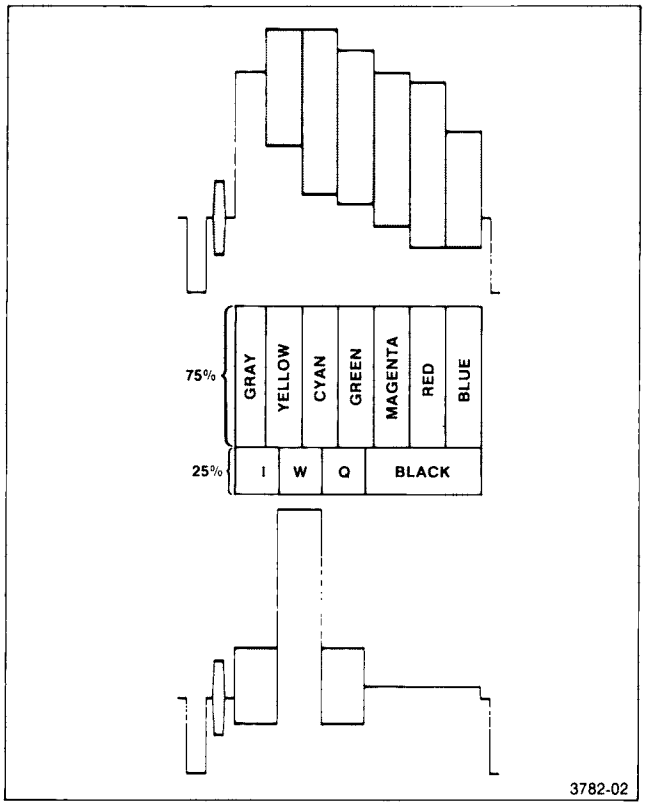


Fig. 1-2. EIA Color Bars Signal.

Figure 1-4 shows the SMPTE color bars signal as seen on a waveform monitor, triggered at horizontal rate. Vector relationships of the various burst and chrominance components are shown in Fig. 1-5. Refer to Specification in Section 2 of this manual for additional details on signal characteristics.

The color bars signal is used for making phase and gain adjustments in color monitors, or for verifying overall accuracy of the decoding function. An experienced operator can learn to judge the accuracy of monitor adjustments by direct observation of the color bar pattern. For more objective measurements, the waveforms resulting from the decoding of the color bars signal can be used. For example, the phase

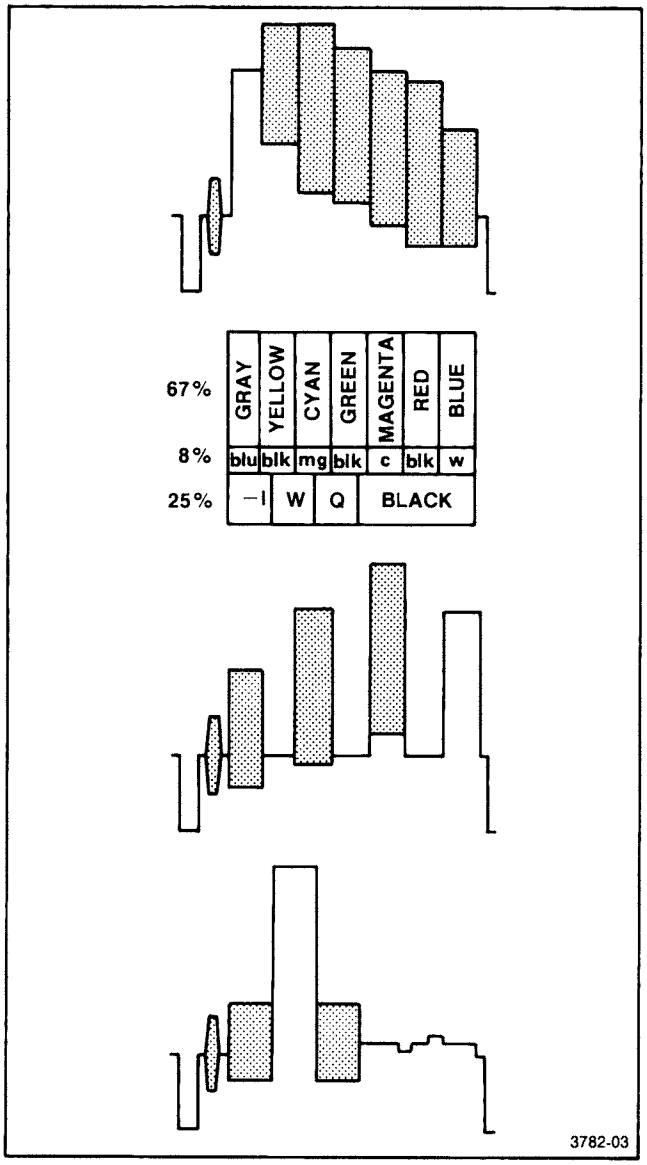


Fig. 1-3. SMPTE Color Bars Signal.

and gain adjustments may be checked by observing the waveforms at appropriate points. The luminance component of the color bars signal provides a convenient gray-scale display for setting color balance and tracking on color monitors.

The accuracy of matrix and phase adjustments in encoders may be readily checked by comparison of the color bars signal with the output of such a device when the signal is applied to the encoder inputs.

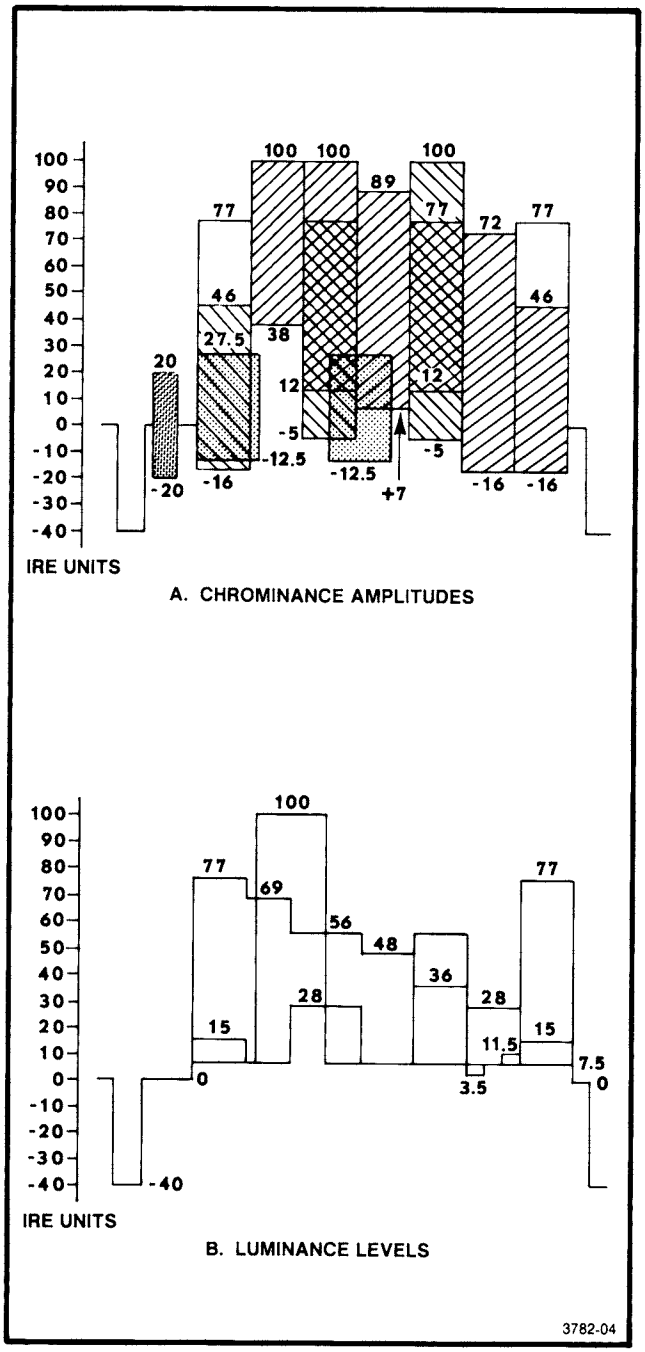
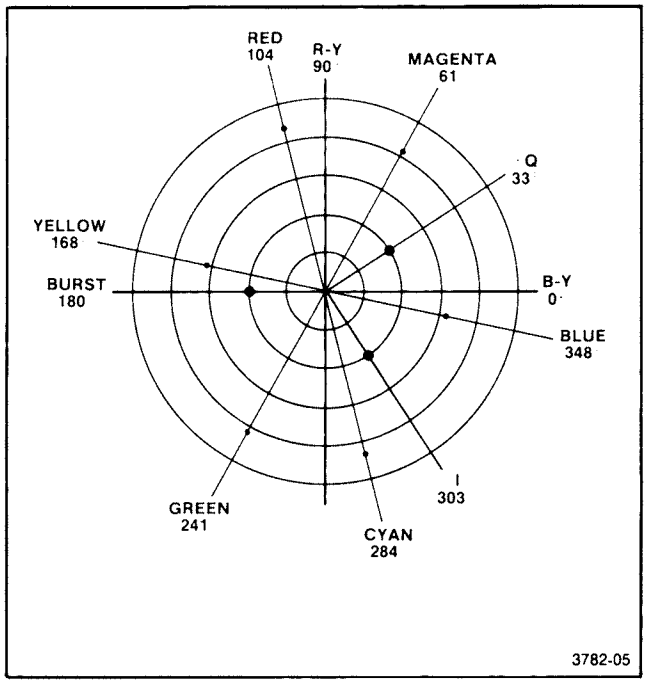


Fig. 1-4. Fieldtime waveform monitor displays of the SMPTE signal; a. chrominance amplitudes, b. luminance levels.

The signal embodies several convenient references and relationships that facilitate its use. The relative amplitudes of all signal components can be checked by direct observation of the complete waveform on a television waveform monitor. A waveform monitor display should exhibit the following relationships (see Fig. 1-6).

a. The positive peak levels of the yellow and cyan bars are nominally equal to reference white level.

b. The negative peak level of the green bar is nominally equal to reference black level, when 7.5% setup is used.



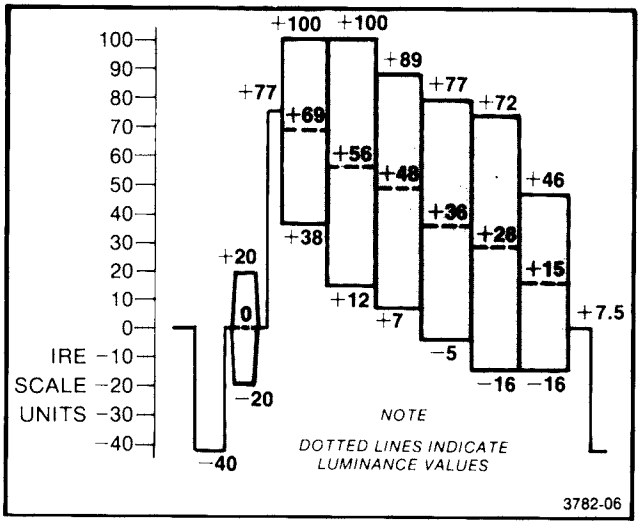


Fig. 1-6. Reference levels for a 75% amplitude, 7.5% setup color bar signal.

c. The negative peak levels of the red and blue bars are nominally equal.

The relative phases and amplitudes of the chrominance portion of the signal are generally checked by observation on a vectorscope (see Fig. 1-5). The quadrature phase relationship between the I and Q components of the encoded signal can be conveniently checked by observation of the −I and Q signal axes.

Observation of the color bars signal waveform at the output of a transmission system can yield a number of clues with respect to the quality of the transmission system. The color bars signal is useful for checking transmission levels, relative high-frequency response, and the presence of differential gain and differential phase.

The Chroma Set and Black Set signals are used to set the Chroma, Hue, and Brightness controls of a picture monitor. The Chroma and Hue controls are set by comparing the blue chrominance from the color bars to the blue chrominance of the reverse color bars. The only prior setup to making these adjustments is that the monitor must be in a blue-only operating mode. This is done by turning off the red and green screens. The actual procedure is as follows:

a. Turn off the picture monitor red and green screens.

b. Compare the extreme left or right blue bar with the reversed color bars segment directly below it. Adjust the monitor Chroma control until there is no color difference (See Fig. 1-7).

c. Next, compare either of the center blue bars to the reverse color bars segment directly below it. Adjust the monitor Hue control until there is no color difference (See Fig. 1-7).

d. With all three of the monitor's screens turned on at ambient viewing conditions, adjust the Brightness control until the gray 11.5 IRE part of the Black Set signal is just visible, but the difference between the blacker than black (3.5 IRE) and the black (7.5 IRE) segments is not discernable (See Fig. 1-8).

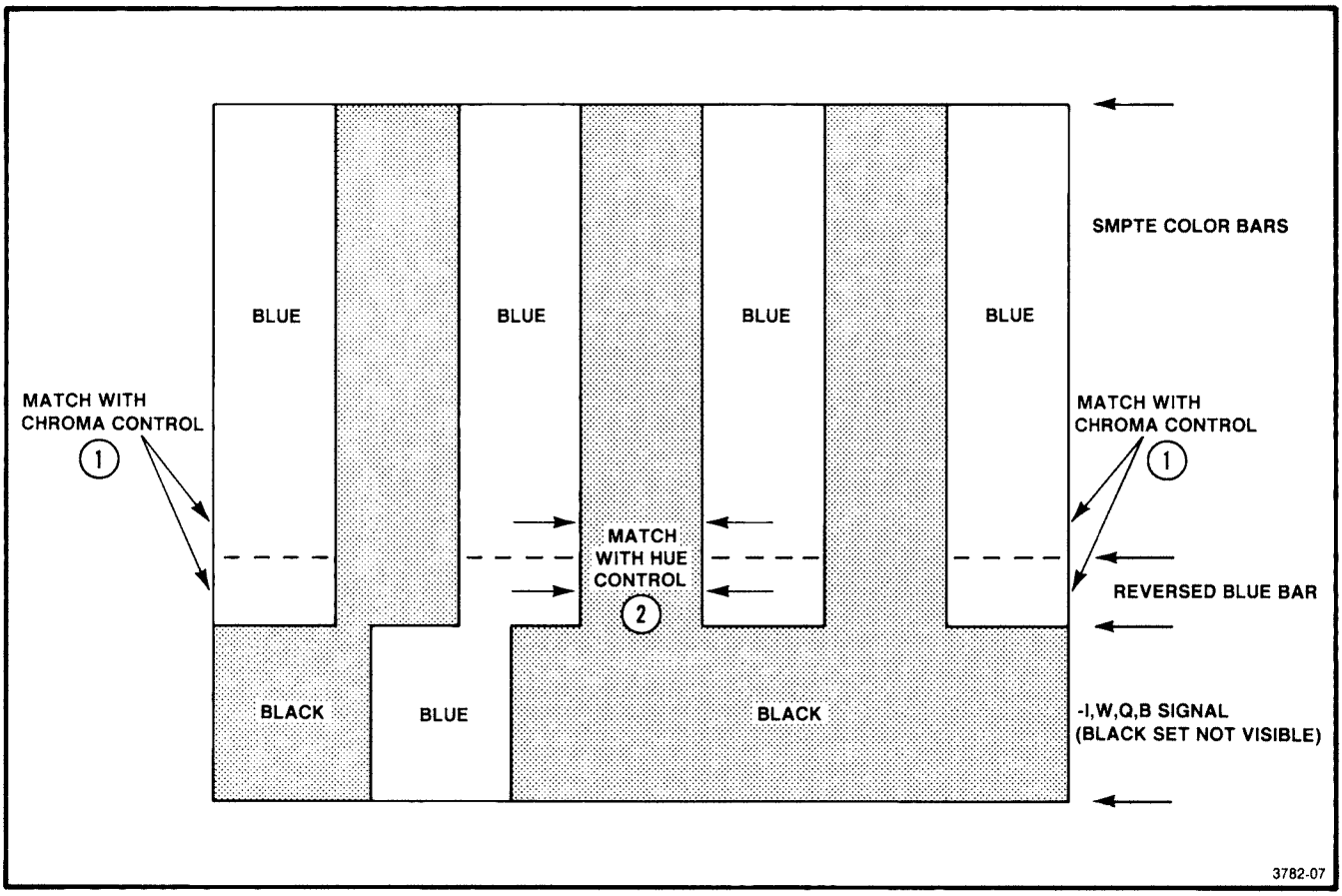


Fig. 1-7. Using SMPTE color bars signal to adjust picture monitor Chroma and Hue controls.

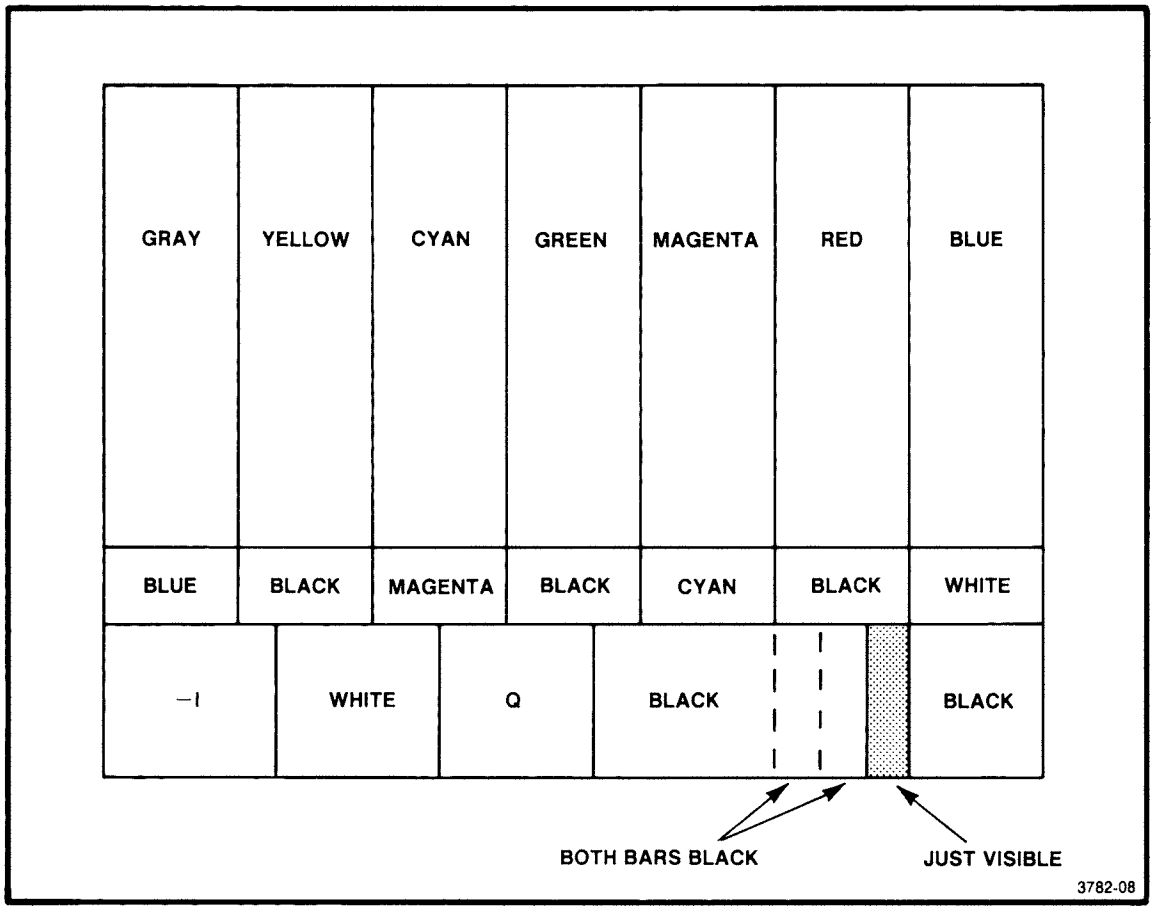


Fig. 1-8. Using the SMPTE Black Set signal to set the picture monitor Brightness control.

Full Field Color Bars Signal

The full field color bars signal consists of eight equal intervals arranged in descending order of luminance amplitudes as follows: gray, yellow, cyan, green, magenta, red, blue, and black (See Fig. 1-9). This signal is normally used for checking luminance, hue, and saturation parameters of the television system.

The paragraphs describing the SMPTE and EIA Standard Color Bars signal, with the exception of the −I,W,Q,B Chroma Set and Black Set, apply to the full field color bars signal as well.

The color bar sequence of the full field color bars signal can be altered for use in various applications.

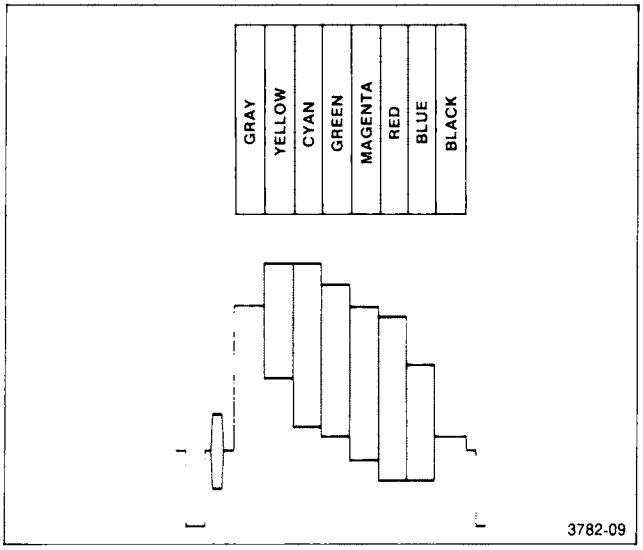


Fig. 1-9. Full Field color bars signal.

Split-Field Y Reference Signal

This signal provides color bars in the first part of the field, and luminance-only gray scale in the second part of the field (see Fig. 1-10). The split-field Y Reference signal is especially useful for checking color balance and tracking of color picture monitors, chrominance-luminance delay, and chrominance-luminance intermodulation.

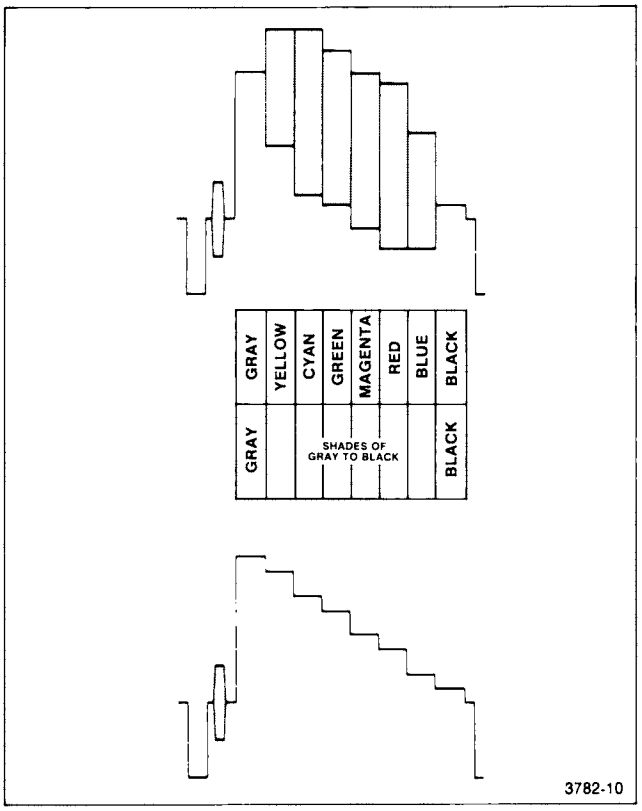


Fig. 1-10. Split field Y Ref signal.

Split-Field Red Signal

This signal includes the color bars in the first part of the field, while the second part contains the red color bar signal only (see Fig. 1-11). Video system noise, VTR head-banding, and red phase are readily seen using the solid red split field signal.

Color of the second part of the field may be changed to any bar color by placement of internal wire jumpers.

It is possible to change the second part of the field to white by pulling module interface pin 56, for the module location, low.This can be done through 1410 rear-panel connector J41. The 1410 Instruction Manual has a table (in System configuration section for serial numbers B010135 and above) to assist in finding the correct J41 pin number.

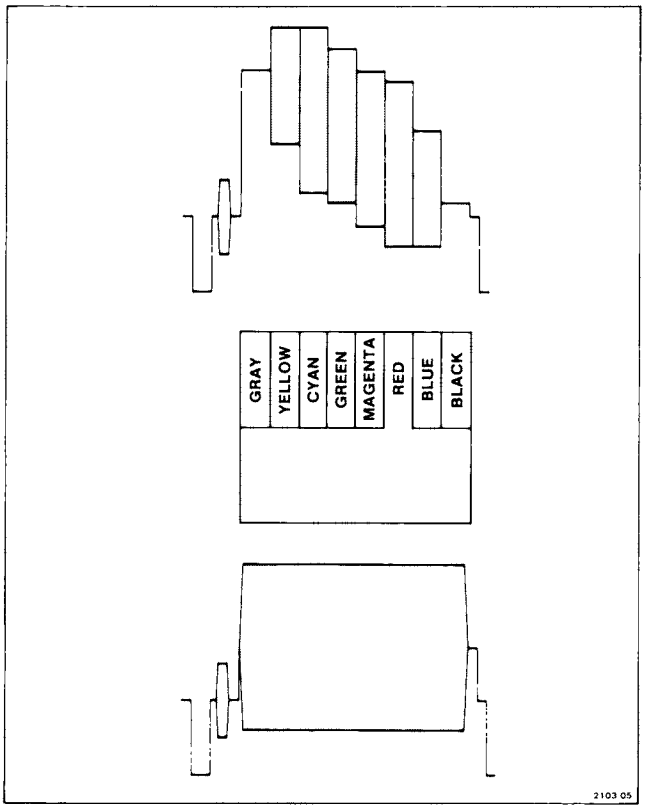


Fig. 1-11. Split field Red signal.

Split-Field Reverse Signal

This signal consists of standard color bars in the top portion of the field, followed by color bars in reverse sequence in the lower portion (see Fig. 1-12). This signal is useful in checking velocity modulation in video tape recorders.

The TSG7 will generate a Vertical Interval Test Signal (VITS) Color Bar on a preselected line. It is normally a 75% Amplitude, 7.5% setup Color Bar; however, in either Full Field or Split Field, several TSG7 front-panel switches will modify the VITS. B−Y, R−Y, and R−Y Phase Alternated directly affect the signal. In the same manner, loss of either Burst or Sync will affect the VITS.

In either SMPTE or EIA signal mode, the front-panel switches are locked-out and therefore cannot affect the VITS.

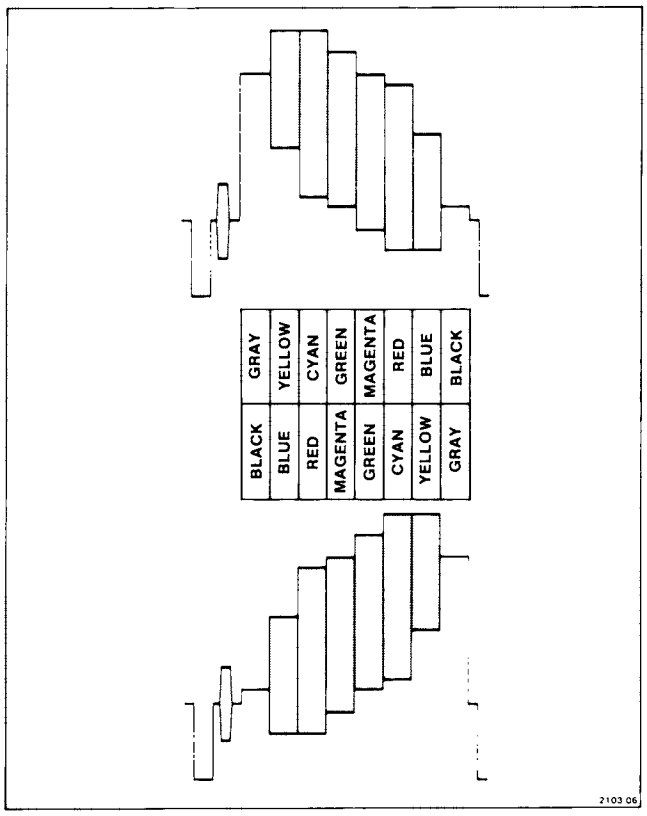


Fig. 1-12. Split field Reverse signal.

SPECIFICATION AND PERFORMANCE CHECK

SPECIFICATION

INTRODUCTION

The following electrical performance requirements 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 between 0°C and +50°C. The instrument must have a warmup period of at least 20 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. (Some items require checking with the protective covers removed from the host 1410. These items are checked in the Calibration Procedure 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 directly verified by checking related Performance Requirement data.

Table 2-1

ELECTRICAL SPECIFICATION

Characteristic	Performance Requirement				Supplemental Information	Perf. Ch. Step No.
Color Bar Signals						
Luminance Component Accuracy	Within 1.5 mV or 1% of level, whichever is greater, measured from blanking level					2, 4
Chrominance Component Accuracy						
Absolute Amplitudes	Within 3% (all subcarrier components)					18
Relative Amplitude	Within 1% or 1 mV plus the p-p residual subcarrier amplitude, whichever is greater,with the red chrominance bar as reference					
Reference Amplitudes	Lum mV	Chrom mV (p-p)	R−Y mV (p-p)	B−Y mV (p-p)		
Blanking Level	0	2.5 or less				1
Sync	−285.7	2.5 or less				2
Burst	0	285.7	0	285.7		20
−I	setup	285.7	239.6	155.6		24
White Ref	714.3	2.5 or less				22

Table 2-1 (cont)

Characteristic	Performance Requirement				Supplemental Information			Perf. Ch. Step No.
Color Bar Signals (cont) Chrominance Component Accuracy (cont) Reference Amplitudes (cont)	Lum mV	Chrom mV (p-p)	R−Y mV (p-p)	B−Y mV (p-p)				
Q	setup	285.7	155.6	239.6				24
Black	setup	2.5 or less						1 & 3
+ Black Set	setup +28.6	2.5 or less						
− Black Set	setup −28.6	2.5 or less						
Bar Amplitudes 75% AMPL, 7.5% SETUP	Lum mV	Chrom mV (p-p)	R−Y mV (p-p)	B−Y mV (p-p)				
White	549.7	2.5 or less	0	0				
Yellow	494.6	444.2	98.9	433.1				
Cyan	400.4	630.1	612.9	146.3				
Green	345.9	588.5	513.9	286.8				
Magenta	256.7	588.5	513.9	286.8				4, 18, 19
Red	202.2	630.1	612.9	146.3				
Blue	108.1	444.2	98.9	433.1				
Black	53.6	2.5 or less	0	0				
Bar Amplitudes 75% AMPL, 0% SETUP	Lum mV				Chrom mV (p-p)	R−Y mV (p-p)	B−Y mV (p-p)	
White	535.7				2.5 or less			
Yellow	476.8				480.2	106.9	468.2	
Cyan	375.0				681.2	662.5	158.1	
Green	316.1				636.2	555.6	310.0	4
Magenta	219.6				636.2	555.6	310.0	
Red	160.7				681.2	662.5	158.1	
Blue	58.9				480.2	106.9	468.2	
Black	0				2.5 or less			

Table 2-1 (cont)

Characteristic	Performance Requirement	Supplemental Information			Perf. Ch. Step No.
Color Bar Signals (cont)					
Bar Amplitudes (cont)					
75% AMPL, 0% SETUP	Lum mV	Chrom mV (p-p)	R−Y mV (p-p)	B−Y mV (p-p)	
White	714.3	2.5 or less			
Yellow	641.6	592.3	131.9	577.4	
Cyan	516.1	840.1	817.1	195.0	
Green	443.4	784.7	685.2	382.4	4
Magenta	324.5	784.7	685.2	382.4	
Red	251.8	840.1	817.1	195.0	
Blue	126.3	592.3	131.9	577.4	
Black	53.6	2.5 or less			
Bar Amplitudes					
100% AMPL, 0% SETUP	Lum mV	Chrom mV (p-p)	R−Y mV (p-p)	B−Y mV (p-p)	
White	714.3	2.5 or less			
Yellow	635.7	640.3	142.6	624.2	
Cyan	500.0	908.2	883.4	210.9	
Green	421.4	848.3	740.8	413.4	4
Magenta	292.9	848.3	740.8	413.4	
Red	214.3	908.2	883.4	210.9	
Blue	78.6	640.3	142.6	624.2	
Black	0	2.5 or less			
Split Field Displays Timing					
SMPTE Color Bars					
Field 1		161 lines			
Field 2		160.5 lines			
Duration	7.5 μs/bar, ±400 ns				5
Reverse Blue Bars					
Field 1		20 lines			
Field 2		20 lines			
Duration	7.5 μs/bar, ±400 ns				5

Table 2-1 (cont)

Characteristic	Performance Requirement	Supplemental Information	Perf. Ch. Step No.
−I,W,Q,B Black Set			
Field 1		60.5 lines	
Field 2		60 lines	
Duration			
−I,W,Q,B	9.4 μs/bar, ±400 ns		6
Black Set	2.5 μs/bar, ±400 ns		7
Black Bar	7.5 μs, ±400 ns		7
EIA Color Bars			
Field 1		181 lines	
Field 2		180.5 lines	
Duration	7.5 μs/bar, ±400 ns		5
−I,W,Q,B			
Field 1		60.5 lines	
Field 2		60 lines	
−I,W,Q Duration	9.4 μs each, ±400 ns		6
B Duration	24.1 μs, ±400 ns		6 & 7
Color Bars/Y Ref, Color Bars/Red, Color Bars/Reverse	Split can be 3/4:1/4 or 1/2:1/2 as selected by a plug-jumper on the logic circuit board. The plug-jumper changes split field timing for all three signals.		
Full Field Displays			
Bar Width	6.6 μs, ±400 ns		9
Color Bar White Bar Rise Time	130 ns, +20 ns, −10 ns		10
−I,Q White Bar Rise Time	250 ns, ±37.5 ns		8
Time Difference between Chrom and Lum Channels	20 ns or less		11
Chrominance			
Rise Time	400 ns, ±60 ns		12
Quadrature Error	0.5° or less		13
R−Y ϕ Switch Error	0.5° or less		14
Residual Subcarrier			
White and Blanking	52 dB below 1 V (±2.5 mV)		16

Table 2-1 (cont)

Characteristic	Performance Requirement	Supplemental Information	Perf. Ch. Step No.
Aberrations	±4% of 1 V		
Spurious Subcarrier	At least 52 dB below 1 V (2.5 mV), except 30 dB (32 mV) during sync, the end of H blanking, and the start of the white bar.	Viewed on 1480-Series Waveform monitor	17
Other Spurious Outputs	At least 52 dB below 1 V (2.5 mV), except 30 dB (32 mV) during sync, the end of H blanking, and the start of the white bar.	Viewed on 1480-Series Waveform monitor	
Composite Video Output			
Amplitude			
Sync	−2.85.7 mV ±2.86 mV		2
Blanking DC Level	0 V ±50 mV		1
Return Loss	At least 30 dB to 5 MHz		26
Isolation			
Passive	Either open or short of one output causes an output level change at the other connector of 1% or less (40 dB) for all components of the signal.		Calibration Procedure
Active (Non-Coherent Crosstalk)	A signal introduced to one output connector is attenuated by at least 40 dB at the other connector for signals between +0.5 and −4.0 volts, at or below color subcarrier frequency (3.579545 MHz).		
Field Period		16.68 ms	Set by SPG
Line Period		63.56 μs	
Timing			
Rise and Fall Time	130 ns +20 ns, −10 ns		10
Front Porch Duration		1.59 μs ±50 ns at 50% point, 1.52 μs at 10% point	Set by SPG
Line Blanking Interval		11.1 μs	
Breezeway		4.75 ns, ±50 ns at 10% point	
Burst			
Rise and Fall Time	400 ns ±60 ns		21
Delay from Line Sync		5.309 μs (19 cycles of subcarrier), ±35 ns	Set by SPG
H.A.D.[a] of Envelope		2.51 μs (9 cycles of subcarrier), ±70 ns	

Table 2-1 (cont)

Characteristic	Performance Requirement	Supplemental Information	Perf. Ch Step No.
Composite Video Output (cont) Burst (cont)			
Amplitude	285.7 mV ±8.57 mV		20
VITS	Available via VITS key (TTL signal applied through the rear-panel REMOTE connector of TSP module). Bar timing identical to Full Field Color Bars	Front panel B−Y, R−Y, and Phase switches will modify VITS in Full or Split Field display.	

[a]H.A.D. = Half Amplitude Duration.

Table 2-2

ENVIRONMENTAL CHARACTERISTICS

Characteristic	Performance Requirement
Temperature	
Storage	−40°C to +65°C
Operating	0°C to +50°C
Altitude	
Storage	To 50,000 feet
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 TSG7 front-panel control names in the text are capitalized; for example, BURST. Control and connector names on test equipment and internal controls in the TSG7 module under test have only the first letter capitalized; for example, test oscilloscope Time/Div., or 1480 Mag control, except when they are used as generic terms.

A short-form procedure is provided to aid in checking calibration of the TSG7. 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 check the instrument to specification. 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. Test Oscilloscope

Time Base. Sweep range from 10 ns/div to 5 ms/div, with provisions for internal and external television triggering, and capable of triggering on sine waves to 4 MHz.

Amplifier. Bandwidth, dc to 30 MHz; minimum deflection, 1 mV/div; two input channels with provisions for independent or differential operation.

For example, a TEKTRONIX 7603 Oscilloscope with 7B53A Dual Time Base, 7A26 Dual Trace Amplifier, and 7A13 Differential Comparator. Also, a 10X probe, P6106 (Tektronix Part No. 010-6106-03).

2. Waveform Monitor

Capable of viewing line rate and field rate signals, with a magnifier to measure rise time and pulse duration, clamp tilt $\leq$0.05% 25 Hz to 50 kHz, cmrr $\geq$66 dB, and $\pm$0.5% frequency response error at 3.58 MHz. For example, a TEKTRONIX 1480 W5F Waveform Monitor.

NOTE

The Video Amplitude Calibration Fixture (Item 6) and a TEKTRONIX 1480-Series Waveform Monitor, equipped with custom modification W5F, provide a measurement system with a tolerance at least three times better than luminance and chrominance amplitude performance requirements. If a waveform monitor (without modification W5F) that has 46 dB common-mode rejection ratio and 2% frequency response is subsitituted, tolerances will be degraded to about 0.5% for luminance amplitude, and 2.67% for chrominance amplitude measurements.

Using the TEKTRONIX 1480-Series Waveform Monitor calibrator and multi-turn protentiometer (previously specified for TSG1) yields tolerances of up to 2% for luminance and 5% for chrominance amplitude measurements.

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 Leveled Sine Wave Generator in a TEKTRONIX TM 500-Series Mainframe.

4. Spectrum Analyzer (optional)

Capable of measuring the harmonics of color subcarrier to $-$40 dB of the fundamental.

For example, a TEKTRONIX 7L12.

5. Vectorscope

Capable of measuring phase difference of less than 0.5° between two signals at color subcarrier frequency.

For example, a TEKTRONIX 520A NTSC Vectorscope.

6. Video Amplitude Calibration Fixture (VAC)

Capable of measuring luminance and chrominance amplitudes from 0.1 mV to 999.9 mV, ±0.05% accuracy. Tektronix Part Number 067-0916-00 with TEKTRONIX TM 500-Series mainframe.

7. Subcarrier Harmonic Rejection Filter

For use with VAC. Tektronix Part No. 015-0407-00.

8. 75 Ω Precision Termination (0.025%)

For use with VAC. Tektronix Part No. 011-0102-01.

9. Attenuator (0.6%)

For use with VAC. Tektronix Part No. 011-0134-00.

10. Return Loss Bridge

Tektronix Part No. 015-0149-00.

11. 75 Ω Coaxial Cable, Low Loss (two required)

Length, 42 inches; connectors, bnc; impedance, 75 Ω. Tektronix Part No. 012-0159-00.

12. 75Ω End-Line Termination, 0.2% (two required)

Tektronix Part No. 011-0102-00.

13. 75 Ω In-Line Termination, 0.2%

Tektronix Part No. 011-0103-02.

14. 50 Ω to 75 Ω Minimum Loss Attenuator

Tektronix Part No. 011-0057-00.

15. 75 Ω 10X Attenuator

Tektronix Part No. 011-0061-00.

