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TEKTRONIX®

TSG1

NTSC COLOR BAR TEST SIGNAL GENERATOR MODULE

INSTRUCTION MANUAL

Tektronix, Inc.
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Beaverton, Oregon 97077

Serial Number _____

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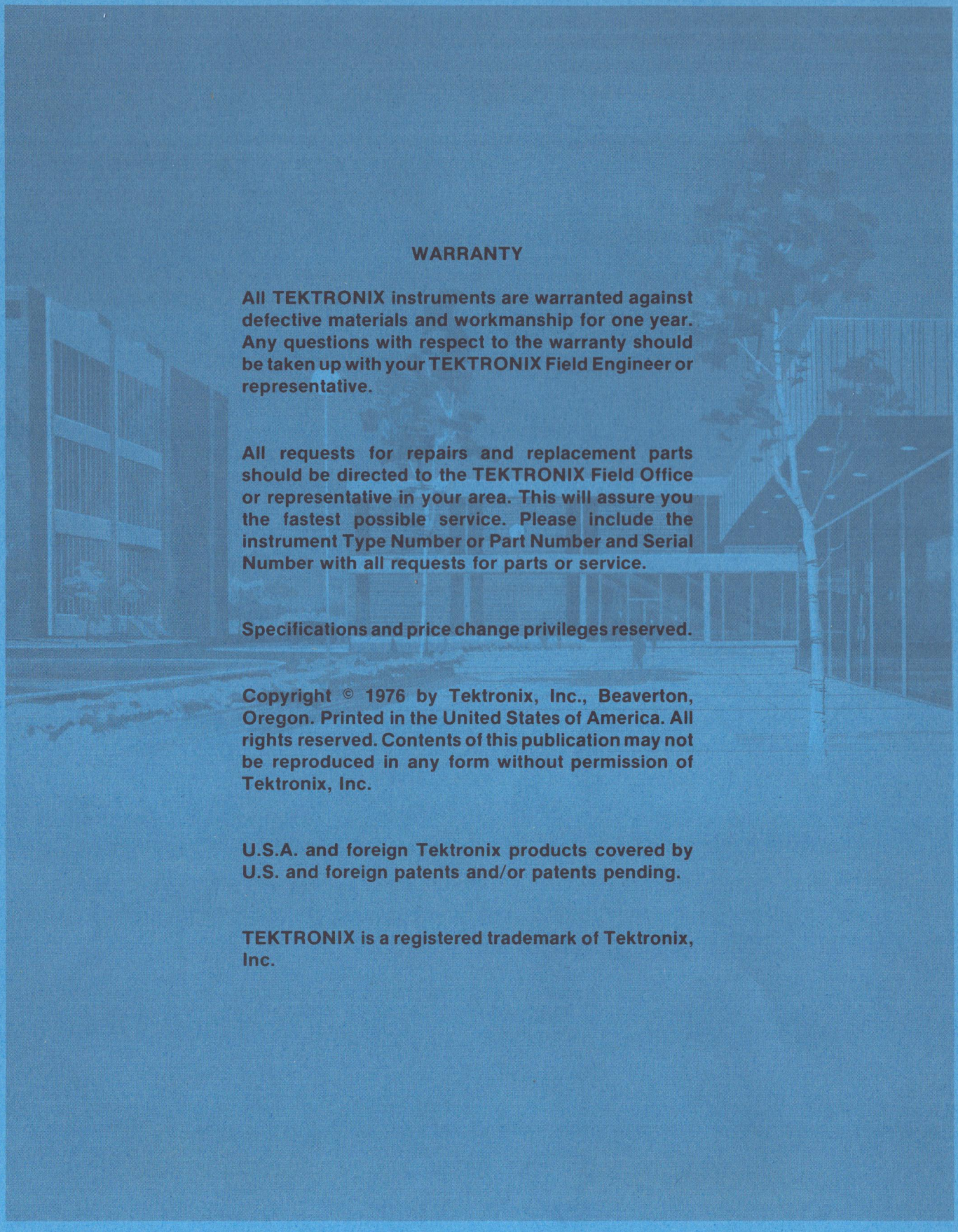

WARRANTY

All TEKTRONIX instruments are warranted against defective materials and workmanship for one year. Any questions with respect to the warranty should be taken up with your TEKTRONIX Field Engineer or representative.

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

Specifications and price change privileges reserved.

U.S.A. and foreign Tektronix products covered by U.S. and foreign patents and/or patents pending.

TABLE OF CONTENTS

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; these instructions are for qualified service personnel only.

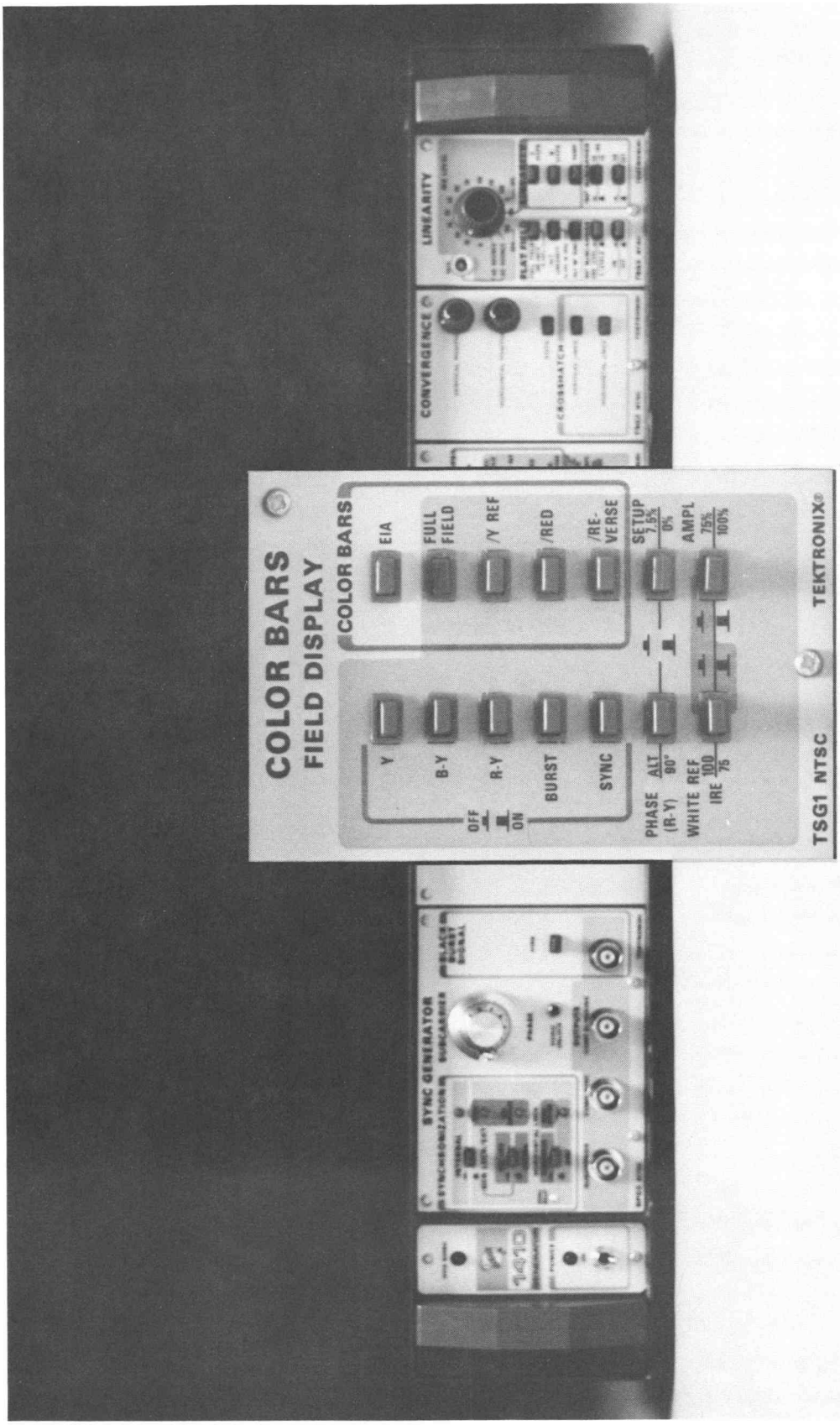

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Fig. 1-1. The TSG1 NTSC Color Bar Test Signal Generator Module.

PART I
OPERATORS INFORMATION

OPERATING INSTRUCTIONS

SAFETY SUMMARY

This manual contains safety information which the operator and service technician must follow to avoid personal injury and to ensure safe operation of the instrument.

WARNING information is intended to protect the operator from personal injury.

CAUTION information is intended to protect the instrument from damage.

The following are general safety precautions that must be observed during all phases of operation and maintenance.

WARNING

To reduce electrical shock hazard, the instrument must be properly grounded. Refer to the 1410 Mainframe instruction manual for more information. Electrical shock hazards are present inside the instrument. Only qualified service personnel should remove the instrument covers.

DESCRIPTION

The TSG1 NTSC Color Bars Test Signal Generator module consists of two circuit boards and one shield board that plug into the 1410 Mainframe Interface board. The TSG1 is designed for use as a part of a modular television test signal generator system. A typical system might consist of a 1410 Mainframe, an SPG1 Sync Pulse Generator, a TSG1, and a TSG2 Convergence Test Pattern Generator. Pin connectors on the bottom edge of each board mate with vertical pins on the Interface board. The shield board is mounted between the circuit boards.

The TSG1 provides composite video test signals consisting of full-field color bars, EIA color bars (color bars for 75% of the field, −I, White, Q, and Black for 25% of the field), or split-field color bars (50% or 75%) with red chrominance, color bars with luminance reference, and color bars of reverse sequence. The 100% saturated color bars are available in either 75% or 100% amplitudes and 0% or 7.5% setup levels. A white reference level of 100 IRE or 75 IRE is also available.

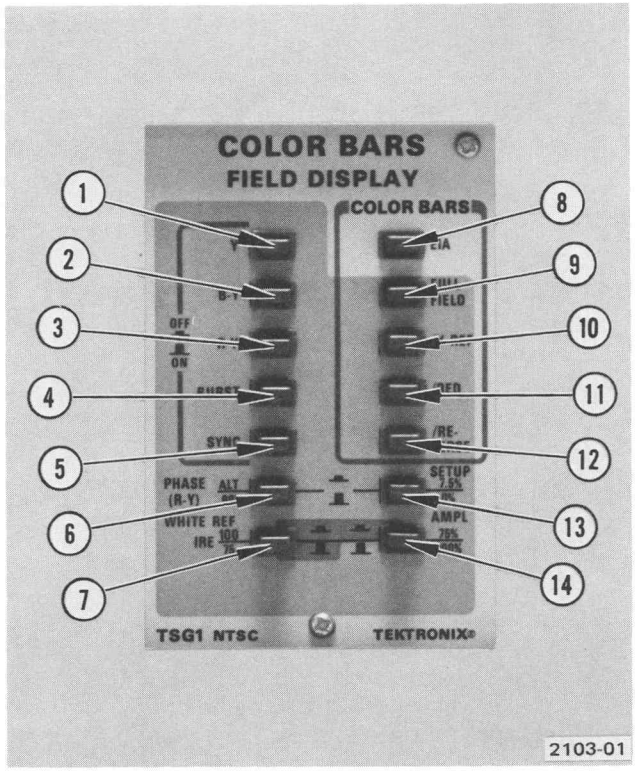

Fig. 1-2. Front Panel Controls.

FRONT PANEL SWITCH FUNCTIONS

1. Y Pushbutton—Luminance selector.
   'Out'—Luminance present in color bars signal.
   'In'—Luminance absent from color bars signal.

2. B-Y Pushbutton—0°/180° Chrominance selector.
   'Out'—0°/180° chrominance present in color bars signal.
   'In'—0°/180° chrominance absent from color bars signal.

3. R-Y Pushbutton—90°/270° chrominance selector.
   'Out'—90°/270° chrominance present in color bars signal.
   'In'—90°/270° chrominance absent from color bars signal.

4. BURST Pushbutton—Color burst selector.
   'Out'—Color burst present in color bars signal.
   'In'—Color burst absent from color bars signal.

5. SYNC Pushbutton—Composite sync selector.
   'Out'—Composite sync present in color bars signal.
   'In'—Composite sync absent from color bars signal.

6. PHASE (R-Y) Pushbutton—R-Y chrominance phase selector.
   'Out'—R-Y chrominance phase is 90°.
   'In'—R-Y chrominance phase is alternating 90°/270° at line rate.

7. WHITE REF Pushbutton—Selects white reference level when AMPL pushbutton is pushed in (75%).
   'Out'—White reference level is 75 IRE (%)—75 IRE, 0% Setup; 77 IRE, 7.5% Setup.
   'In'—White reference level is 100 IRE (%).

NOTE:

8. to 12.: These pushbuttons are self-canceling, allowing only one COLOR BARS mode at a time (see Figs. 1-3 through 1-7).

8. EIA Pushbutton—Standard EIA color bars signal selector provides gray, yellow, cyan, green, magenta, red, and blue for 75% of the field, followed by −I, white, Q, and black for 25% of the field.
   'Out'—EIA color bars signal off.
   'In'—EIA color bars signal on overriding all other TSG1 front-panel pushbutton switch functions.