Table 2-3

SHORT-FORM PERFORMANCE CHECK PROCEDURE

Step	Parameter	Requirement
1	Dc Level	0 V ±50 mV
2	Luminance Gain (Sync)	285.7 mV ±2.86 mV
3	Setup Level	53.6 mV ±1.5 mV
4	Color Bar Luminance (75%, 7.5%)	1% or 1.5 mV (whichever is greater)
	White	543.6 mV to 554.6 mV
	Yellow	489.7 mV to 499.5 mV
	Cyan	396.4 mV to 404.4 mV
	Green	342.4 mV to 349.4 mV
	Magenta	254.1 mV to 259.3 mV
	Red	200.2 mV to 204.2 mV
	Blue	106.6 mV to 109.6 mV
	Black	52.1 mV to 55.1 mV
	Color Bar Luminance (75%, 0%)	
	White	530.3 mV to 541.1 mV
	Yellow	472.0 mV to 481.6 mV
	Cyan	371.3 mV to 378.8 mV
	Green	312.9 mV to 319.3 mV
	Magenta	217.4 mV to 221.8 mV
	Red	159.1 mV to 162.3 mV
	Blue	57.4 mV to 60.4 mV
	Black	Reference
	Color Bar Luminance (100%,0%)	
	White	707.2 mV to 721.4 mV
	Yellow	629.3 mV to 642.1 mV
	Cyan	495.0 mV to 505.0 mV
	Green	417.2 mV to 425.6 mV
	Magenta	290.0 mV to 295.8 mV
	Red	212.2 mV to 216.4 mV
	Blue	77.1 mV to 80.1 mV
	Black	Reference

Table 2-3 (cont)

Step	Parameter	Requirement
	Color Bar Luminance (100%, 7.5%)	
	White	707.2 mV to 721.4 mV
	Yellow	635.2 mV to 648.0 mV
	Cyan	510.9 mV to 521.3 mV
	Green	439.0 mV to 447.8 mV
	Magenta	321.3 mV to 327.7 mV
	Red	249.3 mV to 254.3 mV
	Blue	124.8 mV to 127.8 mV
	Black	52.1 mV to 55.1 mV
	SMPTE, −I,W,Q,B Luminance Levels	
	White Reference	707.2 mV to 721.4 mV
	+Black Set	27.1 mV to 30.1 mV
	−Black Set	27.1 mV to 30.1 mV
5	EIA and SMPTE Color Bars Duration	7.5 μs, ±400 ns (per bar)
6	−I,W,Q Duration	9.4 μs, ±400 ns (each)
7	Black Set and Black Bar Duration SMPTE	
	+Black Set	2.5 μs, ±400 ns
	Setup Level	2.5 μs, ±400 ns
	−Black Set	2.5 μs, ±400 ns
	Black Bar	7.5 μs, ±400 ns
8	−I,Q White Bar Rise Time	250 ns, ±37.5 ns
9	Color Bar Width	6.6 μs, ±400 ns
10	Color Bar White Bar Rise Time	130 ns, +20 ns, −10 ns
11	Chrominance-to-Luminance Delay	20 ns or less
12	Chrominance Rise Time	400 ns, ±60 ns
13	Quadrature Phase Error	0.5° or less (4.4 mV)
14	0°—180° Switch Phase	0.5° or less
15	Chrominance Bandpass Filter	Straight lines between vectors, null at green-magenta transition, minimum harmonics
16	Residual Subcarrier Amplitude	2.5 mV or less
17	Aberrations	
	Spurious Subcarrier and other Spurious Outputs	At least 52 dB below 1 V (2.5 mV), except 30 dB (32 mV) during sync, end of H blanking, and start of white bar.

Table 2-3 (cont)

Step	Parameter	Requirement
18	Chrominance Accuracy (All)	Absolute, 3%, Relative, 1% (Red bar reference)
	Chrominance Accuracy (75%, 7.5%)	
	Total Amplitudes	
	Blue, Yellow	444.2 mV
	Red, Cyan	630.1 mV
	Green, Magenta	588.5 mV
	White, Black	0 V, within 2.5 mV
19	Chrominance Accuracy (75%, 7.5%)	
	R−Y Amplitudes	
	Blue, Yellow	98.9 mV
	Red, Cyan	612.9 mV
	Green, Magenta	513.9 mV
	White	Null
	B−Y Amplitudes	
	Blue, Yellow	433.2 mV
	Red, Cyan	146.3 mV
	Green, Magenta	286.8 mV
	White	Null
20	Burst Amplitude	285.7 mV (same accuracy as chrominance)
21	Burst Rise Time	400 ns ±60 ns
22	White Reference Amplitude	707.2 mV to 721.4 mV
23	SMPTE IQ White Amplitude	707.2 mV to 721.4 mV
24	−I,Q Chrominance Amplitude	285.7 mV (same accuracy as chrominance)
25	Subcarrier Phase	Matches 1410 Subcarrier Phase within 10°
26	Return Loss	30 dB or greater to 5 MHz

PROCEDURE

Preliminary Instructions

Before starting this procedure, the TSG7 should be installed in a 1410 Generator mainframe, along with an appropriate SPG module.

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 Dc Level

a. Set the test oscilloscope for a deflection factor of 10 mV/div with dc coupling.

b. Connect the TSG7 Color Bars rear-panel Module Output to the test oscilloscope input via a 75 Ω cable and 75 Ω termination.

c. Switch the input coupling of the test oscilloscope to Gnd (ground), and vertically position the trace to the crt centerline. Switch the input coupling back to dc.

d. CHECK—for a blanking level of 0 V, ±50 mV (±5 major divisions from screen center).

2. Check Luminance Gain (Sync)

a. Connect the Color Bars rear-panel Module Output to the 1480 Waveform Monitor Ch A input, and terminate the remaining side of the Ch A input with the Precision Termination. Connect Video Amplitude Calibration Fixture (VAC) output to the 1480 Ch B input; do not terminate (see Fig.2-1).

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

System Select	NTSC
Preset Group	7.5–50 (Blue Scale)
Preset Level	40
Reference Offset	LUM/SYNC −SYNC
Amplitude	FULL AMP
Setup Select	No SETUP
Preset/Manual	Preset

c. Set the 1480 controls as follows:

Input	A−B, DC
Response	Flat
Volts Full Scale	1.0
DC Restorer	Off

d. Press in the TSG7 COLOR BARS FULL FIELD push button.

e. Use the VAC Variable to match the Sync tip to the reference level (see Fig. 2-2). Greater resolution can be obtained by setting the 1480 Volts Full Scale to 0.5 or 0.2.

f. CHECK—VAC Output in mV for 285.7, ±2.86 (282.9–288.6 mV).

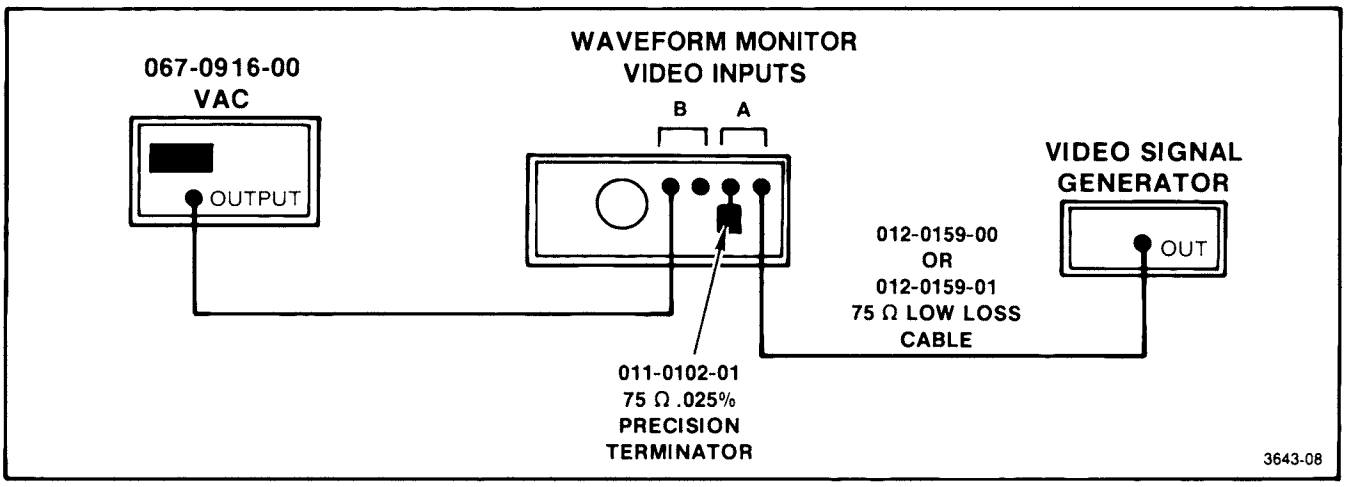


Fig. 2-1. Connecting the Video Amplitude Calibrator and TSG7 for luminance measurements.

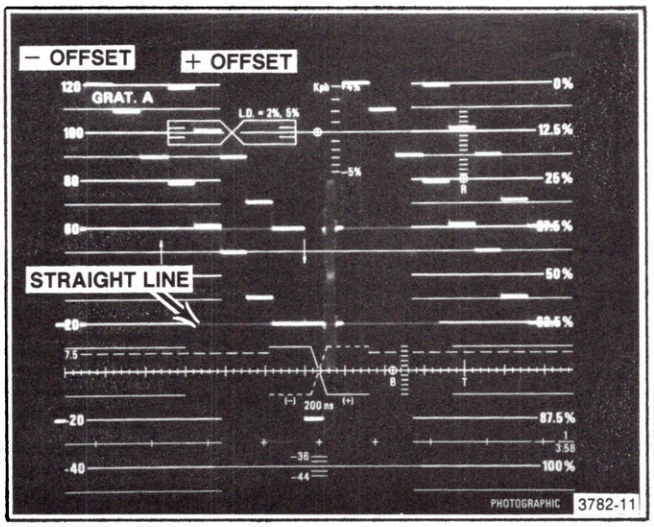


Fig. 2-2. Measuring luminance gain with the VAC.

Table 2-4

COLOR BAR LUMINANCE AMPLITUDES
75% AMPLITUDE/7.5% SETUP

Color Bar	Amplitude	VAC Preset
White	543.6 mV to 554.6 mV	WH
Yellow	489.7 mV to 499.5 mV	YL
Cyan	396.4 mV to 404.4 mV	CY
Green	342.4 mV to 349.4 mV	GN
Magenta	254.1 mV to 259.3 mV	MG
Red	200.2 mV to 204.2 mV	RD
Blue	106.6 mV to 109.6 mV	BU
Black	52.1 mV to 55.1 mV	BK

3. Check Setup Level

a. Press in the TSG7 SETUP push button.

b. Press the VAC 7.5 Preset Level.

c. Use the VAC Variable to match the setup level to the reference level.

d. CHECK—VAC Output in mV for 53.6, ±1.5 (52.1–55.1 mV).

4. Check Color Bar Luminance Amplitudes

a. Press in the TSG7 B–Y, R–Y, SETUP, and AMPL push buttons. Be sure that the WHITE REF push button is out.

b. Set the VAC for Reduced Amp, Setup, and CB Lum.

c. Press the VAC WH Preset.

d. Use the VAC Variable to match the white level (top step) and the reference level.

e. CHECK—luminance levels of the 75%, 7.5% setup color bars as indicated in Table 2-4.

f. Disengage the SETUP push buttons.

g. CHECK—luminance levels of the color bars at 75% and 0% as indicated in Table 2-5.

Table 2-5

COLOR BAR LUMINANCE AMPLITUDES
75% AMPLITUDES/0% SETUP

Color Bar	Amplitude	VAC Preset
White	530.3 mV to 541.1 mV	WH
Yellow	472.0 mV to 481.6 mV	YL
Cyan	371.3 mV to 378.8 mV	CY
Green	312.9 mV to 319.3 mV	GN
Magenta	217.4 mV to 221.8 mV	MG
Red	159.1 mV to 162.3 mV	RD
Blue	57.4 mV to 60.4 mV	BU
Black	Blanking reference	BK

h. Disengage the TSG7 AMPL push button and press the VAC Full Amp push button.

i. CHECK—luminance levels of the color bars at 100% and 0% as indicated in Table 2-6.

Table 2-6

COLOR BAR LUMINANCE AMPLITUDES
100% AMPLITUDE/0% SETUP

Color Bar	Amplitude	VAC Preset
White	707.2 mV to 721.4 mV	WH
Yellow	629.3 mV to 642.1 mV	YL
Cyan	495.0 mV to 505.0 mV	CY
Green	417.2 mV to 425.6 mV	GN
Magenta	290.0 mV to 295.8 mV	MG
Red	212.2 mV to 216.4 mV	RD
Blue	77.1 mV to 80.1 mV	BU
Black	Blanking reference	BK

j. Press in the SETUP push buttons.

k. CHECK—luminance levels of the color bars at 100% and 7.5% as indicated in Table 2-7.

Table 2-7

COLOR BAR LUMINANCE AMPLITUDES
100% AMPLITUDE/7.5% SETUP

Color Bar	Amplitude	VAC Preset
White	707.2 mV to 721.4 mV	WH
Yellow	635.2 mV to 648.0 mV	YL
Cyan	510.9 mV to 521.3 mV	CY
Green	439.0 mV to 447.8 mV	GN
Magenta	321.3 mV to 327.7 mV	MG
Red	249.3 mV to 254.3 mV	RD
Blue	124.8 mV to 127.8 mV	BU
Black	52.1 mV to 55.1 mV	BK

l. Release the VAC Reduced Amp.

m. Press the TSG7 AMPL push button.

n. Press the VAC WH and adjust the Variable to match the white and reference levels.

o. Press the TSG7 SMPTE push button.

p. Use the VAC Tolerance adjustment to again match the white and the reference levels.

q. CHECK—reading of Tolerance dial for $\leq$0.5%.

r. Press the VAC Tolerance knob, Reset push button and Full Amp push button.

s. Set the 1480 Response to Flat.

t. CHECK—luminance levels of the SMPTE, −I,W,Q,B EIA white and Black Set signals as indicated in Table 2-8 (see Fig. 2-3).

Table 2-8

SMPTE −I,W,Q,B LUMINANCE LEVELS

Signal Element	Amplitude	VAC Presets	
		Group	Level
EIA White	707.2 mV to 721.4 mV		
Setup	52.1 mV to 55.1 mV	7.5–50	7.5
−Black Set	Setup −27.1 mV to 30.1 mV	7.5–50	7.5
+Black Set	Setup +27.1 mV to 30.1 mV	7.5–50	7.5

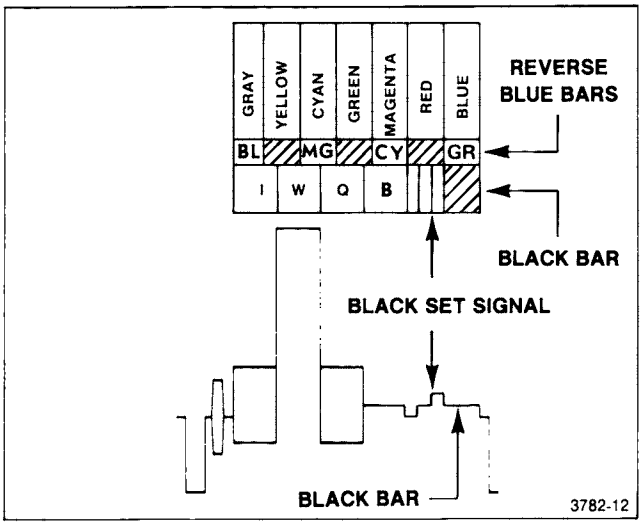


Fig. 2-3. The SMPTE −I,W,Q,B signal with Black Set.

5. Check SMPTE Color Bars and Reverse Blue Bars Duration

a. Connect the Color Bars rear-panel Module Output to the test oscilloscope vertical input via a 75 Ω cable and 75 Ω feed-through termination.

b. Press in the TSG7 and the SMPTE COLOR BARS push buttons.

c. Externally trigger the test oscilloscope from the 1410 V Drive output.

d. Set the test oscilloscope Time/Div to 1 μs, and use the Delay Time Multiplier and Dly Time to place the first (gray) SMPTE color bar within the graticule area.

e. CHECK—duration of the SMPTE gray color bar. Duration should be 7.5 μs within 400 ns (7.1–7.9 μs).

f. CHECK—duration of each color bar in the SMPTE color bars signal by placing each bar within the graticule area with the Delay Time Multiplier. Duration of each bar should be 7.5 μs within 400 ns (7.1–7.9 μs).

g. Rotate the Delay Time Multiplier until the reverse blue bars are measureable.

h. CHECK—duration of each reverse blue bar in the SMPTE color bars signal by placing each bar within the graticule area with the Delay Time Multiplier. Duration of each bar should be 7.5 μs within 400 ns (7.1–7.9 μs).

6. Check −I,W,Q Duration (SMPTE Signal)

a. Using the Delay Time Multiplier, place the −I portion of the −I,W,Q,B signal within the graticule area.

b. CHECK—duration of the −I portion of the −I,W,Q,B signal. Duration should be 9.4 μs within 400 ns (9.0–9.8 μs).

c. CHECK—duration of the W,Q, and B portions of the −I,W,Q,B signal (see Fig. 2-2) by placing each portion within the graticule area with the Delay Time Multiplier. Duration of each portion should be 9.4 μs within 400 ns (9.0–9.8 μs).

7. Check Black Set and Black Bar Duration (−I,W,Q,B part of SMPTE Signal)

a. Using the Delay Time Multiplier, place the leading element of the Black Set signal within the graticule area.

b. CHECK—duration of the leading element of the Black Set signal. Duration should be 2.5 μs, ±400 ns (2.1–2.9 μs).

c. CHECK—duration of the other two elements of the Black Set signal. Duration should be 2.5 μs, ±400 ns (2.1–2.9 μs).

d. Using the Delay Time Multiplier, place the −I,W,Q,B signal black bar (following Black Set signal) within the graticule area.

e. CHECK—duration of the black bar, 7.5 μs, ±400 ns (7.1–7.9 μs).

8. Check −I,Q White Bar Rise Time

a. Change the test oscilloscope Time/Div to 50 ns, and use the Delay Time Multiplier to place the W (white) bar rising portion within the graticule area.

b. CHECK—rise time of the white bar. Rise time should be 250 ns within 37.5 ns (213–287 ns).

9. Check Full Field Color Bar Width

a. Press in the TSG7 FULL FIELD COLOR BARS push button. Press in the B−Y, R−Y, SETUP, and AMPL push buttons.

b. Set the test oscilloscope Time/Div to 1 μs.

c. CHECK—duration of each color bar by placing each bar within the graticule area with the Delay Time Multiplier. Duration of each color bar should be 6.6 μs within 400 ns (6.2–7.0 μs).

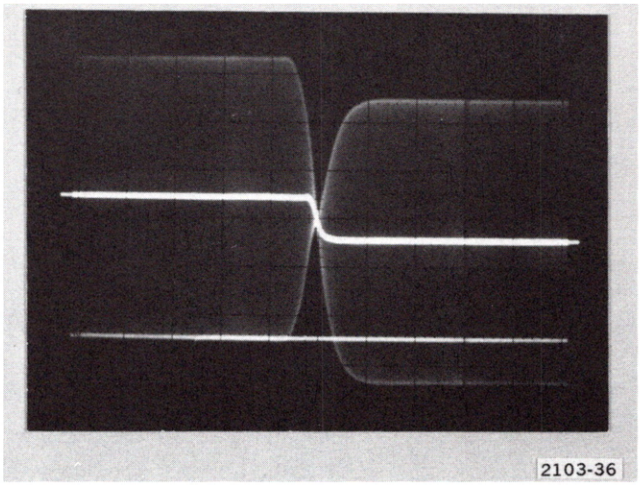


Fig. 2-4. Waveform monitor display showing minimum chrominance-to-luminance delay.

10. Check Color Bar White Bar Rise Time

a. Press in the TSG7 WHITE REF push button.

b. Change the test oscilloscope Time/Div to 20 ns.

c. CHECK—rise time of the white bar. Rise time should be 130 ns, +20 ns to −10 ns (120–150 ns).

11. Check Chrominance-to-Luminance Delay

a. Connect the Color Bar rear-panel Module Output to the 1480 Waveform Monitor Ch A input, and terminate the other Ch A loop-through input connector in 75 Ω. Set the Magnifier to .1 μs/Div.

b. Release the TSG7 WHITE REF, R−Y, and B−Y push buttons and press in the /Y REF push button.

c. Position the display so that the green-magenta transition coincides with a major graticule tick marking.

d. Press and hold in the Horiz Unlock push button on the SPG module.

e. CHECK—that chrominance-to-luminance delay does not exceed 20 ns (1 minor horizontal graticule division). Delay will be indicated by any separation between the chrominance and luminance transition midpoints (see Fig. 2-4).

12. Check Chrominance Rise Time

a. Press the TSG7 FULL FIELD and Y push buttons.

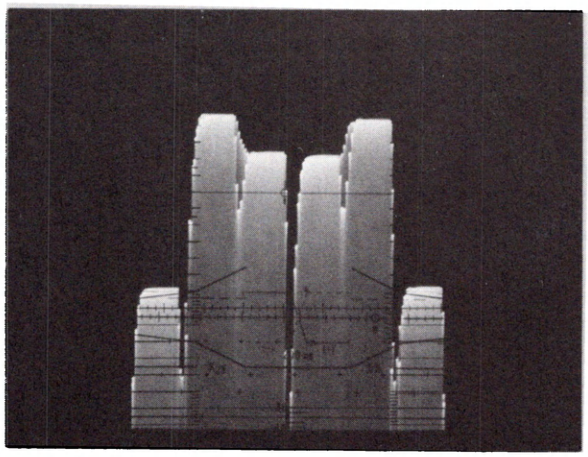
b. Press in and hold the SPG Horiz Unlock push button and position the 1480 display to measure the leading edge of the yellow color bar.

c. CHECK—that rise time of the chrominance signal is 400 ns within 60 ns (340–460 ns).

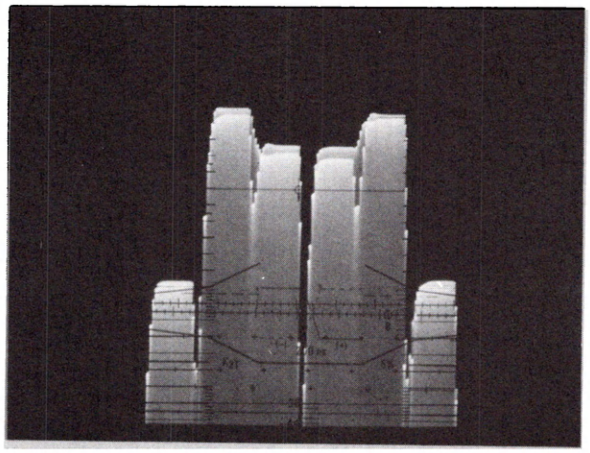
13. Check Quadrature Phase Error

a. Press in the TSG7 FULL FIELD, Y, and PHASE (R−Y) push buttons. Disengage the B−Y push button. Set the 1480 Response to Flat and Volts Full Scale to 0.2.

b. CHECK—Quadrature Phase for 4.4 mV or less, peak-to-peak difference in green or magenta chrominance packets, waveforms overlay as shown in Fig. 2-5. The R scale on Graticule A is 2.85 mV/division at 0.2 Volts Full Scale.



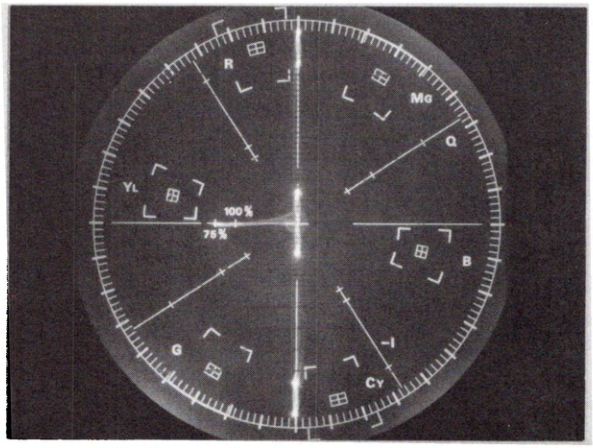
a. Correctly adjusted



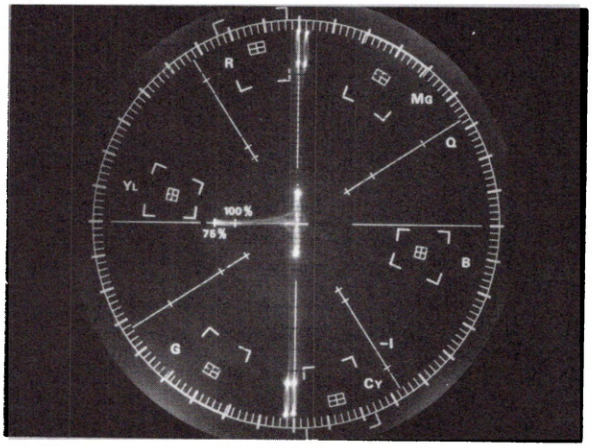
b. Incorrectly adjusted

2103-16

Fig. 2-5. Quadrature Phase waveform monitor display.



a. Correctly adjusted



b. Incorrectly adjusted

2103-15

Fig. 2-6. 0° — 180° Switch Phase vectorscope display.

14. Check 0°–180° Switch Phase

a. Connect the Color Bars rear-panel Module Output to the 520A Vectorscope Ch A input, and terminate the other Ch A loop-through input connector in 75 Ω.

b. Set the 520A controls for Ch A, Aϕ, and Vector display mode.

c. Press in the TSG7 Y, B−Y, and PHASE (R−Y) push buttons.

d. CHECK—that phase error between color bar vectors on the vectorscope display is 0.5° or less (see Fig. 2-6). Use the vectorscope Calibrated Phase dial to measure any error.

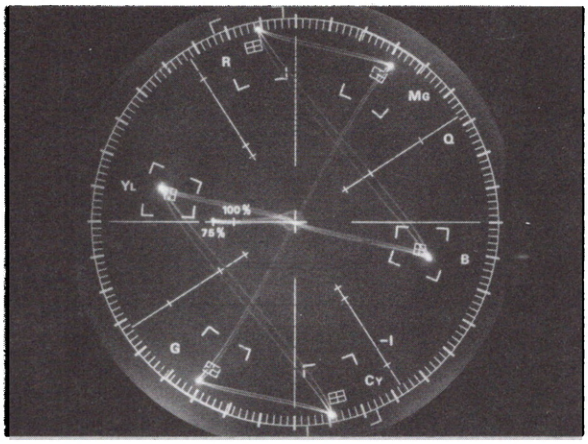
15. Check Chrominance Bandpass Filter Response

a. Press in the TSG7 Y and /REVERSE push buttons. Press in the SPG Horiz Unlock button.

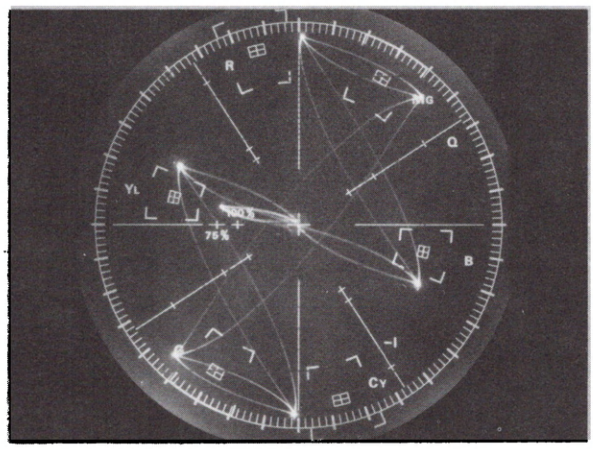
b. CHECK—response of the chrominance bandpass filter. The vectorscope display should be similar to Fig. 2-7a. Fig. 2-7b shows the result of misadjusted filters.

16. Check Residual Subcarrier Amplitude

a. Connect the Color Bars rear-panel Module Output to the test oscilloscope vertical input via a 75 Ω cable and a feed-through 75 Ω termination. Set the test oscilloscope deflection factor to 5 mV/div.



a. Correctly adjusted



b. Incorrectly adjusted

2103-12

Fig. 2-7. Chrominance Bandpass Filter vectorscope display.

b. Press in the TSG7 FULL FIELD, Y, B−Y, R−Y, and PHASE (ALT) push buttons.

c. CHECK—that residual subcarrier amplitude at blanking is less than 2.5 mV (−52 dB less than 0.5 major division).

17. Check Amplitude of Aberrations (Spurious Subcarrier and Other Spurious Outputs)

a. Check that all equipment is set up the same as in Step 16.

b. CHECK—amplitude of spurious subcarrier and other spurious signals. The amplitude should be 32 mV (−30 dB) or less during sync, the end of H blanking, and the start of the white bar; 2.5 mV (52 dB) all other locations.

18. Check Chrominance Amplitudes (75% and 7.5%)

a. Connect the VAC as shown in Fig. 2-8.

b. Set the VAC to measure a 75% Amplitude, 7.5% Setup Red chrominance packet as follows:

System Select	NTSC
Preset Group	CB CHR
Preset Level	RD
Reference Offset	CHR P-P −Sync
Amplitude Select	Reduced
Setup Select	Setup
Preset/Manual	Preset

c. Release all TSG7 front-panel push buttons; then press FULL FIELD, AMPL 75%, SETUP 7.5%, and Y push buttons.

d. Connect the TSG7 Color Bars Module Output, through the Subcarrier Harmonic Rejection Filter, to the 1480 Ch A Video Input. Terminate the other Ch A Video Input with the Precision Terminator (see Fig. 2-8).

e. Set the 1480 for Flat Response, and turn the DC Restorer Off.

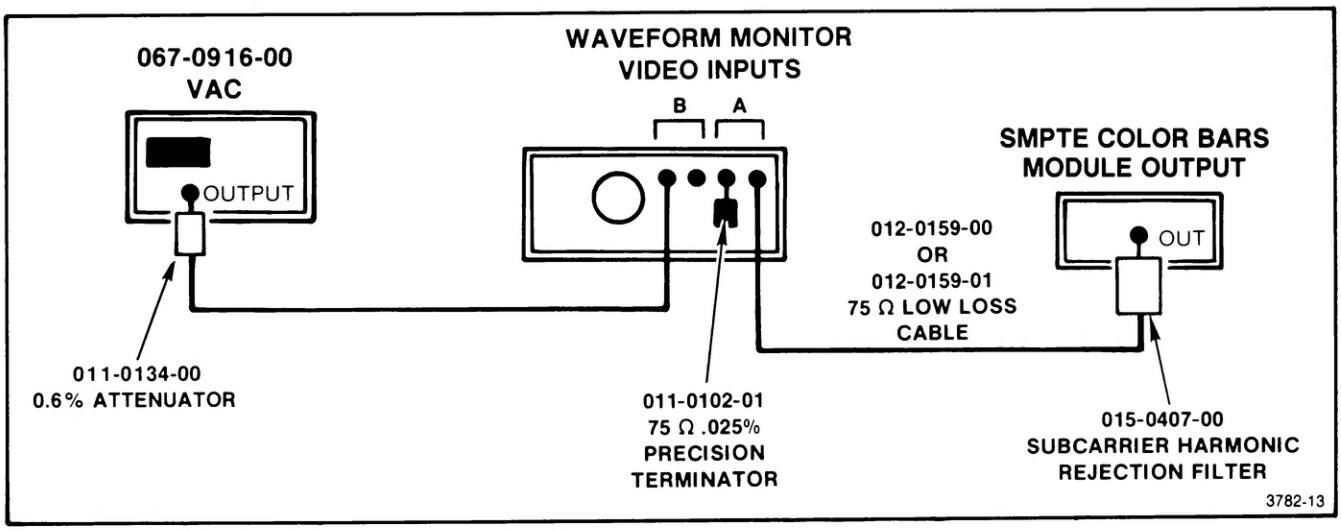


Fig. 2-8. Video Amplitude Calibrator connections for making chrominance amplitude measurements.

f. Use the VAC Variable and Preset Colors to determine amplitudes.

g. CHECK—chrominance peak-to-peak amplitudes to the 3% tolerances listed in Table 2-9.

h. Push the VAC RD push button.

i. Use the VAC Tolerance control to match the red amplitude to the reference. Do not move the Tolerance control for the remainder of this step.

j. Use the VAC Variable and Preset Colors to measure peak-to-peak chrominance amplitudes.

k. CHECK—chrominance peak-to-peak amplitudes to the 1% tolerances listed in Table 2-9.

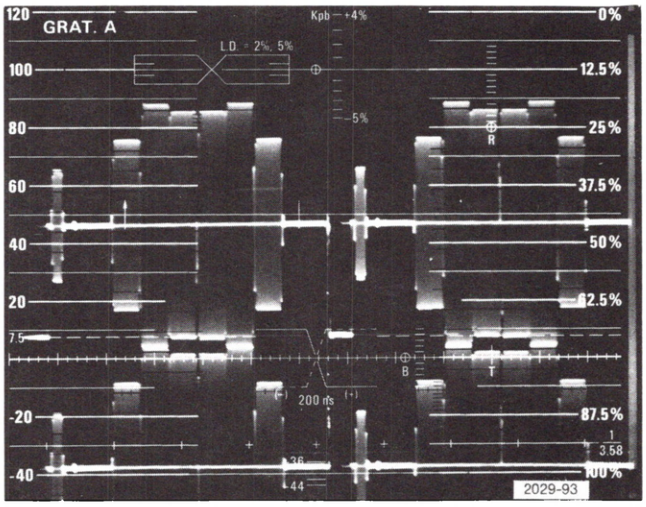


Fig. 2-9. Waveform monitor display showing the red color bar peaks just overlaying.

Table 2-9

PEAK-TO-PEAK CHROMINANCE AMPLITUDES

Color	Absolute Amplitude	3% Tolerance	1% Tolerance
Red, Cyan	630.1 mV	611.2 — 649.0	623.8 — 636.4
Green, Magenta	588.5 mV	570.8 — 606.2	582.6 — 594.4
Blue, Yellow	444.2 mV	430.9 — 457.5	439.8 — 448.6
White, Black	0	2.5 mV or less	2.5 mV or less

19. Check R−Y and B−Y Chrominance Amplitudes (75% and 7.5%)

a. The equipment remains connected as it was in Step 18.

b. Press the TSG7 B−Y push button.

c. Use the VAC Variable and Preset Colors to determine amplitudes.

d. CHECK—R−Y chrominance peak-to-peak amplitudes to the 3% tolerances listed in Table 2-10.

e. Push the VAC RD push button.

f. Use the VAC Tolerance control to match the red amplitude to the reference. Do not move the Tolerance control for the remainder of this step.

g. Use the VAC Variable and Preset Colors to measure peak-to-peak chrominance amplitudes.

h. CHECK—chrominance peak-to-peak amplitudes to the 1% tolerances listed in Table 2-10.

i. Press the TSG7 R−Y push button and release the B−Y push button.

j. Use the VAC Variable and Preset Colors to determine amplitudes.

k. CHECK—B−Y chrominance peak-to-peak amplitudes to the 3% tolerances listed in Table 2-11.

l. Push the VAC RD push button.

m. Use the VAC Tolerance control to match the red amplitude to the reference. Do not move the Tolerance control for the remainder of this step.

n. Use the VAC Variable and Preset Colors to measure peak-to-peak chrominance amplitudes.

o. CHECK—chrominance peak-to-peak amplitudes to the 1% tolerances listed in Table 2-11.

Table 2-10

R−Y CHROMINANCE AMPLITUDES

Color	Absolute Amplitude	3% Tolerance	1% Tolerance
Blue, Yellow	98.9 mV	95.9 — 101.9	97.9 — 99.9
Green, Magenta	513.9 mV	498.5 — 529.3	508.8 — 519.0
Red, Cyan	612.9 mV	594.5 — 631.3	606.8 — 619.0

Table 2-11

B−Y CHROMINANCE AMPLITUDES

Color	Absolute Amplitude	3% Tolerance	1% Tolerance
Red, Cyan	146.3 mV	141.9 — 150.7	144.8 — 147.8
Green, Magenta	286.8 mV	278.2 — 295.4	283.9 — 289.7
Blue, Yellow	433.1 mV	420.1 — 446.1	428.8 — 437.4

20. Check Burst Amplitude

a. Release the TSG7 R−Y push button.

b. Press the VAC 7.5–50 Preset Group and the 40 Preset Level.

c. Use the VAC Variable to bring the burst tips together (just touching).

d. CHECK—for a burst amplitude of 285.7 mV within 3% (277.1–294.3).

21. Check Burst Rise Time

a. Set the 1480 Input to ADC, Volts Full Scale to 0.5, and the Magnifier to 1 μs/div.

b. Position the 1480 display to measure the leading edge of burst.

c. CHECK—for a burst rise time of 400 ns, ±60 ns (340–460 ns).

22. Check White Reference Amplitude

a. Release the Y push button. Press in the AMPL (75%) and WHITE REF (100 IRE) push buttons.

b. Set the 1480 Input to A−B DC, Volts Full Scale to 1, and Magnifier to 10 μs (X1).

c. Press the VAC 55–100 Preset Group, 100 Preset Level, Full Amp, Setup, and +LUM.

d. Release the VAC LUM/SYNC.

e. Use the VAC Variable to bring the White Reference bar to the blanking level.

f. CHECK—for White Reference amplitude of 714.3 mV, ±1% (707.2–721.4 mV).

23. Check EIA White Amplitude

a. Press in the TSG7 SMPTE push button.

b. Press the 1480 15 Lines push button and rotate the Var Line Selector until only the −I,W,Q,B part of the SMPTE signal is displayed (see Fig. 2-3).

c. Use the VAC Variable to place the top of the EIA White Bar to the blanking level.

d. CHECK—for an EIA IQ White Bar amplitude of 714.3 mV, ±1% (707.2–721.4 mV).

24. Check EIA −I,Q Chrominance Amplitudes

a. Press the VAC Preset Group 7.5–50, Preset Level 40, and CHR P-P.

b. Use the VAC Variable to bring the peaks of −I and Q packets together.

c. CHECK—for −I and Q chrominance amplitudes of 285.7 mV ±8.57 mV (277.1–294.3 mV).

d. Press the 1480 OFF (Line Selector).

e. Release the VAC Manual push button.

f. Set the VAC lever switches to 630.1.

g. Use the VAC Tolerance to bring the Red packet peaks together. Do not move the Tolerance control for the remainder of the step.

h. Press the 1480 15 Lines push button.

i. Set the VAC lever switches to 285.7.

j. Use the VAC variable to bring the −I and then the Q packets together.

k. CHECK—for −I and Q chrominance amplitudes of 285.7 mv ±1% (282.8–288.6 mV).

25. Check Subcarrier Phase

a. Connect the 1410 rear-panel Subcarrier output (J20) signal to the 520A Vectorscope Ext CW ϕ Ref input connector, and terminate the other Ext CW ϕ Ref loop-through input in 75 Ω.

Connect the other 1410 rear-panel Subcarrier output (J21) signal through a 75 Ω 10X attenuator and 75 Ω cable (in that order) to the vectorscope Ch A input connector. Terminate the other Ch A loop-through input in 75 Ω.

b. Set the SPG1 or SPG2 to the internal mode of operation.

c. Set the 520A Vectorscope controls as follows:

Ch A, Full Field, Aϕ and Vector buttons pressed in. Ch A Gain control set to Cal, and the ϕ Ref switch set to Ext. Rotate the Ch A Phase control to position the subcarrier vector at 180°.

NOTE

Do not move the 520A Vectorscope Ch A Phase control from this setting until completing this step.

d. Disconnect the 75 Ω cable where it attaches to the 10X attenuator that is connected to the 1410 Subcarrier (J21) connector. Connect this same cable to the TSG7 Color Bar Module rear-panel output connector, so that this signal is applied to Ch A of the vectorscope.

e. CHECK—that the burst vector is at 180° within 10° (170°–190°).

26. 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 TSG7. (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—that the returned amplitude is 16 mV or less (return loss is 30 dB or greater).

This completes the Performance Check Procedure for the TSG7.

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.

PART II
SERVICE INFORMATION

INSTALLATION

There are two types of installation possible with the TSG7, installing a new TSG7 or updating an existing TSG1. This section of the manual is designed to meet the needs of both types of installation. It should be noted here that there are certain calibration steps that will be required for installation; however, performing the full calibration procedure at the time of installation is preferred.

Be sure that all of the operating mode changes are made prior to installation in the 1410 mainframe. These changes are much easier to make when the circuit boards are outside of the mainframe.

OPERATING MODE SELECTION

Color Bar Sequence

Located near the center and rear of the Color Bars Logic board (see Adjustment and Jumper Locations pullout in the rear portion of this manual) are two sets of jumper connectors that allow the color bar sequence to be altered (see Fig. 3-1). The wires in P176 determine the sequence of the chrominance signal. The wires in P273 determine the sequence of the luminance signal. Both the chrominance and luminance circuits require identical changes.

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. 3-1.

Color bars with a white, cyan, magneta, blue, yellow, green, red, and black sequence offer the largest phase transitions for the chrominance signal. This combination is shown in the second set of jumper arrangements in Fig. 3-1. The white, magenta, yellow, red, cyan, blue, green, and black sequence offer the largest luminance transitions, which are useful for measuring nonlinear distortions. This arrangement is shown in the last set of combinations in Fig. 3-1.

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 W174, W175, W178 and W179 must be resoldered as shown in the various arrangements in Fig. 3-2. Also, see the Color Bar Logic Adjustment and Jumper Locations pullout in the rear portion of this manual.

Chrominance Disable

P359 (Chrominance Disable) on the Color Bars Output board provides a simple means of removing the chrominance component from the output signal. This is normally useful only during part of the Calibration Procedure. When pins 2 and 3 are jumpered (factory-set position), chrominance is coupled through the Bandpass Filter to the Chrominance Output Amplifier. Moving the jumper to pins 1 and 2 opens up the signal path between these stages.

R−Y Phase Shifting

Switching of the R−Y PHASE in the ALT (90°/270°) position can be set to occur at either a line or field rate. In the normal factory-set position, switching occurs at a field rate (V/2). Resistor R320 on the A31 Color Bars Output board is connected to Interface pin 36, which receives a V/2 rate signal from an SPG1, SPG2, or SPG3. For line-rate switching, R320 is connected to Interface pin 22, which receives an H/2 rate signal from an SPG module. See the Color Bars Output Adjustment and Jumper Locations pullout page in the back portion of this manual for R320 connections.

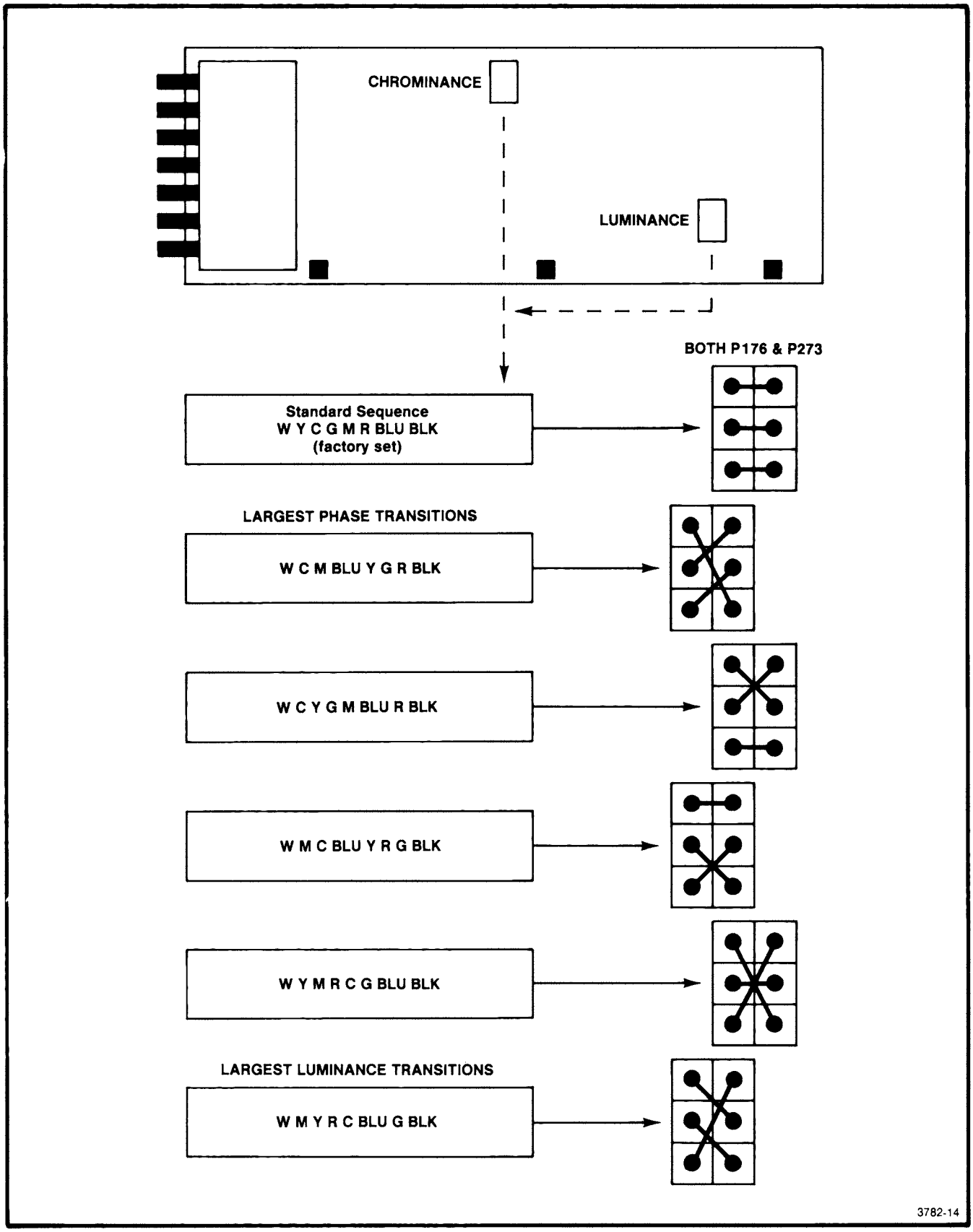


Fig. 3-1. Assigning color bar sequence. Changing jumpers changes all signals including SMPTE and EIA.

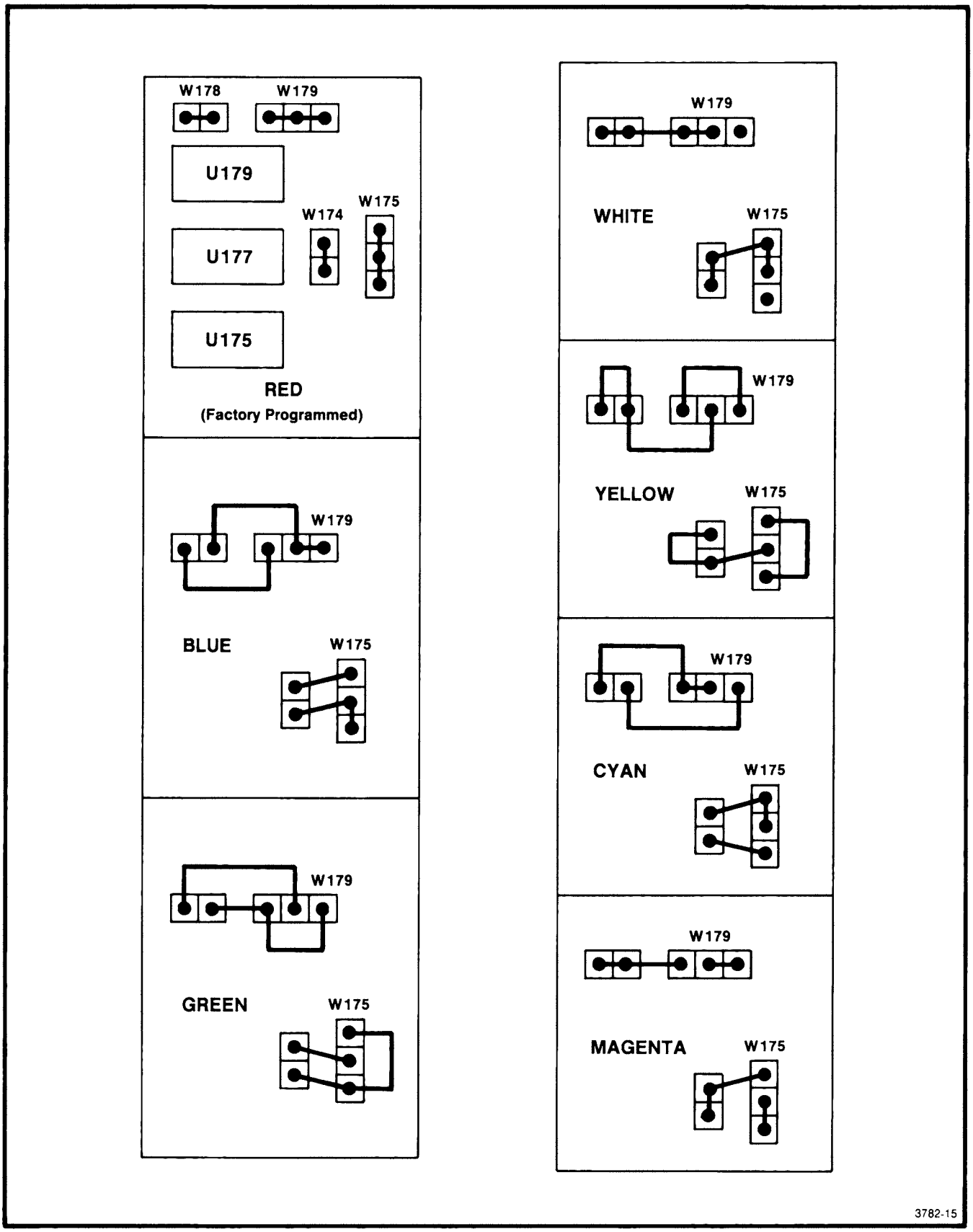


Fig. 3-2. Jumper positions for selection of a color for split field. Jumpers located on A32 (Color Bar Logic circuit board).

INSTALLING IN THE MAINFRAME

To install a complete TSG7 module in a 1410 mainframe, perform all of the steps in the following procedure.

When installing only the Color Bars Logic circuit board A32, skip steps b, c, and d.

WARNING

Disconnect power from the mainframe before starting installation.

a. Remove the top cover from the mainframe. Remove the plastic spacer bars that keep the circuit boards properly spaced.

b. Select a module location for the TSG7. The recommended location for placement of the TSG7 is location 2. See Table 3-1 and Fig. 3-3 for the recommended placement of all the TSG modules when operating with the TSG7.

c. 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.

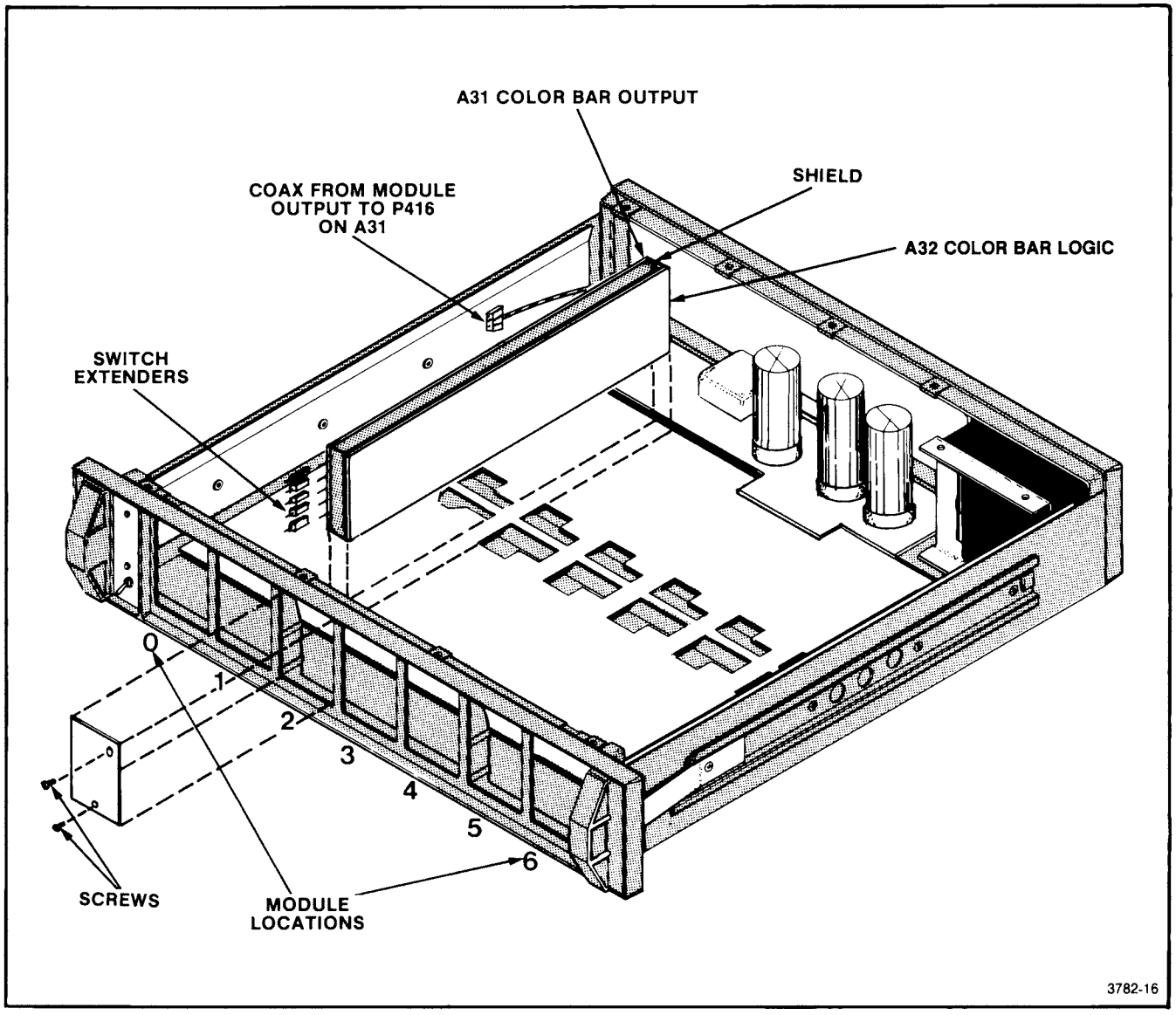


Fig. 3-3. Installing the module circuit boards in the 1410 mainframe.

Table 3-1
RECOMMENDED TEST SIGNAL GENERATOR MODULE LOCATIONS

Module Location	Signal	From
1	Black Burst	SPG1/2 or TSG4
2	Color Bars	TSG7
3	Switcher/Convergence	TSP1 or TSG2
4	Linearity	TSG3
5	Pulse & Bar	TSG5
6	Multiburst	TSG6

d. Position the Color Bars Output board (A31) over the middle row of mainframe interface pins at the selected location; for example, P59 at location 2. Use the plastic guides for proper pin alignment. Seat the board firmly on the interface board.

e. Position the Color Bars Logic board (A32) over the row of pins adjacent to the shield. Align the board pins using the plastic guides, and seat firmly on the interface board.

f. Install the plastic push button extenders on the board push button shafts. (Disregard this step if shafts have extenders installed.)

g. Position the TSG7 front panel over the push button control extenders and secure it to the 1410 mainframe front casting with the screws provided.

h. Connect the coaxial cable from the 1410 Module Output connector selected (P58, pins 1 & 2 for location 2) to the output pins (P416, pins 3 & 4) of the A31 Color Bars Output board. Cables are color coded to match location designations shown in Fig. 3-3.

i. Unless installing other modules at this time, perform the installation checkout, then replace the plastic spacer bars and the 1410 top cover.

NOTE

Boards may be removed without removing the panel or push button extenders by lifting the back of the board first and sliding buttons out of their holes by pulling backwards.

If this installation is to update a TSG1 to a TSG7, the adjustments listed in Table 3-2 will need to be performed.

NOTE

When updating a TSG1 to a TSG7 in a fully loaded 1410, a 1.5 ohm 1/4 watt resistor should be added in parallel with R237 on the 1410 power supply board. This increases the current capability of the +5 V supply, to handle the higher power requirements of the TSG7. See the 1410 manual for the location of R237.

INSTALLATION CHECKOUT

After installation of the TSG7, the Performance Check in Section 2 of this manual should be performed to determine if the module is operating within specified limits. If the TSG7 is not performing in conformance with the stated performance requirements, use the Calibration Procedure in Section 4 to bring the TSG7 within specification.

VITS Key

A standard color bars signal (75% amplitude, 7.5% setup) Vertical Interval Test Signal (VITS) may be enabled on a specific line during the vertical interval. The TSG7 front-panel switches, except BURST, SYNC, PHASE, R−Y, and B Y, have no affect on the VITS.

Table 3-2
UPDATE CALIBRATION PROCEDURE
(Short-Form)

Adjustment Name	Circuit Number	Circuit Board	Requirement	Calibration Procedure Step
Luminance Gain	R449	A31	285.7 mV ±2.86 mV	1
DC Level	R459	A31	0 V ±50 mV	2
Chrominance Gain	R379	A31	285.7 mV ±8.6 mV	15

Now run the complete Performance Check Procedure in Section 2. Make other necessary adjustments according to the Calibration Procedure in Section 4.

Table 3-3
J41 PIN ASSIGNMENTS FOR
REMOTE OPERATION OF THE TSG7

Module Location	J41 Remote Pin Number For	
	VITS Key	EIA Mode
1	24	18
2	23	15
3	22	12
4	21	9
5	20	6
6	19	3
Ground	36	

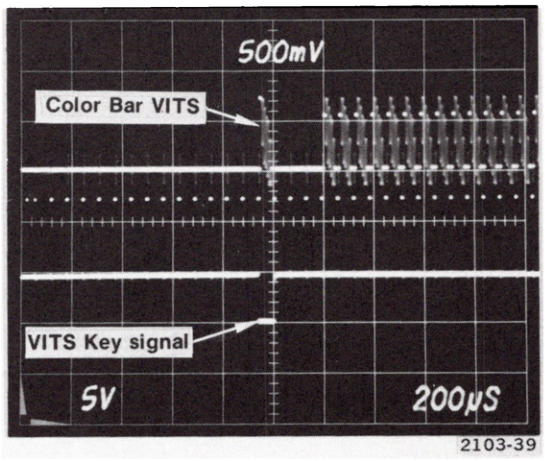


Fig. 3-4. VITS Key signal and Color Bar VITS.

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. Figure 3-4 shows an example of the VITS Key signal and the color bar VITS.

An internal VITS Key signal may be obtained from a TSP1 NTSC Switcher/Convergence Pattern Generator module for line 16, 17, 18, 19, 20, or 21 on field 1, field 2, or both fields. See the TSP1 Instruction Manual to determine the VITS Key line and field programming for specific module locations of the TSG7.

An external VITS Key may be applied to the TSG7 via the 1410 REMOTE connector, J41. Table 3-3 shows the correct pin number on J41 for each module location the TSG7 may be installed in.

CALIBRATION PROCEDURE

INTRODUCTION

The procedure in this section serves as a guide to perform a complete calibration of the TSG7. Section 2 includes a Performance Check procedure that checks those characteristics that can be checked without removing the instrument from the mainframe enclosure and without removing protective cabinet panels. To determine if the instrument requires calibration, the Performance Check procedure should be performed before starting. Certain items in the Calibration Procedure require checking before or during adjustment. In these cases, the check procedure will be described, or reference will be made to the appropriate step in the Performance Check procedure.

The procedure described here carries into checks that require access to the instrument internal areas. Limits, tolerances, and waveforms appearing in this procedure are adjustment guides and are not intended as instrument specifications, except as listed in Section 2, Specification.

The TSG7 front-panel control names in the text are capitalized; for example, BURST. Control and connector names on test equipment and internal controls or adjustments in the TSG7 module have only the first letter capitalized; for example, 1480 Mag control, or test oscilloscope Time/Div., except when they are used as generic terms. Examples of generic terms are: sweep rate, deflection factor, output voltage, etc.

A short-form procedure is provided to aid in performing calibration of the TSG7. It may be used as a calibration guide by the experienced calibrator, or it may be used as a record of calibration. Since the step numbers correspond to those in the complete procedure, this short-form procedure also serves as an index to the complete calibration procedure.

TEST EQUIPMENT

The capabilities of the test equipment described in the following list are the minimum required to check the instrument to specification. 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. Test Oscilloscope

Time Base. Sweep range from 10 ns/div to 5 ms/div, with provisions for internal and external television triggering, and capable of triggering on sine waves to 4 MHz.

Amplifier. Bandwidth, dc to 30 MHz; minimum deflection, 1 mV/div; two input channels with provisions for independent or differential operation.

For example, a TEKTRONIX 7603 Oscilloscope with 7B53A Dual Time Base, 7A26 Dual Trace Amplifier, and 7A13 Differential Comparator. Also, a 10× probe, P6106 (Tektronix Part No. 010-6106-03).

2. Waveform Monitor

Capable of viewing line rate and field rate signals, with a magnifier to measure rise time and pulse duration clamp tilt ≤0.05% 25 Hz to 50 kHz, cmrr ≥66 dB, and ±0.5% frequency response error at 3.58 MHz. For example, a TEKTRONIX 1480 W5F Waveform Monitor.

NOTE

The Video Amplitude Calibration Fixture (Item 6) and a TEKTRONIX 1480-Series Waveform Monitor equipped with custom modification W5F, provide a measurement system with a tolerance at least three times better than luminance and chrominance amplitude performance requirements. If a waveform monitor (without modification W5F) that has 46 dB common-mode rejection ratio and 2% frequency response is substituted, tolerances will be degraded to about 0.5% for luminance amplitude, and 2.67% for chrominance amplitude measurements.

Using the TEKTRONIX 1480-Series Waveform Monitor calibrator and multi-turn potentiometer (previously specified for TSG1) yields tolerances of up to 2% for luminance and 5% for chrominance amplitude measurements.

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 Leveled Sine-Wave Generator in a TEKTRONIX TM 500-Series Mainframe.

4. Spectrum Analyzer (optional)

Capable of measuring the harmonics of color subcarrier to −40 dB of the fundamental.

For example, a TEKTRONIX 7L12.

5. Vectorscope

Capable of measuring phase difference of less than 0.5° between two signals at color subcarrier frequency.

For example, a TEKTRONIX 520A NTSC Vectorscope.

6. Video Amplitude Calibration Fixture (VAC)

Capable of measuring luminance and chrominance amplitudes from 0.1 mV to 999.9 mV, ±0.05% accuracy. Tektronix Part 067-0916-00 with TEKTRONIX TM 500-Series mainframe.

7. Subcarrier Harmonic Rejection Filter

For use with VAC. Tektronix Part No. 015-0407-00.

8. 75 Ω Precision Termination (0.025%)

For use with VAC. Tektronix Part No. 011-0102-01.

9. Attenuator, 0.6%

For use with VAC. Tektronix Part No. 011-0134-00.

10. Return Loss Bridge

Tektronix Part No. 015-0149-00.

11. 75 Ω Coaxial Cable, Low Loss (two required)

Length, 42 inches; connectors, bnc; impedance, 75 Ω. Tektronix Part No. 012-0159-00.

12. 75 Ω End-Line Termination, 0.2% (two required)

Tektronix Part No. 011-0102-00.

13. 75 Ω In-Line Termination, 0.2%

Tektronix Part No. 011-0103-02.

14. 50 Ω to 75 Ω Minimum Loss Attenuator

Tektronix Part No. 011-0057-00.

15. 75 Ω 10× Attenuator

Tektronix Part No. 011-0061-00.

16. Extender Circuit Board

Tektronix Part No. 670-4441-02. (Supplied as a standard accessory with the 1410 Mainframe.)

Table 4-1
SHORT-FORM CALIBRATION PROCEDURE

Step	Parameter	Requirement	Adjust
1.	Adjust Luminance Gain	285.7 mV, ±2.86 mV	R449
2.	Adjust DC Level	0 V, ±50 mV	R459
3.	Adjust Color Bar (Wide-Band) Filter Response	Best transient response with rise time of 130 ns, +20 ns, −10 ns	L484, L487
4.	Adjust −IQ White (Narrow-Band) Filter Response	Best transient response with rise time of 250 ns, ±37.5 ns	L464, L467
5.	Adjust Residual Subcarrier Amplitude	2.5 mV or less	R402, R403, C371, C373
6.	Check/Adjust Chrominance Bandpass Filter Response	Straight lines between vectors, null at green-magenta transition, minimum harmonic content	L357, L367
7.	Adjust B−Y and R−Y Filter Response and Spurious Subcarrier Amplitude	Best transient response with 32 mV or less spurious subcarrier during sync, end of H blanking, and start of white bar	L424, L444, L432, L442
8.	Adjust 0°–180° Switch Phase	0.5° or less	C351
9.	Adjust Quadrature Phase	Minimum difference in amplitude on consecutive lines	L365
10.	Adjust Color Bar Luminance Amplitudes	1% or 1.5 mV, whichever is greater	
	75% Ampl. 7.5% Setup		Green–R289 Red–R298 Blue–R299
	75% Ampl. 0% Setup		Check
	100% Ampl. 0% Setup		Check
	100% Ampl. 7.5% Setup		Check
11.	Check V^{CB} Voltage	−10.1 V, ±0.2 V	Check
12.	Adjust White Reference Amplitude	714.3 mV, ±7.14 mV	R278
13.	Adjust EIA −IQ White Amplitude	714.3 mV, ±7.14 mV	R279
14.	Check SMPTE Black Set Signal Amplitude	Setup + and − 27.1 mV to 30.1 mV	Check
15.	Adjust Chrominance Gain	285.7 mV, ±8.6 mV	R379
16.	Adjust R−Y and B−Y Chrominance Amplitudes	R−Y and B−Y within 1% with red chrominance bar as reference	Green–R258 and R208 Blue–R248 and R219 Red–R249 and R209
17.	Check Chrominance Amplitudes	3% total, 1% relative	Check
18.	Adjust −I and Q Chrominance Amplitudes (75% Ampl, 7.5% Setup)	3% absolute, 1% relative	R227, R228, R237, R269
19.	Adjust Chrominance-to-luminance Delay	20 ns or less	R179
20.	Adjust Subcarrier Phase	Within 10° of 1410 phase	L317, C318
21.	Check Isolation	40 dB or greater	Check

PROCEDURE

Install the TSG7 Color Bars Output circuit board on the extender to gain access to the adjustments and test points in the following procedure. Carefully align the board pin connectors to ensure good electrical contact.

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

To locate a particular adjustment or test point, fold out the Adjustments and Jumpers Locations illustration in Section 8.

1. Adjust Luminance Gain

a. Connect the Color Bars rear-panel MODULE OUTPUT connector to the 1480 Ch A input, and terminate the other Ch A loop-through input with the precision 75 Ω termination. Connect the VAC output to the Ch B input of the 1480; do not terminate (see Fig. 4-1).

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

System Select	NTSC
Preset Group	7.5–50 (Blue Scale)
Preset Level	40
Reference Offset	LUM/SYNC −SYNC
Amplitude	FULL AMP
Setup Select	No SETUP
Preset/Manual	Preset

c. Set the 1480 controls as follows:

Input	A−B, DC
Response	Flat
Volts Full Scale	1.0
DC Restorer	Off

d. Position the reference level and sync tip onto the 1480 screen (Vertical Position).

e. ADJUST—R449 to match sync tip and reference level (285.7 mV).

2. Adjust DC Level

a. Set the test oscilloscope for a deflection factor of 10 mV/div with dc input coupling.

b. Connect the TSG7 MODULE OUTPUT to the test oscilloscope input via a 75 Ω cable and 75 Ω termination.

c. Switch the input coupling of the test oscilloscope to Gnd (ground), and vertically position the trace to the crt centerline. Switch the input coupling back to dc.

d. ADJUST—R459 (DC Level) for 0 volts blanking level (set trace to crt centerline).

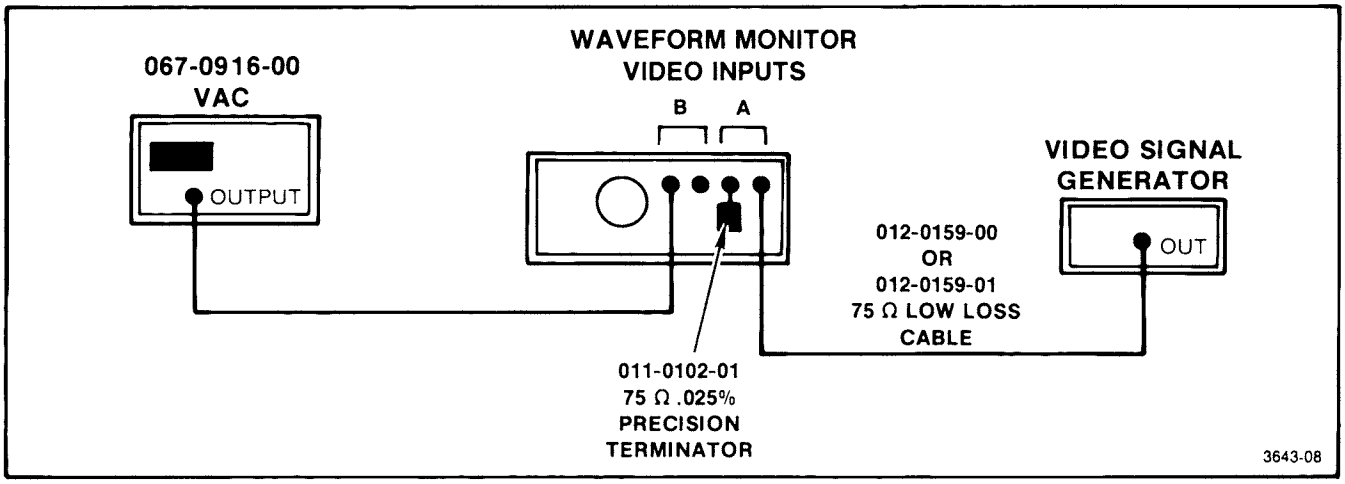


Fig. 4-1. Connecting the Video Amplitude Calibrator and TSG7 for luminance measurements.

3. Adjust Color Bar (Wide-Band) Filter Response

a. Equipment connections remain the same as in Step 2.

b. Press in the TSG7 AMPL, WHITE REF, R−Y, and B-Y push buttons.

c. Set the test oscilloscope sweep rate to view the white reference bar, and set the deflection factor for several divisions of vertical deflection.

d. ADJUST—L484 and L487 (Wide Band Filter) for best transient response on the white bar, with minimum aberrations. Check rise time of the white bar. Rise time should be 130 ns, +20 ns, −10 ns.

4. Adjust −IQ White (Narrow-Band) Filter Response

a. Equipment connections remain the same as in Step 2.

b. Press in the TSG7 COLOR BARS EIA push button.

c. Set the test oscilloscope sweep rate to view the −IQ white bar, and set the deflection factor for several divisions of vertical deflection.

d. Move the jumper on P359 (Color Bars Output board) from pins 2 and 3 to pins 1 and 2 (this will remove all chrominance from the display and facilitate adjustment).

e. ADJUST—L464 and L467 (Narrow Band Filter) for best transient response on the −IQ white bar, with minimum aberrations. Check rise time of the −IQ white bar. Rise time should be 250 ns, ±37.5 ns.

f. Replace the jumper on P359 to pins 2 and 3.

5. Adjust Residual Subcarrier Amplitude

a. Connect the TSG7 MODULE OUTPUT to the 520A Vectorscope Ch A input via a 75 Ω cable. Set the vectorscope for Ch A, Aϕ, and Vector display. Set the vectorscope Ch A Gain switch and variable controls for maximum gain. Set the TSG7 PHASE (R−Y) to ALT.

b. Connect the other Ch A loop-through input of the vectorscope to the + Input of the 7A13 Differential Comparator via a 75 Ω cable, terminated in 75 Ω at the + Input connector. Set the 7A13 BW (bandwidth) to 5 MHz.

c. ADJUST—R403 (R−Y Balance) and C371 (Resid Subcr) to bring the two residual vectors [−(R−Y) and +(R−Y)] together (not necessarily zero residual subcarrier) on the vectorscope display.

d. ADJUST—R402 (B−Y Balance) and C373 (Resid Subcr) for minimum residual subcarrier on both (+) and (−) phases of the R−Y ALT signal on the test oscilloscope display. Residual subcarrier should be typically 1 mV or less.

6. Check/Adjust Chrominance Bandpass Filter Response

a. Press in the Horiz Unlock push button on the SPG front panel. Press in the Y and /REVERSE push buttons on the TSG7.

b. Disconnect the 75 Ω cable and 75 Ω termination from the 7A13 + Input connector. Connect the 75 Ω cable to the 1480 Waveform Monitor Ch A input. Terminate the other Ch A loop-through input with the 75 Ω termination. (The Color Bars MODULE OUTPUT should still be looped through the vectorscope Ch A loop-through connectors as described in Step 5.)

NOTE

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

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. 4-2a. Incorrect adjustment of the Bandpass Filter is shown in Fig. 4-2b.

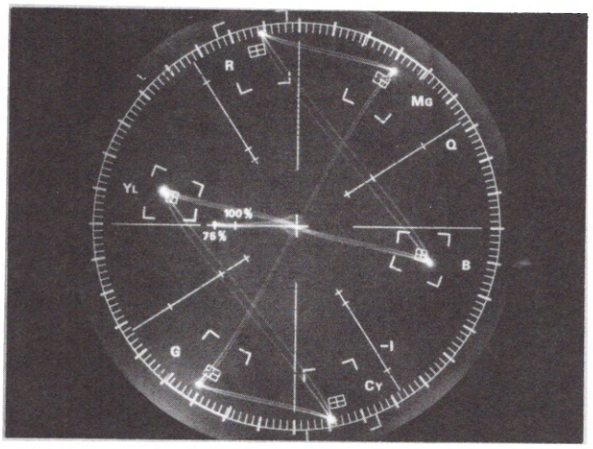
e. CHECK—for a waveform monitor display similar to that shown in Fig. 4-3a. Incorrect adjustment of the Bandpass Filter is shown in Fig. 4-3b.

f. CHECK—that harmonics are 30 dB or greater down from the chrominance subcarrier fundamental, using the spectrum analyzer. Figure 4-4 shows the spectrum analyzer display.

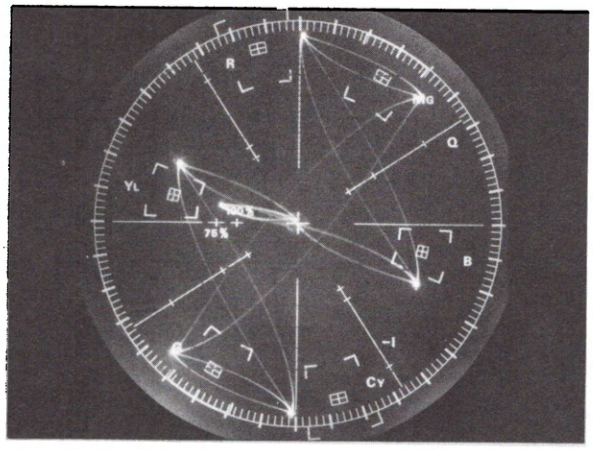
NOTE

The adjustments in this step affect the harmonic content of the output signal. No adjustment from the original calibration should be attempted without using a spectrum analyzer.

g. ADJUST—L357 and L367 (Chrominance Bandpass) for straight lines on the vector display (Fig. 4-2a), and for a null at the green-magenta crossover point on the waveform monitor display (Fig. 4-3a). Check the spectrum analyzer display to be sure that any adjustment does not result in greater harmonic content in the signal, as described in part f and illustrated in Fig. 4-4. Inductor L357 affects primarily harmonics, while L367 has more affect on transient response. However, there is considerable interaction between the two adjustments.



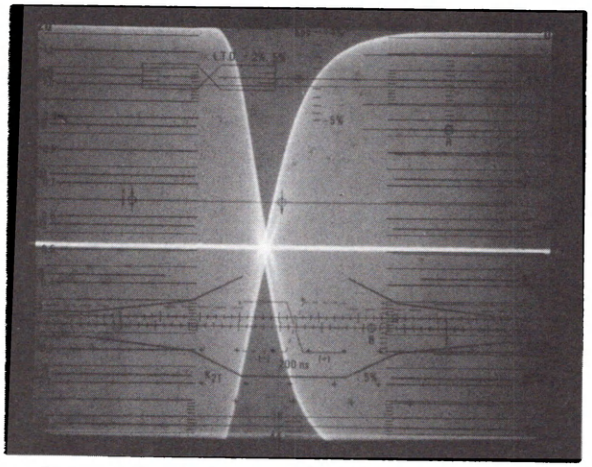
a. Correctly adjusted



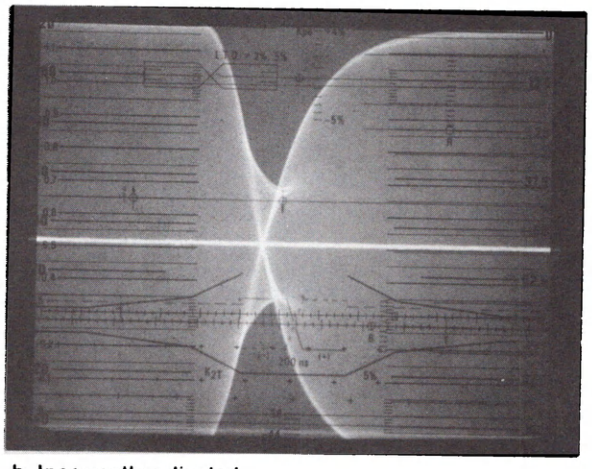
b. Incorrectly adjusted

2103-12

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



a. Correctly adjusted



b. Incorrectly adjusted

2103-13

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

@

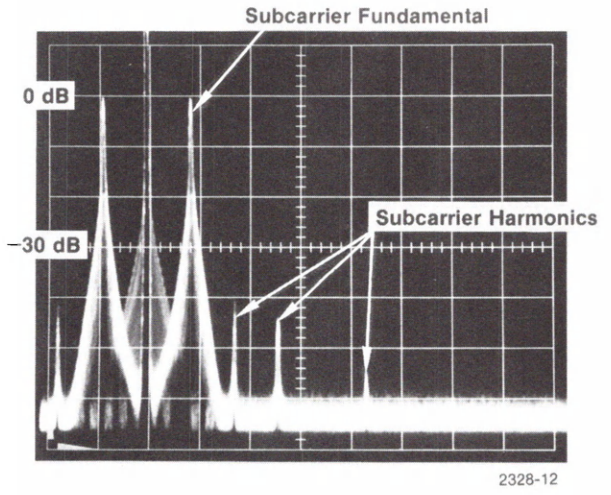


Fig. 4-4. Chrominance Bandpass Filter spectrum analyzer display.

7. Adjust B−Y and R−Y Filter Response and Spurious Subcarrier Admplitude

a. Press in the TSG7 FULL FIELD push button, the Y push button, and the R−Y push button. The B−Y push button should be set to the out position.

b. Connect the Color Bars MODULE OUTPUT to the test oscilloscope vertical input via a 75 Ω cable and a 75 Ω termination. Set the test oscilloscope BW (bandwidth) to Full.

c. ADJUST—L424 + B−Y and L444 − B−Y for best shaping of the B−Y chrominance envelope and minimum spurious B−Y subcarrier at the beginning of the white bar. Adjust C211 (B-Y Matching) for minimum ringing at the start of the white bar.

d. Press in the B−Y push button, and release the R−Y push button.

e. ADJUST—L432 + R−Y and L442 − R−Y for best shaping of the R−Y chrominance envelope and minimum spurious R−Y subcarrier at the beginning of the white bar. Adjust C221 (R-Y Matching) for minimum ringing at the start of the white bar.

f. Leave the B−Y push button pressed in (OFF), and press in the R−Y and PHASE (R−Y) ALT push buttons.

g. Set the test oscilloscope deflection factor to 10 mV/div, and set the sweep rate to view sync, H blanking, and the start of the white bar.

h. CHECK—for a spurious subcarrier amplitude of 32 mV (−30 dB) or less (3.2 major divisions or less) during sync, the end of H blanking, and the start of the white bar.

i. ADJUST—L424, L444, L432, and L442 slightly to optimize burst shaping and to minimize spurious subcarrier.

NOTE

Adjustments in Step 6 and 7 may interact. Check and repeat adjustment if necessary.

8. Adjust 0°—180° Switch Phase

a. Press in the TSG7 FULL FIELD, Y B−Y, and PHASE (R−Y) ALT push buttons.

b. Connect the TSG7 MODULE OUTPUT to the vectorscope Ch A input, and terminate the other loop-through input in 75 Ω. Set the vectorscope controls for a vector display.

c. ADJUST—C351 (Switch Phase) for minimum dot separation in the display (0.5° or less) as shown in Fig. 4-5a. Use the vectorscope Calibrated Phase dial to measure any error.

9. Adjust Quadrature Phase

a. Press in the TSG7 FULL FIELD, Y, and PHASE (R-Y) ALT push buttons.

b. Connect the Color Bars MODULE OUTPUT to the 1480 Waveform Monitor Ch A input, and terminate the other Ch A loop-through input in 75 Ω.

c. Set the 1480 Response to 3.58 MHz, and Volts Full Scale to 0.2.

d. ADJUST—L365 (Quad Phase) for minimum difference in green or magenta chrominance amplitudes (4.4 mV max.) (see Fig. 4-6). The R scale on Graticule A is 2.85 mV/div at 0.2 V Full Scale.

e. Set the 1480 Response to Flat.

10. Adjust Color Bar Luminance Amplitudes

a. Press in the TSG7 B−Y, R−Y, SETUP, and AMPL push buttons. Check that the FULL FIELD button is pressed in.