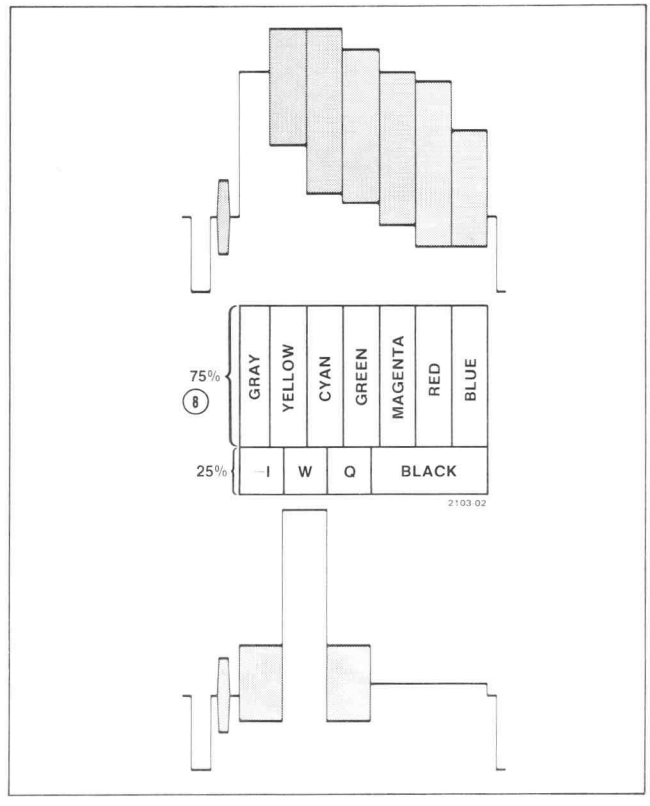

Fig. 1-3. EIA COLOR BARS.

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9. FULL FIELD Pushbutton—Full field color bars signal selector provides white, yellow, cyan, green, magenta, red, blue, and black for full field.
'Out'—Full field color bars signal off.
'In'—Full field color bars signal on.

10. /Y REF Pushbutton—Split field signal selector: Normal color bars in upper half and luminance levels only (gray scale) of color bars sequence in lower half. Split is either 50%/50% or 75%/25% as selected in SPG modules.
'Out'—Split field signal off.
'In'—Split field signal on.

11. /RED Pushbutton—Split field signal selector: Normal color bars in upper half and same chrominance/luminance of red bar filling the lower half.
'Out'—Split field signal off.
'In'—Split field signal on.

12. /REVERSE Pushbutton—Split field signal selector: Normal color bars in upper half and reverse sequence color bars in lower half (black, blue, red, magenta, green, cyan, yellow, and white).
'Out'—Split field signal off.
'In'—Split field signal on.

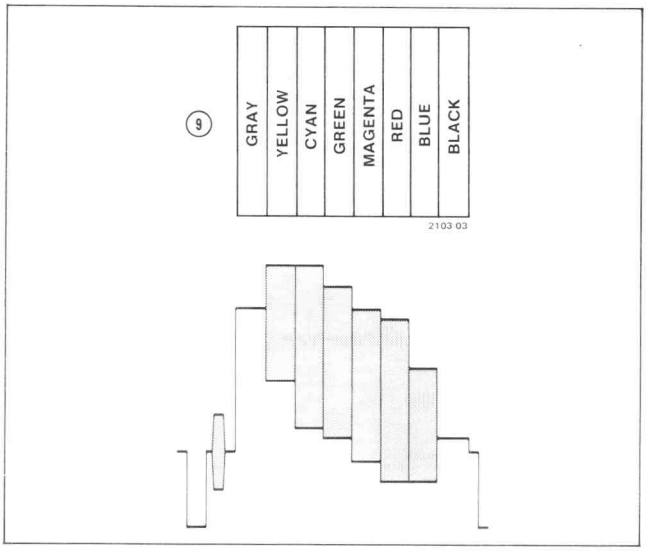

Fig. 1-4. FULL FIELD COLOR BARS.

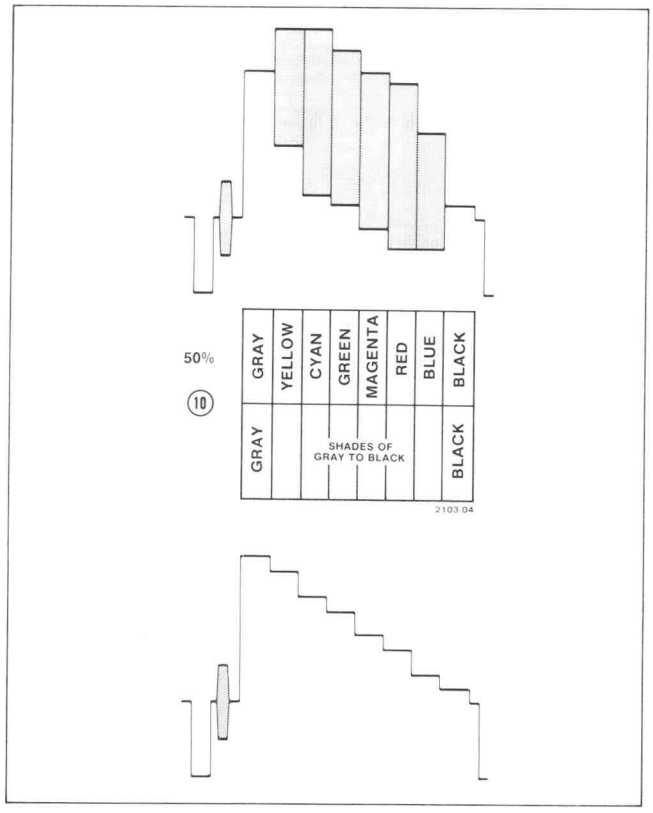

Fig. 1-5. SPLIT FIELD Y REF.

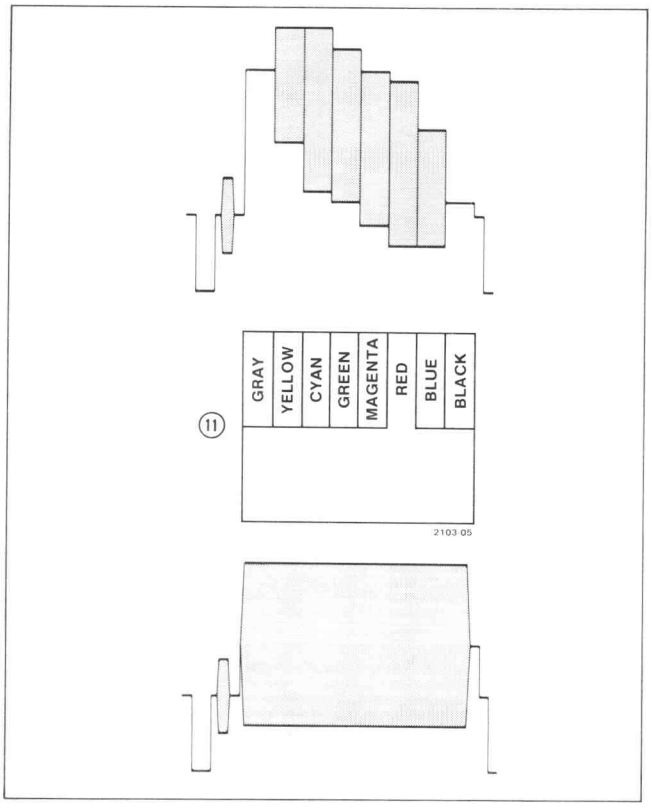

Fig. 1-6. SPLIT FIELD RED.

13. SETUP Pushbutton—Setup level selector provides either 7.5% setup of the 100% white reference level or 0% setup making the black level the same as the blanking level.
    'Out'—0% setup.
    'In'—7.5% setup.

14. AMPL Pushbutton—Color bars signal amplitude selector provides either 75% or 100% maximum amplitude.
    'Out'—100% amplitude.
    'In'—75% amplitude (WHITE REF pushbutton operates in this position only).

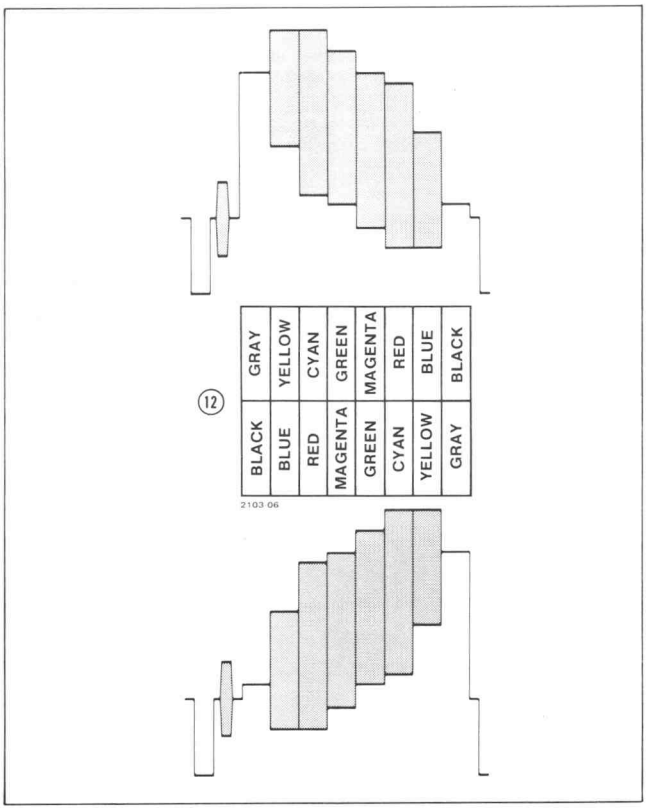

Fig. 1-7. SPLIT FIELD REVERSE.

GENERAL INFORMATION

With its variety of test signals, the TSG1 is an excellent tool for use in analyzing television system defects or anomalies. The ease with which these test signals can be modified for optional split-field ratios also adds to module flexibility. The following paragraphs list the TSG1 test signals and their general applications. Also see Figs. 1-2 through 1-7.

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. Three-fourths of the active scanning lines in each field are divided into seven equal intervals arranged in descending order of luminance as follows: gray, yellow, cyan, green, magenta, red, and blue; see Fig. 1-8a. The remaining one-fourth of the active scanning lines in each field is 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 phase corresponding to +Q, and a reference black interval; see Fig. 1-8a.

Fig. 1-8b shows the color bar signal as seen on a waveform monitor triggered at horizontal rate. Vector relationships of the various burst and chrominance components are shown in Fig. 1-8c. Refer to the specifications for additional details on signal characteristics.

The standard color bar signal may be 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 on the display device. For more objective measurements, the waveforms resulting from the decoding of the standard color bar signal can be used. For example, the phase and gain adjustments may be checked by observing the waveforms at appropriate points. The luminance component of the color bar 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 standard color bar signal with the output of such a device when the standard signal is applied to the encoder inputs. 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. 1-8b):

(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.
(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. 1-8c). 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.

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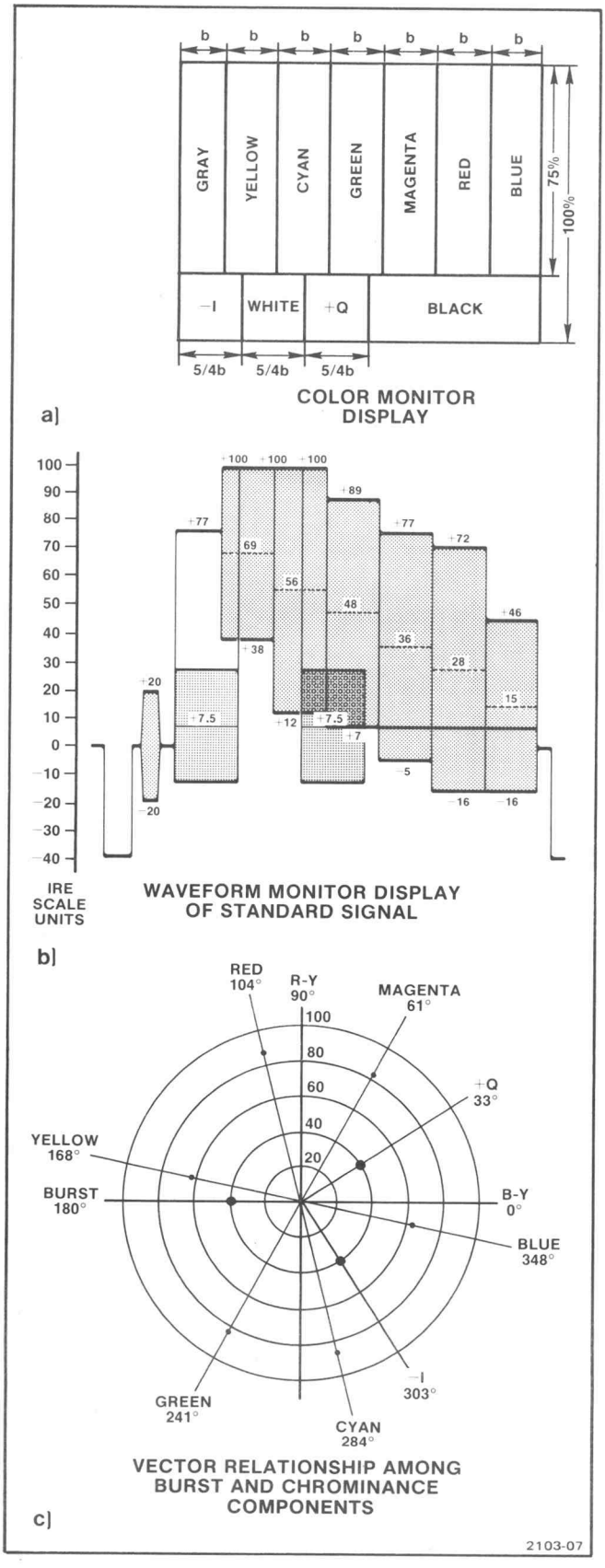

Fig. 1-8. Picture monitor, waveform monitor, and vectorscope displays of the standard EIA test pattern signal.