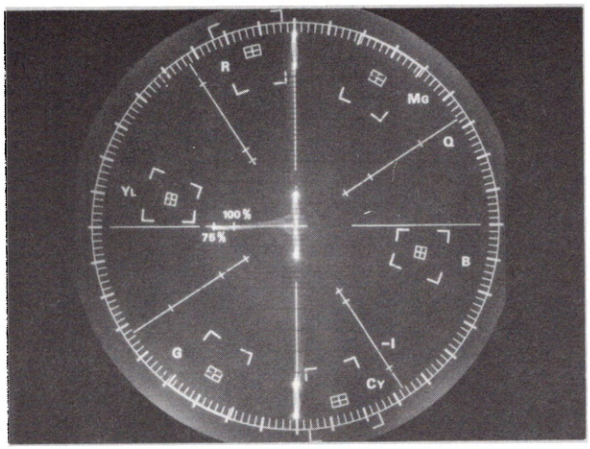
b. Connect the TSG7 MODULE OUTPUT to the 1480 Waveform Monitor Ch A input, and terminate the other Ch A loop-through input with the precision 75 Ω termination. The VAC should still be connected to the 1480 Ch B input.

c. Set the VAC front-panel control as follows:

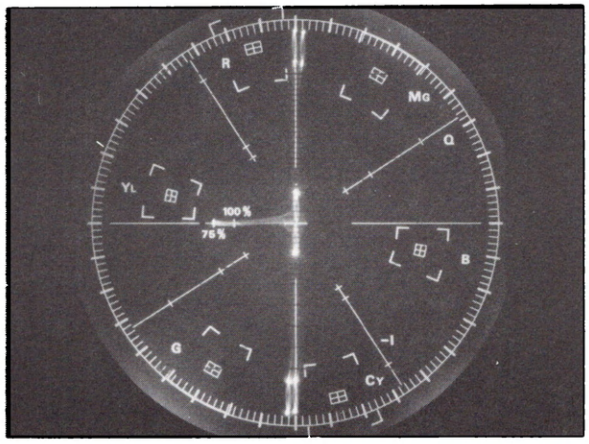
System Select	NTSC
Preset Group	CBLUM
Preset Level	GN
Reference Offset	LUM/SYNC +LUM
Amplitude	Reduced AMP
Setup Select	Setup
Preset/Manual	Preset

d. Set the 1480 controls as follows:

Input	A−B, DC
Response	Flat
Volts Full Scale	1.0
DC Restorer	Off



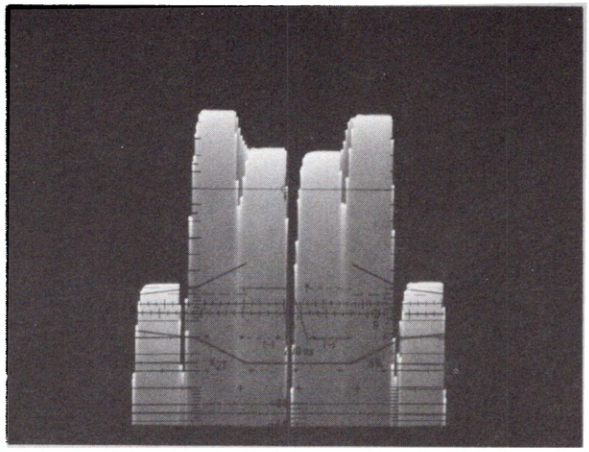
a. Correctly adjusted



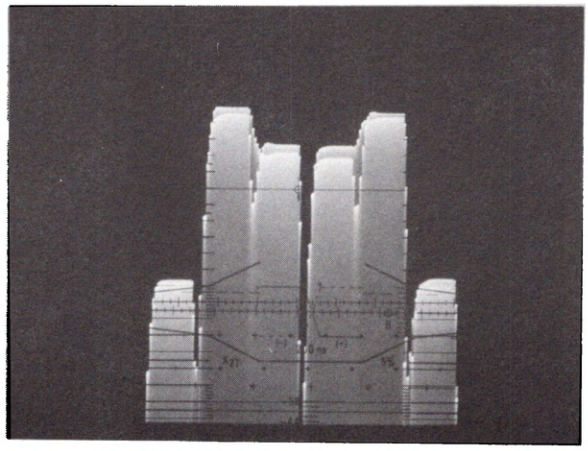
b. Incorrectly adjusted

2103-15

Fig. 4-5. 0° — 180° Switch phase vectorscope display.



a. Correctly adjusted



b. Incorrectly adjusted

2103-16

Fig. 4-6. Quadrature Phase waveform monitor display.

e. Locate the green luminance level (4th step from top), center step with 1480 Position Control, and then increase the 1480 Volts Full Scale to 0.2 and recenter the step.

f. ADJUST—R289 (green) for a match of reference (baseline) and −reference (green luminance step).

g. Push the VAC RD Preset Level and locate the red luminance level (3rd step up from the blanking level) by using the 1480 Vertical Position.

h. ADJUST—R298 (red) for a match of reference (baseline) and −reference (red luminance step).

i. Push the VAC VU Preset Level and locate the blue luminance level (2nd step up from blanking level) by using the 1480 Vertical Position.

j. ADJUST—R299 (blue) for a match of reference (baseline) and −reference (blue luminance step).

k. CHECK—all luminance levels using Table 4-2, the VAC Preset Levels, and Variable.

l. If the luminance levels do not make the tolerances listed in Table 4-1, perform optional step 11.

11. Check V^{CB} Voltage (Optional if Errors in Luminance Amplitudes)

a. Connect the 10× probe tip from the Differential Comparator plug-in to TP198 on the Color Bars Logic board. The Differential Comparator should be set for comparator (Vc) measurements.

b. Press in the TSG7 AMPL and SETUP push buttons (75% and 7.5%).

c. CHECK—that V^{CB} is −10.1 V, ±2% (−9.9 V to −10.3 V).

NOTE

The following V^{CB} voltages should be within 2% of the error tolerance of each other. Apply V^{CB} voltage found in part c to the formula:

Measured Value ÷ Standard Value × 100 = V^{CB} relative voltage in %, where the standard value is in V^{CB} found in part c.

Example: Assume that the 75%, 7.5% V^{CB} voltage measures −10.2 V. Applying the formula: −10.2 ÷ −10.1 × 100 = 101%.

Note that the 75%, 7.5% V^{CB} voltage is 1% above the standard value. All other voltages in the following parts should be within 2% of their relative V^{CB} voltage.

d. Disengage the AMPL push button (100% and 7.5%).

Table 4-2
TSG7 LUMINANCE AMPLITUDES

TSG7 Amplitudes	AMPL SETUP	75% 7.5%	75% 0%	100% 0%	100% 7.5%	
VAC Setting	AMP	Reduced	Reduced	Full	Full	
	Setup	Setup	No Setup	No Setup	Setup	
Check or Adjust	**Color**	**Measured Amplitude-Between**				**VAC Button**
Check	Black	52.1-55.1 mV	0 ±1.5 mV	0 ±1.5 mV	52.1-55.1 mV	BK
Adj R299	Blue	106.6-109.6 mV	57.4-60.4 mV	77.1-80.1 mV	124.8-127.8 mV	BU
Adj R298	Red	200.2-204.2 mV	159.1-162.3 mV	212.2-216.4 mV	249.3-254.3 mV	RD
Check	Magenta	254.1-259.3 mV	217.4-221.8 mV	290.0-295.0 mV	321.3-327.7 mV	MG
Adj R289	Green	342.4-349.4 mV	312.9-319.3 mV	419.3-423.5 mV	439.0-447.8 mV	GN
Check	Cyan	396.4-404.4 mV	371.2-378.8 mV	495.0-505.0 mV	510.9-521.3 mV	CY
Check	Yellow	489.7-499.5 mV	472.0-481.6 mV	629.3-642.1 mV	634.7-647.5 mV	YL
Check	White	543.6-554.6 mV	530.3-541.1 mV	707.2-721.4 mV	707.2-721.4 mV	WH

Note: R289, R298, and R299 can be adjusted, within tolerances, to help bring in other color luminance levels.

e. CHECK—for V^{CB} of −13.4 V, ±2%.

f. Disengage the SETUP push button (100% and 0%).

g. CHECK—for V^{CB} of −14.6 V, ±2%.

h. Press in the AMPL push button (75% and 0%).

i. CHECK—for V^{CB} of ±10.9 V, ±2%.

12. Adjust White Reference Amplitude

a. Press in the TSG7 AMPL (75%) and WHITE REF (100 IRE) push buttons. Be sure the Y push button is ON (push button out).

b. Use the same equipment hookup and 1480 Waveform Monitor settings as described in Step 1 part c.

c. Set the VAC to Full Amplitude.

d. ADJUST—R278 (White) for a white reference level of 714.3 mV.

13. Adjust EIA −IQ White Amplitude

a. Use the same VAC settings as step 12.

b. Press in the TSG7 EIA push button.

c. Set the 1480 to 15 lines and rotate the Var Line Selector until the EIA −I,W,Q,B signal is displayed (see Fig. 4-7).

d. ADJUST—R279 for a white amplitude of 714.3 mV.

14. Check SMPTE Black Set Signal Amplitude

a. Set the SPG (SPG1 or 2) to EXT GENLOCK and check that burst and chrominance are removed from the SMPTE −I,W,Q,B signal.

b. Set the VAC to Preset Group 7.5-50, Preset Level 7.5 (Blue Scale).

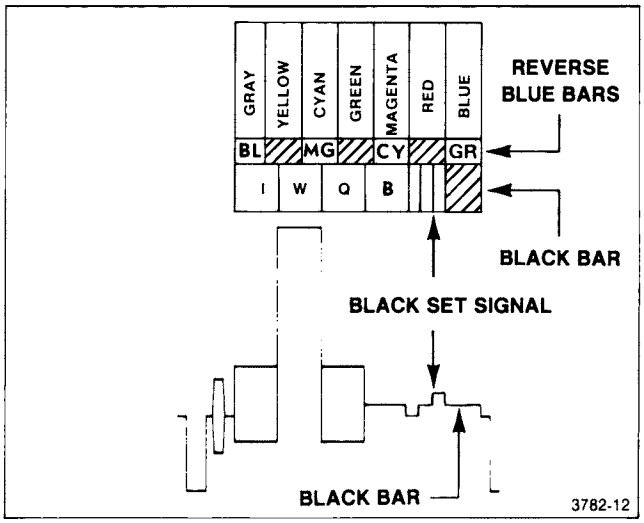


Fig. 4-7. The SMPTE −I,W,Q,B signal with Black Set.

c. CHECK—for + and − Black Set signal amplitudes of 27.1 to 30.1 mV by adjusting VAC Variable to match reference (baseline) and −reference (Black Set signal level).

15. Adjust Chrominance Gain

a. Push the SPG Genlock push button (internal).

b. Connect the VAC and the TSG7 MODULE OUTPUT to the 1480 as shown in Fig. 4-8.

c. Set the VAC front-panel controls as follows:

System Select	NTSC
Preset Group	7.5-50 (Blue)
Preset Level	40 (Blue Scale)
Reference Offset	CHR P-P −Sync
Amplitude	Full Amp
Setup	No Setup
Preset/Manual	Preset

d. Push the 1480 Line Selector push button Off.

e. Push the TSG7 FULL FIELD push button, and all other push buttons in the out position.

f. ADJUST—R379 (Chrominance Gain) so that the negative peak of burst on the + reference offset and the positive peak of burst on the − reference offset are touching (285.7 mV).

16. Adjust R−Y and B−Y Chrominance Amplitudes

a. Press the TSG7 AMPL, SETUP, Y, and B−Y push buttons.

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

System Select	NTSC
Presetup Group	CB R−Y/V D'R
Preset Level	RD
Reference Offset	CHR P-P −Sync
Amplitude	Reduced
Setup	Setup
Preset/Manual	Preset

c. ADJUST—R−Y chrominance amplitudes as indicated in Table 4-3. Adjust R249 (red), R258 (green), and R248 (blue).

d. CHECK—for no subcarrier on the white bar. If subcarrier amplitude on the white bar is greater than 2.5 mV, recheck equipment and connections and recheck all R−Y chrominance amplitudes. If subcarrier amplitude on the white bar is less than 2.5 mV, readjust R248 slightly for minimum subcarrier.

e. CHECK—amplitude of the R−Y chrominance of the other color bars and burst as indicated in Table 4-3. Use the red chrominance bar as the reference amplitude. Step 18 in the Performance Check in Section 2 of this manual describes a technique for checking chrominance amplitudes relative to the red chrominance bar amplitude.

f. Press in the TSG7 R−Y push button, and release the B−Y button (to the ON position).

g. ADJUST—B−Y chrominance amplitudes as indicated in Table 4-3. Adjust R209 (red), R208 (green), and R219 (blue).

h. CHECK—for no subcarrier on the white bar. If subcarrier amplitude on the white bar is greater than 2.5 mV, recheck equipment and connections and recheck all B−Y chrominance amplitudes. If subcarrier amplitude on the white bar is less than 2.5 mV, readjust R219 slightly for minimum subcarrier.

i. CHECK—amplitudes of the B−Y chrominance of the other color bars and burst as indicated in Table 4-3. Use the red chrominance bar as the reference amplitude.

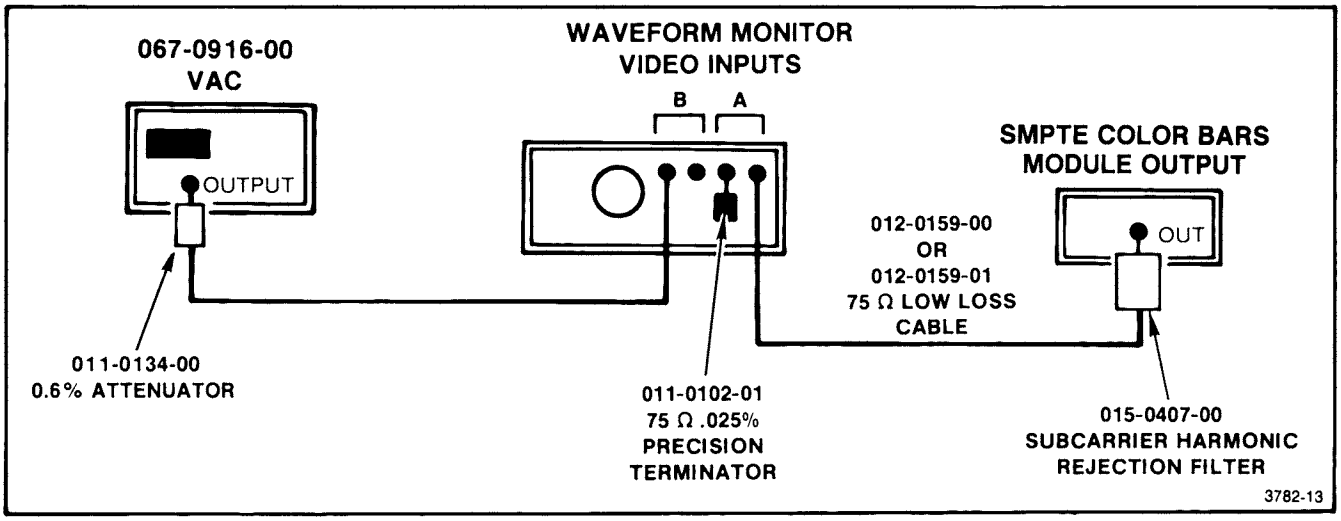


Fig. 4-8. Video Amplitude Calibrator connections for making chrominance measurements.

Table 4-3
R−Y and B−Y CHROMINANCE AMPLITUDES (75%, 7.5%)

VAC Preset Level	Amplitude (±1% Relative to Red)		
	R−Y Peak-to-Peak	B−Y Peak-to-Peak	Chrom. Peak-to-Peak
RD (Red)	612.9 mV (Adjust R249)	146.3 mV (Adjust R209)	630.1 mV
GN (Green)	513.9 mV (Adjust R258)	286.8 mV (Adjust R208)	588.5 mV
BU (Blue)	98.9 mV (Adjust R248)	433.1 mV (Adjust R219)	444.2 mV
WH (White)	Check for no modulation on white bar (See Step 16, part d)	Check for no modulation on white bar (See Step 16, part h)	2.5 mV or less
YL (Yellow)	98.9 mV	433.1 mV	444.2 mV
CY (Cyan)	612.9 mV	146.3 mV	630.1 mV
MG (Magenta)	513.9 mV	286.8 mV	588.5 mV
BK (Black)	0	0	2.5 mV or less

17. Check Chrominance Amplitudes (75%, 7.5%)

a. Set the VAC front-panel controls as follows:

System Select	NTSC
Preset Group	CB CHR
Preset Level	RD
Reference Offset	CHR P-P −Sync
Amplitude	Reduced
Setup	Setup
Preset/Manual	Preset

b. Press the TSG7 FULL FIELD, AMPL, and SETUP push buttons. All other push buttons out.

c. CHECK—chrominance amplitudes according to the Table 4-3, Chrom. Peak-to-Peak column.

18. Adjust −I and Q Chrominance Amplitude

a. Set the VAC front-panel controls as follows:

System Select	NTSC
Preset Group	XXXX
Preset Level	XXXX
Reference Offset	CHR P-P −Sync
Amplitude	Full Amp
Setup	No Setup
Preset/Manual	Manual
Lever Switches	155.6

b. Remove plug P269, and adjust R227 to match the −I chrominance + reference negative peak to the − reference positive peak.

c. ADJUST and CHECK—the chrominance amplitudes of the −I and Q signals as shown in Table 4-4.

Table 4-4
−I AND Q AMPLITUDES

(All amplitudes should be ±3% absolute and 1% relative to Red amplitude)

Check	Remove/ Replace	Amplitude	Tolerance (Absolute)	Adjust
$-I_B$	P269	155.6 mV	±4.67 mV	R227
$-I_R$	P199	239.6 mV	±7.19 mV	R269
−I		285.7 mV	±8.57 mV	Check
Q_B	P269	239.6 mV	±7.19 mV	R228
Q_R	P199	155.6 mV	±4.67 mV	R237
Q		285.7 mV	±8.57 mV	Check

19. Adjust Chrominance-to-Luminance Delay

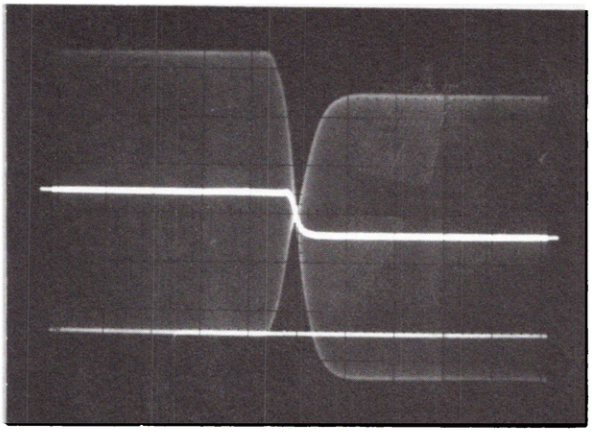
a. Connect the TSG7 MODULE OUTPUT to the 1480 Waveform Monitor Ch A input, and terminate the other Ch A loop-through input in 75 Ω. Set the 1480 Magnifier to .1 μs/Div.

b. Press in the TSG7 /Y REF push button.

c. Position the display so that the green-magenta transition coincides with a major graticule marking.

d. Press and hold in the Horiz Unlock push button on the SPG module.

e. ADJUST—R179 (Luminance Timing Delay) for a minimum delay between chrominance and luminance. Delay is indicated by any separation between the chrominance and luminance transition mid-points (see Fig. 4-9). The delay should not exceed 20 ns (1 minor horizontal graticule division).



2103-36

Fig. 4-9. Waveform monitor display showing minimum chrominance-to-luminance delay.

20. Adjust Subcarrier Phase

a. Connect the 1410 rear-panel Subcarrier output signal (J20) to the 520A Vectorscope Ext CW ϕ Ref input connector, and terminate the other Ext CW ϕ Ref loop-through input in 75 Ω.

b. Connect the other 1410 rear-panel Subcarrier output signal (J21) through a 75 Ω 10× attenuator and a 75 Ω cable (in that order) to the vectorscope Ch A input connector. Terminate the other Ch A loop-through input in 75 Ω.

c. Set the SPG1 or SPG2 to the internal mode of operation.

d. Set the 520A Vectorscope controls as follows:

Ch A, Full Field Aϕ, and Vector push buttons pressed in.

Ch A Gain control set to Cal, and the ϕ Ref switch set to Ext.

Rotate the Ch A Phase control to position the subcarrier vector at 180°.

NOTE

Do not move the vectorscope Ch A Phase control from this setting until completing this step.

e. Disconnect the 75 Ω cable where it attaches to the 10× attenuator that is connected to the 1410 Subcarrier (J21) connector. Connect this same cable to the TSG7 rear-panel MODULE OUTPUT connector, so that this signal is applied to Ch A of the vectorscope.

f. Set C318 (Subcarrier Phase) to mid-range.

g. ADJUST—L317 (Subcarrier Phase) to position the burst vector at 180°.

21. Check Isolation

a. Connect the TSG7 Color Bars MODULE OUTPUT to the test oscilloscope vertical input, via a 75 Ω cable and a 75 Ω termination.

b. Set the TSG7 for 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, alternately short and unshort the unused output pins of P416 (on A31 Color Bars Output board).

e. CHECK—that the TSG7 output signal changes amplitude 1% or less (40 dB or greater isolation) as the unused output is alternately terminated and shorted.

This completes the Calibration Procedure for the TSG7.

THEORY OF OPERATION

The TSG7 Theory of Operation is divided into two parts. The first, an overview, provides basic insight into the operation of the TSG7 by means of simplified block diagrams. The second part provides a more detailed discussion of individual circuits.

INTRODUCTION

Circuits in the TSG7 use the power supplies of the 1410 mainframe. Subcarrier, sync, blanking, and timing signals are from the SPG via the 1410 mainframe. The TSG7 circuits are grouped into two main categories; logic on diagrams 1 and 2, and output on diagram 3. The logic circuits are the timing and current drives for the output circuits. The output circuits are the filters, modulators, and output amplifiers.

BLOCK DIAGRAM DESCRIPTION

This description is in conjunction with Figs. 5-1, 5-2, and 5-3; simplified block diagrams. These diagrams are not complete, but rather are intended to convey the essence of TSG7 operation. A more detailed block diagram is contained in Section 9 of this manual.

Logic and Switching Circuits

Figure 5-1 provides a block diagram of the TSG7 Control and Timing Logic.

Mode Control. Six front-panel display push button switches control generation of the SMPTE, EIA, Full Field, and Split Field Color Bars test signals. These switches control mainframe drive signals for use in the Counters, Switching PROM, and signal drive circuitry. All test signals, except SMPTE and EIA color bars may be modified by the remaining front-panel control switches. The Vertical Interval Test Signals (VITS) may be altered by the B−Y, R−Y, sync, burst, and 90° switches only.

Switching PROM. Uses signals from the Mode Control circuitry and the SPG to control the Horizontal Timing

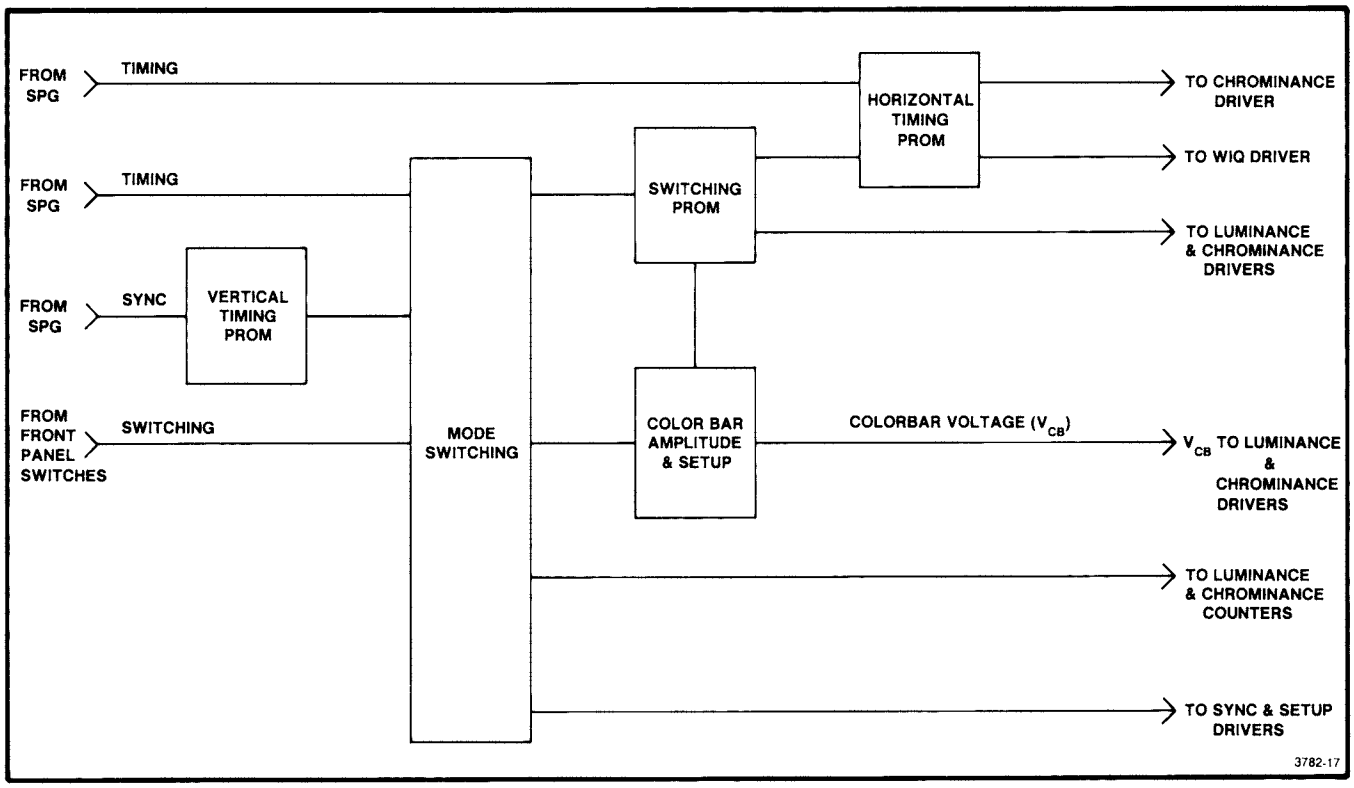


Fig. 5-1. TSG7 Timing and Control Logic.

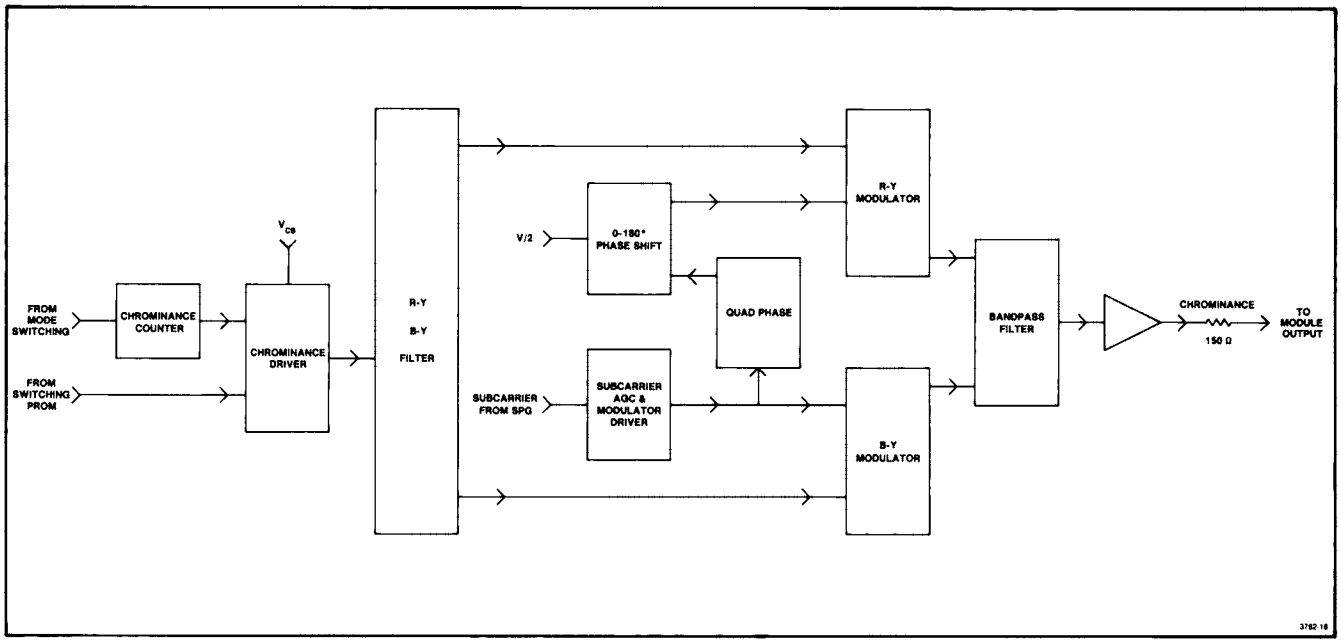


Fig. 5-2. TSG7 Chrominance generating and processing circuitry.

PROM. It also develops the B−Y and R−Y inhibit signals that go to the chrominance drive circuitry to inhibit chrominance during blanking and at other times.

Horizontal Timing PROM. Uses the horizontal rate signals from the SPG to develop timing for the −I,W,Q, Black Set signal, and the color bar clock.

Color Bar Amplitude and Setup. This circuit provides a selectable Color Bar Voltage (VCB) supply for the Chrominance and Luminance Drivers. VCB is changed by front-panel switches to provide a choice of 75% or 100% color bar amplitude and 0% or 7.5% setup.

Chrominance Path

Figure 5-2 provides a block diagram of the TSG7 chrominance processing path.

Chrominance Counter. Color bar clock, supplied by the Horizontal Timing PROM, and switching information, from Mode Switching, are used by the counter to derive the timing for the color bar chrominance.

Chrominance Drivers. The −I, Q, red, green, and blue signals drive current switches to form the R−Y and B−Y signal components.

B−Y, R−Y Filters. Used to shape the R−Y and B−Y signal components.

Subcarrier AGC, and Modulator Drive. Provide subcarrier with constant amplitude and fixed symmetry to the B−Y Modulator and Quad Phase circuits.

Quad Phase. Drives the R−Y Modulator with subcarrier that is shifted 90° from the B−Y subcarrier drive signal.

0—180° Phase Shifter. Controlled by the front-panel R−Y Phase switch, selects whether the quadrature phased subcarrier will be applied to the + or − subcarrier input of the R−Y Modulator.

R−Y and B−Y Modulators. Combine the modulating signals with the input subcarrier to provide modulated subcarrier of the proper phase and amplitude.

Bandpass Filter. Vectorially sums the R−Y and B−Y modulated signal and reduces or eliminates out of band harmonics.

Chrominance Amplifier. Sets the overall chrominance gain and provides the required low output impedance.

Luminance Path

Figure 5-3 represents the luminance processing path through the TSG7.

Luminance Counter. Color bar clock, supplied by the Horizontal Timing PROM, and switching information, from Mode Switching, are used by the counter to derive the timing for the color bar luminance. The clock to the Luminance Counter is delayed, and is adjustable, to compensate for the inherent delay in the chrominance processing circuitry.

Luminance Drivers. Set the luminance amplitudes through current switches. Color bars luminance is summed with current from the sync, setup, and black set current sources to form the composite luminance drive.

Wide Band Filter. Shapes the color bar luminance, setup (including Black Set), and sync drive signals.

Narrow Band Filter. Shapes the white, I, and Q (WIQ) drive signals.

Luminance Amplifier. The shaped signals, from the filters, drive this amplifier, which sets both gain and dc offset. The color bars signal chrominance and luminance are combined at the module output. The output is capable of driving two 75 Ω loads.

Detailed Discussion

The following detailed circuit descriptions are designed for use with the schematic diagrams in Section 9. Material is divided, first by diagram number and then by individual circuit blocks.

DIAGRAM 1
COLOR BAR LOGIC COUNTERS

Mode Switching

All front-panel push button switches are overridden by the EIA and SMPTE switches. Engaging either causes U129D, pin 11 to go high and disables the front-panel switch functions. A low on the VITS Key line overrides the front-panel switches, except for BURST, SYNC, 90°, B−Y,

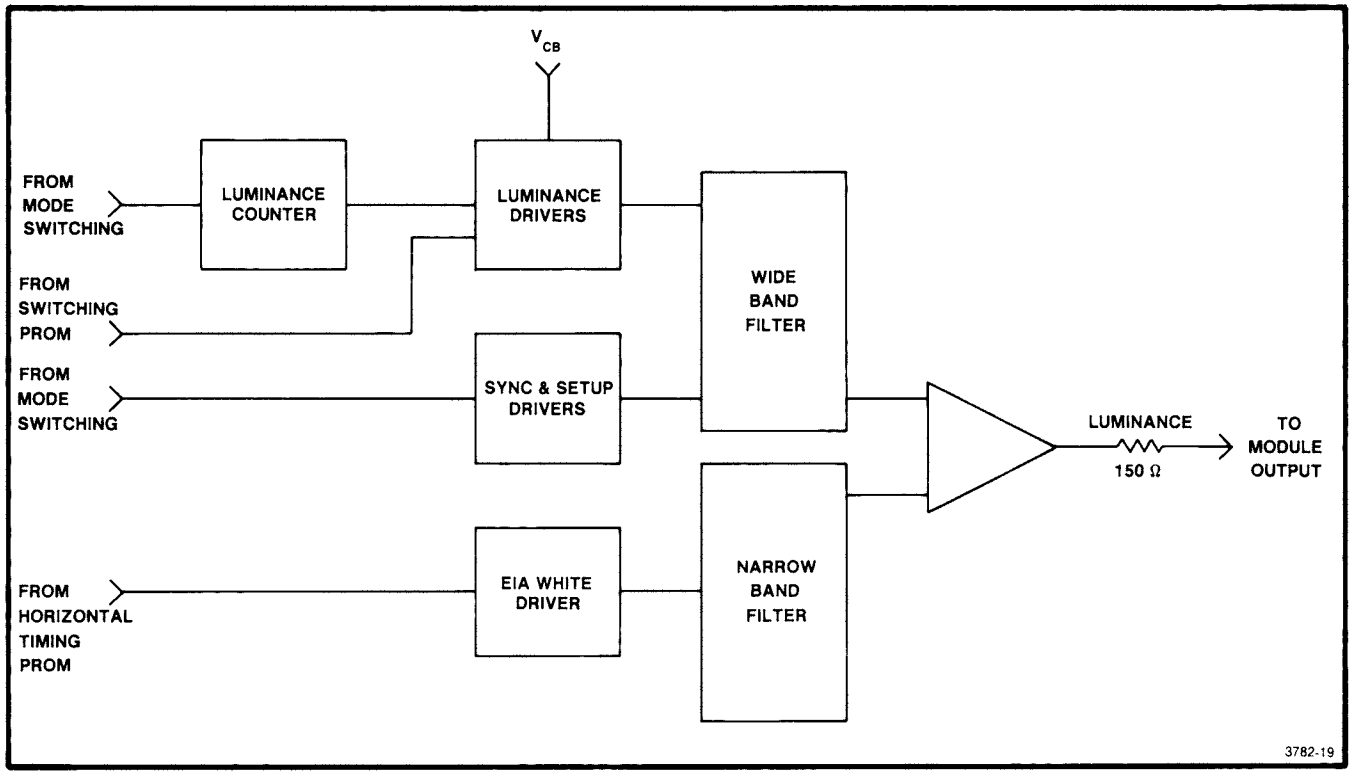


Fig. 5-3. Luminance generating and processing circuitry.

and R−Y, and generates a line of color bars signal on the selected VITS line.

Color Bars/Y Ref. When switch S106 is engaged, the inverted 1/2 V or 1/4 V signal (depending on the position of P155) is gated through U149B to U168A and then U169C to the load input of the Chrominance Counter, U179. A low from U169C then forces the counter into the load mode. This causes the counter outputs to be high during the second part of the field so chrominance information will not be generated.

/Red. When switch S105 is engaged, the 1/2 V or 1/4 V signal is gated through U149D to U168A and then U169C to the load input of the Chrominance Counter. The Red Reference signal is also gated through U166D and then U167C, to the data inputs of the counter as well as coupled through U169A, to the load input of the Luminance Counter, U175. The 1/2 V or 1/4 V signal is also gated through U129B and U167B to the Luminance Counter data inputs. In this manner, both counters are held in the load mode while the data inputs are set for red during the second part of the field.

The solid portion of the split field display can be programmed to any color by changing the data input wire straps; W174, W175, W178, W179.

U167B and C, in the Chrominance and Luminance Counter circuits, are used to change from the programmed color to white, during the second part of the field. With /Red selected, a low at interface pin 56 (the White Reference) will change the data inputs of both counters to a low state causing the second portion of the field to be white.

/Reverse. When switch S104 is engaged, the 1/4 V or 1/2 V signal is gated through U149A and then U167D to pin 5 of both coutners, U175 and U179. A high counts down, a low counts up. During reverse color bars, the counters are loaded high and then count down, starting from the second pulse. (The first color bar (clock pulse 1) is black for reversed color bars.) The counters are disabled during the first clock pulse by horizontal blanking, that is gated through U164C by the Reverse signal, to the enable inputs of the counters (pin 4). A high on pin 4 disables the counter.

EIA Display. When switch S108 is engaged, U129D output (SMPTE and EIA Enable) goes high, and the front-panel switches are disabled. This level is coupled to the Switching PROM (U162), pin 3, and in turn switches the Horizontal Timing PROM, U163, to EIA timing. IC U162 also generates the Switch (S) Inhibit signal, latched by U172, to disable the front-panel Amplitude and Setup switches. IC U162 also generates the Chrominance (C) Inhibit signal, which is also latched by U172.

The output of U129D (SMPTE and EIA Enable) is also used to gate the 1/4 V signal through U164A to disable color bar luminance during the −I,W,Q part of the EIA signal.

SMPTE Display. When switch S109 is engaged, the outputs of both U129C and D go high. These levels are also coupled to the Switching PROM, and in turn switches the Horizontal Timing PROM to SMPTE timing.

In this mode, U163 generates a chrominance inhibit signal (pin 14) that is used to inhibit chrominance for every other bar during SMPTE Reverse color bars. The Y, R, G inhibit signal is gated, at U157A, with the I/12 V signal (from the Vertical Timing PROM) to develop the chrominance inhibit at U162, pin 12.

VITS Generation. If a low is placed on the pin of the 1410 Remote Connector (J41) for the location where the TSG7 is plugged in, a VITS signal can be generated. The VITS Key must be generated during the vertical invterval at the desired line for the VITS signal. The signal is inverted by U166B and used to override the vertical blanking pulse at U168D. The VITS Key signal is also used to disable the Y switch at U149C. The output of U166B is also used to enable the Switching PROM, U162 pin 7, to produce the standard eight bar color bars program in the Horizontal Timing PROM, U163, during the VITS line.

Luminance Inhibit Logic, Sync, and Setup

The horizontal blanking, from the SPG, is buffered (U159D) and combined with vertical blanking (from U168D), and the switch inhibit signal (from U164B) and video disable (from U159A) at U147A. The output of U147A is inverted (U157B) and used to switch the Setup current source.

The horizontal blanking is combined with vertical blanking (from U168D), and 1/4 V (from U164A) at U147B to form one input to U177D. U177B gates the blue signal from the Chrominance Counter, U179, and the 1/12 V signal (from the Vertical Timing PROM, U155) to generate the inhibit for every other color bar during the SMPTE reverse color bars. U182 latches the inhibit signal at luminance time.

The outputs of U182 (pin 15) and U147B are "AND'd" in U177D to form a signal to inhibit luminance during blanking, −I,W,Q, and SMPTE reverse color bars. Resistor R137 and C138 at U168D are used to delay the rising edge of vertical blanking, to compensate for delay in the chrominance turn-off. This simultaneously turns off both chrominance and luminance at the end of the half-line. Diode CR137 prevents the falling edge from being delayed (see Fig. 5-4).

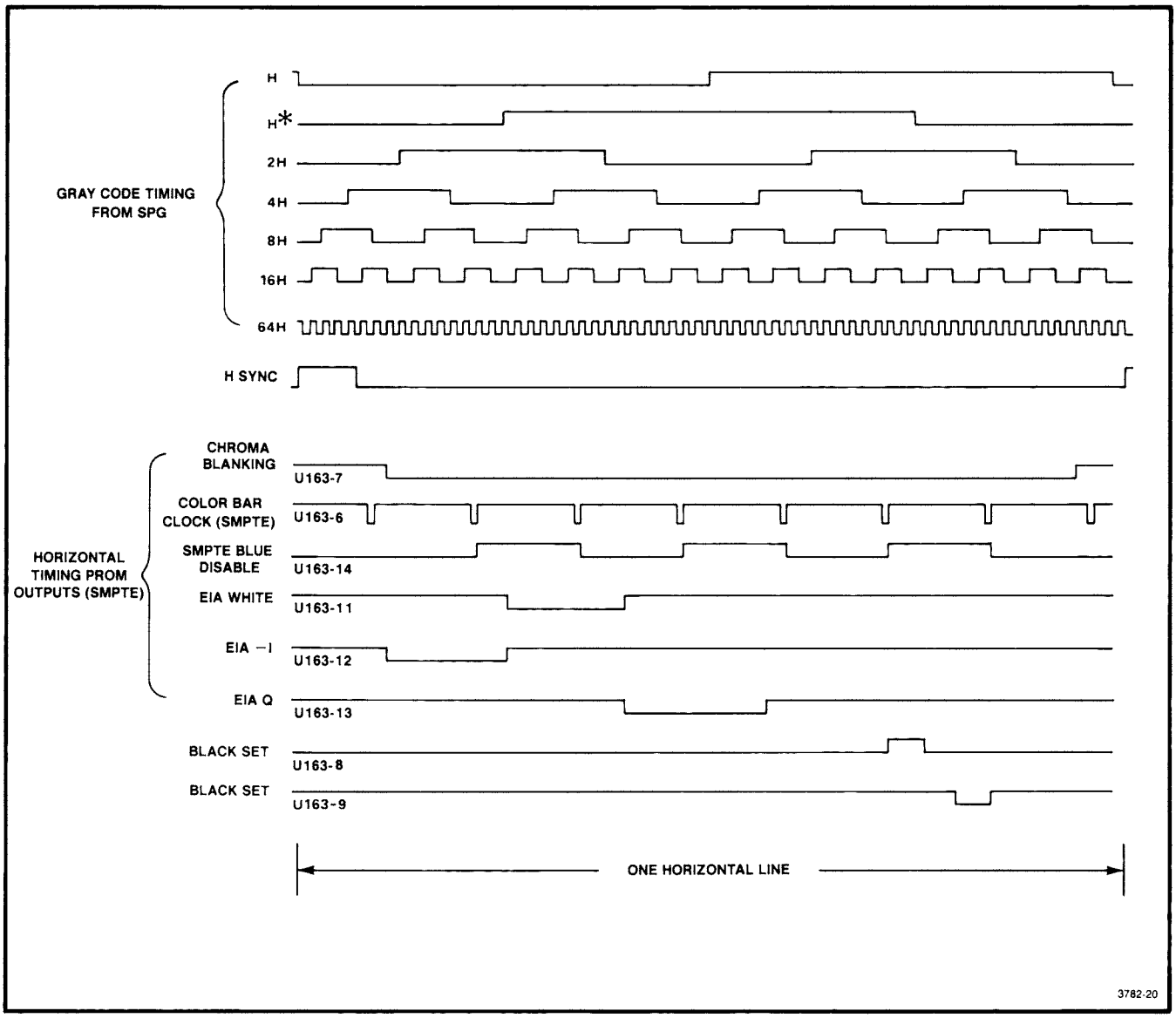


Fig. 5-4. Horizontal Time PROM outputs for SMPTE signal, also includes the input SPG Gray Code.

Video disable is buffered by U159A and then goes to U169B, U147A, U147B, U162, and U163. When video disable goes high, it turns off all luminance and chrominance drivers except sync.

Vertical Timing

The Vertical Timing PROM, U155, uses the sync count from U145 and develops 1/12, 1/4, and 1/2 field signals for use in timing the split field, −I,Q,W; and reverse SMPTE color bars displays. IC U145 is a dual, 4-bit asynchronous counter wired as a single 8-bit counter, counting sync pulses at the clock input, pin 1. Vertical blanking at pins 2 and 12 clear the counter (all outputs low); the count starts at the first sync pulse after vertical blanking. The outputs of U145 go to U155, a 256 X 4 PROM, containing a stored program to develop vertical timing. Pin 12 goes high during SMPTE reverse color bar time, pin 11 is high the last 1/2 of the field, and pin 10 is high the last 1/4 of the field.

Switching PROM

The Switching PROM, U162, is a 256 X 4 bit PROM that has a stored program using the front-panel switching information and timing information from the other two PROMs to generate four outputs. The C1 and C2 outputs from pins 9 and 10 are used to control the Horizontal Timing PROM. The pin 11 and 12 outputs are the chrominance inhibit (pin 12) and the switch inhibit (pin 11) that are used for switching during EIA and SMPTE color bars. All four outputs are latched; pins 11 and 12 by U172, and pins 9 and 10 by U182.

Horizontal Timing

The Horizontal Timing PROM, U163, (512 X 8) contains a stored program that uses seven horizontal rate gray-coded timing counts from the SPG to develop timing for the color bar clock, −I, EIA White, Q, and Black Set signals. These six PROM-generated signals are latched by U172. The luminance signals (EIA White and Black Set) are again latched, to the luminance time, by U182. In addition, the signal to disable chrominance during SMPTE, reverse bars, and a slightly wider horizontal blanking signal are also derived.

ICs U168B and C create a positive pulse at each transition of the 1 MHz rate. The positive edge of the pulses is delayed approximately 100 nsec, by U165, and used to clock U172 (latch). The delay allows for the delay through the Horizontal Timing Prom (U163).

Pins 18 and 19 of U163, the two Most Significant Bit (MSB) inputs, are used to control the timing mode for the Horizontal Timing PROM. They use the C1 and C2 outputs from U162 after latching by the Luminance Latch, U182. Figure 5-5 details the states of U163 for the SMPTE signal.

IC U163 (Horizontal Timing PROM) is a tri-state PROM; when pin 15 goes high, the outputs go to a high impedance state. Thus, the −I and Q output pins (12 and 13) are pulled low by R172 and R174 while the rest of the outputs are pulled high by R106 during video disable.

Chrominance and Luminance Counters

The Chrominance Counter, U179, generates the color bar chrominance timing signals. The Luminance counter is U175, and it generates the color bar luminance timing. The load inputs (pin 11) to U179 and U175 are driven by the inverted sync from the SPG. The clock for U179 is from U172, the latched output of the Horizontal Timing PROM, U163. The clock to U175 is the same signal, but delayed by approximately 260 ns by U165A to compensate for the inherent delay in the chrominance processing circuitry.

All outputs of the Chrominance and Luminance Counters, U179 and U175, are reset high during composite sync time, and normal color bar count begins when the color bar clock signal sets all outputs low (generates the white bar). The time between clock pulses determines the duration of chrominance and luminance for each color. There are eight clock pulses per line: the counters start at zero and count up to seven, and at the eighth positive clock edge all counter outputs are high (black). The next occurrence of inverted sync at the load inputs resets all outputs high and the counter is ready for the next line count to start. Since the clock output (U172-2) is also used to clock the EIA White latch, U182, the color bar clock will be a different sequence of pulses during −I, Q, and EIA White time, when the counter outputs are not used.

The enable inputs (pin 4) of both counters are driven by U164C. During standard color bars, this is low and the counters are always enabled. When reversed, sequence color bars are being generated, a high pin 9 input of U164C gates horizontal blanking to the enable inputs, and the counter is disabled during the first clock pulse; the counter then begins on the second clock pulse. It is necessary to start the count on the second clock pulse because the first color bar of the reversed sequence bars is black and the counter outputs must remain high. When SMPTE reverse bars are being generated, the first bar is blue and the counters are not disabled.

Reverse bars are generated by setting the counter down/up inputs (pin 5) high and the counters count down from seven to zero.

See Fig. 5-5 for a timing diagram of the operation of the Chrominance Counter, U179.

See Fig. 5-6 for a timing diagram of the operation of the Luminance Counter, U175.

Luminance Drive

Transistors Q178 (blue), Q277 (red), and Q265 (green) provide current to drive the luminance amplifier. Adjustable current drive to the transistors is through potentiometers R299, R298, and R289 that are connected to the color bar voltage (VCB). Varying the VCB provides a means of selecting the color bar luminance amplitude. VCB is varied by two front-panel push button switches, 100%–75% Amplitude and 0%–7.5% Setup.

Diodes CR293, CR284, and CR283 are current steering diodes driven by the outputs of the Luminance Counter. For instance, if pin 3 (blue) of U175 is high, CR293 turns on and steers current away from the emitter of Q278 and turns it off. If however, there is a low at the blue output of the counter (pin 3), current will flow in the collector of Q278. This current is added to the currents from Q277 and Q265 and a voltage which corresponds to the luminance level current at the output of the Wide Band Filter.

The 100 IRE white bar current is provided by Q264 unless diverted by CR272, CR273, CR274, or CR275. When the front-panel Amplitude switch is at 75% and the White Reference switch is at 100 IRE, Q264 turns on and provides additional current during white bar time. Diodes CR272, CR273, and CR275 form an "OR Gate" to turn off Q264 at any time except during white bar. White bar time is the only time that all the outputs of U175 are low. Signals from U129A and U177D are "OR'd" through U159B to ensure that Q264 is off during generation of SMPTE or EIA Color Bars and VITS. Potentiometer R278 connects to VCB and provides adjustable white current.

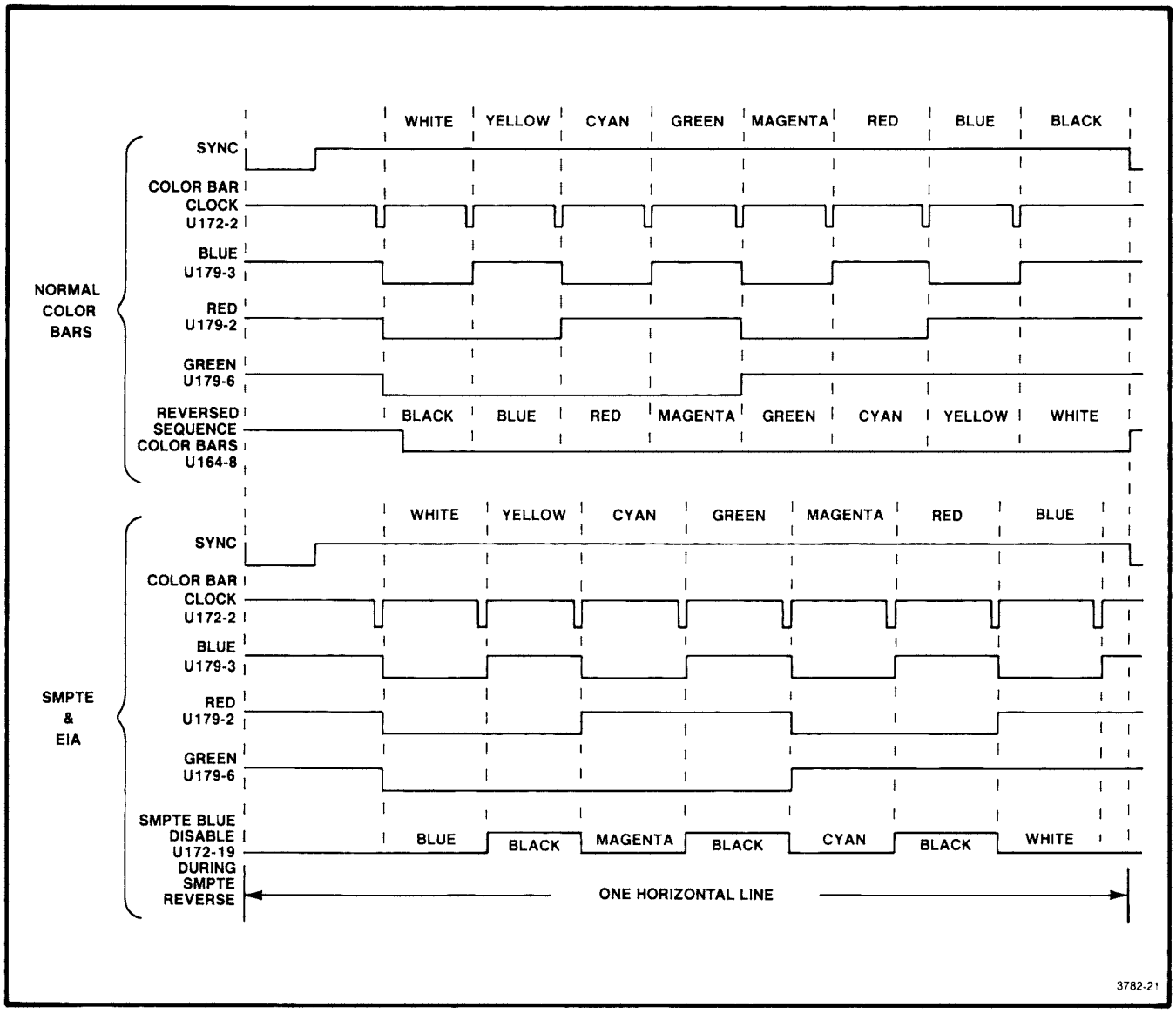


Fig. 5-5. Operation of the Chrominance Counter (U179). Shows both Normal and SMPTE and EIA signal relationships.

Sync and Setup Drivers

Composite sync and setup are added to the luminance signal by Q253 and Q256, respectively. Steering diodes CR251 and CR261 control Q253 and Q256. IC Q255 and CR263 provide the −4 IRE and +4 IRE Black Set levels. Diodes CR252 and CR262 are steering diodes to turn Q255 and CR263 off, except during the −4 and +4 IRE levels of the Black Set signal. When setup low output of U182 goes high, it turns CR262 off and CR263 on to supply current for the −4 IRE level.

DIAGRAM 2
COLOR BAR LOGIC DRIVERS

The red, green, and blue chrominance drive inputs terminate at the R−Y and B−Y drivers.

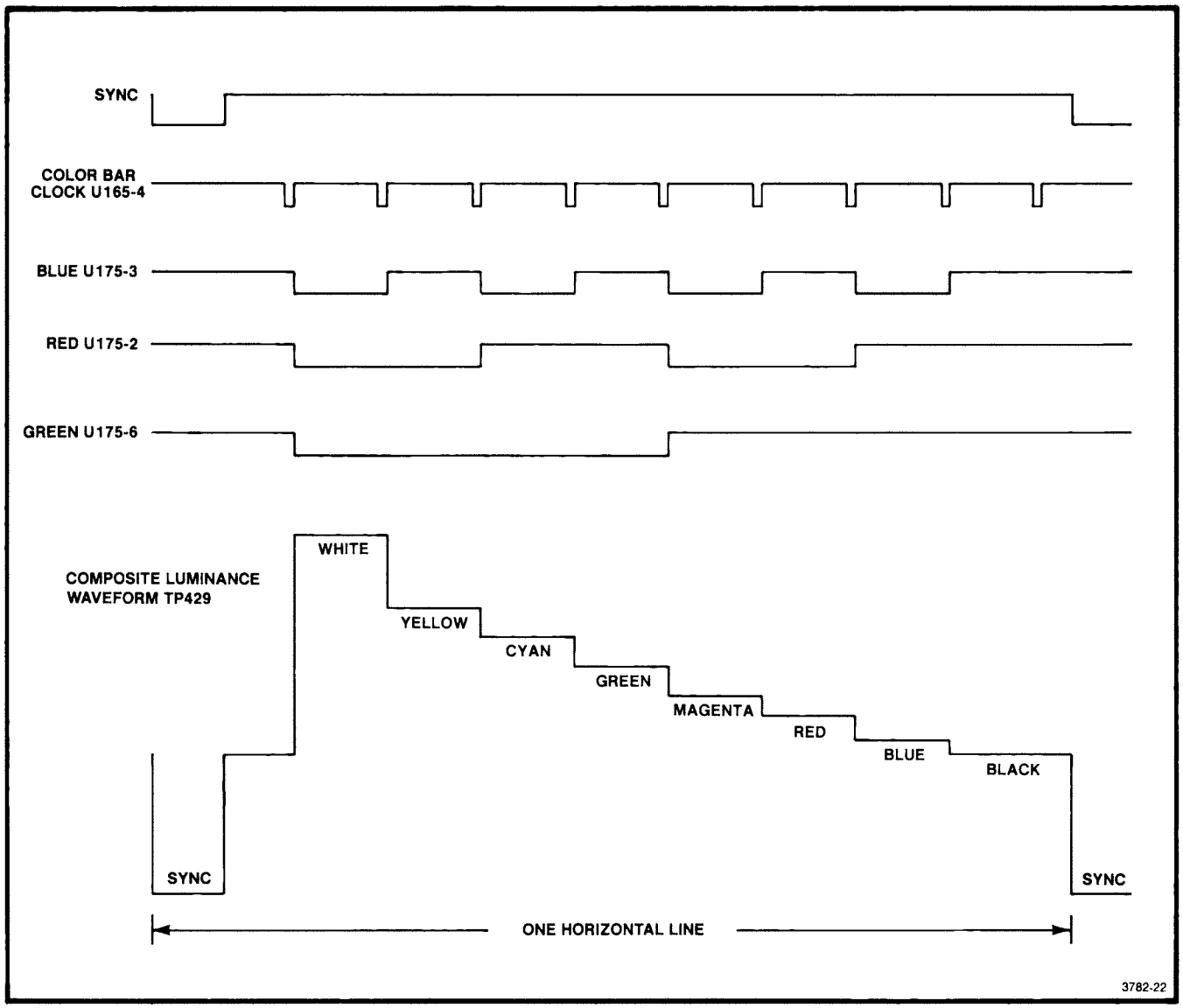


Fig. 5-6. Operation of Luminance Counter. Counter can be reversed by pulling U175-5 low.

R−Y Drive and B−Y Drive

When the red signal from U179 goes low, Q205 and Q224 are turned on, allowing the amount of current set by R209 (RB) and R249 (RR) to flow through the filters to the Modulators (Diagram 3). When the red drive goes high, CR196 and CR238 conduct, Q205 and Q224 are turned off, and signal current no longer flows to the Modulators. Diodes CR186 and CR181 limit voltage swing at the emitters of Q205 and Q224 to 0.6 volts. Blue and Green drives operation is identical to the operation of the Red drive, and, therefore, need not be described separately.

−I and Q Chrominance Drive

When the output of U152A is low, Q223 and Q226 are turned on, allowing the current set by R228 and R237 to flow through the filters to the modulators.

The collector current flowing in Q226 is supplied to the + R−Y input, to the R−Y Filter, and Modulator. Collector current from Q244 is supplied to the −R−Y input. Collector current from both Q223 and Q225 are summed and supplied to the +B−Y input, to the B−Y Filter, and Modulator. Diodes CR191 and CR192 with CR174 limit the emitter voltage swing of Q225, Q223, Q226, and Q244 to 0.6 volts.

Burst Drive

Burst current flows in the collector of Q204 when the output of U157D is low. Current flow is through the −B−Y side of the B−Y Filter and Modulator. Diodes CR211 and CR212 limit emitter voltage swing to 0.6 V. If the front-panel Burst switch is in the Off position, U157D pin 12 is held low and pin 11 goes high (turning off burst), except when either the SMPTE or EIA signal is selected.

Color Bar Amplitude and Setup

Color Bar Voltage (VCB) used by the R−Y and B−Y Drive circuits is developed in the collector circuit of Q118. Transistor Q118 and U127 form a voltage follower amplifier. The amplitude of VCB is determined by one of two voltage dividers. IC U125, which switches dividers, is a CMOS quad bilateral switch, controlled by Q133 driven by the switch inhibit signal from U172.

In the various color bar modes, except SMPTE and EIA, U125B Control input is high and switch B is closed, coupling the voltage reference from the Amplitude/Setup voltage divider string (R112-R121-R111-R122) to the − Input of U127. There are four possible voltages, selected by S102B and S103B, that are equivalent to the setup and amplitude levels denoted on the TSG7 front panel.

When either SMPTE or EIA is selected, a 75% Amplitude and 7.5% Setup signal is required. To insure that only this reference voltage is available, Q133 is turned on and U125A and U125C switched on. The output of U125C, which is −15 V, is directly coupled to the U125B Control input and switch B is open.

With switch B open and switch A closed, the VCB reference is the voltage divider, R113 and R115.

B−Y and R−Y Inhibit

The inhibit signal from U162, latched by U172, is combined with vertical blanking in U152. When the B−Y switch is pushed in, there is a low on pin 10 of U152, which brings pin 8 high and forward biases CR195, CR194, and CR193 to turn off Q205, Q215, and Q213. With the switch out, B−Y is inhibited only during horizontal and vertical blanking, and −I,Q,W time. R−Y inhibit operates in a similar way.

EIA White Luminance Drive

Transistor Q243 is enabled by the EIA White enable signal from U182, pin 7. The white signal current is set by R279 and R267. Diodes CR174 and CR182 limit the emitter voltage swing to 0.6 V. Output is through the Wide Band Filter to the Luminance Amplifier.

Power

Transistor Q254, wired as a diode, provides the decoupled 0.6 V supply for the common bases of the chrominance and luminance drive stages.

DIAGRAM 3
COLOR BARS OUTPUTS

Wide Band and Narrow Band Filters

The EIA White signal current from Q243 (Diagram 2) is coupled by Q462 to the Narrow Band Filter. This filter has a sine-squared response rise time of 250 ns. The color bar luminance levels, setup and composite sync signals are coupled by Q492 to the Wide Band Filter. The sine-squared response of this filter is 130 ns. The filter outputs drive the Luminance Output Amplifier.

Luminance Output Amplifier

This circuit is an inverting operational amplifier with variable DC Level and Lum Gain controls. Resistor R459 provides dc level adjustment of the output, while R449 provides the luminance gain adjustment. The amplifier is capable of driving two 75 Ω external loads.

Subcarrier AGC and Modulator Driver

This circuit ensures that the Modulator is always driven with a constant subcarrier signal amplitude. The circuit also maintains correct input waveform symmetry to ensure balanced drive to the Modulator.

Transistor Q314 provides isolation from the subcarrier source. Inductor L317 and C318 provide adjustment of color bar burst phase to subcarrier phase. The subcarrier signal, through the action of an averaging self-bias circuit, has a 50% duty cycle at the collector of Q337. Paraphase amplifier Q338 and Q348 provides agc and drives push-pull output stages Q344 and Q345. Thus, the subcarrier signal at the secondary of T355 is of constant amplitude and shape.

Quad Phase

The subcarrier signal is coupled from T355 through the Quad Phase network (C353, L365, and C363) to the R−Y Modulator carrier input. In passing through the network, the subcarrier signal is shifted 90° in phase. Thus, the subcarrier drive for U832 is 90° out of phase with respect to U384.

0° — 180° Phase Shifter

Phase selection of the R—Y component is provided by this circuit. In the 90° phase mode, Q322 is on, suppressing drive to the shift circuitry. Q342 is on and shunts the drive for pin 8 of U382. In the ALT position, the amplifier is driven at V/2 (or H/2 rate, internally programmed with connection of R320) rate, turning Q341 and Q342 on and off alternately. Capacitor C351 balances the circuit for exactly 180° phase shift. The R—Y component of output chrominance, thus is shifted between 90° and 270° on alternate fields or lines.

B—Y and R—Y Filters

These identical filters are linear phase networks with approximately 1.5 MHz bandwidth, thus preventing the B—Y or R—Y signal components from exceeding the 3.58 MHz subcarrier frequency. The filters are adjusted for identical bandwidths and delays.

B—Y and R—Y Modulators

Amplitude modulation of the subcarrier is accomplished in the double-balanced modulators, U384 and U382. Referring to Fig. 5-7, 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 Bandwidth Filter through T375.

Bandwidth Filter

The Bandwidth 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 by L357 and L367 to provide minimum harmonic amplitude and best amplitude, shaping, and overlay of the chrominance packets.

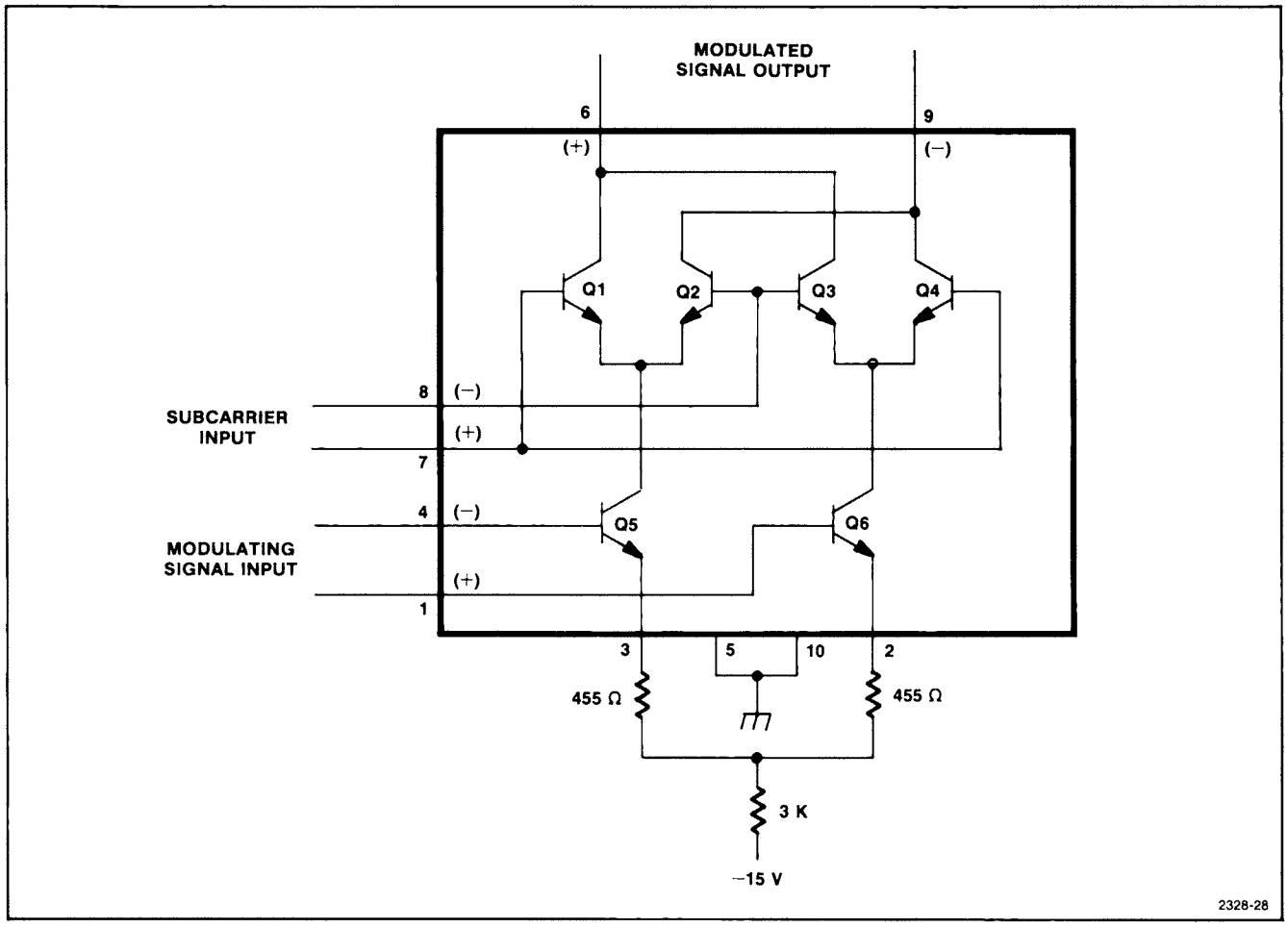


Fig. 5-7. Modulator operation.

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. 5-8).

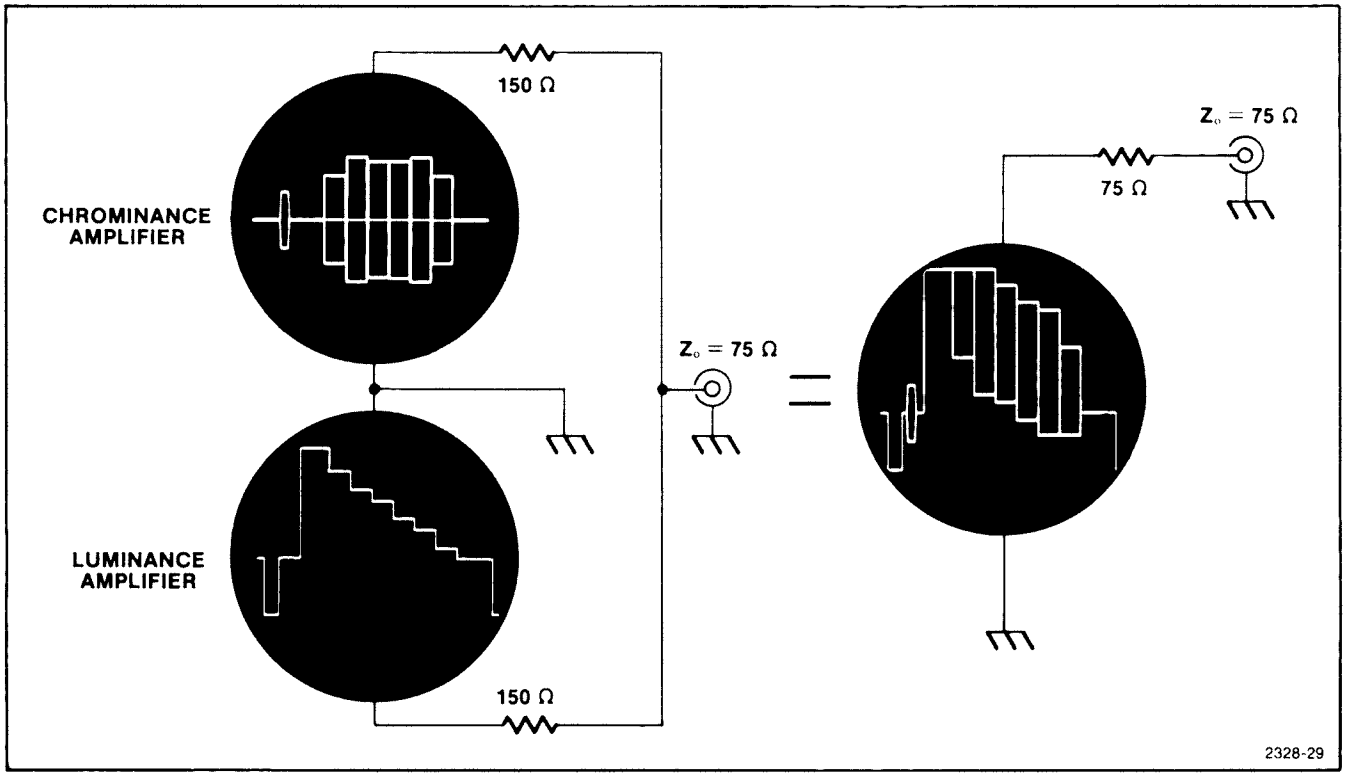


Fig. 5-8. Chrominance and Luminance Output Amplifiers.

MAINTENANCE

INTRODUCTION

The maintenance information contained in this section is divided into three categories: Preventive Maintenance, Troubleshooting, and Repair.

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

The 1410 Mainframe Instruction Manual contains information on color coding of wires and components, a comprehensive troubleshooting procedure, troubleshooting equipment required, semiconductor basing illustrations, and other general servicing information. Only information pertinent to the TSG7 is included in this manual.

PREVENTIVE MAINTENANCE

A regular schedule of preventive maintenance improves instrument reliability. The interval should be determined by the severity of the operating environment.

Cleaning

WARNING

Turn off the instrument power and remove the power cord before cleaning the instrument.

Dust accumulating on the circuit boards acts as an insulating blanket, preventing efficient heat dissipation, and possible 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 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 1410 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.

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.

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 1000 hours of operation if used continuously, or every six months if used infrequently.

A Performance Check Procedure is given in Section 2 of this manual.

WARNING

THE FOLLOWING SHOULD BE PERFORMED BY QUALIFIED SERVICE PERSONNEL ONLY.

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. The 1410 mainframe Instruction Manual includes a Troubleshooting Equipment list and a procedure to follow when troubleshooting the instrument.

Diagrams

Circuit diagrams are shown on the foldout pages in Section 9 of this manual. The circuit number and electrical value of each component are shown on the diagrams. Important waveforms and voltages are also shown. A Parts Locating chart near each diagram is provided for easy component locating.

Circuit Boards

The etched-circuit boards are outlined on the schematic diagrams, and circuit board illustrations are provided on the back of preceding foldout pages. Assembly numbers are assigned to each circuit board as a method of identifying an individual circuit board.

Component numbering of each part on each circuit board is assigned on a grid system, with the lowest circuit number in one corner of the board, increasing to the highest circuit number in the opposite corner of the board.

When troubleshooting circuit boards in the instrument, the use of an extender board facilitates access to the board connections and components. Removing the suspected circuit board to the extender board will save time in looking for faults. An extender board is supplied as a standard accessory with the 1410 Generator system. See the Maintenance section of the 1410 Instruction Manual for directions on use of the Circuit Board Extender.

CAUTION

Be sure that the pins on the Interface board are not bent. Forcing a bent pin into a connector may permanently damage the connector.

The TSG7 circuit-board illustrations and schematic diagrams are arranged for simultaneous usage. The foldout page containing the circuit-board illustration opens to the left while the schematic diagram foldout page opens to the right (see Fig. 6-1).

Wire Color Code

Insulated wires are color-coded to facilitate circuit tracing.

Resistor Color Code

Color stripes on resistors signify electrical values, tolerances, etc., according to the EIA standard color code. Refer to the color code illustration in the Maintenance section of the 1410 mainframe manual. Resistors not color-coded usually have the value imprinted on the body.

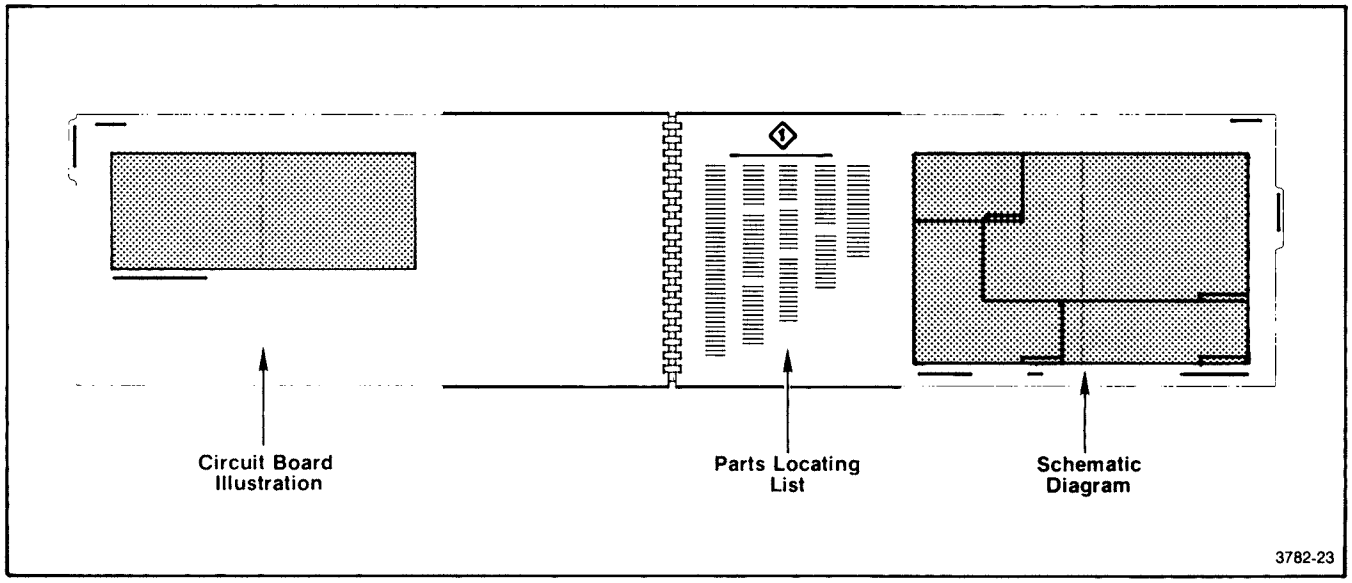


Fig. 6-1. Using the schematic diagram and circuit board illustration simultaneously.

Capacitor Markings

The capacitance value of a common disc capacitor or small electrolytic is marked in microfarads on the side of the component body. White ceramic capacitors are color coded in picofarads using a modified EIA code. The "tear drop" capacitors are color-coded in microfarads using a modified EIA code with the dot indicating both temperature and positive (+) side. See the color code illustrations provided in the Maintenance section of the 1410 mainframe manual.

Transistor and Integrated-Circuit Lead Configuration

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

PROMS

The TSG7 contains three Programmable Read Only Memories (PROMs), U155, U162, and U163. These PROMs contain specific codes for the application in which they are employed. They are not interchangeable, and may even be damaged if plugged into another socket. The three TSG7 PROMs can only be replaced by pre-programmed PROMs, available from Tektronix, Inc. If in doubt about part numbers, consult the Replaceable Electrical Parts listings in Section 7.

Static-Sensitive Parts

CAUTION

STATIC DISCHARGE CAN DAMAGE ANY SEMICONDUCTOR COMPONENTS USED IN THIS INSTRUMENT.

This instrument contains electrical components that are susceptible to damage from static charges; see Table 6-1. Observing the following precautions will aid in avoiding the breakdown of these parts. When returning static-sensitive parts to Tektronix, Inc., package them in antistatic or conductive material. Static voltages of 1 to 30 kV are common in unprotected environments.

CAUTIONS TO BE AWARE OF IN SERVICING STATIC-SENSITIVE EQUIPMENT

a. *Minimize the handling of static-sensitive parts.*

b. *Transport and store static-sensitive parts in their original containers, on a metal rail, or on conductive foam. Label any container having a static sensitive assembly or device.*

c. *Discharge the static charge on yourself by using a wrist strap before handling these devices. It is recommended that servicing of static-sensitive assemblies or devices be performed only at a static-free work station by qualified personnel.*

d. *Nothing capable of generating or holding a static charge should be allowed on the work station surface.*

e. *Keep the leads shorted together whenever possible.*

f. *Pick up the part by the body, never by the leads.*

g. *Do not subject the part to sliding movements over any surface.*

h. *Avoid handling parts in areas having a floor or work surface covering that contributes to the generation of a static charge.*

i. *Use a soldering iron that has a connection to earth ground.*

j. *Use any special anti-static suction type desoldering tool, such as Silverstat Soldapulit, or a wick-type desoldering device.*

Table 6-1
RELATIVE SUSCEPTIBILITY TO TO STATIC DISCHARGE DAMAGE

Semiconductor Classes	Relative Susceptibility Levels[a]
MOS or CMOS microcircuits or discretes, or linear microcircuits with MOS inputs. (Most Sensitive)	1
ECL	2
Schottky signal diodes	3
Schottky TTL	4
High-frequency bipolar transistors	5
JFETs	6
Linear microcircuits	7
Low-power Schottky TTL	8
TTL (Least Sensitive)	9

[a] **Voltage equivalent for levels:**

1 = 100 to 500 V 4 = 500 V 7 = 400 to 1000 V(est.)
2 = 200 to 500 V 5 = 400 to 600 V 8 = 900 V
3 = 250 V 6 = 600 to 800 V 9 = 1200 V

(Voltage discharged from a 100 pF capacitor through a resistance of 100 Ω.)

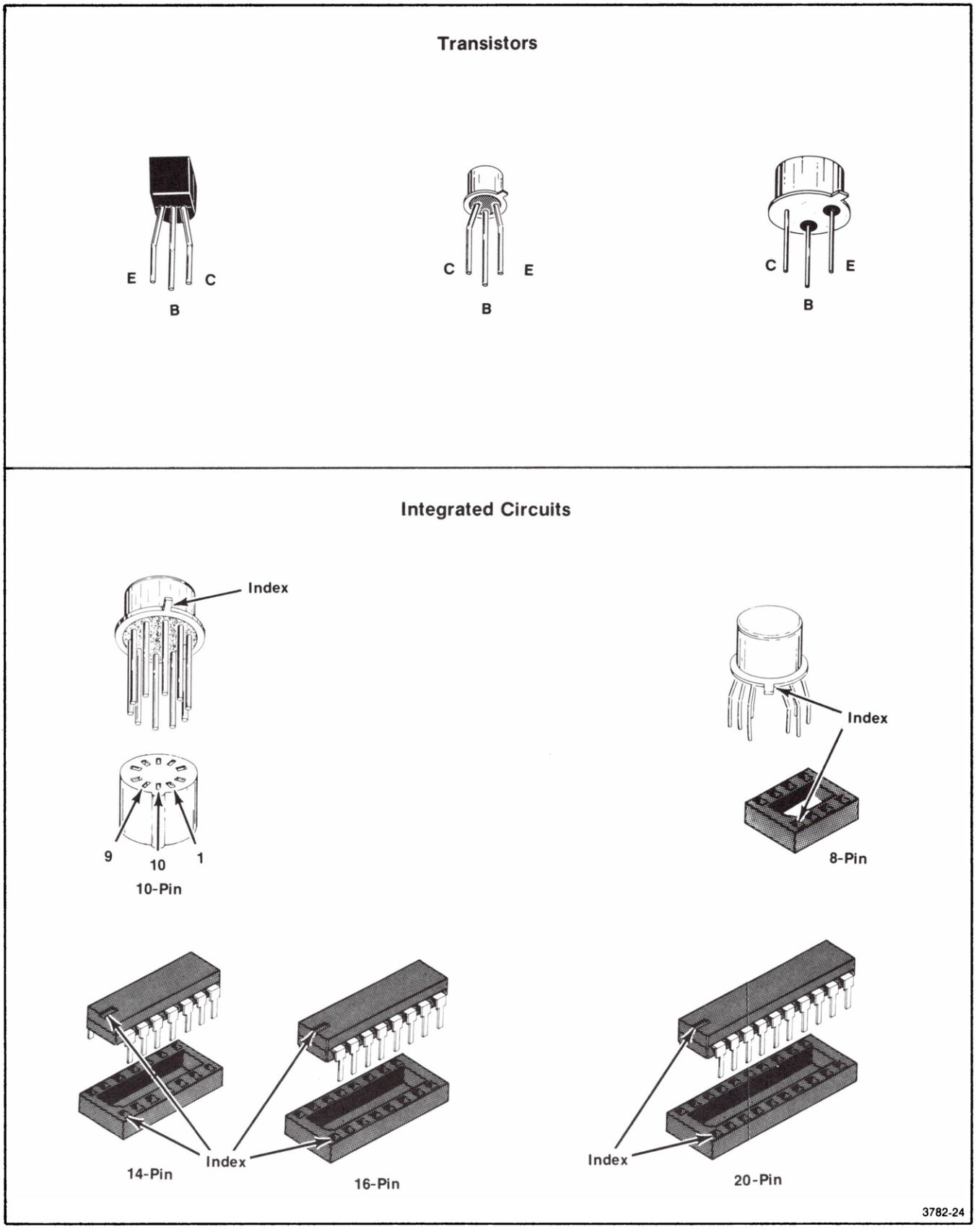


Fig. 6-2. Semiconductor basing diagrams.