When making rapid checks of color television transmission systems, observation of the standard color bar 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 bar signal is useful for checking transmission level, relative high frequency response, and the presence of differential gain and phase.

Full Field Color Bar Signal

The standard full field color bar signal consists of eight equal intervals arranged in descending order of luminance as follows: gray, yellow, cyan, green, magenta, red, blue, and black. See Fig. 1-4. This signal is used for checking luminance, hue, and saturation parameters of the television system. The above EIA Standard Color Bar paragraphs with the exception of the −IWQB remarks apply to the full field color bar signal as well.

Split Field Y Reference Signal

This signal provides standard color bars in the first part of the test pattern display and luminance-only shades of gray to black in the second part. See Fig. 1-5. The split field Y Reference signal is especially useful for checking color balance and tracking of color picture monitors.

Split Field Red Signal

This signal includes the standard color bars in the first part while the second part contains the red color bar signal only. See Fig. 1-6. Video system noise, VTR head banding, and red phase are readily seen using the solid red split field signal.

Split Field Reverse Signal

This signal provides standard color bars in the first part and color bars in reverse order during the second part. See Fig. 1-7. Dynamic range and color tracking of video monitors can be checked with this test signal pattern.




100/7.5 WITH 2 DIGIT COEFFICIENTS

NTSC COLOR BAR AMPLITUDES

Y	BY	RY	PPCHR
714.286	.000	.000	.000
641.607	-577.411	131.903	592.285
516.071	195.045	-817.134	840.090
443.393	-382.365	-685.231	784.694
324.464	382.365	685.231	784.694
251.786	-195.045	817.134	840.090
126.250	577.411	-131.903	592.285
53.571	0.000	0.000	0.000

100/0 USING 2 DIGIT COEFFICIENTS

NTSC COLOR BAR AMPLITUDES

Y	BY	RY	PPCHR
714.286	.000	.000	.000
635.714	-624.228	142.598	640.308
500.000	210.860	-883.388	908.205
421.429	-413.368	-740.790	848.318
292.857	413.368	740.790	848.318
214.286	-210.860	883.388	908.205
78.571	624.228	-142.598	640.308
0.000	0.000	0.000	0.000

75/7.5 WITH 2 DIGIT COEFFICIENTS

NTSC COLOR BAR AMPLITUDES

Y	BY	RY	PPCHR
549.107	.000	.000	.000
494.598	-433.058	98.927	444.214
400.446	146.284	-612.851	630.067
345.938	-286.774	-513.923	588.521
256.741	286.774	513.923	588.521
202.232	-146.284	612.851	630.067
108.080	433.058	-98.927	444.214
53.571	0.000	0.000	0.000

75/0 USING 2 DIGIT COEFFICIENTS

NTSC COLOR BAR AMPLITUDES

Y	BY	RY	PPCHR
535.714	.000	.000	.000
476.786	-468.171	106.948	480.231
375.000	158.145	-662.541	681.154
316.071	-310.026	-555.593	636.239
219.643	310.026	555.593	636.239
160.714	-158.145	662.541	681.154
58.929	468.171	-106.948	480.231
0.000	0.000	0.000	0.000

SPECIFICATION

ELECTRICAL CHARACTERISTICS

The electrical performance requirements for this instrument module are valid over the environmental limits listed at the end of this section. Calibration at 20° C to 30° C ambient with a 20-minute warm-up period is required to maintain stated accuracies.

Characteristic	Performance Requirement			
Luminance Signal Accuracy	Within 1% or 1.5 mV, whichever is greater.			
Chrominance Accuracy				
Absolute Amplitudes	Within 3% (all subcarrier components).			
Relative Amplitudes	Within 1% or 1 mV plus p-p residual subcarrier amplitude, whichever is greater, of the red chrominance bar.			
Reference Amplitudes (mV)	Lum	Chrom P-P	R-Y P-P	B-Y P-P
Blanking Level	0	2.5 or less		
Sync	−285.7	2.5 or less		
Burst	0	285.7	0	285.7
−I	0	285.7	239.6	155.6
White Ref	714.3	2.5 or less		
Q		285.7	155.6	239.6
Black	as setup	2.5 or less		
Bar Amplitudes (mV)				
75% AMPL, 7.5% SETUP				
White	549.1	2.5 or less		
Yellow	494.6	444.2	99.2 98.9	433.0
Cyan	400.4	630.0	612.9	146.0
Green	345.9	588.4 .5	513.6 .9	287.0
Magenta	256.7	588.4 .5	513.6	287.0
Red	202.2	630.0 .1	612.9	146.0
Blue	108.1	444.2	99.2 98.9	433.0
Black	53.6	2.5 or less		
75% AMPL, 0% SETUP				
White	535.7	2.5 or less		
Yellow	476.8	480.2	107.2	468.1
Cyan	375.0	681.2	662.6	157.8
Green	316.1	636.0	555.2	310.3
Magenta	219.6	636.0	555.2	310.3
Red	160.7	681.2	662.6	157.8
Blue	58.9	480.2	107.2	468.1
Black	0	2.5 or less		

+20% = 756.08

ELECTRICAL CHARACTERISTICS (cont)

Characteristic	Performance Requirement			
Bar Amplitudes (mV) (cont)	Lum	Chrom P-P	R-Y P-P	B-Y P-P
100% AMPL, 7.5% SETUP				
White	714.3	2.5 or less		
Yellow	641.1	592.3	132.2	577.3
Cyan	516.1	840.1	817.2	194.7
Green	443.4	784.5	684.8	382.7
Magenta	324.5	784.5	684.8	382.7
Red	251.8	840.1	817.2	194.7
Blue	126.3	592.3	132.2	577.3
Black	53.6	2.5 or less		
100% AMPL, 0% SETUP				
White	714.3	2.5 or less		
Yellow	635.7	640.3	143.0	624.1
Cyan	500.0	908.2	883.5	210.5
Green	421.4	848.1	740.3	413.8
Magenta	292.9	848.1	740.3	413.8
Red	214.3	908.2	883.5	210.5
Blue	78.6	640.3	143.0	624.1
Black	0	2.5 or less		

Split Field Displays Timing	
EIA Color Bars	
Field 1	179 lines.
Field 2	179.5 lines.
Duration	7.5 μs/bar.
−I, W, Q, B	
Field 1	62.5 lines.
Field 2	62 lines
−I, W, Q, B Duration	9.4 μs.
B Duration	24.1 μs.
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 plug-jumper on Sync Timing board in Sync Generator (SPG1, SPG2, or SPG3). The plug-jumper changes split field timing for all three signals.
Full Field Displays Timing	
Bar Width	6.45 μs.
Color Bar White Bar Risetime	130 ns +20 ns, −10 ns.
−I, Q White Bar Risetime	250 ns ±37.5 ns.

ELECTRICAL CHARACTERISTICS (cont)

Characteristic	Performance Requirement
Full Field Displays Timing (cont)	
Time Difference Between Chrom and Lum Channels	20 ns or less.
Chrominance	
Risetime	400 ns ±60 ns.
Quadrature Error	0.5° or less.
R-Y Ø Switch Error	0.5° or less.
Residual Subcarrier	
White and Blanking	⩾−52 dB below 1 V (2.5 mV).
Aberrations	±4% of 1 V.
Spurious Subcarrier	At least 52 dB below 1 V when viewed on 1480-Series Waveform Monitor except 30 dB during sync, the end of H blanking, and the start of the white bar.
Other Spurious Outputs	At least 52 dB below 1 V when viewed on a 1480-Series Waveform Monitor except 30 dB during sync, the end of H blanking, and the start of the white bar.
Composite Video Output	
Amplitude	
Total	1 V into 75 Ω.
Sync	−285.7 mV ±2.86 mV.
Peak Level	714.3 mV ±7.14 mV.
Blanking DC Level	0 V ±50 mV.
Return Loss	At least 30 dB to 5 MHz.
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.
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.
Field Period	16.68 ms.
Line Period	63.56 μs.
Timing	
Rise and Fall Time	130 ns +20 ns, −10 ns.
Front Porch Duration	1.59 μs ±50 ns at 50% point, 1.52 μs at 10% point.
Line Blanking Interval	11.1 μs. @ 50% pt. ≈ 10 μs at +4 IRE pt.
Breezeway	475 ns ±50 ns at 10% point.

→ 1.46 μs at +4 to −4 IRE pt., FCC 1.27 μs min

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ELECTRICAL CHARACTERISTICS (cont)

Characteristic	Performance Requirement
Burst	
Rise and Fall Time	400 ns ±60 ns.
Delay from Line Sync	5.309 μs (19 Cycles of subcarrier) ±35 ns.
H.A.D. of Envelope	2.51 μs (9 Cycles of subcarrier) ±70 ns.
Amplitude	285.7 mV ±8.57 mV.
Phasing on Successive Lines	180°.
VITS	Available via VITS key (TTL signal applied through the rear-panel REMOTE connector). Bar timing identical to Full Field Color Bars; changing the FULL FIELD display does not alter the VITS color bars.

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.

WARNING

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

PART II
SERVICE INFORMATION

INSTALLATION

INSTALLING IN THE MAINFRAME

Use the following steps to install the TSG1 module in the 1410 Mainframe. Turn the mainframe POWER switch off before attempting installation.

1. Select one of the available 1410 Mainframe module locations for installation of the TSG1 module: Use locations 2 through 6 with the SPG1 or SPG2 installed, or locations 1 through 6 with the SPG3 installed (see Fig. 3-1).

2. Position the shield board over the four pins located between the circuit board pins on the Mainframe Interface board. Seat the shield board firmly on the Interface board.

3. Position the A31 Color Bar Output board over the middle row of Mainframe Interface pins, using the plastic guides for proper pin alignment. Seat the board firmly on the Interface board.

4. Position the A30 Color Bars Logic Board over the row of Mainframe Interface pins adjacent to the shield board. Align the board pins using the plastic guides and seat firmly on the Interface board.

5. Install the plastic pushbutton extenders on the board pushbutton shafts.

6. Position the TSG1 front panel over the pushbu.ton control extenders and secure it to the 1410 Mainframe front casting with the screws provided.

7. Connect the coaxial cable from the appropriate rear-panel MODULE OUTPUT connector to the board output connector. Reverse the installation steps to remove the module.

OPERATING MODE SELECTION

Color Bar Sequence

Located near the center and rear of the Color Bar Logic board (see Adjustment and Jumper Locations pullout) are two sets of jumper connectors that allow the color bar sequence to be altered; see Fig. 3-2. The second set of jumper combinations produces a color bar sequence (white, cyan, magenta, blue, yellow, green, red, and black) with the largest chrominance phase transitions. The last set shown in the figure produces the widest dynamic range, which is useful for measuring nonlinear distortions.

Split Field Color Selection

A choice of any color in the color bar signal is available for the solid color portion of the split field test signal. Refer to Fig. 3-3 for wire strapping details, and to the Color Bar Logic Adjustment and Jumper locations pullout at the rear of the manual.

VITS Key

Insert a low at selected line time on the VITS Key line to operate the module during VITS time.

EIA Mode Selection

Insert a low on the Remote line, pin 57 (Mainframe connector, J41), to switch the module to EIA mode.

PACKAGING

At installation time, save the shipping carton and packing materials for repackaging in case shipment becomes necessary.

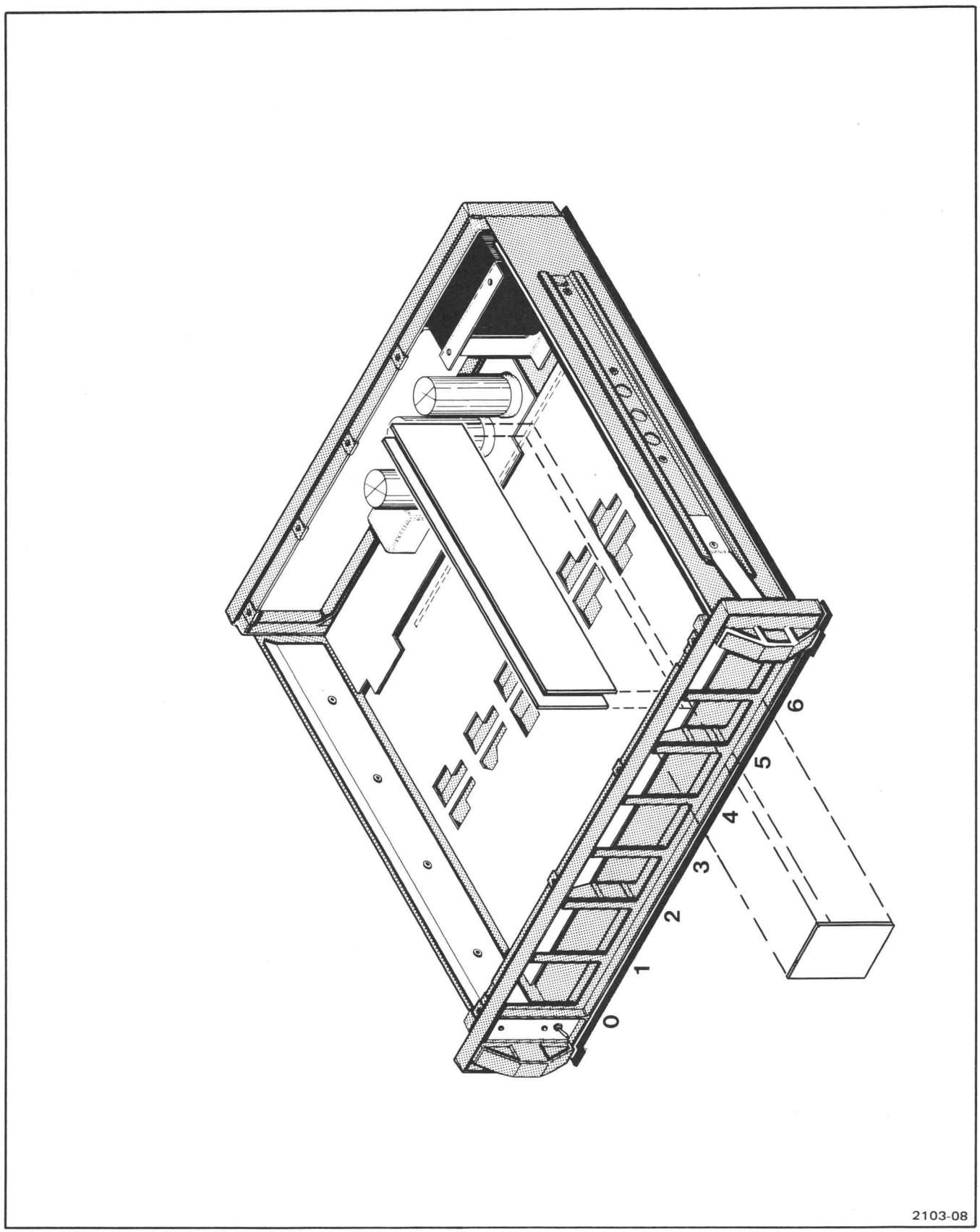

Fig. 3-1. Installing the module circuit board in the Mainframe.

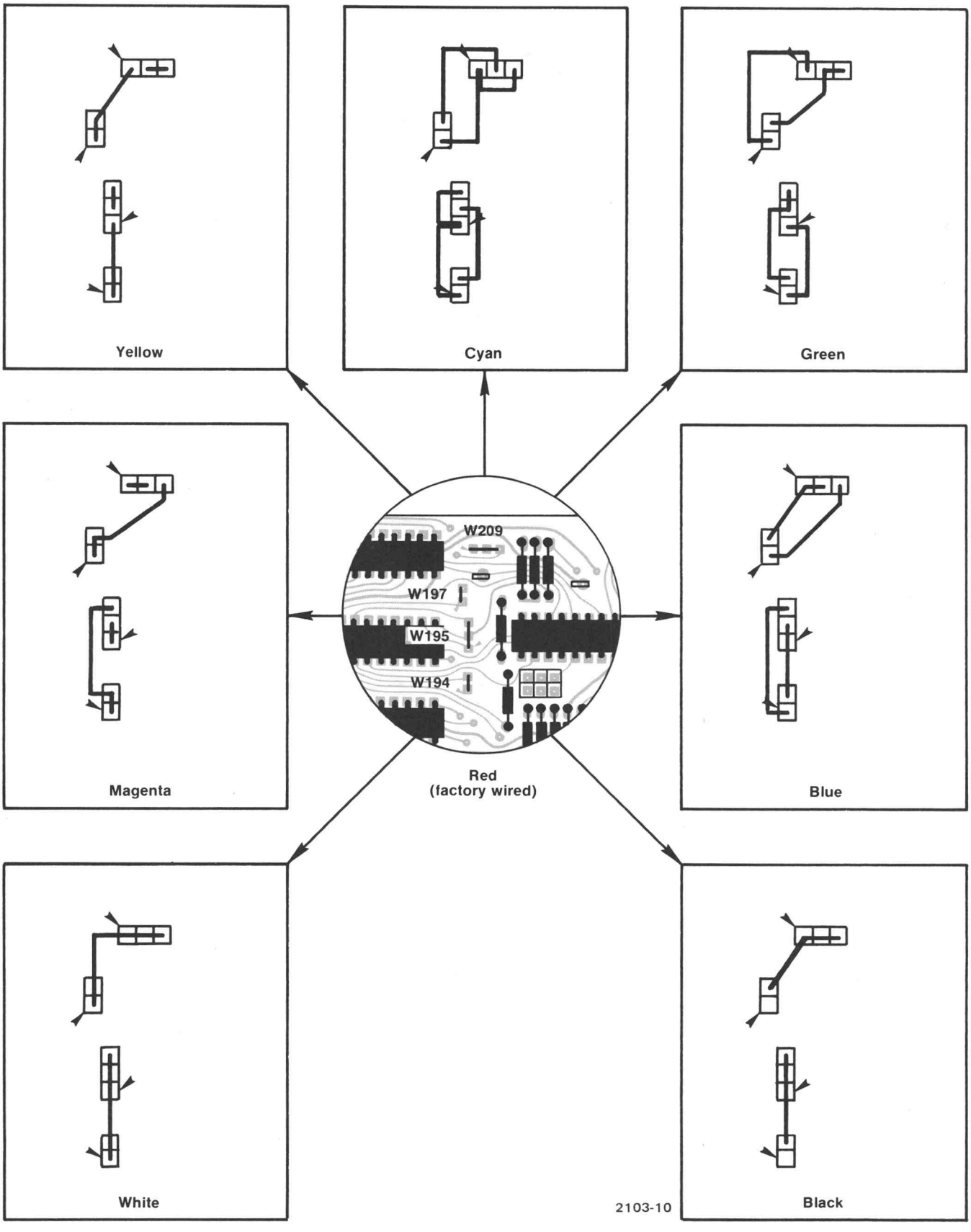

Fig. 3-2. Programming the Color Bar Logic board for altered color bar sequence.

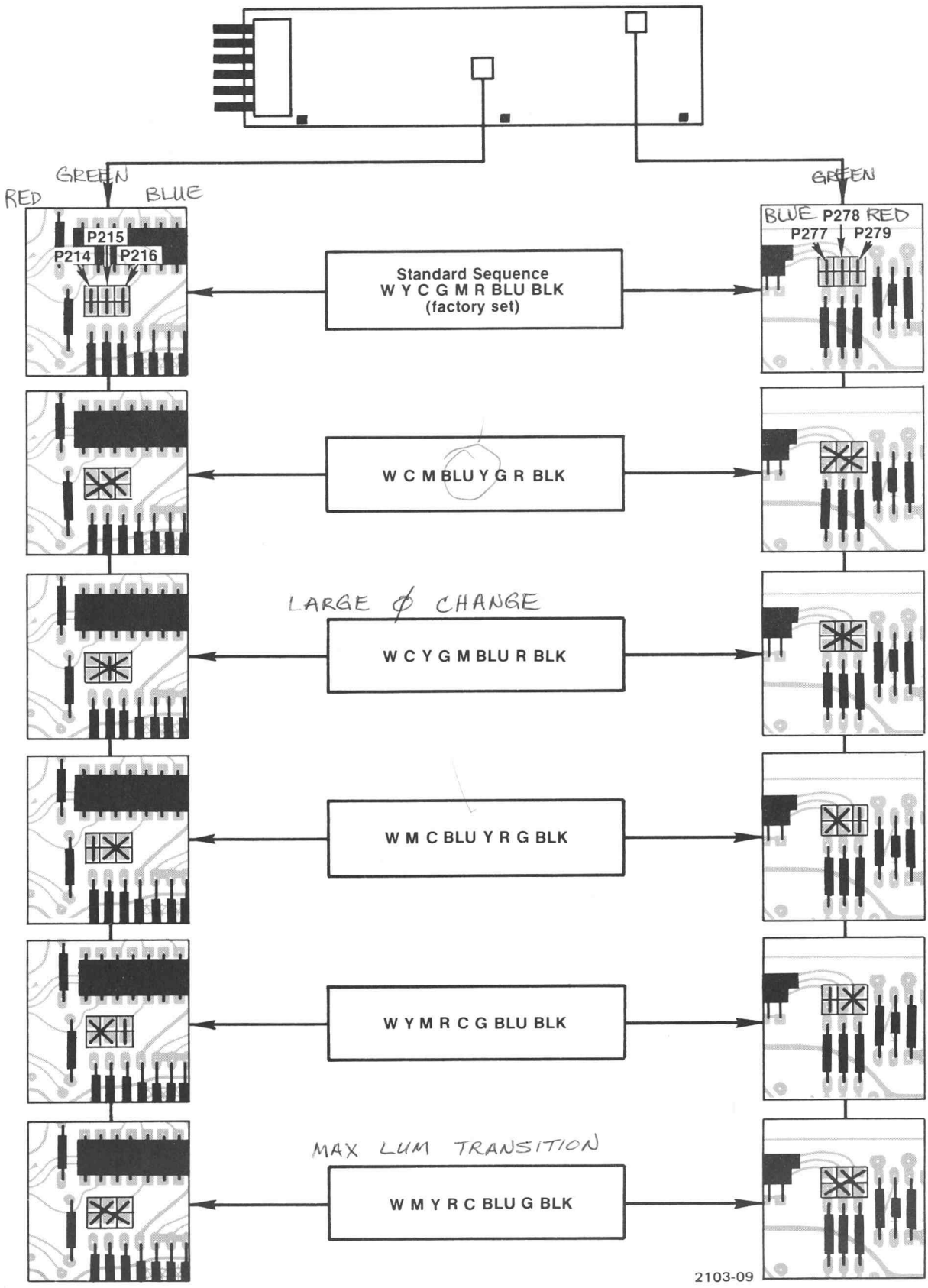

Fig. 3-3. Split Field Color Selection on the Color Bar Logic board (see also Color Bar Logic).

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PERFORMANCE CHECK/CALIBRATION PROCEDURE

Introduction

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

Performance checks are identified by the word "Check" in the step heading. These steps may be performed to verify instrument performance. Steps that include the word "Adjust" must be performed during calibration.

The TSG1 front panel control names in the text are capitalized; for example, BURST. Control and connector names on test equipment and internal controls in the TSG1 module under test have only the first letter capitalized; for example, Test Oscilloscope, Time/Div., or 1480 Mag control.

A short-form procedure is provided to aid in checking calibration of the TSG1. 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 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 calibrate the instrument. Test equipment used in preparing these procedures are given in each example. If alternative equipment is used, it must meet or exceed the listed requirements.

1. Waveform Monitor. Capable of viewing line rate and field rate signals, with a magnifier to measure risetime and pulse duration. For example, a Tektronix 1480 Waveform Monitor.

2. Test Oscilloscope. 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 7A13, 7A18, and 7B53A plug-in units.

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

4. Spectrum Analyzer (optional). A Tektronix 1401A or 7L12.

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

6. Vectorscope. Capable of viewing two signals simultaneously. For example, a Tektronix 520A.

7. Calibration Fixture. See Fig. 4-1.

8. Cable. Tektronix Part No. 012-0074-00.

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

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

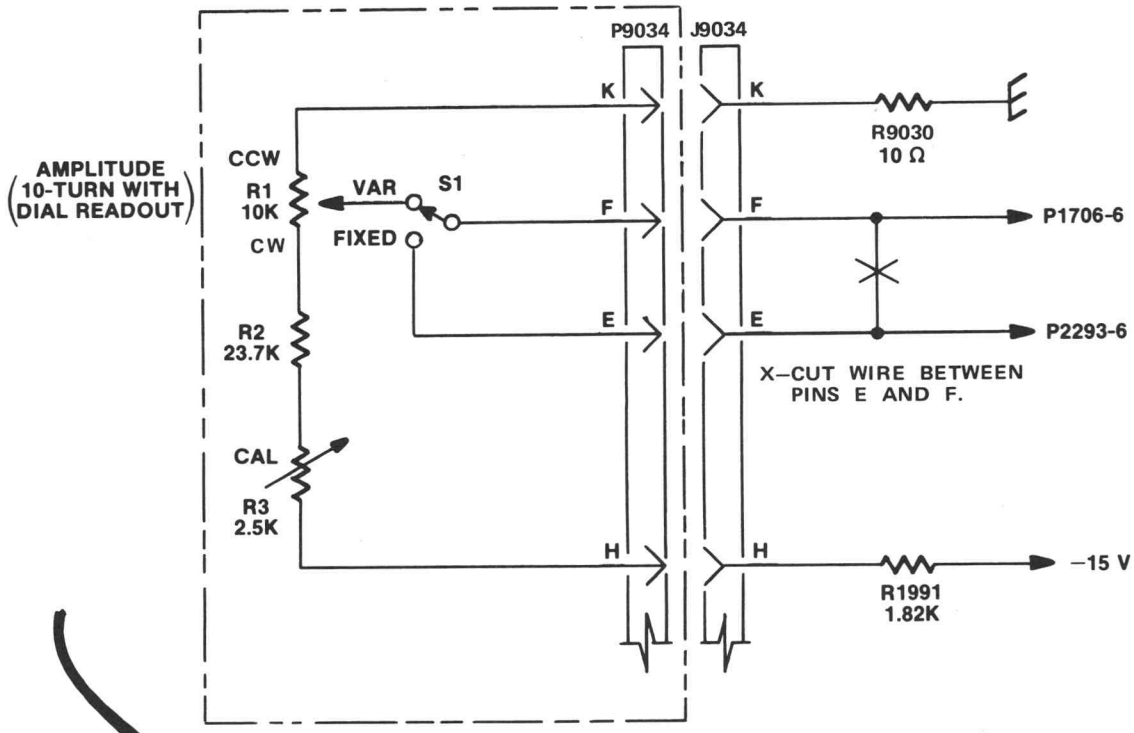
11. Extender Circuit Board. Tektronix Part No. 670-4441-00.