Troubleshooting Procedure

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

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 (Section 1) and Installation (Section 3).

Check Associated Boards. Before troubleshooting the TSG7 circuit boards, check that the 1410 mainframe is operating properly. Check that the TSG7 circuit boards are making good contact through the interconnecting pins. Make sure that other boards on the interface board are not defective. Check that the test oscilloscope probe, if used, is not defective and is properly compensated.

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.

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.

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 diagram. To obtain operating conditions similar to those used to take these waveforms, refer to the instructions at the start of the diagram section.

CAUTION

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

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.

REPAIR

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

Obtaining Replacement Parts

Most electrical and mechanical parts can be obtained through your local Tektronix field office or representative. However, you should be able to obtain many of the standard electronic components from a local commercial source in your area. Before you purchase or order a part from a source other than Tektronix, Inc., please check the electrical parts list for the proper value, rating, tolerance, and description.

Location Guide for Replacing Parts

The exploded-view drawings associated with the Replaceable Mechanical Parts list (located at the rear of this 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.

Push-Button Switch Replacement

Before removing a push-button switch, disengage all push-button actuating arms so that they do 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 lifitng 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 for the various boards are given in Section 7, Replaceable Electrical Parts.

WARNING

Disconnect the instrument power cord before removing and replacing circuit boards.

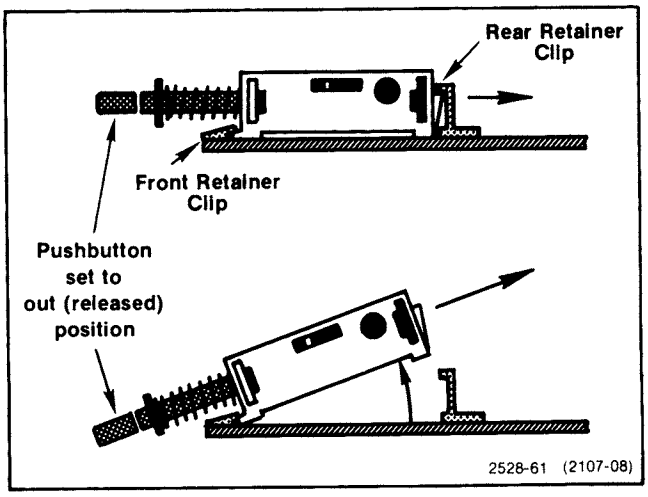


Fig. 6-3. Removing a push button switch.

Circuit Board Removal

a. Remove the two test-module stabilizer bars. Hold-downs are secured by three flat-head screws each.

b. Check to see if the board to be removed has firmly-mounted control-shaft extenders. If it does, they must be removed before attempting to remove the board.

c. To avoid unnecessary knob loosening, do not remove push-button knobs from switches.

d. Raise the board just enough to clear the interface pins.

e. Disconnect interconnecting plugs from the board.

f. Slide the board toward the rear of the isntrument (while elevating the rear of the board) until the front-panel switch extenders, if any, have cleared.

g. Lift the circuit board upward from the interface board.

h. Reverse this procedure to replace the circuit board within its module. 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 circuit board.

Extracting Integrated 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.

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.

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

ACTR	ACTUATOR	PLSTC	PLASTIC
ASSY	ASSEMBLY	QTZ	QUARTZ
CAP	CAPACITOR	RECP	RECEPTACLE
CER	CERAMIC	RES	RESISTOR
CKT	CIRCUIT	RF	RADIO FREQUENCY
COMP	COMPOSITION	SEL	SELECTED
CONN	CONNECTOR	SEMICOND	SEMICONDUCTOR
ELCTLT	ELECTROLYTIC	SENS	SENSITIVE
ELEC	ELECTRICAL	VAR	VARIABLE
INCAND	INCANDESCENT	WW	WIREWOUND
LED	LIGHT EMITTING DIODE	XFMR	TRANSFORMER
NONWIR	NON WIREWOUND	XTAL	CRYSTAL

CROSS INDEX - MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip Code
00213	NYTRONICS COMPONENTS GROUP INC SUBSIDIARY OF NYTRONICS INC	ORANGE ST	DARLINGTON SC 29532
00853	SANGAMO WESTON INC SANGAMO CAPACITOR DIV	SANGAMO RD P O BOX 128	PICKENS SC 29671
01121	ALLEN-BRADLEY CO	1201 SOUTH 2ND ST	MILWAUKEE WI 53204
01295	TEXAS INSTRUMENTS INC SEMICONDUCTOR GROUP	13500 N CENTRAL EXPRESSWAY P O BOX 225012 M/S 49	DALLAS TX 75265
02735	RCA CORP SOLID STATE DIVISION	ROUTE 202	SOMERVILLE NJ 08876
03508	GENERAL ELECTRIC CO SEMI-CONDUCTOR PRODUCTS DEPT	W GENESEE ST	AUBURN NY 13021
04222	AVX CERAMICS DIV OF AVX CORP	19TH AVE SOUTH P O BOX 867	MYRTLE BEACH SC 29577
04713	MOTOROLA INC SEMICONDUCTOR GROUP	5005 E MCDOWELL RD	PHOENIX AZ 85008
05397	UNION CARBIDE CORP MATERIALS SYSTEMS DIV	11901 MADISON AVE	CLEVELAND OH 44101
07263	FAIRCHILD CAMERA AND INSTRUMENT CORP SEMICONDUCTOR DIV	464 ELLIS ST	MOUNTAIN VIEW CA 94042
07716	TRW INC TRW ELECTRONICS COMPONENTS TRW IRC FIXED RESISTORS/BURLINGTON	2850 MT PLEASANT AVE	BURLINGTON IA 52601
11236	CTS OF BERNE INC	406 PARR ROAD	BERNE IN 46711
14552	MICRO/SEMICONDUCTOR CORP	2830 S FAIRVIEW ST	SANTA ANA CA 92704
18324	SIGNETICS CORP	811 E ARQUES	SUNNYVALE CA 94086
19701	MEPCO/ELECTRA INC A NORTH AMERICAN PHILIPS CO	P O BOX 760	MINERAL WELLS TX 76067
24546	CORNING GLASS WORKS	550 HIGH ST	BRADFORD PA 16701
32997	BOURNS INC TRIMPOT DIV	1200 COLUMBIA AVE	RIVERSIDE CA 92507
52763	STETTNER ELECTRONICS INC	6135 AIRWAYS BLVD PO BOX 21947	CHATTANOOGA TN 37421
52769	SPRAGUE-GOODMAN ELECTRONICS INC	134 FULTON AVE	GARDEN CITY PARK NY 11040
54473	MATSUSHITA ELECTRIC CORP OF AMERICA	ONE PANASONIC WAY	SECAUCUS NJ 07094
55680	NICHICON /AMERICA/ CORP	927 E STATE PKY	SCHAUMBURG IL 60195
57668	ROHM CORP	16931 MILLIKEN AVE	IRVINE CA 92713
59660	TUSONIX INC	2155 N FORBES BLVD	TUCSON, ARIZONA 85705
59821	CENTRALAB INC SUB NORTH AMERICAN PHILIPS CORP	7158 MERCHANT AVE	EL PASO TX 79915
74970	JOHNSON E F CO	299 10TH AVE S W	WASECA MN 56093
80009	TEKTRONIX INC	4900 S W GRIFFITH DR P O BOX 500	BEAVERTON OR 97077

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A31	670-4456-00	B010100	B010419	CIRCUIT BD ASSY:COLOR BAR OUTPUT	80009	670-4456-00
A31	670-4456-01	B010420	B101153	CIRCUIT BD ASSY:COLOR BAR OUTPUT	80009	670-4456-01
A31	670-4456-02	B101154		CIRCUIT BD ASSY:COLOR BAR OUTPUT	80009	670-4456-02
A32	670-7274-00	B010100	B101234	CIRCUIT BD ASSY:SMPTE COLOR BAR	80009	670-7274-00
A32	670-7274-01	B101235	B101560	CIRCUIT BD ASSY:SMPTE COLOR BAR	80009	670-7274-01
A32	670-7274-02	B101561		CIRCUIT BD ASSY:SMPTE COLOR BAR	80009	670-7274-02
A100	670-4459-00			CIRCUIT BD ASSY:SHIELD	80009	670-4459-00
C117	281-0812-00			CAP,FXD,CER DI:1000PF,10%,100V	04222	MA101C102KAA
C123	281-0775-00			CAP,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
C135	281-0775-00			CAP,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
C137	281-0788-00			CAP,FXD,CER DI:470PF,10%,100V	04222	MA101C471KAA
C138	281-0788-00			CAP,FXD,CER DI:470PF,10%,100V	04222	MA101C471KAA
C139	281-0775-00			CAP,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
C153	281-0775-00			CAP,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
C157	281-0775-00			CAP,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
C164	283-0634-00			CAP,FXD,MICA DI:65PF,1%,100V	00853	D155E650F0
C166	281-0812-00			CAP,FXD,CER DI:1000PF,10%,100V	04222	MA101C102KAA
C171	281-0775-00			CAP,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
C175	283-0634-00			CAP,FXD,MICA DI:65PF,1%,100V	00853	D155E650F0
C177	281-0773-00			CAP,FXD,CER DI:0.01UF,10%,100V	04222	MA201C103KAA
C178	281-0775-00			CAP,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
C181	290-0782-00			CAP,FXD,ELCTLT:4.7UF,+75-10%,35VDC	55680	ULB1V4R7TAAANA
C211	281-0140-00			CAP,VAR,CER DI:5-25PF,100V	59660	518-023A 5-25
C221	281-0140-00			CAP,VAR,CER DI:5-25PF,100V	59660	518-023A 5-25
C271	281-0775-00			CAP,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
C291	290-0782-00			CAP,FXD,ELCTLT:4.7UF,+75-10%,35VDC	55680	ULB1V4R7TAAANA
C313	283-0003-00			CAP,FXD,CER DI:0.01UF,+80-20%,150V (END USAGE 670-4456-00)	59821	D103Z40Z5UJDCEX
C313	281-0775-00			CAP,FXD,CER DI:0.1UF,20%,50V (BEGIN USAGE 670-4456-01)	04222	MA205E104MAA
C316	283-0000-00			CAP,FXD,CER DI:0.001UF,+100-0%,500V (END USAGE 670-4456-00)	59660	831-610-Y5U0102P
C316	283-0636-00			CAP,FXD,MICA DI:36PF,1.4%,100V (BEGIN USAGE 670-4456-01)	00853	D155E360G0
C318	281-0226-00			CAP,VAR,PLASTIC:4-38PF,100V	52769	GXD38000
C324	283-0000-00			CAP,FXD,CER DI:0.001UF,+100-0%,500V (END USAGE 670-4456-00)	59660	831-610-Y5U0102P
C324	281-0812-00			CAP,FXD,CER DI:1000PF,10%,100V (BEGIN USAGE 670-4456-01)	04222	MA101C102KAA
C325	283-0648-00			CAP,FXD,MICA DI:10PF,5%,500V (END USAGE 670-4456-00)	00853	D155C100D0
C325	283-0637-00			CAP,FXD,MICA DI:20PF,2.5%,500V (BEGIN USAGE 670-4456-01)	00853	D155E200D0
C329	283-0341-00			CAP,FXD,CER DI:0.047UF,10%,100V (END USAGE 670-4456-00)	04222	SR301C473KAA
C329	281-0775-00			CAP,FXD,CER DI:0.1UF,20%,50V (BEGIN USAGE 670-4456-01)	04222	MA205E104MAA
C335	281-0775-00			CAP,FXD,CER DI:0.1UF,20%,50V (END USAGE 670-4456-00)	04222	MA205E104MAA
C335	281-0791-00			CAP,FXD,CER DI:270PF,10%,100V (BEGIN USAGE 670-4456-01)	04222	MA101C271KAA
C336	283-0084-00			CAP,FXD,CER DI:270PF,5%,1000V (END USAGE 670-4456-00)	59660	838533X5F02715
C336	281-0791-00			CAP,FXD,CER DI:270PF,10%,100V (BEGIN USAGE 670-4456-01)	04222	MA101C271KAA
C339	283-0084-00			CAP,FXD,CER DI:270PF,5%,1000V (END USAGE 670-4456-00)	59660	838533X5F02715
C339	281-0791-00			CAP,FXD,CER DI:270PF,10%,100V (BEGIN USAGE 670-4456-01)	04222	MA101C271KAA

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
C340	283-0081-00			CAP,FXD,CER DI:0.1UF,+80-20%,25V (END USAGE 670-4456-00)	59821	2DDU69E104Z
C340	281-0775-00			CAP,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
C341	283-0081-00			CAP,FXD,CER DI:0.1UF,+80-20%,25V (END USAGE 670-4456-00)	59821	2DDU69E104Z
C341	281-0775-00			CAP,FXD,CER DI:0.1UF,20%,50V	04222	MA205E104MAA
C342	----- -----			(BEGIN USAGE 670-4456-01)		
C342	----- -----			(BEGIN USAGE 670-4456-01)		
C342	283-0003-00			CAP,FXD,CER DI:0.01UF,+80-20%,150V (END USAGE 670-4456-00)	59821	D103Z40Z5UJDCEX
C342	281-0773-00			CAP,FXD,CER DI:0.01UF,10%,100V (BEGIN USAGE 670-4456-01)	04222	MA201C103KAA
C344	283-0081-00			CAP,FXD,CER DI:0.1UF,+80-20%,25V (END USAGE 670-4456-00)	59821	2DDU69E104Z
C344	281-0775-00			CAP,FXD,CER DI:0.1UF,20%,50V (BEGIN USAGE 670-4456-01)	04222	MA205E104MAA
C345	283-0084-00			CAP,FXD,CER DI:270PF,5%,1000V (END USAGE 670-4456-00)	59660	838533X5F02715
C345	281-0791-00			CAP,FXD,CER DI:270PF,10%,100V (BEGIN USAGE 670-4456-01)	04222	MA101C271KAA
C346	283-0084-00			CAP,FXD,CER DI:270PF,5%,1000V (END USAGE 670-4456-00)	59660	838533X5F02715
C346	281-0791-00			CAP,FXD,CER DI:270PF,10%,100V (BEGIN USAGE 670-4456-01)	04222	MA101C271KAA
C347	283-0081-00			CAP,FXD,CER DI:0.1UF,+80-20%,25V (END USAGE 670-4456-00)	59821	2DDU69E104Z
C347	281-0775-00			CAP,FXD,CER DI:0.1UF,20%,50V (BEGIN USAGE 670-4456-01)	04222	MA205E104MAA
C348	283-0084-00			CAP,FXD,CER DI:270PF,5%,1000V (END USAGE 670-4456-00)	59660	838533X5F02715
C348	281-0791-00			CAP,FXD,CER DI:270PF,10%,100V (BEGIN USAGE 670-4456-01)	04222	MA101C271KAA
C349	283-0081-00			CAP,FXD,CER DI:0.1UF,+80-20%,25V (END USAGE 670-4456-00)	59821	2DDU69E104Z
C349	281-0775-00			CAP,FXD,CER DI:0.1UF,20%,50V (BEGIN USAGE 670-4456-01)	04222	MA205E104MAA
C351	281-0116-00			CAP,VAR,AIR DI:1.5-9.1PF,530V	74970	189-0754-075
C352	283-0081-00			CAP,FXD,CER DI:0.1UF,+80-20%,25V (END USAGE 670-4456-00)	59821	2DDU69E104Z
C352	281-0775-00			CAP,FXD,CER DI:0.1UF,20%,50V (BEGIN USAGE 670-4456-01)	04222	MA205E104MAA
C353	283-0598-00			CAP,FXD,MICA DI:253PF,5%,300V	00853	D155F253OJ0
C363	283-0598-00			CAP,FXD,MICA DI:253PF,5%,300V	00853	D155F253OJ0
C367	283-0618-00			CAP,FXD,MICA DI:130PF,2%,400V (END USAGE 670-4456-00)	00853	D155F131G0
C367	283-0725-00			CAP,FXD,MICA DI:214PF,1%,500V (BEGIN USAGE 670-4456-01)	00853	D155F2140F0
C371	281-0064-00			CAP,VAR,PLASTIC:0.25-1.5PF,600V (BEGIN USAGE 670-4456-01)	52769	ER-530-013
C372	----- -----			(SELECTED,ADDED IF NECESSARY)		
C373	281-0064-00			CAP,VAR,PLASTIC:0.25-1.5PF,600V	52769	ER-530-013
C374	281-0661-00			CAP,FXD,CER DI:0.8PF,+/-0.1PF,500V (END USAGE 670-4456-00)	52763	2RDPLZ007 OP80BC
C377	283-0601-00			CAP,FXD,MICA DI:22PF,10%,300V (END USAGE 670-4456-00)	00853	D155E220K0
C377	283-0677-00			CAP,FXD,MICA DI:82PF,1%,500V (BEGIN USAGE 670-4456-01)	00853	D155E820F0
C378	281-0773-00			CAP,FXD,CER DI:0.01UF,10%,100V	04222	MA201C103KAA
C385	283-0003-00			CAP,FXD,CER DI:0.01UF,+80-20%,150V (END USAGE 670-4456-00)	59821	D103Z40Z5UJDCEX
C385	281-0773-00			CAP,FXD,CER DI:0.01UF,10%,100V (BEGIN USAGE 670-4456-01)	04222	MA201C103KAA

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
C396	283-0081-00			CAP,FXD,CER DI:0.1UF,+80-20%,25V (END USAGE 670-4456-00)	59821	2DDU69E104Z
C396	281-0775-00			CAP,FXD,CER DI:0.1UF,20%,50V (BEGIN USAGE 670-4456-01)	04222	MA205E104MAA
C397	281-0773-00			CAP,FXD,CER DI:0.01UF,10%,100V	04222	MA201C103KAA
C398	281-0529-00			CAP,FXD,CER DI:1.5PF,+/-25PF,500V (END USAGE 670-4456-00)	52763	2RDPLZ007 1P50CC
C398	281-0534-00			CAP,FXD,CER DI:3.3PF,+/-0.25PF,500V (BEGIN USAGE 670-4456-01)	52763	2RDPLZ007 3P30CC
C405	281-0577-00			CAP,FXD,CER DI:14PF,5%,500V (END USAGE 670-4456-00)	52763	2RDPLZ007 14P0JC
C405	283-0648-00			CAP,FXD,MICA DI:10PF,5%,500V (BEGIN USAGE 670-4456-01)	00853	D155C100D0
C406	283-0177-00			CAP,FXD,CER DI:1UF,+80-20%,25V (END USAGE 670-4456-00)	04222	SR302E105ZAATR
C406	281-0775-00			CAP,FXD,CER DI:0.1UF,20%,50V (BEGIN USAGE 670-4456-01)	04222	MA205E104MAA
C413	290-0536-00			CAP,FXD,ELCTLT:10UF,20%,25V TANTALUM	05397	T368B106M025AS
C414	283-0177-00			CAP,FXD,CER DI:1UF,+80-20%,25V	04222	SR302E105ZAATR
C415	281-0577-00			CAP,FXD,CER DI:14PF,5%,500V (END USAGE 670-4456-00)	52763	2RDPLZ007 14P0JC
C415	283-0648-00			CAP,FXD,MICA DI:10PF,5%,500V (BEGIN USAGE 670-4456-01)	00853	D155C100D0
C422	283-0639-00			CAP,FXD,MICA DI:56PF,1%,100V (END USAGE 670-4456-00)	00853	D155E560F0
C422	283-0637-00			CAP,FXD,MICA DI:20PF,2.5%,500V (BEGIN USAGE 670-4456-01)	00853	D155E200D0
C424	283-0639-00			CAP,FXD,MICA DI:56PF,1%,100V (END USAGE 670-4456-00)	00853	D155E560F0
C424	283-0637-00			CAP,FXD,MICA DI:20PF,2.5%,500V (BEGIN USAGE 670-4456-01)	00853	D155E200D0
C427	283-0081-00			CAP,FXD,CER DI:0.1UF,+80-20%,25V (END USAGE 670-4456-00)	59821	2DDU69E104Z
C427	281-0775-00			CAP,FXD,CER DI:0.1UF,20%,50V (BEGIN USAGE 670-4456-01)	04222	MA205E104MAA
C432	283-0598-00			CAP,FXD,MICA DI:253PF,5%,300V (END USAGE 670-4456-00)	00853	D155F253QJ0
C432	283-0785-00			CAP,FXD,MICA DI:250PF,1%,500V (BEGIN USAGE 670-4456-01)	00853	D155F251F0
C433	283-0598-00			CAP,FXD,MICA DI:253PF,5%,300V (END USAGE 670-4456-00)	00853	D155F253QJ0
C433	283-0785-00			CAP,FXD,MICA DI:250PF,1%,500V (BEGIN USAGE 670-4456-01)	00853	D155F251F0
C434	283-0639-00			CAP,FXD,MICA DI:56PF,1%,100V (END USAGE 670-4456-00)	00853	D155E560F0
C434	283-0637-00			CAP,FXD,MICA DI:20PF,2.5%,500V (BEGIN USAGE 670-4456-01)	00853	D155E200D0
C442	283-0639-00			CAP,FXD,MICA DI:56PF,1%,100V (END USAGE 670-4456-00)	00853	D155E560F0
C442	283-0637-00			CAP,FXD,MICA DI:20PF,2.5%,500V (BEGIN USAGE 670-4456-01)	00853	D155E200D0
C444	283-0598-00			CAP,FXD,MICA DI:253PF,5%,300V (END USAGE 670-4456-00)	00853	D155F253QJ0
C444	283-0785-00			CAP,FXD,MICA DI:250PF,1%,500V (BEGIN USAGE 670-4456-01)	00853	D155F251F0
C445	281-0529-00			CAP,FXD,CER DI:1.5PF,+/-25PF,500V (END USAGE 670-4456-00)	52763	2RDPLZ007 1P50CC
C445	281-0534-00			CAP,FXD,CER DI:3.3PF,+/-0.25PF,500V (BEGIN USAGE 670-4456-01)	52763	2RDPLZ007 3P30CC
C451	290-0745-00			CAP,FXD,ELCTLT:22UF,+50-10%,25V	54473	ECE-A25V22L
C452	283-0598-00			CAP,FXD,MICA DI:253PF,5%,300V (END USAGE 670-4456-00)	00853	D155F253QJ0

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
C452	283-0785-00			CAP,FXD,MICA DI:250PF,1%,500V (BEGIN USAGE 670-4456-01)	00853	D155F251F0
C453	290-0745-00			CAP,FXD,ELCTLT:22UF,+50-10%,25V	54473	ECE-A25V22L
C457	283-0081-00			CAP,FXD,CER DI:0.1UF,+80-20%,25V (END USAGE 670-4456-00)	59821	2DDU69E104Z
C457	281-0775-00			CAP,FXD,CER DI:0.1UF,20%,50V (BEGIN USAGE 670-4456-01)	04222	MA205E104MAA
C462	283-0639-00			CAP,FXD,MICA DI:56PF,1%,100V (BEGIN USAGE 670-4456-01)	00853	D155E560F0
C463	290-0745-00			CAP,FXD,ELCTLT:22UF,+50-10%,25V	54473	ECE-A25V22L
C464	283-0666-00			CAP,FXD,MICA DI:890PF,2%,100V	00853	D151F891G0
C465	283-0634-00			CAP,FXD,MICA DI:65PF,1%,100V	00853	D155E650F0
C466	283-0628-00			CAP,FXD,MICA DI:410PF,1%,500V (END USAGE 670-4456-00)	00853	D155F411F0
C466	283-0698-00			CAP,FXD,MICA DI:390PF,1%,500V (BEGIN USAGE 670-4456-01)	00853	D155F391F0
C468	283-0644-00			CAP,FXD,MICA DI:150PF,1%,500V	00853	D155F151F0
C483	283-0660-00			CAP,FXD,MICA DI:510PF,2%,500V	00853	D155F511G0
C485	283-0636-00			CAP,FXD,MICA DI:36PF,1.4%,100V	00853	D155E360G0
C486	283-0672-00			CAP,FXD,MICA DI:200PF,1%,500V	00853	D155F201F0
C488	283-0633-00			CAP,FXD,MICA DI:77PF,1%,100V (END USAGE 670-4456-00)	00853	D155E770F0
C488	283-0647-00			CAP,FXD,MICA DI:70PF,1%,100V (BEGIN USAGE 670-4456-01)	00853	D155E700F0
C490	281-0775-00			CAP,FXD,CER DI:0.1UF,20%,50V (BEGIN USAGE 670-4456-01)	04222	MA205E104MAA
CR137	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR174	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR181	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR182	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR183	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR184	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR185	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR186	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR191	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR192	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR193	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR194	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR195	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR196	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR197	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR203	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR205	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR211	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR212	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR216	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR217	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR224	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR225	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR226	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR231	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR232	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR237	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR238	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR242	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR247	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR250	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR251	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR252	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
CR254	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR255	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR256	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR261	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR262	152-0153-00			SEMICOND DVC,DI:SW,SI,10V,50MA,.DO-7	07263	FD7003
CR263	152-0153-00			SEMICOND DVC,DI:SW,SI,10V,50MA,.DO-7	07263	FD7003
CR267	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR272	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR273	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR274	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR275	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR281	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR283	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR284	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR285	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR291	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR293	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR294	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR295	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR296	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
CR327	152-0141-02			SEMICOND DVC,DI:SW,SI,30V,150MA,30V,DO-35	03508	DA2527 (1N4152)
L317	114-0280-00			COIL,RF:VARIABLE,12-43UH	80009	114-0280-00
L342	----- -----			(BEGIN USAGE 670-4456-01)		
L342	----- -----			(BEGIN USAGE 670-4456-01)		
L357	114-0281-00			COIL,RF:VARIABLE,35-70UH (END USAGE 670-4456-00)	80009	114-0281-00
L357	114-0280-00			COIL,RF:VARIABLE,12-43UH	80009	114-0280-00
L365	114-0257-00			COIL,RF:VARIABLE,6-11UH	80009	114-0257-00
L367	114-0281-00			COIL,RF:VARIABLE,35-70UH (END USAGE 670-4456-00)	80009	114-0281-00
L367	114-0280-00			COIL,RF:VARIABLE,12-43UH	80009	114-0280-00
L424	114-0254-00			COIL,RF:VARIABLE,30-60UH	80009	114-0254-00
L432	114-0254-00			COIL,RF:VARIABLE,30-60UH	80009	114-0254-00
L442	114-0254-00			COIL,RF:VARIABLE,30-60UH	80009	114-0254-00
L444	114-0254-00			COIL,RF:VARIABLE,30-60UH	80009	114-0254-00
L464	114-0278-00			COIL,RF:VARIABLE,4.6-16.7UH (END USAGE 670-4456-00)	80009	114-0278-00
L464	114-0303-00			COIL,RF:VARIABLE,6.5-23UH (BEGIN USAGE 670-4456-01)	80009	114-0303-00
L467	114-0278-00			COIL,RF:VARIABLE,4.6-16.7UH	80009	114-0278-00
L484	114-0257-00			COIL,RF:VARIABLE,6-11UH	80009	114-0257-00
L487	114-0308-00			COIL,RF:VARIABLE,2.9-6.5UH	80009	114-0308-00
Q118	151-0302-00			TRANSISTOR:NPN,SI,TO-18	04713	ST899
Q133	151-0220-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0220-00
Q204	151-0192-00			TRANSISTOR:SELECTED	04713	SPS8801
Q205	151-0192-00			TRANSISTOR:SELECTED	04713	SPS8801
Q213	151-0192-00			TRANSISTOR:SELECTED	04713	SPS8801
Q215	151-0192-00			TRANSISTOR:SELECTED	04713	SPS8801
Q223	151-0192-00			TRANSISTOR:SELECTED	04713	SPS8801
Q224	151-0192-00			TRANSISTOR:SELECTED	04713	SPS8801
Q225	151-0192-00			TRANSISTOR:SELECTED	04713	SPS8801
Q226	151-0192-00			TRANSISTOR:SELECTED	04713	SPS8801
Q233	151-0192-00			TRANSISTOR:SELECTED	04713	SPS8801
Q234	151-0192-00			TRANSISTOR:SELECTED	04713	SPS8801
Q243	151-0192-00			TRANSISTOR:SELECTED	04713	SPS8801
Q244	151-0192-00			TRANSISTOR:SELECTED	04713	SPS8801
Q253	151-0192-00			TRANSISTOR:SELECTED	04713	SPS8801
Q254	151-0220-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0220-00

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
Q255	151-0192-00			TRANSISTOR:SELECTED	04713	SPS8801
Q256	151-0192-00			TRANSISTOR:SELECTED	04713	SPS8801
Q264	151-0192-00			TRANSISTOR:SELECTED	04713	SPS8801
Q265	151-0192-00			TRANSISTOR:SELECTED	04713	SPS8801
Q277	151-0192-00			TRANSISTOR:SELECTED	04713	SPS8801
Q278	151-0192-00			TRANSISTOR:SELECTED	04713	SPS8801
Q314	151-0456-00			TRANSISTOR:NPN,SI,TO-92	07263	S39988
Q322	151-0302-00			TRANSISTOR:NPN,SI,TO-18	04713	ST899
Q331	151-0190-00			TRANSISTOR:NPN,SI,TO-92	80009	151-0190-00
Q333	151-0190-00			TRANSISTOR:NPN,SI,TO-92	80009	151-0190-00
Q337	151-0456-00			TRANSISTOR:NPN,SI,TO-92	07263	S39988
Q338	151-0190-00			TRANSISTOR:NPN,SI,TO-92	80009	151-0190-00
Q341	151-0225-00			TRANSISTOR:NPN,SI,TO-106	04713	SPS7890
Q342	151-0225-00			TRANSISTOR:NPN,SI,TO-106	04713	SPS7890
Q344	151-0190-00			TRANSISTOR:NPN,SI,TO-92	80009	151-0190-00
Q345	151-0190-00			TRANSISTOR:NPN,SI,TO-92	80009	151-0190-00
Q348	151-0190-00			TRANSISTOR:NPN,SI,TO-92	80009	151-0190-00
Q377	151-0190-00			TRANSISTOR:NPN,SI,TO-92	80009	151-0190-00
Q386	151-0190-00			TRANSISTOR:NPN,SI,TO-92	80009	151-0190-00
Q387	151-0220-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0220-00
Q397	151-0220-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0220-00
Q398	151-0103-00			TRANSISTOR:NPN,SI,TO-5	04713	SM1307
Q426	151-0103-00			TRANSISTOR:NPN,SI,TO-5	04713	SM1307
Q427	151-0220-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0220-00
Q436	151-0220-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0220-00
Q446	151-0460-00			TRANSISTOR:NPN,SI,TO-18 (END USAGE 670-4456-00)	04713	2N3947
Q446	151-0190-00			TRANSISTOR:NPN,SI,TO-92 (BEGIN USAGE 670-4456-01)	80009	151-0190-00
Q447	151-0459-00			TRANSISTOR:PNP,SI,TO-18 (END USAGE 670-4456-00)	04713	ST1068
Q447	151-0220-00			TRANSISTOR:PNP,SI,TO-92 (BEGIN USAGE 670-4456-01)	80009	151-0220-00
Q462	151-0192-00			TRANSISTOR:SELECTED	04713	SPS8801
Q482	151-0220-00			TRANSISTOR:PNP,SI,TO-92	80009	151-0220-00
Q492	151-0192-00			TRANSISTOR:SELECTED	04713	SPS8801
R106	307-0446-00			RES NTWK,FXD,FI:10K OHM,20%,(9)RES	11236	750-101-R10K
R109	315-0103-00			RES,FXD,FILM:10K OHM,5%,0.25W	19701	5043CX10K00J
R111	321-0130-00			RES,FXD,FILM:221 OHM,1%,0.125W,TC=T0	19701	5043ED221R0F
R112	321-0259-03			RES,FXD,FILM:4.87K OHM,0.25%,0.125W,TC=T2	07716	CEAC48700C
R113	321-0259-03			RES,FXD,FILM:4.87K OHM,0.25%,0.125W,TC=T2	07716	CEAC48700C
R114	321-0202-00			RES,FXD,FILM:1.24K OHM,1%,0.125W,TC=T0	24546	NA55D1241F
R115	321-1704-03			RES,FXD,FILM:2.386K OHM,0.25%,0.125W,TC=T2	07716	CEAC23860C
R116	315-0202-00			RES,FXD,FILM:2K OHM,5%,0.25W	57668	NTR25J-E 2K
R118	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
R121	321-0213-03			RES,FXD,FILM:1.62K OHM,0.25%,0.125W,TC=T2	07716	CEAC16200C
R122	321-0168-02			RES,FXD,FILM:549 OHM,0.5%,0.125W,TC=T2	19701	5033RC549R0D
R123	315-0103-00			RES,FXD,FILM:10K OHM,5%,0.25W	19701	5043CX10K00J
R124	315-0103-00			RES,FXD,FILM:10K OHM,5%,0.25W	19701	5043CX10K00J
R132	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
R133	315-0752-00			RES,FXD,FILM:7.5K OHM,5%,0.25W	57668	NTR25J-E07K5
R137	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
R141	315-0153-00			RES,FXD,FILM:15K OHM,5%,0.25W	19701	5043CX15K00J
R142	315-0202-00			RES,FXD,FILM:2K OHM,5%,0.25W	57668	NTR25J-E 2K
R143	315-0751-00			RES,FXD,FILM:750 OHM,5%,0.25W	57668	NTR25J-E750E
R144	315-0103-00			RES,FXD,FILM:10K OHM,5%,0.25W	19701	5043CX10K00J
R169	315-0560-00			RES,FXD,FILM:56 OHM,5%,0.25W	57668	NTR25J-E56E0
R171	307-0696-00			RES NTWK,FXD,FI:7,10K OHM,2%,0.15W EACH	01121	108A103

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
R172	315-0202-00			RES,FXD,FILM:2K OHM,5%,0.25W	57668	NTR25J-E 2K
R173	321-0231-00			RES,FXD,FILM:2.49K OHM,1%,0.125W,TC=T0	19701	5033ED2K49F
R174	315-0202-00			RES,FXD,FILM:2K OHM,5%,0.25W	57668	NTR25J-E 2K
R175	315-0101-00			RES,FXD,FILM:100 OHM,5%,0.25W	57668	NTR25J-E 100E
R176	315-0751-00			RES,FXD,FILM:750 OHM,5%,0.25W	57668	NTR25J-E750E
R177	321-0222-00			RES,FXD,FILM:2.00K OHM,1%,0.125W,TC=T0	19701	5033ED2K00F
R179	311-1282-00			RES,VAR,NONWW:TRMR,5K OHM,0.5W	32997	3329S-L58-502
R181	315-0681-00			RES,FXD,FILM:680 OHM,5%,0.25W	57668	NTR25J-E680E
R182	315-0681-00			RES,FXD,FILM:680 OHM,5%,0.25W	57668	NTR25J-E680E
R186	315-0751-00			RES,FXD,FILM:750 OHM,5%,0.25W	57668	NTR25J-E750E
R187	315-0331-00			RES,FXD,FILM:330 OHM,5%,0.25W	57668	NTR25J-E330E
R188	315-0331-00			RES,FXD,FILM:330 OHM,5%,0.25W	57668	NTR25J-E330E
R189	315-0331-00			RES,FXD,FILM:330 OHM,5%,0.25W	57668	NTR25J-E330E
R191	315-0681-00			RES,FXD,FILM:680 OHM,5%,0.25W	57668	NTR25J-E680E
R192	321-1702-03			RES,FXD,FILM:13.05K OHM,0.25%,0.125W,TC=T2	07716	CEAC13051C
R199	315-0101-00			RES,FXD,FILM:100 OHM,5%,0.25W	57668	NTR25J-E 100E
R201	315-0681-00			RES,FXD,FILM:680 OHM,5%,0.25W	57668	NTR25J-E680E
R202	315-0681-00			RES,FXD,FILM:680 OHM,5%,0.25W	57668	NTR25J-E680E
R203	315-0681-00			RES,FXD,FILM:680 OHM,5%,0.25W	57668	NTR25J-E680E
R205	321-0309-00			RES,FXD,FILM:16.2K OHM,1%,0.125W,TC=T0	19701	5033ED16K20F
R206	321-0281-00			RES,FXD,FILM:8.25K OHM,1%,0.125W,TC=T0	19701	5043ED8K250F
R208	311-1280-00			RES,VAR,NONWW:TRMR,1K OHM,0.5W	32997	3329S-L58-102
R209	311-1281-00			RES,VAR,NONWW:TRMR,2.5K OHM,0.5W	32997	3329S-L58-252
R210	315-0681-00			RES,FXD,FILM:680 OHM,5%,0.25W	57668	NTR25J-E680E
R211	315-0101-00			RES,FXD,FILM:100 OHM,5%,0.25W	57668	NTR25J-E 100E
R215	321-0263-00			RES,FXD,FILM:5.36K OHM,1%,0.125W,TC=T0	07716	CEAD53600F
R216	321-0322-00			RES,FXD,FILM:22.1K OHM,0.1%,0.125W,TC=T0	19701	5033ED22K10F
R219	311-1280-00			RES,VAR,NONWW:TRMR,1K OHM,0.5W	32997	3329S-L58-102
R220	315-0101-00			RES,FXD,FILM:100 OHM,5%,0.25W	57668	NTR25J-E 100E
R221	315-0681-00			RES,FXD,FILM:680 OHM,5%,0.25W	57668	NTR25J-E680E
R222	315-0101-00			RES,FXD,FILM:100 OHM,5%,0.25W	57668	NTR25J-E 100E
R226	321-0305-00			RES,FXD,FILM:14.7K OHM,1%,0.125W,TC=T0	19701	5033ED14K70F
R227	311-1282-00			RES,VAR,NONWW:TRMR,5K OHM,0.5W	32997	3329S-L58-502
R228	311-1281-00			RES,VAR,NONWW:TRMR,2.5K OHM,0.5W	32997	3329S-L58-252
R230	315-0681-00			RES,FXD,FILM:680 OHM,5%,0.25W	57668	NTR25J-E680E
R231	315-0101-00			RES,FXD,FILM:100 OHM,5%,0.25W	57668	NTR25J-E 100E
R235	321-0322-00			RES,FXD,FILM:22.1K OHM,0.1%,0.125W,TC=T0	19701	5033ED22K10F
R236	321-0250-00			RES,FXD,FILM:3.92K OHM,1%,0.125W,TC=T0	07716	CEAD39200F
R237	311-1282-00			RES,VAR,NONWW:TRMR,5K OHM,0.5W	32997	3329S-L58-502
R241	315-0681-00			RES,FXD,FILM:680 OHM,5%,0.25W	57668	NTR25J-E680E
R242	315-0101-00			RES,FXD,FILM:100 OHM,5%,0.25W	57668	NTR25J-E 100E
R244	321-0327-00			RES,FXD,FILM:24.9K OHM,1%,0.125W,TC=T0 (END USAGE 670-7274-00)	07716	CEAD24901F
R244	321-0326-00			RES,FXD,FILM:24.3K OHM,1%,0.125W,TC=T0 (BEGIN USAGE 670-7274-01)	19701	5043ED24K30F
R245	321-0257-00			RES,FXD,FILM:4.64K OHM,1%,0.125W,TC=T0	19701	5043ED4K640F
R248	311-1281-00			RES,VAR,NONWW:TRMR,2.5K OHM,0.5W	32997	3329S-L58-252
R249	311-1279-00			RES,VAR,NONWW:TRMR,500 OHM,0.5W	32997	3329S-L58-501
R258	311-1279-00			RES,VAR,NONWW:TRMR,500 OHM,0.5W	32997	3329S-L58-501
R260	321-0391-00			RES,FXD,FILM:115K OHM,1%,0.125W,TC=T0	07716	CEAD11502F
R264	315-0470-00			RES,FXD,FILM:47 OHM,5%,0.25W	57668	NTR25J-E47E0
R265	321-0305-00			RES,FXD,FILM:14.7K OHM,1%,0.125W,TC=T0	19701	5033ED14K70F
R266	321-0370-00			RES,FXD,FILM:69.8K OHM,1%,0.125W,TC=T0	07716	CEAD69801F
R267	321-0263-00			RES,FXD,FILM:5.36K OHM,1%,0.125W,TC=T0	07716	CEAD53600F
R268	321-0396-00			RES,FXD,FILM:130K OHM,1%,0.125W,TC=T0	07716	CEAD13002F
R269	311-1281-00			RES,VAR,NONWW:TRMR,2.5K OHM,0.5W	32997	3329S-L58-252
R270	315-0470-00			RES,FXD,FILM:47 OHM,5%,0.25W	57668	NTR25J-E47E0
R271	315-0470-00			RES,FXD,FILM:47 OHM,5%,0.25W	57668	NTR25J-E47E0