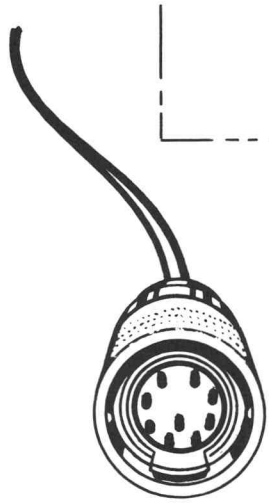
Calibration Fixture

This fixture and the 1480 Waveform Monitor provides a variable calibration voltage level which can be read directly from a 10-turn dial. The schematic diagram and parts list for the fixture appear in Fig. 4-1. When S1 is in the Fixed position, the 1480 calibration voltage is determined by the circuit in the fixture.

With P9034 connected to J9034 on the 1480, and S1 in the Fixed position, calibrate the graticule for 140 IRE (IV). Set the Amplitude dial to 1000 and S1 to Variable. Adjust R3 (CAL), to exactly match the internal 1 V calibrator level. The dial is now calibrated so that each turn of the dial represents 100 mV.

CALIBRATION FIXTURE





P9034
REAR VIEW

J9034
REAR VIEW

PARTS LIST

Ckt No.	Description	TEKTRONIX p/n
P9034	9-pin Amphenol #165-13	134-0049-00
R1	10kΩ ± 5%, Ind. Lin. ±0.1%, 10-turn, prec. var.	311-1729-00
R2	23.7kΩ ± 1%, 1/8 W, metal film	321-0325-00
R3	2.5kΩ ± 20%	311-0086-00
S1	SPDT	260-0613-00
	10-turn dial for R1, Kilo-dial Mod. 461-S-41	331-0139-00
Misc.	Approx. 3 ft. of 4-conductor cable and a small metal or plastic enclosure or case.	

Set R1 fully counterclockwise (ccw) and the dial at 0 when installing.

2107-04

Fig. 4-1. Calibration Fixture illustration.

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Measurements

The signal to be measured must be fed to the 1480 CH A input, and both the Oper and Cal buttons pushed in. To check amplitude within a given tolerance, adjust the Amplitude dial while watching the waveform monitor display. When the level being measured overlays the blanking level, read the amplitude directly from the dial.

To adjust a signal level, use the Calibration Fixture as a reference. First, set the Amplitude dial to the desired level. Then, adjust the proper control so that the signal level overlays the blanking level. The signal now matches the Amplitude level.

SHORT FORM PROCEDURE

PROCEDURE

Install the TSG1 module circuit boards on the extender to access all of the adjustments in the following procedure. Carefully align the board pin connectors to ensure good electrical contact.

1. Check/Adjust Luminance Gain

a. Connect the Color Bars rear-panel MODULE OUTPUT connector to the 1480 CH A input and terminate in 75 Ω. Push in the COLOR BARS FULL FIELD pushbutton.

b. Set the 1480 Display to 10 μs/div, Volts Full Scale to 0.5, and push in the Cal and Oper switches.

c. Check—Using the Amplitude dial of the Calibration Fixture to match the sync tip with blanking, read 285.7 mV, ±2.86 mV.

d. Adjust—R449 (Luminance Gain) for 285.7 mV of sync amplitude.

2. Check/Adjust DC Level

a. Set the 1480 Volts Full Scale to 1.0, Display to 10 μs/div, push in the Oper switch, and set the DC Restorer Off and Response switch to Aux Video In. Position the trace to the 0 IRE graticule line and change the TSG1 MODULE OUTPUT cable to the Aux Video In connector.

b. Check—The waveform blanking level should be 0 V ±50 mV (±7 IRE).

c. Adjust—R459 (DC Level) for 0 volts blanking level. Recheck Step 1 signal amplitude after making this adjustment. Return the TSG1 output cable to the 1480 CH A input connector.

3. Check Setup Level

a. Push in the SETUP pushbutton on the TSG1 front panel.

b. Check—Setup level should be 53.6 mV, ±1.5 mV.

4. Check/Adjust Wide Band Filter Response

a. Connect the Test Oscilloscope 10X probe to TP489.

b. Check—The signal should have square corners and minimum aberrations.

c. Adjust—L484 and L487 (Wide Band Filter) for best transient response—square corners and minimum aberrations.

5. Check V_{CB} Voltage

a. Place the 10X probe from the Differential Comparator (7A13) on TP218 located on the Color Bar Logic board.

b. Push in the TSG1 AMPL and SETUP pushbuttons (75%, 7.5%).

c. Check—V_{CB} should be 10.1 V, ±2% (9.9—10.3 V).

NOTE

The following V_{CB} voltages should be within 2% of each other. Apply V_{CB} voltage found in (c) to the formula:

$$\frac{\text{Measured Value}}{\text{Standard Value}} \times 100 = V_{CB} \text{ relative voltage in \%}$$

where the standard value is the V_{CB} found in (c).

Example: Assume that the 75%, 7.5% V_{CB} voltage measures 10.2 V. Applying the formula:

$$\frac{10.2}{10.1} \times 100 = 101\%$$

Note that the 75%, 7.5% V_{CB} voltage is 1% above the standard value. Repeat this step for each remaining V_{CB} voltage. All other voltages should be within 2% of the relative V_{CB} voltage.

d. Disengage the AMPL pushbutton (100%, 7.5%).

e. Check—V_{CB} should be 13.4 V, ±2%.

f. Disengage the SETUP pushbutton (100%, 0%).

g. Check—V_{CB} Should be 14.6 V, ±2%.

h. Push in the AMPL pushbutton (75%, 0%).

i. Check—V_{CB} should be 10.9 V, ±2%.

6. Check/Adjust Color Bar Luminance Amplitudes

a. Push in the TSG1 B-Y, R-Y, SETUP, and AMPL pushbuttons.

b. Check—Luminance levels (75%, 7.5%) are as follows:

TABLE 4-1

Color Bar (75%, 7.5%)	Amplitude	Adjust
White	543.6 mV to 554.6 mV	Check
Yellow	489.7 mV to 499.5 mV	Check
Cyan	396.4 mV to 404.4 mV	Check
Green	342.4 mV to 349.4 mV	R298 for 345.9 mV
Magenta	254.1 mV to 259.3 mV	Check
Red	200.2 mV to 204.2 mV	R286 for 202.2 mV
Blue	107.0 mV to 109.2 mV	R296 for 108.1 mV
Black	52.6 mV to 54.6 mV	Check

c. Disengage the SETUP pushbutton.

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d. Check—Luminance levels (75%, 0%) are as follows:

TABLE 4-2

Color Bar (75%, 0%)	Amplitude
White	530.3 mV to 541.1 mV
Yellow	472.0 mV to 481.6 mV
Cyan	371.2 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	57.9 mV to 59.9 mV
Black	0

e. Disengage the AMPL pushbutton.

f. Check—Luminance levels (100%, 0%) are as follows:

TABLE 4-3

Color Bar (100%, 0%)	Amplitude
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	419.3 mV to 423.5 mV
Magenta	290.0 mV to 295.0 mV
Red	212.2 mV to 216.4 mV
Blue	77.6 mV to 79.6 mV
Black	0

g. Push in the SETUP pushbutton.

h. Check—Luminance levels (100%, 7.5%) are as follows:

TABLE 4-4

Color Bar (100%, 7.5%)	Amplitude
White	707.2 mV to 721.4 mV
Yellow	634.7 mV to 647.5 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	125.0 mV to 127.6 mV
Black	52.6 mV to 54.6 mV

7. Check/Adjust White Bar Risetime

a. Push in AMPL and WHITE REF pushbuttons.

b. Check—White Reference risetime should be 130 ns +20 ns, −10 ns.

c. Adjust—L484 and L487 (Wide Band Filter) for correct risetime. Sync leading and trailing edges should be clean with minimum aberrations.

8. Check/Adjust IQ White Risetime and Narrow Band Filter Response

a. Place the 10X Test Oscilloscope probe on TP429.

b. Check—IQ White Risetime should be 250 ns ±37.5 ns.

c. Adjust—L464 and L467 (Narrow Band Filter) for correct risetime with minimum aberrations.

NOTE

Adjustment may be facilitated by removing Q223, Q232, Q254, and Q263 to remove I and Q portions of signal.

9. Check/Adjust B-Y and R-Y Filter Response

a. Connect the Test Oscilloscope 10X probe to the test point (TP) under test.

b. Check—Signals at the following test points should have square corners and minimum aberrations: TP415, TP416, TP434, and TP435.

c. Adjust—Filters for best transient response.

L424	+(B-Y)	TP414
L444	−(B-Y)	TP423
L432	+(R-Y)	TP422
L442	−(R-Y)	TP442

10. Check/Adjust Chrominance Bandpass Filter Response

a. Push in the HORIZ UNLOCK pushbutton on the SPG front panel. Push in the Y and /REVERSE pushbuttons on the TSG1 front panel.

b. Check—Vectorscope display should be similar to Fig. 4-2a.

c. Check—Waveform Monitor display should be similar to Fig. 4-3a.

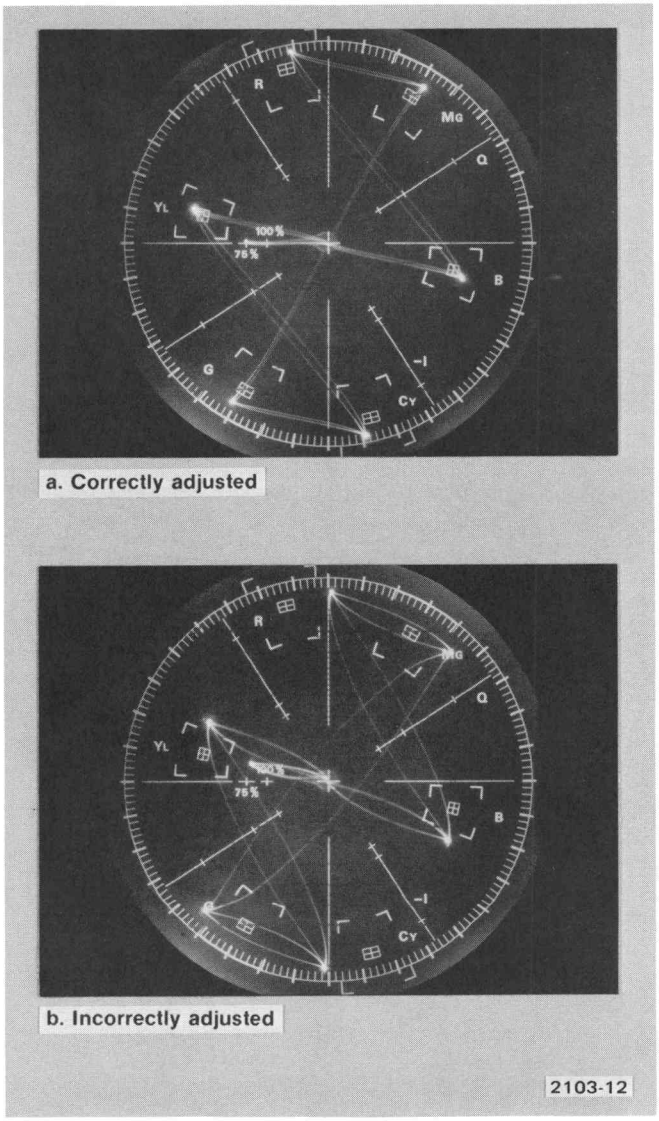

Fig. 4-2. Chrominance Bandpass Filter vectorscope display.

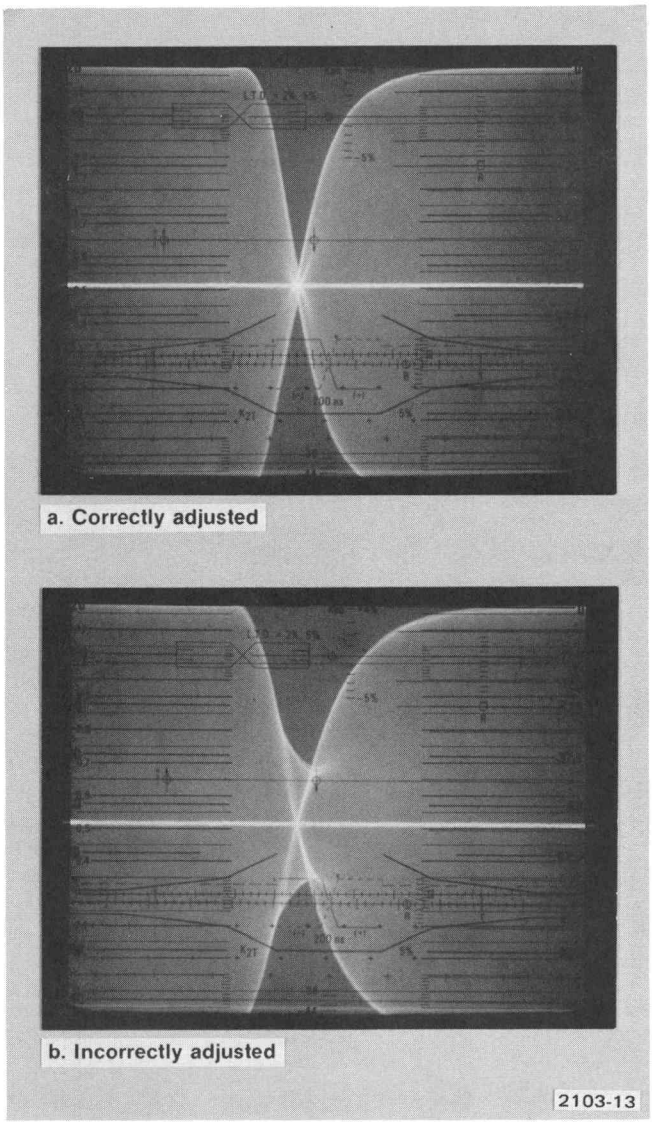

Fig. 4-3. Chrominance Bandpass Filter waveform monitor display.

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d. Check—Third-order harmonics are attenuated 30 dB or more.

NOTE

The adjustments in this step affect the harmonic content of the output signal. Only slight adjustment from the original calibration should be attempted without using a spectrum analyzer.

e. Adjust—L357 and L367 (Chrominance Bandpass) for straight lines on the vector display (Fig. 4-2a) and for a null at the crossover point on the waveform monitor display (Fig. 4-3a).

11. Preadjust Luminance-to-Chrominance Delay

a. Push in the SPG module Horiz Unlock pushbutton and push in the TSG1 /REVERSE pushbutton.

b. Set the 1480 VFS to 0.5 and Mag to .1 μs/div.

c. Adjust—R144 (Luminance Delay) for a null between the green and magenta color bars (see Fig. 4-4).

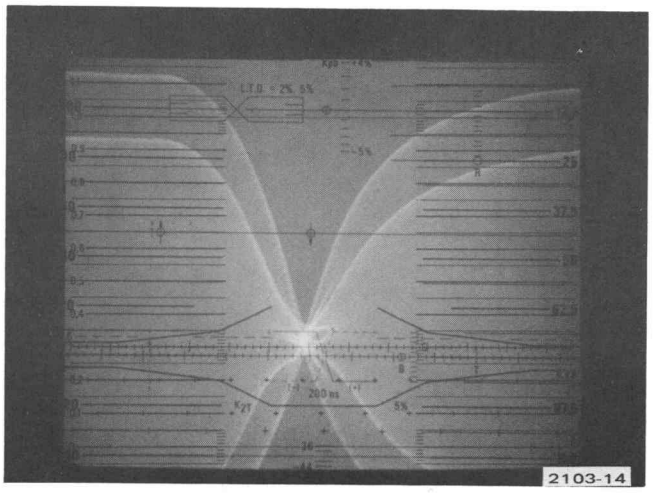

Fig. 4-4. Luminance-to-Chrominance Delay waveform monitor display.

12. Check/Adjust 0°—180° Switch Phase

a. Push in the TSG1 Y, B-Y, and PHASE (R-Y) pushbuttons.

b. Check—Phase error between color bar vectors on the vectorscope display should be 0.5° or less (see Fig. 4-5). Use the vectorscope Calibrated Phase dial to measure any error.

c. Adjust—C351 (Switch Phase) for minimum dot separation—0.5° or less.

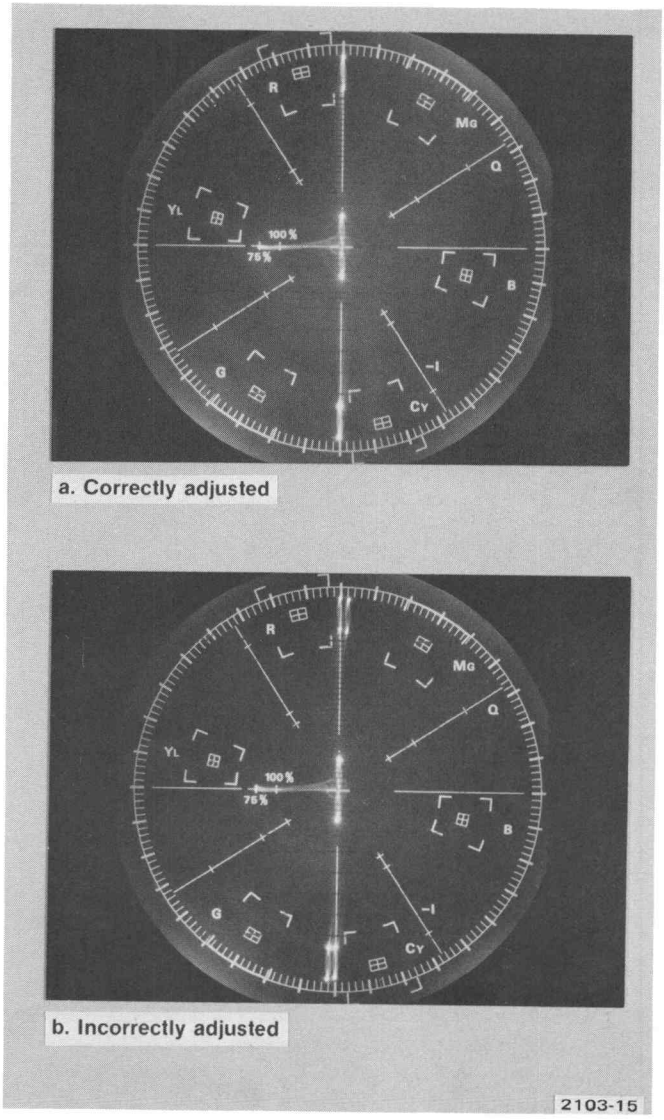

Fig. 4-5. 0°—180° Switch Phase vectorscope display.

13. Adjust Quadrature Phase

a. Push in the TSG1 FULL FIELD, Y, and PHASE (R-Y) pushbuttons. Set the 1480 Response to 3.58 MHz and VFS to 0.2.

b. Adjust—L365 (Quad-Phase) for best waveform overlay (see Fig. 4-6).

c. Set the 1480 to Flat Response and adjust L357 and L367 (Chrominance Bandpass) for best waveform overlay.

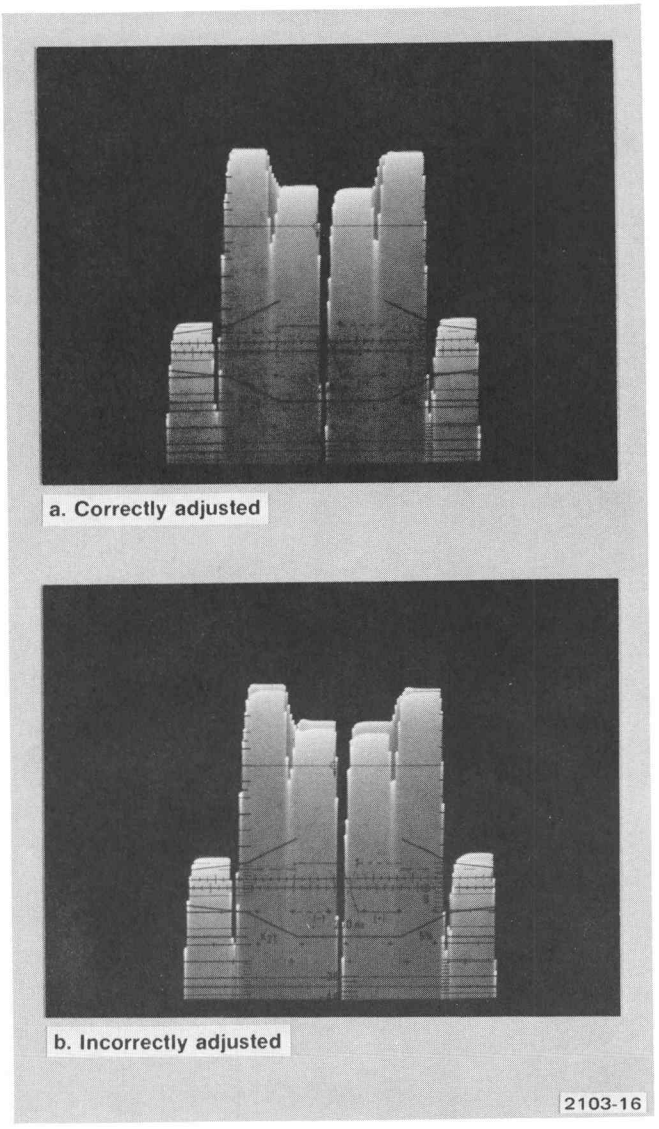

Fig. 4-6. Quadrature Phase waveform monitor display.

14. Check/Adjust Residual Subcarrier Amplitude

a. Connect the TSG1 output cable to the Test Oscilloscope with an in-line 75 Ω terminator. Set the Vertical Amplifier to 10 mV/div.

b. Push in the TSG1 FULL FIELD pushbutton.

c. Check—Residual subcarrier amplitude at blanking level should be 2.5 mV (−52 dB) or less (0.25 major division or less).

d. Adjust—R402 (B-Y Bal), R403 (R-Y Bal), and C373 (Residual Subcarrier) for 2.5 mV or less residual subcarrier.

15. Check/Adjust Spurious Subcarrier Amplitude

a. Push in the TSG1 Y pushbutton.

b. Check—Spurious subcarrier amplitude should be 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.

c. Adjust—L424, L432, L442, and L444 (Step 10c) for 32 mV or less spurious subcarrier amplitude. Repeat Step 10.

NOTE

Adjustments in Steps 11 to 15 may interact. Check and repeat if necessary.

16. Preadjust Chrominance Gain

a. Midrange R249 (Burst).

b. Adjust R378 (Chrominance Gain) for 286 mV of burst amplitude on the 1480 display.

17. Check Chrominance Amplitude

a. Push in the TSG1 FULL FIELD, AMPL (75%), and SETUP (7.5%) pushbuttons. Push in the 1480 Oper and Cal pushbuttons and use the Calibration Fixture to measure chrominance amplitudes. Fig. 4-7 shows the waveform for measuring the red color bar with the 1480 Calibration Fixture.

b. Note the amplitudes measured.

c. Check—Relative amplitudes are within 1% of each other. Measure the Red Color bar amplitude, and apply the result to the following formula:

$$\frac{\text{Measured Value}}{\text{Standard Value}} \times 100 = \text{Red relative amplitude in \%}$$

where the standard value is the absolute value given in the table below.

EXAMPLE: Assume that the red color bar measured 636.2 mV. Applying the formula:

$$\frac{636.2 \text{ mV}}{630.0 \text{ mV}} \times 100 = 101\%$$

Note that the red color bar is 1% above the standard value.

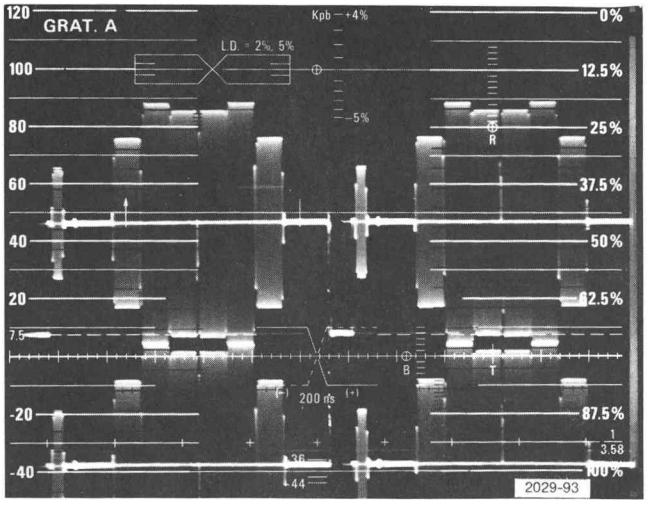

Fig. 4-7. Waveform display showing the red color bar peaks just overlaying.