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
R272	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
R276	321-1702-03			RES,FXD,FILM:13.05K OHM,0.25%,0.125W,TC=T2	07716	CEAC13051C
R278	311-1281-00			RES,VAR,NONWW:TRMR,2.5K OHM,0.5W	32997	3329S-L58-252
R279	311-1279-00			RES,VAR,NONWW:TRMR,500 OHM,0.5W	32997	3329S-L58-501
R280	315-0681-00			RES,FXD,FILM:680 OHM,5%,0.25W	57668	NTR25J-E680E
R281	315-0102-00			RES,FXD,FILM:1K OHM,5%,0.25W	57668	NTR25JE01K0
R285	321-0304-00			RES,FXD,FILM:14.3K OHM,1%,0.125W,TC=T0	19701	5033ED14K30F
R286	321-0280-00			RES,FXD,FILM:8.06K OHM,1%,0.125W,TC=T0	19701	5033ED8K060F
R289	311-1280-00			RES,VAR,NONWW:TRMR,1K OHM,0.5W	32997	3329S-L58-102
R292	315-0331-00			RES,FXD,FILM:330 OHM,5%,0.25W	57668	NTR25J-E330E
R295	321-0308-00			RES,FXD,FILM:15.8K OHM,1%,0.125W,TC=T0	07716	CEAD 15801F
R296	321-0349-00			RES,FXD,FILM:42.2K OHM,1%,0.125W,TC=T0	07716	CEAD42201F
R298	311-1281-00			RES,VAR,NONWW:TRMR,2.5K OHM,0.5W	32997	3329S-L58-252
R299	311-1283-00			RES,VAR,NONWW:TRMR,10K OHM,0.5W	32997	3329S-L58-103
R311	315-0103-00			RES,FXD,FILM:10K OHM,5%,0.25W	19701	5043CX10K00J
R312	315-0103-00			RES,FXD,FILM:10K OHM,5%,0.25W	19701	5043CX10K00J
R313	315-0154-00			RES,FXD,FILM:150K OHM,5%,0.25W	57668	NTR25J-E150K
R314	315-0100-00			RES,FXD,FILM:10 OHM,5%,0.25W	19701	5043CX10RR00J
R315	315-0103-00			RES,FXD,FILM:10K OHM,5%,0.25W	19701	5043CX10K00J
R316	315-0103-00			RES,FXD,FILM:10K OHM,5%,0.25W	19701	5043CX10K00J
R317	321-0222-00			RES,FXD,FILM:2.00K OHM,1%,0.125W,TC=T0	19701	5033ED2K00F
R320	315-0202-00			RES,FXD,FILM:2K OHM,5%,0.25W	57668	NTR25J-E 2K
R322	315-0101-00			RES,FXD,FILM:100 OHM,5%,0.25W	57668	NTR25J-E 100E
R323	315-0512-00			RES,FXD,FILM:5.1K OHM,5%,0.25W	57668	NTR25J-E05K1
R324	315-0103-00			RES,FXD,FILM:10K OHM,5%,0.25W	19701	5043CX10K00J
R325	321-0193-00			RES,FXD,FILM:1K OHM,1%,0.125W,TC=T0	19701	5033ED1K00F
R326	321-0222-00			RES,FXD,FILM:2.00K OHM,1%,0.125W,TC=T0	19701	5033ED2K00F
R327	321-0260-00			RES,FXD,FILM:4.99K OHM,1%,0.125W,TC=T0	19701	5033ED4K990F
R328	321-0289-00			RES,FXD,FILM:10.0K OHM,1%,0.125W,TC=T0	19701	5033ED10K0F
R329	315-0512-00			RES,FXD,FILM:5.1K OHM,5%,0.25W (END USAGE 670-4456-00)	57668	NTR25J-E05K1
R329	315-0751-00			RES,FXD,FILM:750 OHM,5%,0.25W (BEGIN USAGE 670-4456-01)	57668	NTR25J-E750E
R331	315-0392-00			RES,FXD,FILM:3.9K OHM,5%,0.25W	57668	NTR25J-E03K9
R332	315-0392-00			RES,FXD,FILM:3.9K OHM,5%,0.25W	57668	NTR25J-E03K9
R333	315-0752-00			RES,FXD,FILM:7.5K OHM,5%,0.25W (END USAGE 670-4456-00)	57668	NTR25J-E07K5
R333	315-0912-00			RES,FXD,FILM:9.1K OHM,5%,0.25W (BEGIN USAGE 670-4456-01)	57668	NTR25J-E09K1
R334	315-0392-00			RES,FXD,FILM:3.9K OHM,5%,0.25W	57668	NTR25J-E03K9
R335	315-0101-00			RES,FXD,FILM:100 OHM,5%,0.25W	57668	NTR25J-E 100E
R336	315-0202-00			RES,FXD,FILM:2K OHM,5%,0.25W	57668	NTR25J-E 2K
R337	315-0512-00			RES,FXD,FILM:5.1K OHM,5%,0.25W	57668	NTR25J-E05K1
R338	315-0103-00			RES,FXD,FILM:10K OHM,5%,0.25W	19701	5043CX10K00J
R339	315-0302-00			RES,FXD,FILM:3K OHM,5%,0.25W	57668	NTR25J-E03K0
R342	315-0101-00			RES,FXD,FILM:100 OHM,5%,0.25W	57668	NTR25J-E 100E
R343	315-0202-00			RES,FXD,FILM:2K OHM,5%,0.25W	57668	NTR25J-E 2K
R344	315-0101-00			RES,FXD,FILM:100 OHM,5%,0.25W	57668	NTR25J-E 100E
R345	315-0101-00			RES,FXD,FILM:100 OHM,5%,0.25W	57668	NTR25J-E 100E
R346	315-0202-00			RES,FXD,FILM:2K OHM,5%,0.25W	57668	NTR25J-E 2K
R347	315-0512-00			RES,FXD,FILM:5.1K OHM,5%,0.25W	57668	NTR25J-E05K1
R348	315-0103-00			RES,FXD,FILM:10K OHM,5%,0.25W	19701	5043CX10K00J
R349	315-0100-00			RES,FXD,FILM:10 OHM,5%,0.25W	19701	5043CX10RR00J
R354	321-0154-00			RES,FXD,FILM:392 OHM,1%,0.125W,TC=T0	07716	CEAD392R0F
R357	315-0101-00			RES,FXD,FILM:100 OHM,5%,0.25W	57668	NTR25J-E 100E
R358	321-0193-00			RES,FXD,FILM:1K OHM,1%,0.125W,TC=T0 (END USAGE 670-4456-00)	19701	5033ED1K00F
R358	321-0126-00			RES,FXD,FILM:200 OHM,1%,0.125W,TC=T0 (BEGIN USAGE 670-4456-01)	19701	5033ED200R0F

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
R359	315-0100-00			RES,FXD,FILM:10 OHM,5%,0.25W	19701	5043CX10RR00J
R362	321-0126-00			RES,FXD,FILM:200 OHM,1%,0.125W,TC=T0	19701	5033ED200R0F
R363	321-0126-00			RES,FXD,FILM:200 OHM,1%,0.125W,TC=T0	19701	5033ED200R0F
R368	321-0193-00			RES,FXD,FILM:1K OHM,1%,0.125W,TC=T0 (END USAGE 670-4456-00)	19701	5033ED1K00F
R368	321-0126-00			RES,FXD,FILM:200 OHM,1%,0.125W,TC=T0 (BEGIN USAGE 670-4456-01)	19701	5033ED200R0F
R369	321-0271-00			RES,FXD,FILM:6.49K OHM,1%,0.125W,TC=T0	07716	CEAD64900F
R371	315-0101-00			RES,FXD,FILM:100 OHM,5%,0.25W	57668	NTR25J-E 100E
R372	315-0101-00			RES,FXD,FILM:100 OHM,5%,0.25W	57668	NTR25J-E 100E
R373	315-0101-00			RES,FXD,FILM:100 OHM,5%,0.25W	57668	NTR25J-E 100E
R374	315-0101-00			RES,FXD,FILM:100 OHM,5%,0.25W	57668	NTR25J-E 100E
R378	315-0103-00			RES,FXD,FILM:10K OHM,5%,0.25W	19701	5043CX10K00J
R379	311-1920-00			RES,VAR,NONWW:TRMR,500 OHM,10%,0.5 W (END USAGE 670-4456-00)	32997	3386C-T07-501
R379	311-1919-00			RES,VAR,NONWW:TRMR,1K OHM,10%,0.5 W (END USAGE 670-4456-00)	32997	3386C-T07-102
R379	311-1237-00			RES,VAR,NONWW:1K OHM,10%,0.50W (BEGIN USAGE 670-4456-01)	32997	3386X-DY6-102
R382	315-0101-00			RES,FXD,FILM:100 OHM,5%,0.25W	57668	NTR25J-E 100E
R383	315-0101-00			RES,FXD,FILM:100 OHM,5%,0.25W	57668	NTR25J-E 100E
R385	315-0101-00			RES,FXD,FILM:100 OHM,5%,0.25W	57668	NTR25J-E 100E
R387	315-0470-00			RES,FXD,FILM:47 OHM,5%,0.25W (END USAGE 670-4456-00)	57668	NTR25J-E47E0
R388	321-0256-00			RES,FXD,FILM:4.53K OHM,1%,0.125W,TC=T9	19701	5033ED4K530F
R389	321-0213-00			RES,FXD,FILM:1.62K OHM,1%,0.125W,TC=T0 (END USAGE 670-4456-00)	07716	CEAD16200F
R389	321-0205-00			RES,FXD,FILM:1.33K OHM,1%,0.125W,TC=T0 (BEGIN USAGE 670-4456-01)	19701	5033ED1K330F
R390	315-0101-00			RES,FXD,FILM:100 OHM,5%,0.25W	57668	NTR25J-E 100E
R391	321-0812-07			RES,FXD,FILM:455 OHM,0.1%,0.125W,TC=T9	19701	5033RE455R0B
R392	321-0812-07			RES,FXD,FILM:455 OHM,0.1%,0.125W,TC=T9	19701	5033RE455R0B
R393	321-0812-07			RES,FXD,FILM:455 OHM,0.1%,0.125W,TC=T9	19701	5033RE455R0B
R394	321-0812-07			RES,FXD,FILM:455 OHM,0.1%,0.125W,TC=T9	19701	5033RE455R0B
R395	315-0101-00			RES,FXD,FILM:100 OHM,5%,0.25W	57668	NTR25J-E 100E
R396	315-0154-00			RES,FXD,FILM:150K OHM,5%,0.25W	57668	NTR25J-E150K
R397	315-0911-00			RES,FXD,FILM:910 OHM,5%,0.25W	57668	NTR25J-E910E
R398	315-0101-00			RES,FXD,FILM:100 OHM,5%,0.25W	57668	NTR25J-E 100E
R400	315-0302-00			RES,FXD,FILM:3K OHM,5%,0.25W	57668	NTR25J-E03K0
R401	315-0154-00			RES,FXD,FILM:150K OHM,5%,0.25W	57668	NTR25J-E150K
R402	311-1915-00			RES,VAR,NONWW:TRMR,20K OHM,10%,0.5 W (END USAGE 670-4456-00)	32997	3386C-T07-203
R402	311-1198-00			RES,VAR,NONWW:TRMR,20K OHM,0.5W (BEGIN USAGE 670-4456-01)	32997	3386X-T07-203
R403	311-1915-00			RES,VAR,NONWW:TRMR,20K OHM,10%,0.5 W (END USAGE 670-4456-00)	32997	3386C-T07-203
R403	311-1198-00			RES,VAR,NONWW:TRMR,20K OHM,0.5W (BEGIN USAGE 670-4456-01)	32997	3386X-T07-203
R404	315-0302-00			RES,FXD,FILM:3K OHM,5%,0.25W	57668	NTR25J-E03K0
R406	315-0302-00			RES,FXD,FILM:3K OHM,5%,0.25W	57668	NTR25J-E03K0
R407	321-0114-00			RES,FXD,FILM:150 OHM,1%,0.125 W,TC=T0 (END USAGE 670-4456-01)	19701	5033ED150R0F
R407	321-0114-03			RES,FXD,FILM:150 OHM,0.25%,0.125W,TCT2 (BEGIN USAGE 670-4456-02)	19701	5033RC150R0C
R408	321-0114-00			RES,FXD,FILM:150 OHM,1%,0.125 W,TC=T0 (END USAGE 670-4456-01)	19701	5033ED150R0F
R408	321-0114-03			RES,FXD,FILM:150 OHM,0.25%,0.125W,TCT2 (BEGIN USAGE 670-4456-02)	19701	5033RC150R0C
R409	308-0252-00			RES,FXD,WW:390 OHM,5%,3W	00213	1240S 390-5
R410	321-0961-07			RES,FXD,FILM:500.5 OHM,0.1%,0.125W,TC=T9	19701	5033RE500R5B
R411	321-0961-07			RES,FXD,FILM:500.5 OHM,0.1%,0.125W,TC=T9	19701	5033RE500R5B

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
R412	321-0961-07			RES,FXD,FILM:500.5 OHM,0.1%,0.125W,TC=T9	19701	5033RE500R5B
R413	321-0961-07			RES,FXD,FILM:500.5 OHM,0.1%,0.125W,TC=T9	19701	5033RE500R5B
R425	315-0470-00			RES,FXD,FILM:47 OHM,5%,0.25W (END USAGE 670-4456-00)	57668	NTR25J-E47E0
R427	315-0302-00			RES,FXD,FILM:3K OHM,5%,0.25W	57668	NTR25J-E03K0
R428	321-0114-00			RES,FXD,FILM:150 OHM,1%,0.125 W,TC=T0 (END USAGE 670-4456-01)	19701	5033ED150R0F
R428	321-0114-03			RES,FXD,FILM:150 OHM,0.25%,0.125W,TCT2 (BEGIN USAGE 670-4456-02)	19701	5033RC150R0C
R429	321-0114-00			RES,FXD,FILM:150 OHM,1%,0.125 W,TC=T0 (END USAGE 670-4456-01)	19701	5033ED150R0F
R429	321-0114-03			RES,FXD,FILM:150 OHM,0.25%,0.125W,TCT2 (BEGIN USAGE 670-4456-02)	19701	5033RC150R0C
R438	321-0188-00			RES,FXD,FILM:887 OHM,1%,0.125W,TC=T0 (END USAGE 670-4456-00)	07716	CEAD887R0F
R438	321-0190-00			RES,FXD,FILM:931 OHM,1%,0.125W,TC=T2 (BEGIN USAGE 670-4456-01)	19701	5043ED931R0F
R439	308-0426-00			RES,FXD,WW:470 OHM,5%,3W	00213	1240S-470-5
R446	315-0681-00			RES,FXD,FILM:680 OHM,5%,0.25W	57668	NTR25J-E680E
R447	321-0277-00			RES,FXD,FILM:7.50K OHM,1%,0.125W,TC=T0	24546	NA55D7501F
R448	321-0277-00			RES,FXD,FILM:7.50K OHM,1%,0.125W,TC=T0	24546	NA55D7501F
R449	311-1921-00			RES,VAR,NONWW:TRMR,250 OHM,10%,0.5 W (END USAGE 670-4456-00)	32997	3386C-T07-251
R449	311-1244-00			RES,VAR,NONWW:TRMR,100 OHM,0.5W (BEGIN USAGE 670-4456-01)	32997	3386X-T07-101
R454	321-0256-00			RES,FXD,FILM:4.53K OHM,1%,0.125W,TC=T9	19701	5033ED4K530F
R455	321-0251-00			RES,FXD,FILM:4.02K OHM,1%,0.125W,TC=T0	19701	5033ED4K020F
R456	321-0289-00			RES,FXD,FILM:10.0K OHM,1%,0.125W,TC=T0	19701	5033ED10K0F
R457	315-0622-00			RES,FXD,FILM:6.2K OHM,5%,0.25W	19701	5043CX6K200J
R458	321-0218-00			RES,FXD,FILM:1.82K OHM,1%,0.125W,TC=T0 (END USAGE 670-4456-00)	19701	5033ED1K82F
R458	321-0216-00			RES,FXD,FILM:1.74K OHM,1%,0.125W,TC=T0 (BEGIN USAGE 670-4456-01)	07716	CEAD17400F
R459	311-1920-00			RES,VAR,NONWW:TRMR,500 OHM,10%,0.5 W (END USAGE 670-4456-00)	32997	3386C-T07-501
R459	311-1248-00			RES,VAR,NONWW:TRMR,500 OHM,0.5W (BEGIN USAGE 670-4456-01)	32997	3386X-T07-501
R460	315-0101-00			RES,FXD,FILM:100 OHM,5%,0.25W	57668	NTR25J-E 100E
R461	315-0101-00			RES,FXD,FILM:100 OHM,5%,0.25W	57668	NTR25J-E 100E
R469	321-0117-00			RES,FXD,FILM:162 OHM,1%,0.125W,TC=T0	07716	CEAD162R0F
R470	321-0322-00			RES,FXD,FILM:22.1K OHM,0.1%,0.125W,TC=T0	19701	5033ED22K10F
R471	315-0202-00			RES,FXD,FILM:2K OHM,5%,0.25W	57668	NTR25J-E 2K
R472	321-0289-00			RES,FXD,FILM:10.0K OHM,1%,0.125W,TC=T0	19701	5033ED10K0F
R473	321-0193-00			RES,FXD,FILM:1K OHM,1%,0.125W,TC=T0	19701	5033ED1K00F
R481	315-0101-00			RES,FXD,FILM:100 OHM,5%,0.25W	57668	NTR25J-E 100E
R489	321-0117-00			RES,FXD,FILM:162 OHM,1%,0.125W,TC=T0	07716	CEAD162R0F
R490	315-0101-00			RES,FXD,FILM:100 OHM,5%,0.25W	57668	NTR25J-E 100E
R491	321-0322-00			RES,FXD,FILM:22.1K OHM,0.1%,0.125W,TC=T0	19701	5033ED22K10F
S102	263-0010-00			SWITCH PB ASSY:1 PUSH,7.5 MM,W/2 CONTACTS	80009	263-0010-00
S103	263-0010-00			SWITCH PB ASSY:1 PUSH,7.5 MM,W/2 CONTACTS	80009	263-0010-00
S104	263-0094-00			SWITCH PB ASSY:6 LATCH,7.5MM,12 CONT	80009	263-0094-00
S105	263-0094-00			SWITCH PB ASSY:6 LATCH,7.5MM,12 CONT	80009	263-0094-00
S106	263-0094-00			SWITCH PB ASSY:6 LATCH,7.5MM,12 CONT	80009	263-0094-00
S107	263-0094-00			SWITCH PB ASSY:6 LATCH,7.5MM,12 CONT	80009	263-0094-00
S108	263-0094-00			SWITCH PB ASSY:6 LATCH,7.5MM,12 CONT	80009	263-0094-00
S109	263-0094-00			SWITCH PB ASSY:6 LATCH,7.5MM,12 CONT	80009	263-0094-00
S301	263-0010-00			SWITCH PB ASSY:1 PUSH,7.5 MM,W/2 CONTACTS	80009	263-0010-00
S302	263-0010-00			SWITCH PB ASSY:1 PUSH,7.5 MM,W/2 CONTACTS	80009	263-0010-00
S303	263-0010-00			SWITCH PB ASSY:1 PUSH,7.5 MM,W/2 CONTACTS	80009	263-0010-00
S304	263-0010-00			SWITCH PB ASSY:1 PUSH,7.5 MM,W/2 CONTACTS	80009	263-0010-00

Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
S305	263-0010-00			SWITCH PB ASSY:1 PUSH,7.5 MM,W/2 CONTACTS	80009	263-0010-00
S306	263-0010-00			SWITCH PB ASSY:1 PUSH,7.5 MM,W/2 CONTACTS	80009	263-0010-00
S307	263-0010-00			SWITCH PB ASSY:1 PUSH,7.5 MM,W/2 CONTACTS	80009	263-0010-00
T355	120-1071-00			TRANSFORMER,RF:TOROID	80009	120-1071-00
T375	120-1070-00			TRANSFORMER,RF:TOROID	80009	120-1070-00
U125	156-0644-03			MICROCKT,DGTL:QUAD BILATERAL SWITCH,BURN-IN	02735	CD4066BFX
U127	156-0921-01			MICROCKT,LINEAR:OPERATIONAL AMPLIFIER,SEL	80009	156-0921-01
U129	156-0382-02			MICROCKT,DGTL:QUAD 2 INP NAND GATE BURN	18324	N74LS00NB
U145	156-1172-01			MICROCKT,DGTL:DUAL 4 BIT BIN CNTR,SCRN	01295	SN74LS393NP3
U147	156-0985-01			MICROCKT,DGTL:DUAL 5-INPUT NOR GATE,SCRN	04713	SN74LS260NDS
U149	156-0383-02			MICROCKT,DGTL:QUAD 2-INP NOR GATE,SCRN,	18324	N74LS02NB
U152	156-0386-02			MICROCKT,DGTL:TRIPLE 3-INP NAND GATE,SCRN	07263	74LS10PCQR
U155	160-1173-00			MICROCKT,DGTL:256 X 4 PROM,PROGRAMMED	80009	160-1173-00
U157	156-0382-02			MICROCKT,DGTL:QUAD 2 INP NAND GATE BURN	18324	N74LS00NB
U159	156-0479-02			MICROCKT,DGTL:QUAD 2-INP OR GATE,SCRN	01295	SN74LS32NP3
U162	160-1172-00			MICROCKT,DGTL:256 X 4 PROM,PROGRAMMED	80009	160-1172-00
U163	160-1169-00			MICROCKT,DGTL:512 X 8 PROM,PRGM	80009	160-1169-00
U164	156-0480-02			MICROCKT,DGTL:QUAD 2-INP & GATE,SCRN,	01295	SN74LS08NP3
U165	156-0733-02			MICROCKT,DGTL:DUAL MONOSTABLE MV W/ST INP	01295	SN74LS221N3
U166	156-0385-02			MICROCKT,DGTL:HEX INVERTER,SCRN	07263	74LS04PCQR
U167	156-0479-02			MICROCKT,DGTL:QUAD 2-INP OR GATE,SCRN	01295	SN74LS32NP3
U168	156-0381-02			MICROCKT,DGTL:QUAD 2-INP EXCL OR GATE	07263	74LS86PCQR
U169	156-0718-03			MICROCKT,DGTL:TRIPLE 3-INP NOR GATE,SCRN	01295	SN74LS27NP3
U172	156-0982-03			MICROCKT,DGTL:OCTAL-D-EDGE TRIG FF,SCRN	01295	SN74LS374N3
U175	156-0422-02			MICROCKT,DGTL:UP/DOWN SYN BINARY CNTR,SCRN	18324	N74LS191NB
U177	156-0382-02			MICROCKT,DGTL:QUAD 2 INP NAND GATE BURN	18324	N74LS00NB
U179	156-0422-02			MICROCKT,DGTL:UP/DOWN SYN BINARY CNTR,SCRN	18324	N74LS191NB
U182	156-0391-02			MICROCKT,DGTL:HEX LATCH W/CLEAR,SCRN	01295	SN74LS174NP3
U382	156-0130-00			MICROCKT,LINEAR:MODULATOR/DEMODULATOR	80009	156-0130-00
U384	156-0130-00			MICROCKT,LINEAR:MODULATOR/DEMODULATOR	80009	156-0130-00
VR343	152-0279-00			SEMICOND DVC,DI:ZEN,SI,5.1V,5%,0.4W,DO-7	14552	TD3810989
W414	131-0566-00			BUS,CONDUCTOR:DUMMY RES,0.094 OD X 0.225 L (END USAGE 670-4456-00)	24546	OMA 07

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. Also included are functional diagrams for commercially-available integrated circuits used in this instrument.

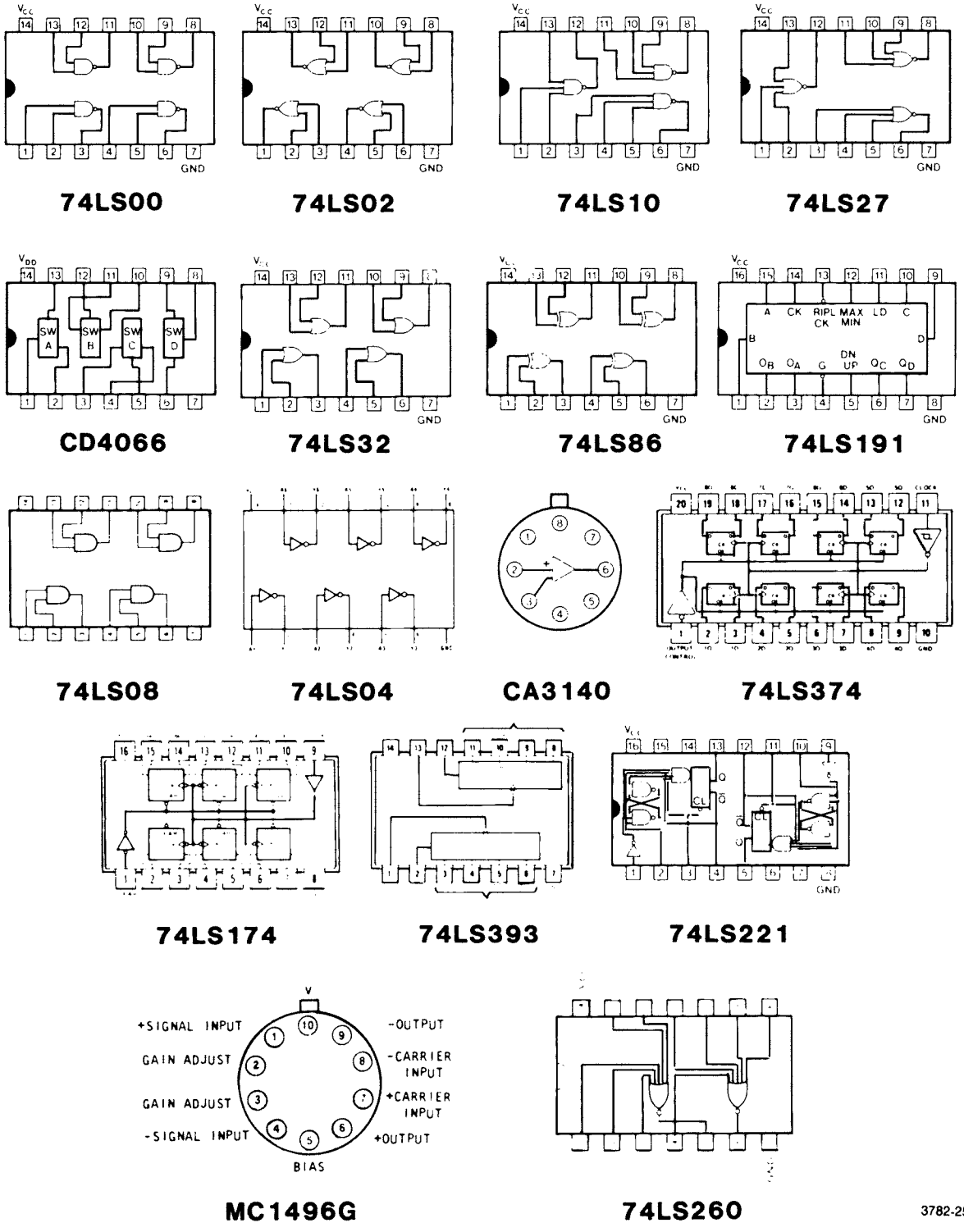


Fig. 8-1. Functional diagrams for integrated circuits in the TSG7, excluding PROMS.

@

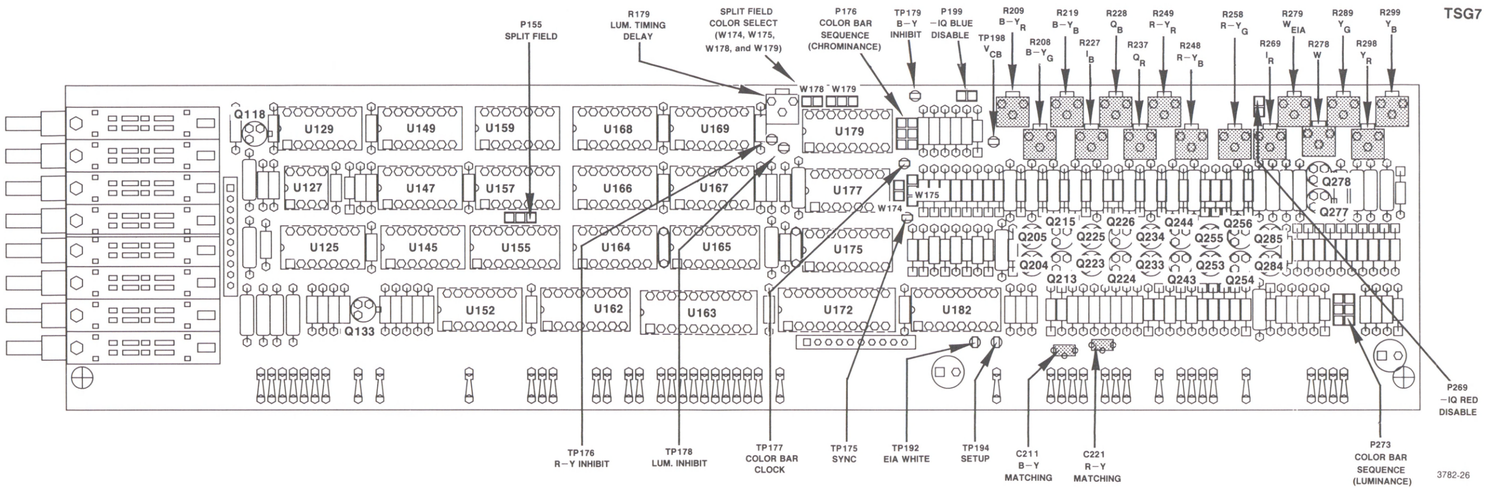


FIG. 8-2 A32 COLOR BAR LOGIC BOARD ADJUSTMENT AND JUMPER LOCATIONS

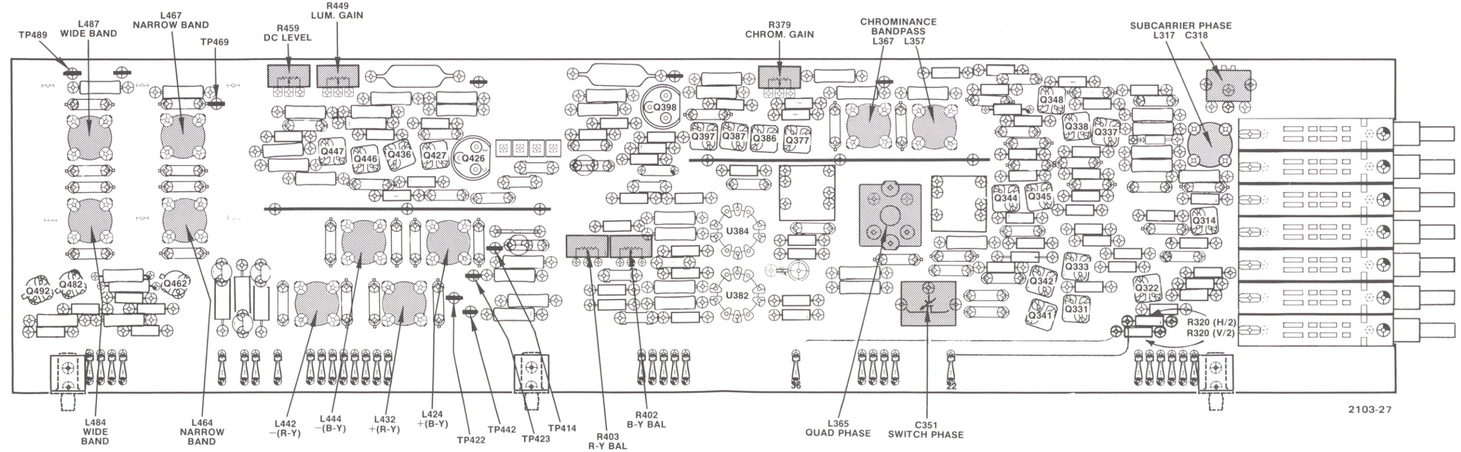


FIG. 8-3 A31 COLOR BAR OUTPUT BOARD ADJUSTMENT LOCATIONS

DIAGRAMS AND CIRCUIT BOARD ILLUSTRATIONS

Symbols

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

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

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

Abbreviations are based on ANSI Y1.1-1972.

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

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

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

Component Values

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

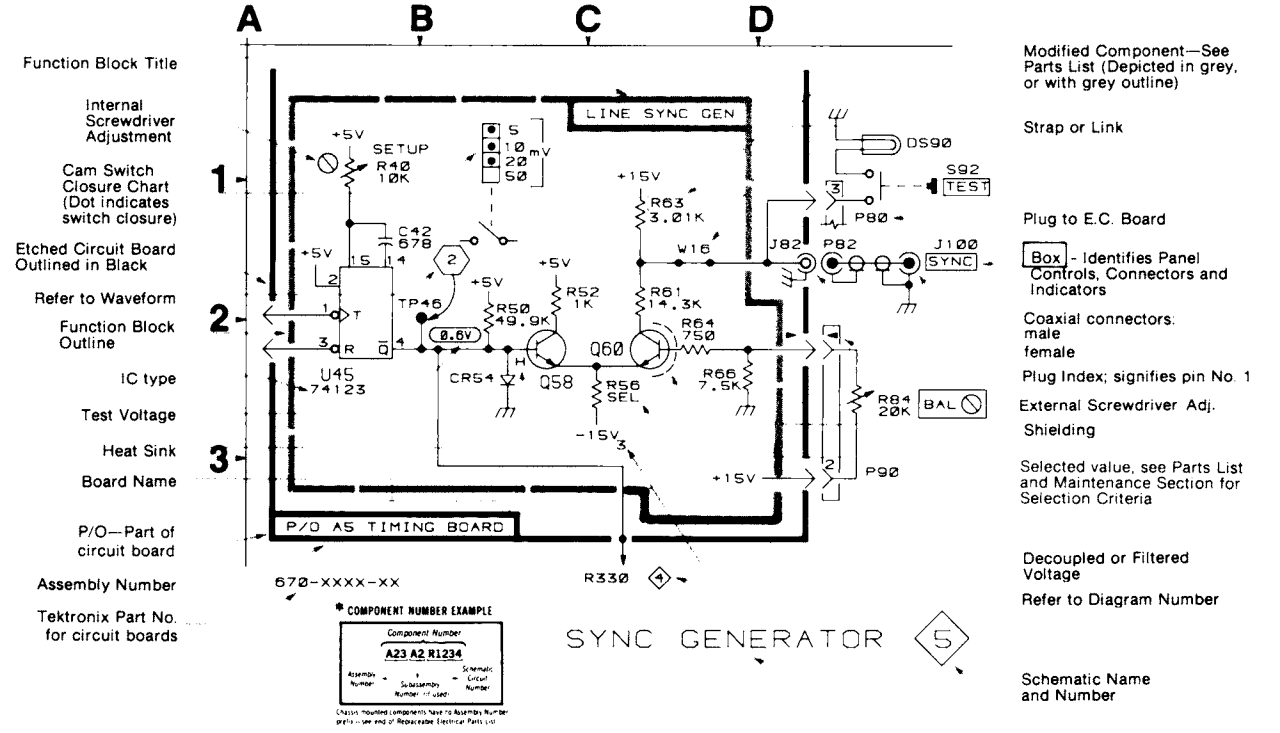
Capacitors = Values one or greater are in picofarads (pF). Values less than one are in microfarads (μF).
Resistors = Ohms (Ω).

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

Assembly Numbers and Grid Coordinates

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

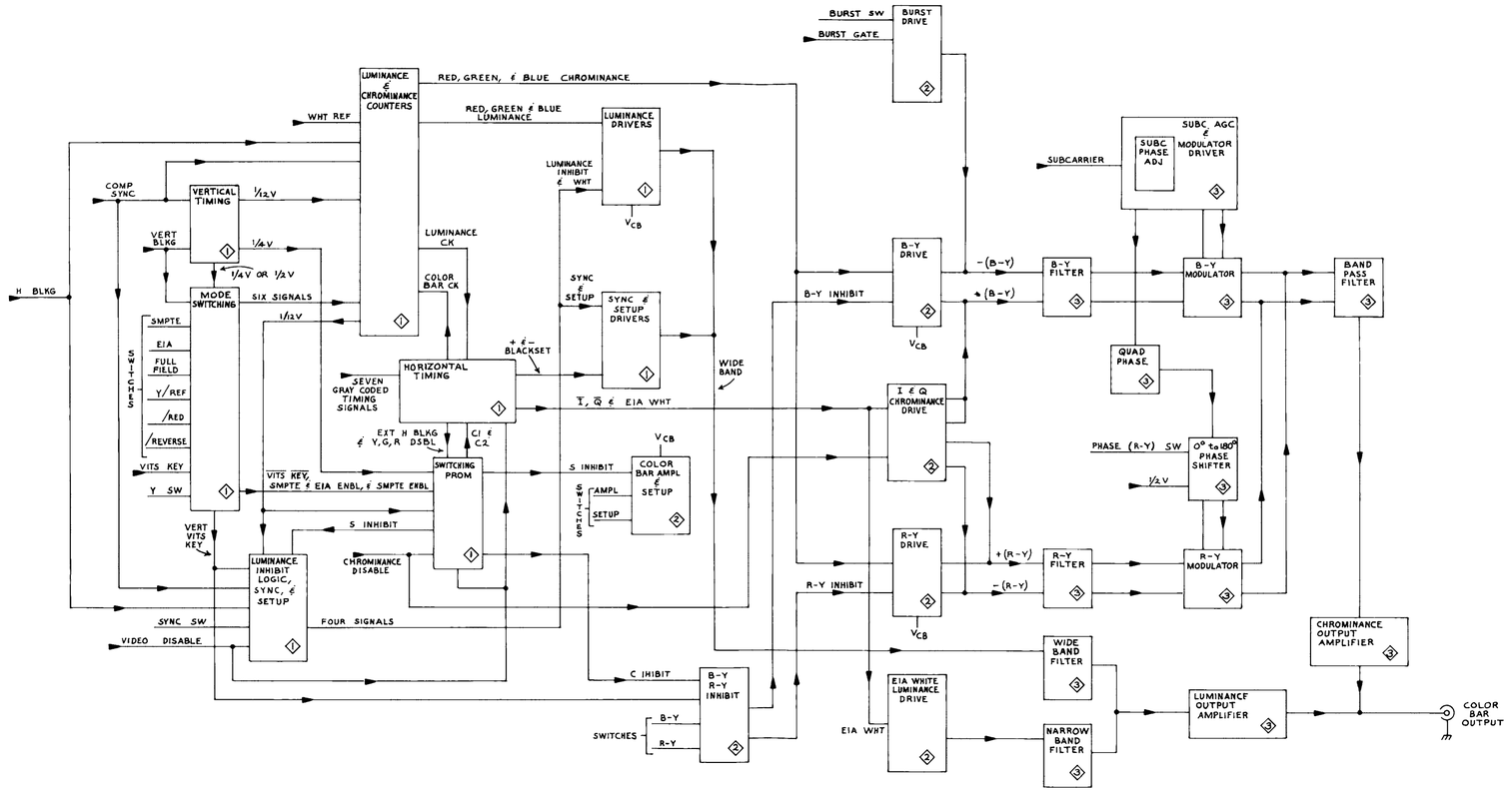
The schematic diagram and circuit board component location illustration have grids. A lookup table with the grid coordinates is provided for ease of locating the component. Only the components illustrated on the facing diagram are listed in the lookup table. When more than one schematic diagram is used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



@

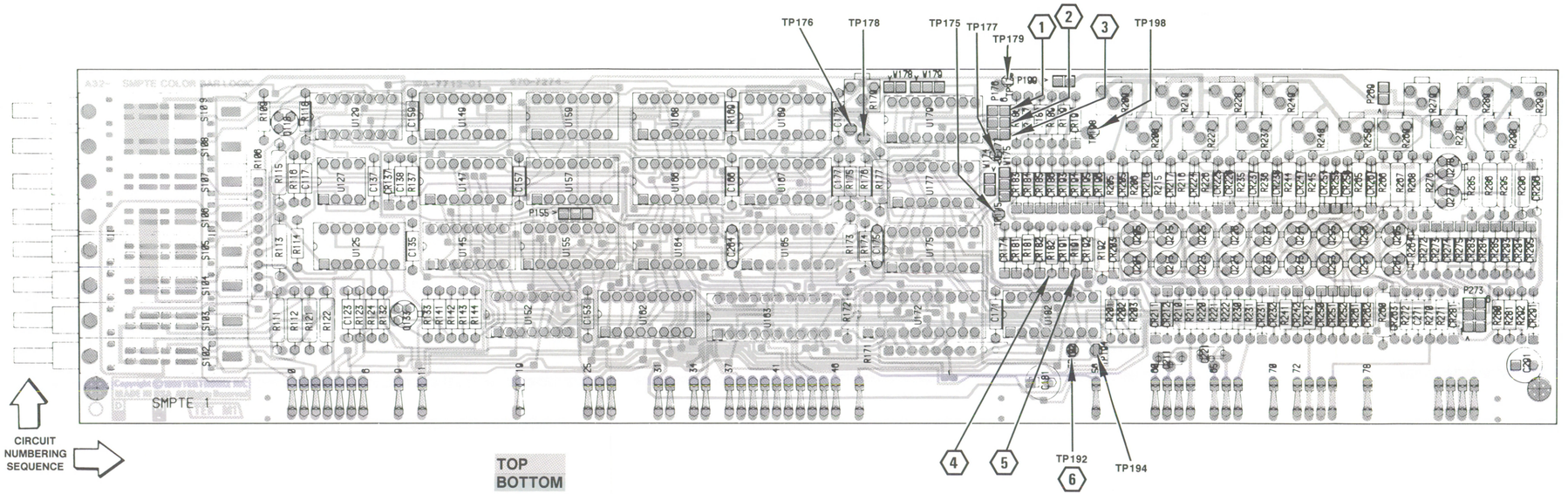
WAVEFORM CONDITIONS

All waveforms were taken with the front panel FULL FIELD pushbutton engaged except as indicated (EIA pushbutton engaged).