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

EXAMPLE: assume that the blue color bar measured 454.0 mV. Applying the formula:

$$\frac{453.0 \text{ mV}}{444.2 \text{ mV}} \times 100 = 102\%$$

e. Note that the blue color bar is within 1% of the red relative amplitude.

B-Y.

TABLE 4-5

Color (75%, 7.5%)	Absolute Amplitude	Tolerance
Blue, Yellow	444.2 mV	430.9—457.5 mV
Red, Cyan	630.0 mV	611.1—648.9 mV
Green, Magenta	588.4 mV	570.5—606.0 mV
White, Black	0 mV	2.5 mV or less

2942

f. If the above requirements are met, go to Step 20, otherwise, perform Steps 18 and 19.

18. Adjust R-Y and B-Y Chrominance Amplitudes

a. Push in the TSG1 B-Y pushbutton (Y pushed in)

b. Adjust—R-Y chrominance amplitudes within 1% or 1 mV, whichever is greater, see Table 4-6.

c. Disengage the B-Y pushbutton.

d. Push in the TSG1 R-Y pushbutton.

e. Adjust—B-Y chrominance amplitudes within 1% or 1 mV, whichever is greater, see Table 4-6.

f. Disengage the R-Y pushbutton.

19. Check Total Chrominance Amplitudes

a. With both R-Y and B-Y pushbuttons disengaged and the Y pushbutton pushed in, check the chrominance amplitudes in Table 4-6.

20. Check/Adjust Burst Amplitude

a. Set the Calibration Fixture Amplitude dial so that the burst tips just touch on the 1480 display.

b. Check—Burst amplitude should be 285.7 mV ±8.57 mV.

c. Adjust—R249 (Burst) for 285.7 mV of burst amplitude.

21. Check/Adjust White Reference Amplitude

a. Push in AMPL and WHITE REF pushbuttons.

b. Check—White Reference amplitude should be 714.3 mV ±7.14 mV.

c. Adjust—R276 (White) for white level of 714.3 mV.

22. Check/Adjust EIA IQ White Amplitude

a. Push in the COLOR BARS EIA pushbutton.

b. Check—IQ White amplitude should be 714.3 mV ±7.14 mV.

23. Check/Adjust I and Q Amplitudes (75%, 7.5%)

TABLE 4-7

All amplitudes should be ±3% absolute and ±1% relative to Red amplitude measured in Step 17.

Check	Remove/ Replace	Amp.	Adjust
I_B	Q263	155.6 mV	R229
I_R	Q232	239.6 mV	R269
I		285.7 mV	
Q_B	Q254	239.6 mV	R239
Q_R	Q223	155.6 mV	R259
Q		285.7 mV	

Display the EIA signal on the vectorscope and check that the —I and Q signal vectors are aligned with the vectorscope —I and Q graticule markings when the burst is at 180°.

24. Check/Adjust Luminance-to-Chrominance Delay

a. Push in the TSG1 /REVERSE, B-Y, and R-Y pushbuttons. Set the 1480 Volts Full Scale to 0.5 and Mag to .1 μs/div.

TABLE 4-6

Color (75%, 7.5%)	Amplitude (±1% Relative to Red)		
	R-Y P-P	B-Y P-P	Chrom P-P
White	Adjust ~~R528~~ 258 for modulation null on white bar	Adjust R228 for modulation null on white bar	2.5 mV or less
Yellow	99.2 mV	433 mV	444.2 mV
Cyan	612.9 mV	146 mV	630.0 mV
Green	513.6 mV (Adjust R268)	287 mV (Adjust R238)	588.4 mV
Magenta	513.6 mV	287 mV	588.4 mV
Red	612.9 mV	146 mV (Adjust R248)	630.0 mV
Blue	99.2 mV (Adjust R274)	433 mV	444.2 mV
Black			2.5 mV or less

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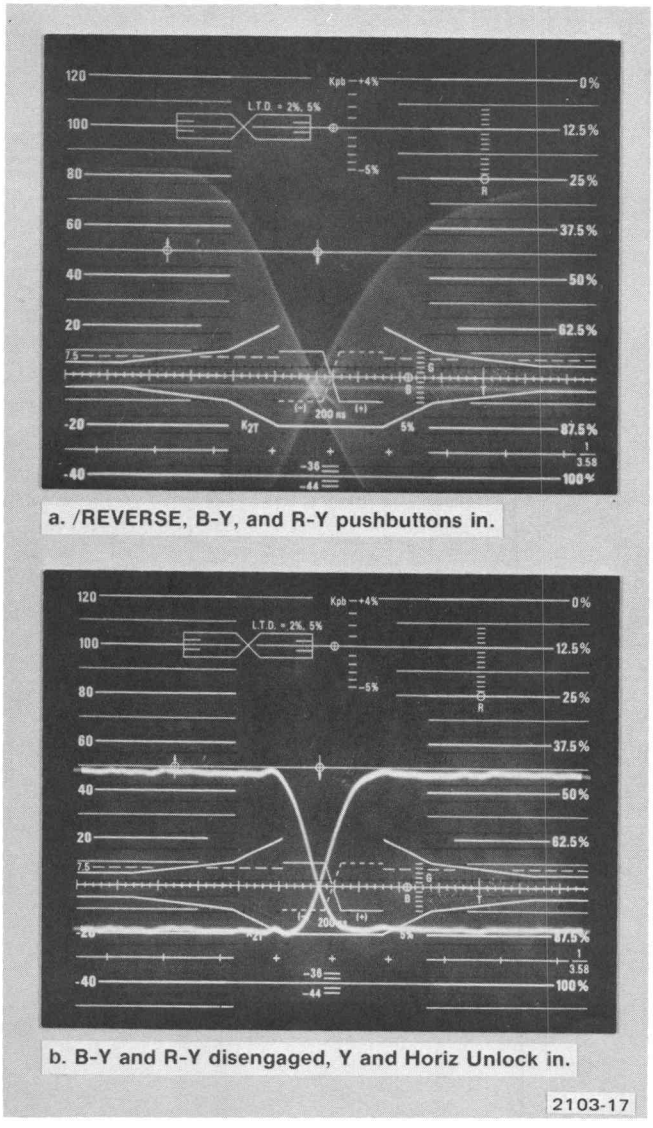
b. Position the display so that the green-magenta transistion coincides with a major graticule tick marking (see Fig. 4-8a).

c. Disengage the TSG1 B-Y and R-Y pushbuttons and push in the Y and SPG Horiz Unlock pushbuttons.

d. Vertically position the 1480 display to the horizontal graticule line and measure the difference from luminance (see Fig. 4-8b).

e. Check—Delay should not exceed 20 ns (1 minor horizontal graticule division).



a. /REVERSE, B-Y, and R-Y pushbuttons in.

b. B-Y and R-Y disengaged, Y and Horiz Unlock in.

2103-17

Fig. 4-8. Waveform monitor display showing minimum Luninance-to-Chrominance delay.

f. Adjust—R144 (Luminance Timing Delay) to within 20 ns delay between luminance and chrominance.

25. Check Chrominance Risetime

a. Push in the SPG Horiz Unlock pushbutton and position the 1480 display to measure the leading edge of the magenta color bar.

b. Check—Chrominance risetime should be 400 ns ±60 ns.

26. Check Burst Risetime

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

b. Check—Burst risetime should be 400 ns ±60 ns.

27. Check/Adjust Subcarrier Phase

a. Connect the 1410 Mainframe subcarrier output cable to the vectorscope CW Ext Φ Ref input and loop through to CH B through the 10X attenuator pad. Connect the TSG1 output cable to CH A. Display CH A and CH B. See Fig. 4-9.

b. Check—TSG1 subcarrier phase is within 10° (factory setting) of the 1410 subcarrier phase.

c. Adjust—C318 and L317 (Subcarrier Phase) to within 10° of the 1410 subcarrier phase, or to compensate for cable delay in the installation.

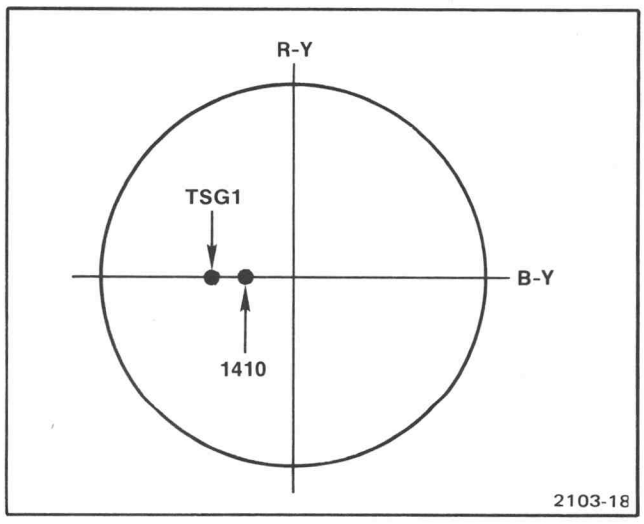


Fig. 4-9. Subcarrier phase adjustment illustration.

28. Check Isolation

a. Note the color bar amplitude on the 1480 display and short the unused output pins on the Color Bar Output board together.

b. Check—Change in output should not exceed 1%.

c. Move cable to opposite set of pins and repeat steps a and b.

d. Connect the Test Oscilloscope to the rear panel MODULE OUTPUT connector through a 75 Ω in-line terminator.

e. Connect the Sine-wave Generator to the unused pair of output pins through a 75 Ω in-line terminator. Set the Sine-wave Generator frequency to 3.58 MHz.

f. Check—The subcarrier added to the output signal should be suppressed 40 dB or more as the generator amplitude is varied from 0.5 V to 4 V (5 mV to 40 mV). Reverse output connections on the Color Bar Output board and repeat check.

29. Check Return Loss

a. Connect the Return Loss Bridge to the Test Oscilloscope Differential Comparator. Set the Differential Comparator for differential measurements.

b. Connect the Sine-wave Generator output through a "T" connector to the Return Loss Bridge input (see the Return loss Bridge instruction manual) and to the Test Oscilloscope Vertical Amplifier plug-in. Balance the bridge.

c. Set the Test Oscilloscope for alternate channel viewing.

d. Set the Sine-wave Generator frequency for 50 kHz output.

e. Remove the 75 Ω terminator from the Return Loss Bridge Unknown arm.

f. Set the Sine-wave Generator Amplitude control for 500 mV output as monitored on the Test Oscilloscope.

g. Connect the Return Loss Bridge Unknown arm to the TSG1 module output connector.

h. Check—Amplitude should not exceed 16 mV (30 dB return loss) as the frequency is varied from 50 kHz to 5 MHz. Maintain constant sine-wave amplitude as monitored on the Test Oscilloscope Vertical Amplifier channel.

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THEORY OF OPERATION

This section is divided into two parts. The first part is a basic overview of instrument operation that describes circuit relationships and signal flow as illustrated in the Block Diagram. The Circuit Description is a more detailed discussion of each of the circuit diagrams.

BLOCK DIAGRAM DESCRIPTION

The circuit diagrams are blocked off according to circuit function. These circuit block titles are used as indexes to the circuit diagram discussion.

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

Mode Control

Five front-panel COLOR BARS pushbutton switches control generation of the EIA, full field, and split field color bar test signals. These switches control color bar logic switching and mainframe drive signals for use in the counter, chrominance, and signal drive circuitry. All test signals except the EIA signal may be modified by front-panel pushbuttons.

Counters

Color bar timing information supplied by the SPG Sync Timing Module is used by the counters to derive the chrominance and luminance signals. These signals are used in the chrominance and luminance signal drive circuits.

Chrominance and Luminance

Chrominance, luminance, and IQW drive signals are combined to develop the B-Y and R-Y drive for use in the modulators. Front-panel control of setup and amplitude levels is provided by this circuitry.

Modulators

The B-Y and R-Y Modulators utilize chrominance information developed in preceding circuits. The Modulators operate in a double balanced configuration, which produces an output containing only the required sidebands of chrominance information with a minimum of higher-order harmonics.

Output

The Modulator outputs are filtered and applied to the Chrominance Output Amplifier. Luminance information, including W and composite sync signals, is combined at the outputs of the Wide Band and Narrow Band Filters and applied to the Luminance Output Amplifier. The chrominance and luminance signals are combined and applied to the rear-panel composite video output connector.

CIRCUIT DESCRIPTION

DIAGRAM 1a
COLOR BAR LOGIC (COUNTERS)

Circuits on this diagram provide color bar test signal control and the chrominance/luminance drive signals.

Chrominance/Luminance Counter

U196 generates the chrominance timing signals and U199 generates the luminance timing signals. See Fig. 5-1. The U196 and U199 load inputs (pin 11) are driven by inverting composite sync; clock inputs (pin 14) are driven by the color bar timing signal; and the enable inputs (pin 4) are driven by the enable signal from U186. A high at the up/down inputs (pin 5) causes the counters to count down in the reverse mode. U156 provides an adjustable luminance timing delay to compensate for inherent delay in the chrominance processing circuitry.