TSG7 @ /GEM 5/81

BLOCK DIAGRAM



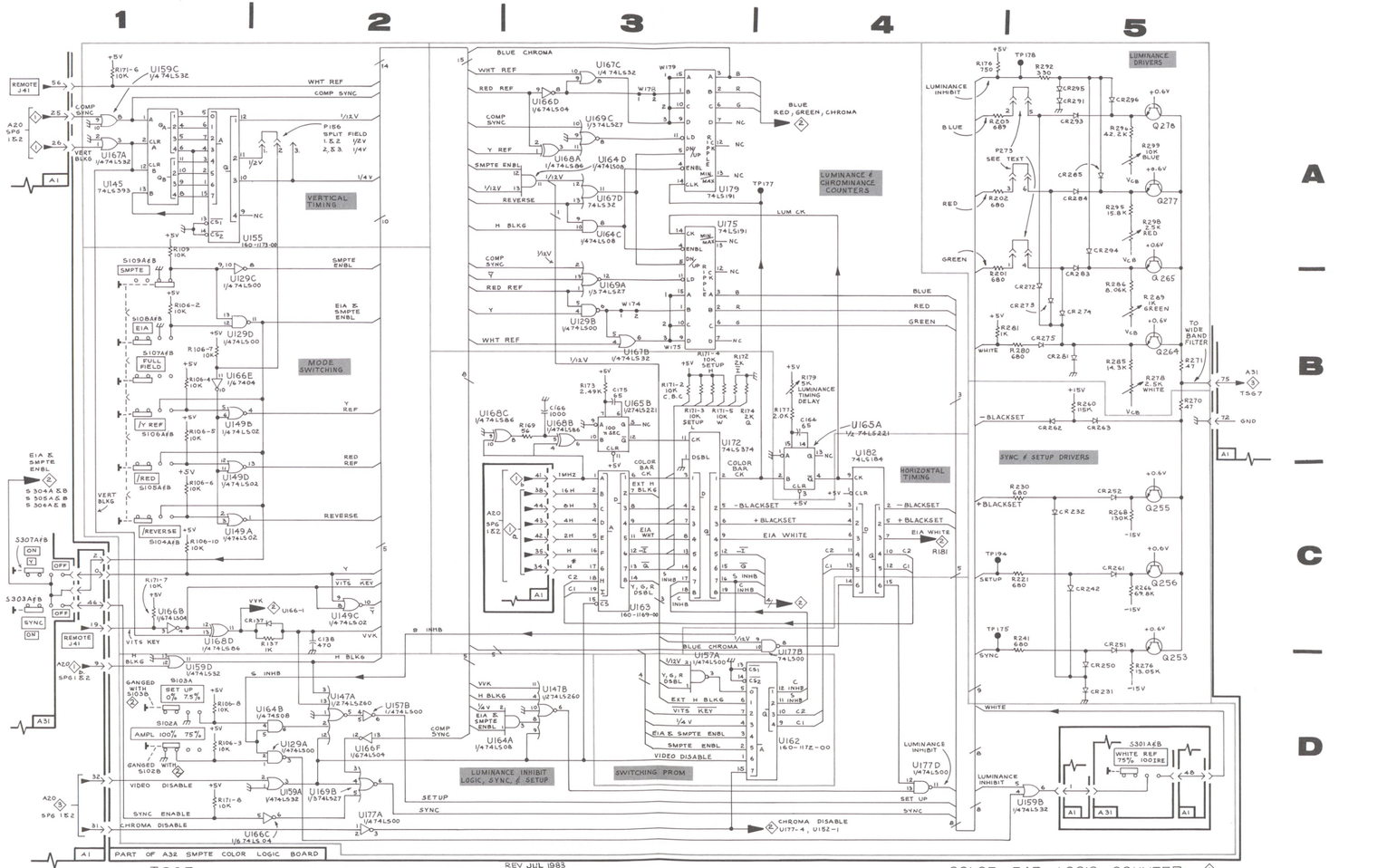
3782-27

Fig. 9-1 A32 Color Bar Logic board component locations.

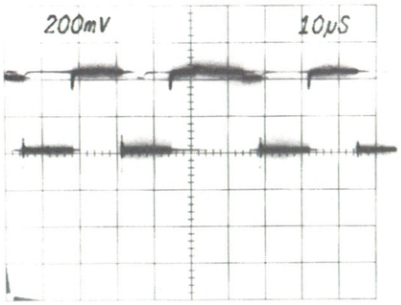
① COLOR BAR LOGIC COUNTER DIAGRAM

ASSEMBLY A32

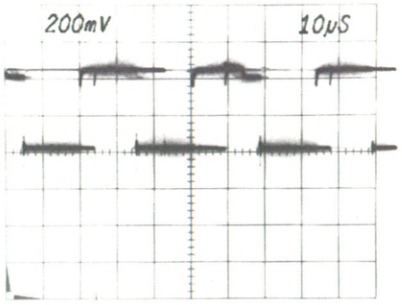
CIRCUIT NUMBER	SCHEM LOCATION
C138	2C
C164	4B
C166	3B
C175	3B
CR137	2C
CR231	5C
CR232	5C
CR242	5C
CR250	5C
CR251	5C
CR252	5B
CR261	5C
CR262	5B
CR263	5B
CR272	5A
CR273	5A
CR274	5B
CR275	5B
CR281	5B
CR283	5A
CR284	5A
CR285	5A
CR291	5A
CR293	5A
CR294	5A
CR295	5A
CR296	5A
P155	2A
P273	5A
Q253	5C
Q255	5B
Q256	5C
Q264	5B
Q265	5A
Q277	5A
Q278	5A
R1062	1B
R1063	1D
R1064	1B
R1065	1B
R1066	1B
R1067	1B
R1068	1D
R10610	1C
R109	1A
R137	2C
R169	3B
R171B	3B
R171C	3B
R171D	3B
R171E	3B
R171F	1A
R1717	1C
R1718	1D
R172	3B
R173	3B
R174	3B
R176	4A
R177	4B
R179	4B
R201	4A
R202	4A
R203	4A
R221	5C
R230	5B
R241	5C
R260	5B
R266	5C
R268	5C
R270	5B
R271	5B
R276	5C
R278	5B
R280	5B
R281	4B
R285	5B
R286	5A
R289	5B
R292	5A
R295	5A
R296	5A
R298	5A
R299	5A
S102A	1D
S103A	1D
S104A	1C
S104B	1C
S105A	1B
S105B	1B
S106A	1B
S106B	1B
S107A	1B
S107B	1B
S108A	1B
S108B	1B
S109A	1A
S109B	1A
S301A	5D
S301B	5D
S303A	1C
S303B	1C
S307A	1C
S307B	1C
TP175	4C
TP177	4A
TP178	5A
TP194	4C
U129A	2D
U129B	3B
U129C	1A
U129D	1B
U145	1A
U147A	2D
U147B	3D
U149A	1C
U149B	1B
U149C	2C
U149D	1B
U155	1A
U157A	3C
U157B	2D
U159A	2D
U159B	5D
U159C	1A
U159D	1C
U162	4D
U163	3C
U164A	3D
U164B	2D
U164C	3A
U164D	3A
U165A	4B
U165B	3B
U166B	1C
U166C	2D
U166D	3A
U166E	1B
U166F	2D
U167A	1A
U167B	3B
U167C	3A
U167D	3A
U168A	3A
U168B	3B
U168C	3B
U168D	1C
U169A	3A
U169B	2D
U169C	3A
U172	3B
U175	3A
U177A	2D
U177C	4C
U177D	4D
U179	3A
U182	4B
W178	3A
W174	3A
W175	3B
W179	3A



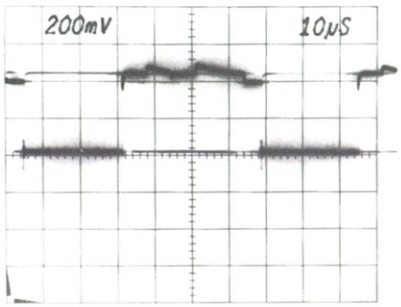
2



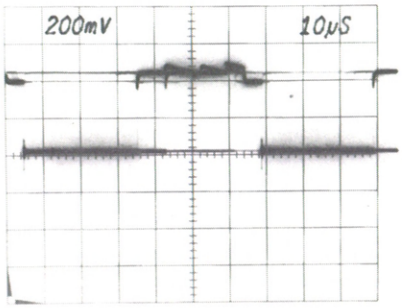
1



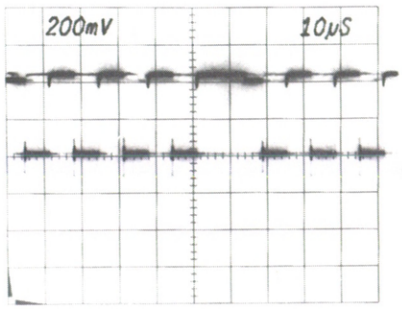
1 EIA



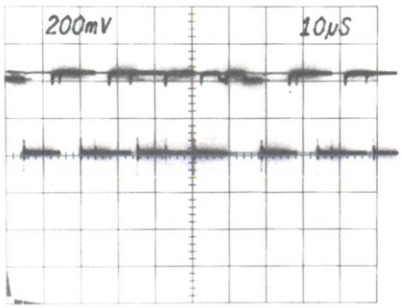
2



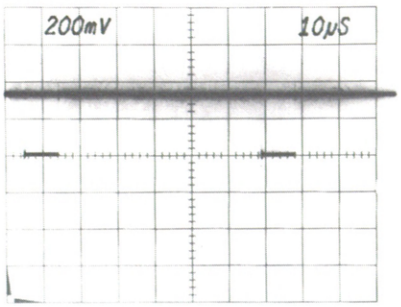
2 EIA



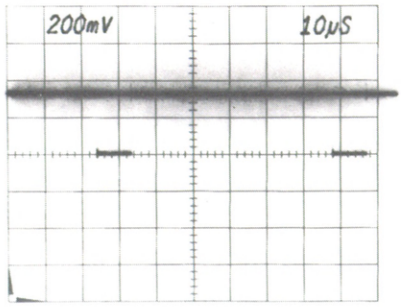
3



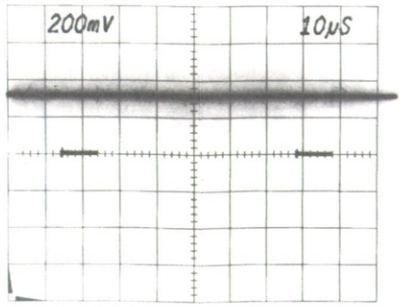
3 EIA



4 EIA



5 EIA



6 EIA

2103-32

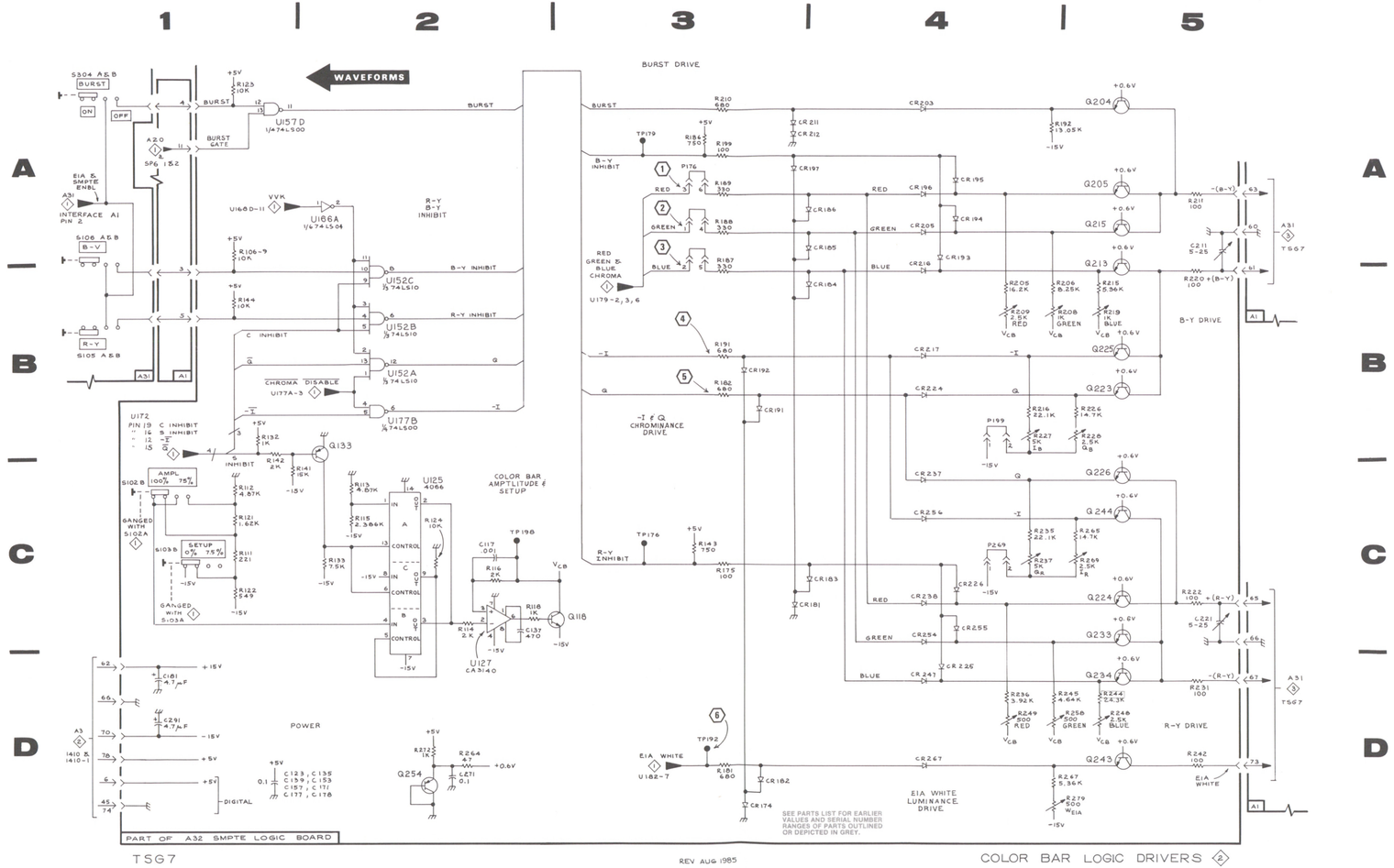
2 COLOR BAR LOGIC DRIVERS DIAGRAM

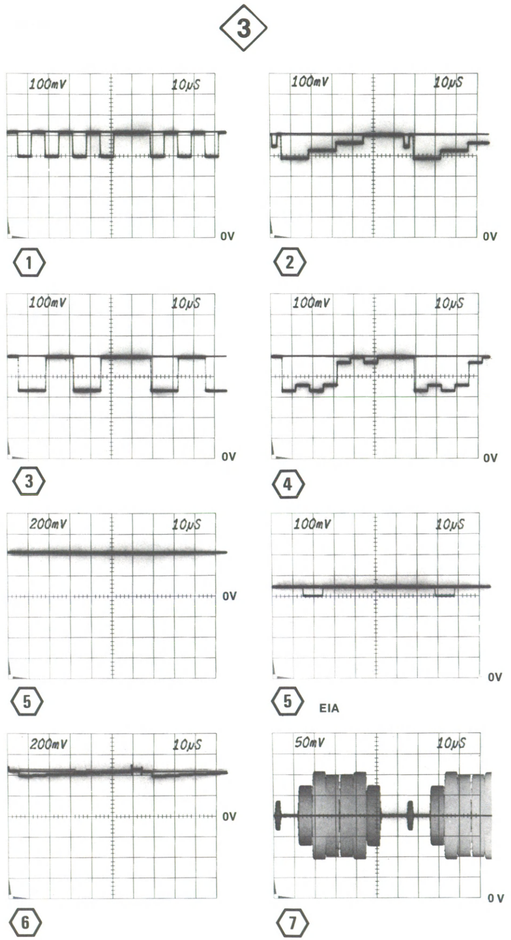
ASSEMBLY A32

CIRCUIT NUMBER	SCHEM LOCATION
C117	2C
C123	1D
C135	2D
C137	2C
C139	1D
C153	2D
C157	1D
C171	2D
C177	1D
C178	2D
C181	1D
C211	5A
C221	5C
C271	2D
C291	1D
CR174	3D
CR181	3C
CR182	3D
CR183	4C
CR184	4B
CR185	4A
CR186	4A
CR191	3B
CR192	3B
CR193	4A
CR194	4A
CR195	4A
CR196	4A
CR197	3A
CR203	4A
CR205	4A
CR211	3A
CR212	3A
CR216	4B
CR217	4B
CR224	4B
CR225	4D
CR226	4C
CR237	4C
CR238	4C
CR247	4D
CR254	4C
CR255	4C
CR256	4C
CR267	4D
P176	3A
P199	4B
P269	4C

CIRCUIT NUMBER	SCHEM LOCATION
Q118	3C
Q133	2B
Q204	5A
Q205	5A
Q213	5A
Q215	5A
Q223	5B
Q224	5C
Q225	5B
Q226	5C
Q233	5C
Q234	5D
Q243	5D
Q244	5C
Q254	2D
R1069	1A
R111	1C
R112	1C
R113	2C
R114	2C
R115	2C
R116	2C
R118	2C
R121	1C
R122	1C
R123	1A
R124	2C
R132	1B
R133	2C
R141	1C
R142	1B
R143	3C
R144	1B
R175	3C
R181	3D
R182	3B
R186	3A
R187	3A
R188	3A
R189	3A
R191	3B
R192	4A
R199	3A
R205	4B
R206	4B
R208	4B
R209	4B
R210	3A
R211	5A

CIRCUIT NUMBER	SCHEM LOCATION
R215	4B
R216	4B
R219	4B
R220	4B
R222	4C
R226	4B
R227	4B
R228	4B
R231	4D
R235	4C
R236	4D
R237	4C
R241	4D
R242	4D
R244	4D
R245	4D
R248	4D
R249	4D
R258	4D
R264	2D
R265	4C
R267	4D
R269	4C
R272	2D
R279	4D
S102B	1C
S103B	1C
S304A	1A
S304B	1A
S305A	1B
S305B	1B
S306A	1A
S306B	1A
TP176	3C
TP179	3A
TP192	3D
TP196	2C
U125	2C
U127	2C
U152A	2B
U152B	2B
U152C	2B
U157D	1A
U166A	2A
U177B	2B





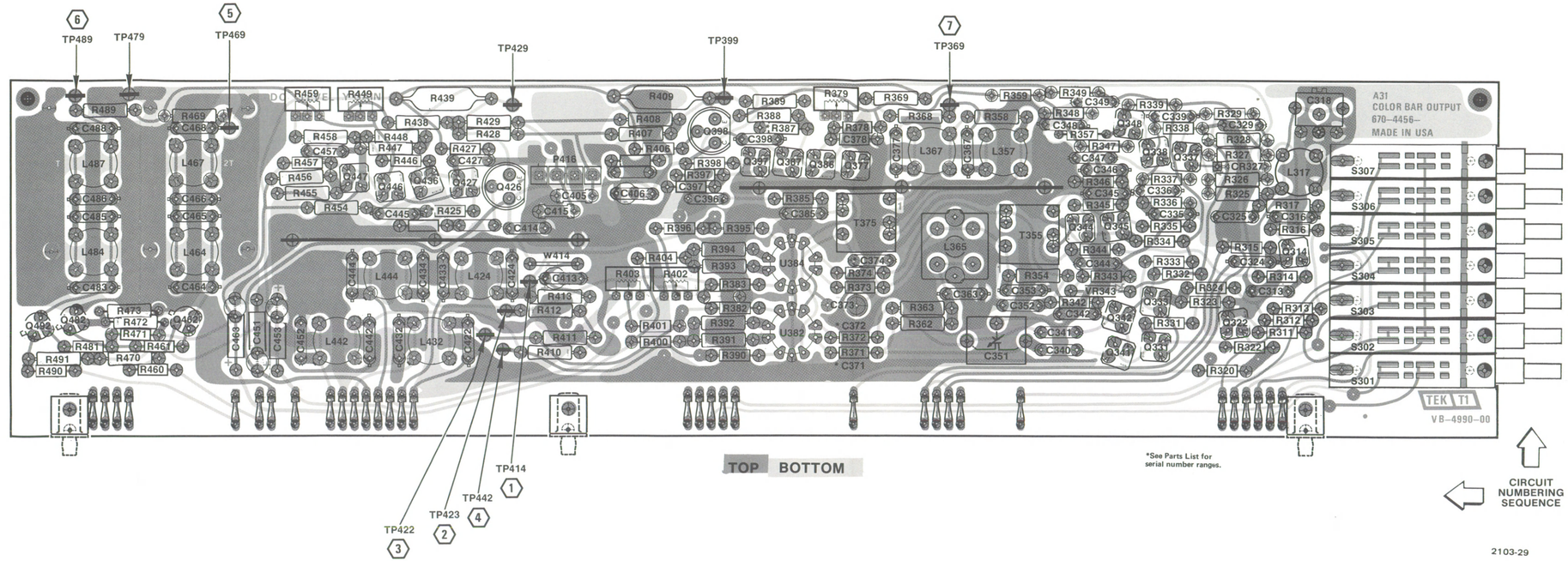
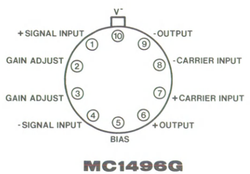


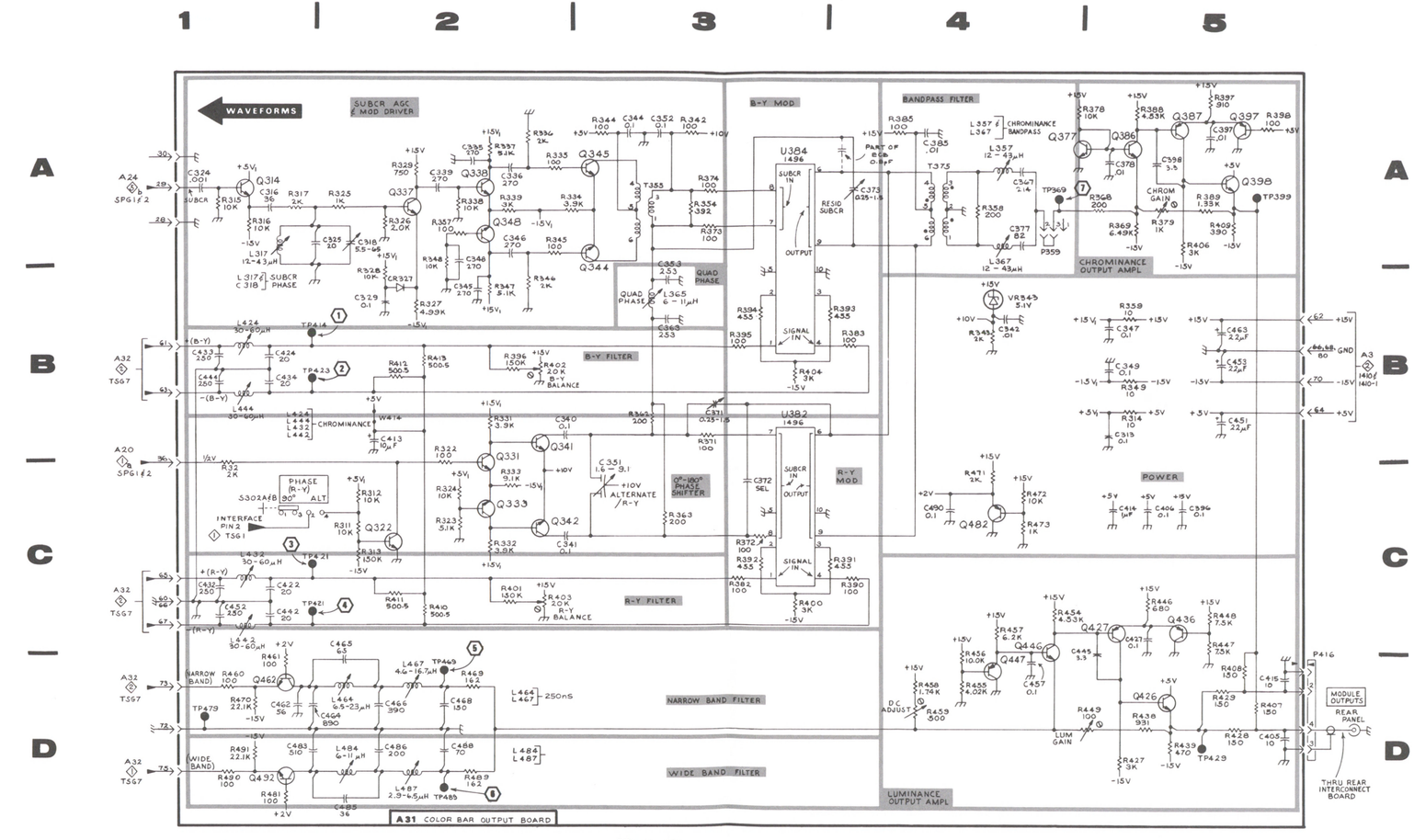
Fig. 9-2. A31—Color Bar Output board component locations.



3

COLOR BAR OUTPUT PART LOCATING CHART

C313	5B	C457	4D	R311	2C	R387	5A	R490	1D
C316	1A	C463	5B	R312	2C	R388	5A	R491	1D
C318	2A	C464	1D	R313	2C	R389	5A		
C324	1A	C465	2D	R314	5B	R390	4C	S112A,B	1C
C325	1A	C466	2D	R315	1A	R391	4C		
C329	2B	C468	2D	R316	1A	R392	3C	T355	3A
C335	2A	C483	1D	R317	1A	R393	4B	T375	4A
C336	2A	C485	2D	R320	1B	R394	3B		
C339	2A	C486	2D	R322	2C	R395	3B	TP369	4A
C340	2B	C488	2D	R323	2C	R396	2B	TP399	5A
C341	2C			R324	2C	R397	5A	TP414	1B
C342	4B	CR327	2A	R325	2A	R398	5A	TP422	1C
C344	3A			R326	2A	R400	3C	TP423	1B
C345	2B	L317	1A	R327	2B	R401	2C	TP429	5D
C346	2A	L357	4A	R328	2B	R402	2B	TP442	1C
C347	5B	L365	3A	R329	2A	R403	2C	TP469	2D
C348	2A	L367	4A	R331	2B	R404	3B	TP479	1D
C349	5B	L424	1B	R332	2C	R406	5A	TP489	2D
C351	3C	L432	1B	R333	2C	R407	5D		
C352	3A	L442	1B	R334	3A	R408	5D	U382	3B
C353	3B	L444	1B	R335	2A	R409	5A	U384	3A
C363	3B	L464	2D	R336	2A	R410	2C		
C367	4A	L467	2D	R337	2A	R411	2C	VR343	4B
C371	3B	L484	2D	R338	2A	R412	2B		
C372	3C	L487	2D	R339	2A	R413	2B	W414	2B
C373	4A			R342	3A	R425	5D		
C374	3A	Q314	1A	R343	4B	R427	5D		
C377	4A	Q322	2C	R344	3A	R428	5D		
C378	5A	Q331	2C	R345	2A	R429	5D		
C385	4A	Q333	2C	R346	2B	R438	5D		
C396	5A	Q337	2A	R347	2B	R439	5D		
C397	5A	Q338	2A	R348	2A	R446	5C		
C398	5A	Q341	2B	R349	5B	R447	5C		
C405	5D	Q342	2C	R354	3A	R448	5C		
C406	5A	Q344	3A	R357	2A	R449	5D		
C413	2B	Q345	3A	R358	4A	R454	4C		
C414	5D	Q348	2A	R359	5B	R455	4D		
C415	5D	Q377	5A	R362	3B	R456	4D		
C422	1C	Q386	5A	R363	3C	R457	4C		
C424	1B	Q387	5A	R368	4A	R458	4D		
C427	5C	Q397	5A	R369	5A	R459	4D		
C432	1C	Q398	5A	R371	3B	R460	1D		
C433	1B	Q426	5D	R372	3C	R461	1D		
C434	1B	Q427	5C	R373	3A	R469	2D		
C442	1C	Q436	5C	R374	4A	R470	1D		
C444	1B	Q446	4C	R378	5A	R471	4C		
C445	5C	Q447	4D	R379	5A	R472	4C		
C451	5B	Q462	1D	R382	3C	R473	4C		
C452	1C	Q482	4C	R383	4B	R481	1D		
C453	5B	Q492	1D	R385	4A	R489	2D		



TSG7

REV JUL 1983

COLOR BAR OUTPUTS 3

REPLACEABLE MECHANICAL PARTS

PARTS ORDERING INFORMATION

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

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

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

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

ITEM NAME

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

FIGURE AND INDEX NUMBERS

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

INDENTATION SYSTEM

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

```
1 2 3 4 5                    Name & Description

Assembly and/or Component
Attaching parts for Assembly and/or Component
                  **** END ATTACHING PARTS ****
  Detail Part of Assembly and/or Component
  Attaching parts for Detail Part
                  **** END ATTACHING PARTS ****
    Parts of Detail Part
    Attaching parts for Parts of Detail Part
                  **** END ATTACHING PARTS ****
```

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.

Attaching parts must be purchased separately, unless otherwise specified.

ABBREVIATIONS

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

CROSS INDEX - MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip Code
00779	AMP INC	P O BOX 3608	HARRISBURG PA 17105
07707	USM CORP SUB OF EMHART INDUSTRIES INC USM FASTENER DIV	510 RIVER RD	SHELTON CT 06484
09922	BURNDY CORP	RICHARDS AVE	NORWALK CT 06852
22526	DU PONT E I DE NEMOURS AND CO INC DU PONT CONNECTOR SYSTEMS	30 HUNTER LANE	CAMP HILL PA 17011
32436	SYSCON INTERNATIONAL, INC.	205 SYCAMORE ST.	SOUTH BEND, IN 46622
80009	TEKTRONIX INC	4900 S W GRIFFITH DR P O BOX 500	BEAVERTON OR 97077
93907	TEXTRON INC CAMCAR DIV	600 18TH AVE	ROCKFORD IL 61101
TK1375	ESAM	PO BOX 376	GRANTS PASS OR 97526

Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
1-1	333-2837-00			1	PANEL,FRONT: (ATTACHING PARTS)	80009	333-2837-00
-2	213-0277-00			2	SCREW,TPG,TF:2-56 X 0.312,SPCL TYPE,PNH,STL (END ATTACHING PARTS)	93907	234-01725-024
-3	366-1691-00			15	PUSH BUTTON:GY,1.2 L	80009	366-1691-00
-4	426-1206-00			15	FRAME,PUSH BTN:MOMENTARY,GRAY PLASTIC	80009	426-1206-00
-5	----- -----			1	CKT BOARD ASSY:COLOR BAR OUTPUT (SEE A33 REPL)		
-6	214-0579-00			10	.TERM,TEST POINT:BRS CD PL	80009	214-0579-00
-7	131-0589-00			4	.TERMINAL,PIN:0.46 L X 0.025 SQ PH BRZ	22526	48283-029
	131-0608-00			3	.TERMINAL,PIN:0.365 L X 0.025 BRZ GLD PL	22526	48283-036
	131-0993-00			1	.BUS,CONDUCTOR:SHUNT ASSEMBLY,BLACK	22526	65474-005
-8	214-2440-00			3	.RECEPTACLE,PIN:CIRCUIT BOARD	80009	214-2440-00
-9	136-0328-03			35	.SOCKET,PIN TERM:U/W 0.025 SQ PINS	22526	47710
-10	337-1417-00			7	.SHIELD,ELEC:0.55 SQ X 0.685 INCH HIGH	32436	A-1020002-1
-11	----- -----			7	.SWITCH PB ASSY:1 PUSH,7.5MM,W/2 CONTACTS .(SEE A33S301,A33S302,A33S303,A33S304, .A33S3,A33S306,A33S307 REPL)		
-12	343-0495-07			1	.CLIP,SWITCH:FRONT,7.5MM X 7 UNIT .(ATTACHING PARTS)	80009	343-0495-07
-13	210-3033-00			7	.EYELET,METALLIC:0.059 OD X 0.156 L,BRS .(END ATTACHING PARTS)	07707	SE-25
-14	343-0499-14			1	.CLIP,SWITCH:7.5MM X 5 UNIT .(ATTACHING PARTS)	80009	343-0499-14
-15	210-3033-00			5	.EYELET,METALLIC:0.059 OD X 0.156 L,BRS .(END ATTACHING PARTS)	07707	SE-25
-16	343-0499-02			1	.CLIP,SWITCH:REAR,7.5MM X 2 UNIT .(ATTACHING PARTS)	80009	343-0499-02
-17	337-1417-00			2	.SHIELD,ELEC:0.55 SQ X 0.685 INCH HIGH .(END ATTACHING PARTS)	32436	A-1020002-1
-18	----- -----			1	CKT BOARD ASSY:SHIELD(SEE A100 REPL)		
-19	136-0328-03			4	.SOCKET,PIN TERM:U/W 0.025 SQ PINS	22526	47710
-20	----- -----			1	CKT BD ASSY:SMPTE COLOR BAR(SEE A32 REPL)		
-21	214-0579-00			8	.TERM,TEST POINT:BRS CD PL	80009	214-0579-00
-22	131-0608-00			19	.TERMINAL,PIN:0.365 L X 0.025 BRZ GLD PL	22526	48283-036
-23	131-0993-02			1	.BUS,CONDUCTOR:SHUNT ASSEMBLY,RED	00779	1-850100-0
-24	131-0993-00			1	.BUS,CONDUCTOR:SHUNT ASSEMBLY,BLACK	22526	65474-005
-25	131-0993-06			1	.BUS,CONDUCTOR:SHUNT ASSEMBLY,BLUE	00779	850100-6
-26	136-0269-02			14	.SKT,PL-IN ELEK:MICROCKT,14 DIP,L CLR,PCB MT	09922	DILB14P-108T
-27	198-2864-00			2	.WIRE SET,ELEC:	TK1375	ORDER BY DESCR
-28	131-0707-00			12	..CONTACT,ELEC:22-26 AWG,BRS,CU BE GLD PL	22526	47439-000
-29	214-2440-00			3	.RECEPTACLE,PIN:CIRCUIT BOARD	80009	214-2440-00
-30	136-0328-03			46	.SOCKET,PIN TERM:U/W 0.025 SQ PINS	22526	47710
-31	136-0634-00	670-7274-00	670-7274-01	2	.SKT,PL-IN ELEK:MICROCIRCUIT,20 DIP	09922	DILB20P-108
	136-0752-00	670-7274-02		2	.SKT,PL-IN ELEK:MICROCIRCUIT,20 DIP	09922	DILB20P-108
-32	136-0514-00			1	.SKT,PL-IN ELEK:MICROCIRCUIT,8 DIP	09922	DILB8P-108
-33	136-0260-02			6	.SKT,PL-IN ELEK:MICROCIRCUIT,16 DIP,LOW CL,P .CB MT	09922	DILB16P-108T
-34	----- -----			2	.SWITCH PB ASSY:1 PUSH,7.5MM,W/2 CONTACTS .(SEE A32S102,A32S103 REPL)		
-35	----- -----			1	.SWITCH PB ASSY:6 LATCH,7.5MM,12 CONT .(SEE A32S104,A32S105,A32S106,A32S107, .A32S1,A32S109 REPL)		
-36	343-0499-03			1	.CLIP,SWITCH:REAR,7.5MM X 3 UNIT .(ATTACHING PARTS)	80009	343-0499-03
-37	210-3050-00			3	.EYELET,METALLIC:0.059 OD X 0.218 L,BRS .(END ATTACHING PARTS)	80009	210-3050-00
-38	343-0499-14			1	.CLIP,SWITCH:7.5MM X 5 UNIT .(ATTACHING PARTS)	80009	343-0499-14
-39	210-3050-00			5	.EYELET,METALLIC:0.059 OD X 0.218 L,BRS .(END ATTACHING PARTS)	80009	210-3050-00
-40	343-0495-08			1	.CLIP,SWITCH:FRONT,7.5MM X 8 UNIT .(ATTACHING PARTS)	80009	343-0495-08
-41	210-3050-00			6	.EYELET,METALLIC:0.059 OD X 0.218 L,BRS .(END ATTACHING PARTS)	80009	210-3050-00

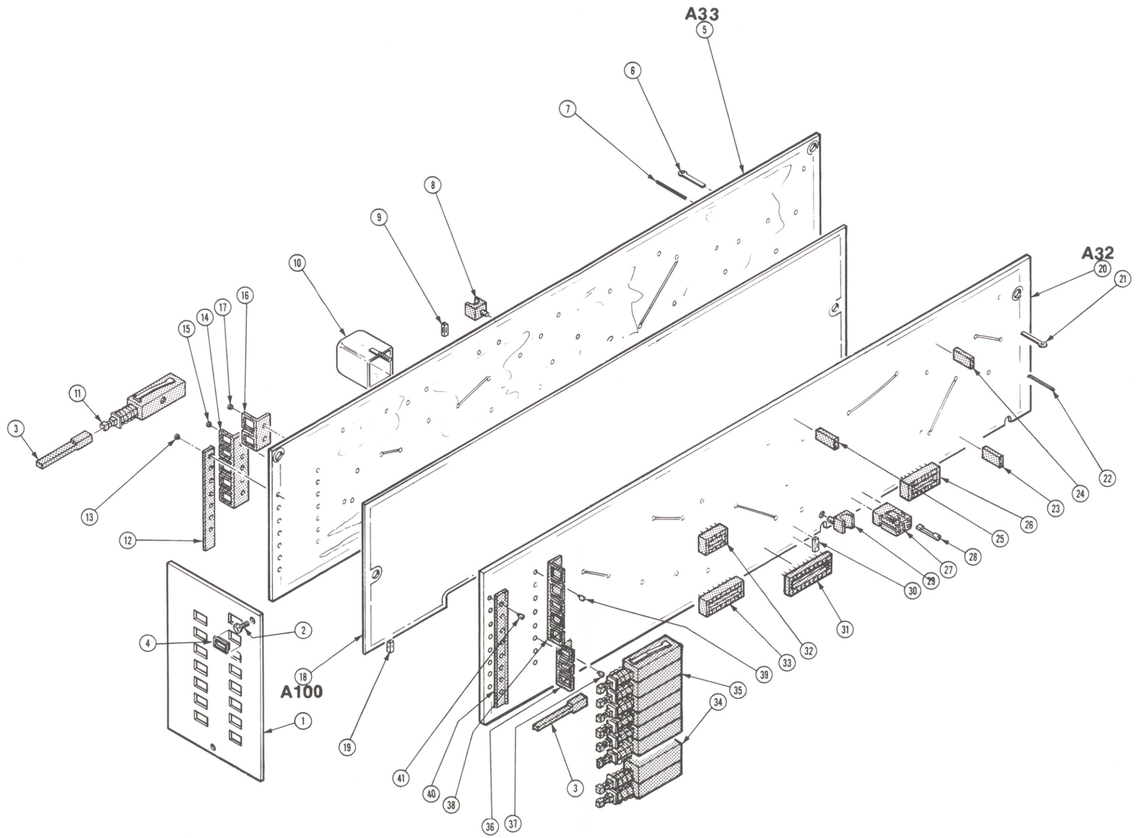

A33
A32
A100

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
						STANDARD ACCESSORIES		
	070-3782-00			1		MANUAL,TECH:INSTR	80009	070-3782-00

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.