The outputs of U196 and U199 are set high during composite sync time. The standard color bar count begins when the color bar timing signal sets all outputs low, which produces the white bar. The duration of each count determines the chrominance and luminance on-time for each color in the color bar test signal. At the eighth positive edge of the color bar timing signal, the enable line goes high, which disables U196 and U199, holding their outputs high. A low at the load inputs during composite sync time then ensures that the outputs remain high until the next video line count starts (color bar timing signal goes high).

Luminance Drive

Q283, Q292, and Q293 are current sources that provide luminance levels for the blue, red, and green color bars respectively. Adjustable current drive for each transistor is provided by R286, R296, and R299. These potentiometers are connected to the color bar voltage drive on Diagram 1b (Q199 collector). Returning the emitters of Q282, Q283, Q292, and Q293 to the color bar voltage drive provides a means for selecting color bar amplitude and setup from the front panel. See Color Bar Setup/Amplitude description in Diagram 1b description for details.

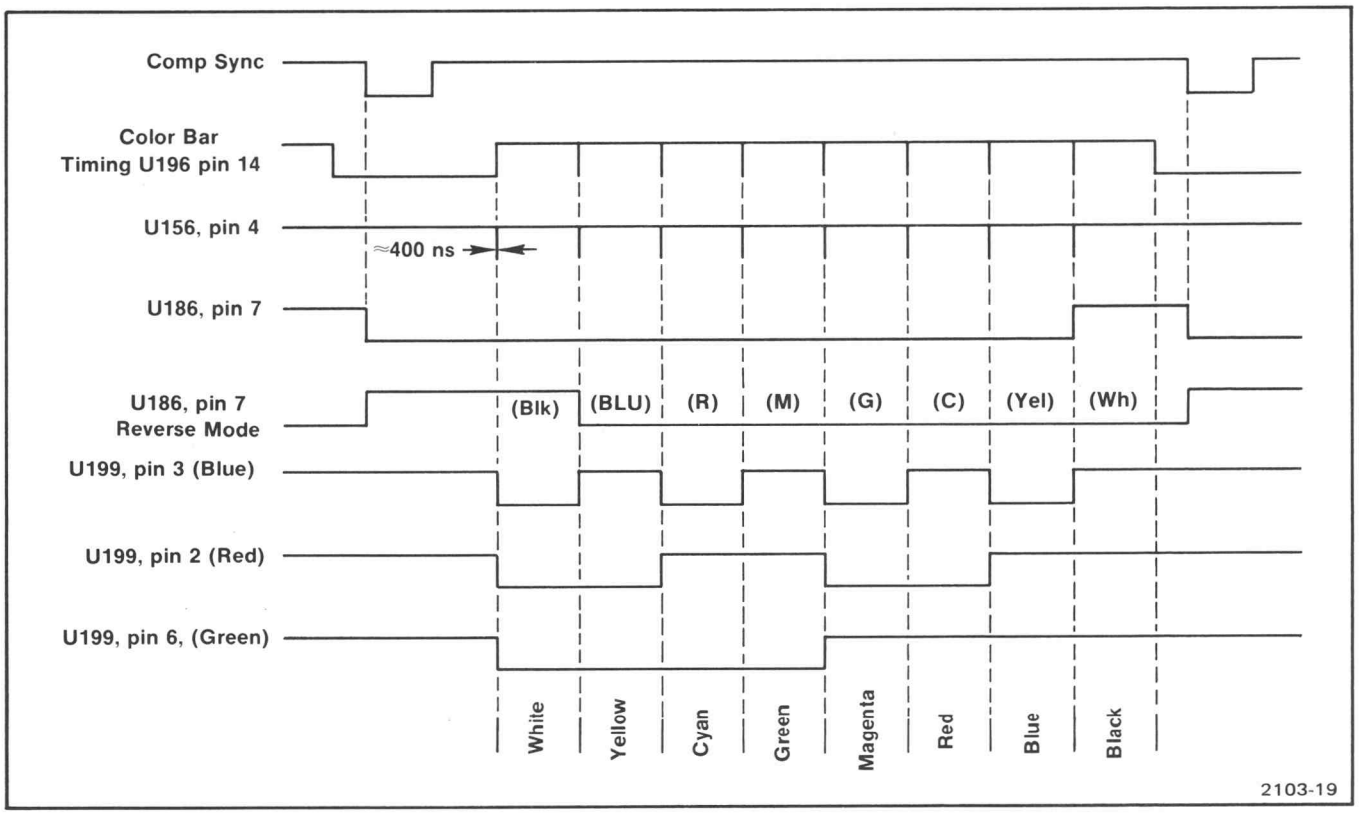


Fig. 5-1. Color Bars Counter Timing Diagram. Chrominance Counter, U196, output occurs 400 ns before U199.

CR284, CR294, and CR296 are current steering diodes driven through buffers by the outputs of U199. For instance, if pin 3 of U199 is high, CR296 turns on, steering emitter current away from Q293 which turns off the transistor. Thus, a low at the counter's "blue" output (pin 3) causes a voltage that corresponds to the blue luminance level to appear at the output of the Wide Band Filter on the Color Bar Output board (see Diagram 2). The red and green color bar luminance levels are similarly generated.

The 100 IRE white bar drive current is provided by Q282 unless diverted by one or more of the steering diodes, CR275, CR276, CR277, or CR286. When the AMPL switch is at 75% and the WHITE REF switch is at 100 IRE, Q282 is turned on providing additional current during white bar time. Signals from U122D and U222D ensure that Q282 is off in the EIA and VITS modes. R276 provides adjustable current and is connected to the color bar voltage drive on Diagram 1b.

Composite sync and setup are added to the luminance signal by Q280 and Q281 respectively. Steering diodes CR273 (SETUP) and CR272 (SYNC) control Q280 and Q281 in the same way as described earlier.

Mode Switching and Drive Logic

All front-panel pushbutton switches are controlled by the EIA switch or Remote line. Pushing in the EIA switch or a low on the Remote line causes U126A to override the switch functions and program the TSG1 to generate the EIA color bar test signal. A low on the VITS Key line also overrides the front-panel switches at U126B to generate a line of color bars signal on the selected VITS line.

Pushing in the /Y REF button allows the 1/2 V—3/4 V signal to pass through U109C, U144D, and U194A, causing the chrominance counter to stop counting during the second part of the field. Thus, only luminance information is generated.

When the /RED pushbutton is engaged, the 1/2 V—3/4 V signal is gated through U109B, U194B, and U196D to Luminance Counter U199 to control the load and data inputs. The 1/2 V—3/4 V signal also passes through U144D, U194A, and U144C to Chrominance Counter U196. During the second part of the field, both counters' data inputs are programmed and held to load mode by U194A to produce the red signal.

The solid color portion of the split field display can be programmed by wire straps W194, W195, W197, and W209 for any color in the color bar signal (see Fig. 3-3, Section 3 and the Color Bar Logic Board Adjustment and Jumper Locations pull-out).

Pushing in the /REVERSE button allows U109A to pass the 1/2 V—3/4 V signal to the count up (low) down (high) inputs of U196 and U199. The signal also presets U186's data inputs to control the enable inputs of U196 and U199.

When the color bar signal is present the data input lines of U196 and U199 are held high by U144C and U126D preloading the outputs high. The output of U186 enables U196 and U199 to count up from the first pulse of the color bar timing signal in the normal sequence, while in reverse mode, the counters start counting down from the second pulse.

When the Video Disable line goes high, U182A's output sets high preventing the color bar timing signal from reaching the counter's clock input. The output then becomes a dc voltage corresponding to blanking level. The Video Disable and Sync Off commands are OR'd at U182C to disable U184B which turns off sync.

U162B OR's horizontal blanking from U122A with vertical blanking to control luminance drive. A logic high coupled from pin 1 to pin 3 of U162A turns off the drive transistors during the IQW portion of the EIA signal. C172 and R172 delay the rising edge of vertical blanking which occurs during half line 263 of field one. The resultant luminance delay compensates for inherent delay in the chrominance turn off (see Fig. 5-2). C153 and R151 introduce a similar delay to the 3/4 V signal.

C153 and R157 delay the 3/4 V signal during the half line to ensure that the luminance and chrominance portions of the signal end simultaneously (see Fig. 5-2).

In the EIA and VITS modes, U124A enables U124B to pass composite blanking (the composite blanking signal consists of the horizontal blanking signal and delayed vertical blanking signal, which are combined by U162B and fed to U124B) to U124D, producing setup. U124A also causes U169 on Diagram 1b, via the Switch Inhibit line, to provide the 7.5% setup level. U124C is enabled when the SETUP switch is in the 7.5% position.

Chrominance Switching and Logic

Pushing in the Y front-panel switch enables U142C, which, by way of U194B, causes U199 to stop generating luminance drive. Similarly, U142B and D disable R-Y and B-Y chrominance drive. A low on the VITS Key line disables U142B, C, and D. U222B and C are driven by composite blanking from U162C. U164A OR's the output of U186 (pin 5, U186 is high for 48 μs starting with the falling edge of horizontal blanking) with the color bar timing signal from U182A (pin 2, U164A goes high 200 ns before pin 3, U164A) to produce an advanced horizontal blanking signal and compensate for delay in the chrominance processing circuitry.

U144A combines the VITS Key signal with vertical blanking. The output of U142A goes high during IQW time to disable chrominance and luminance drive and enable the IQW Logic (Diagram 1b).

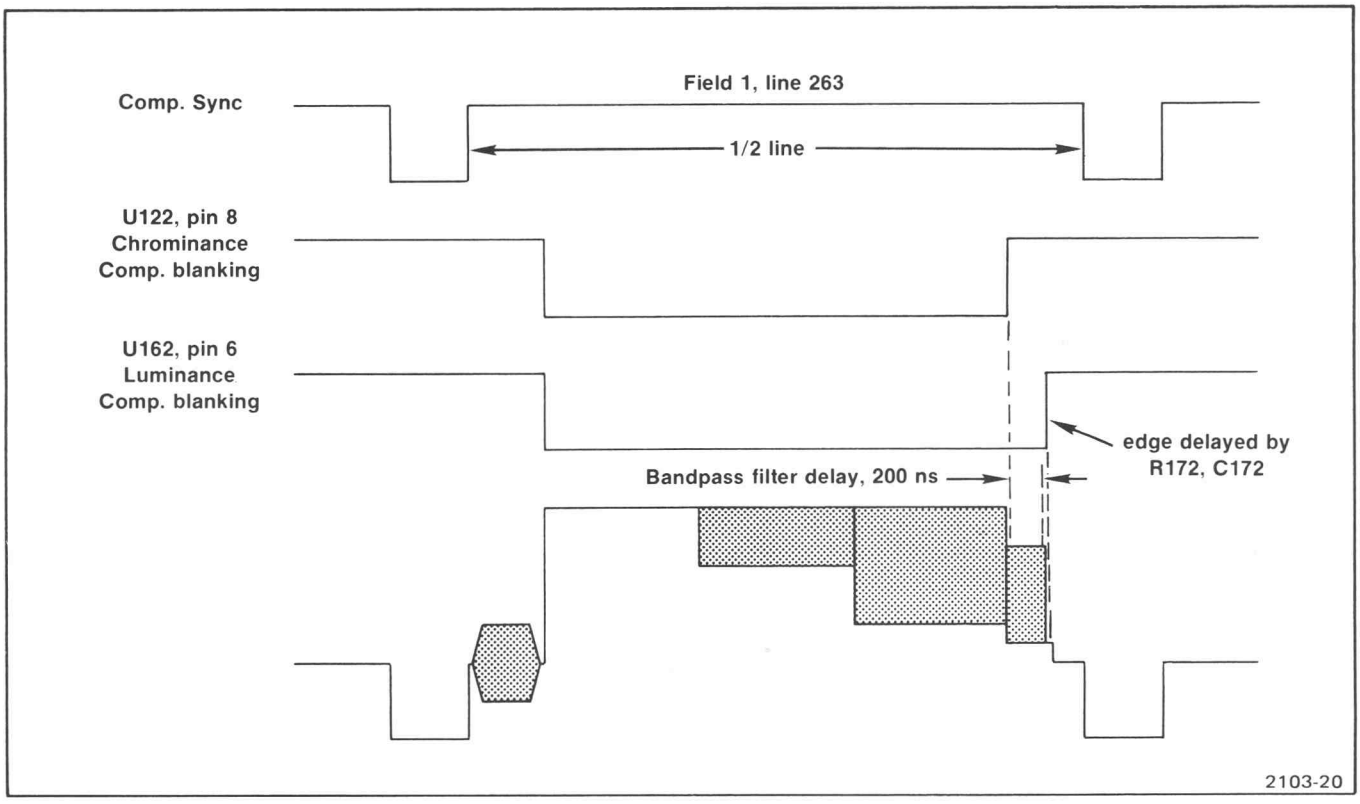


Fig. 5-2. Luminance turn off delay during half-line.

DIAGRAM ① b
COLOR BAR LOGIC (DRIVERS)

Circuits on this diagram provide the Modulator Chrominance Drive signals ±(B-Y), ±(R-Y), Narrow Band Filter drive signal, and variable color bar voltage.

Chrominance Drive, B-Y and R-Y Chrominance Amplitude

The red, green, and blue chrominance drive inputs terminate at the B-Y and R-Y chrominance amplitude stages. Since all six of these stages perform similar functions, the red drive will serve as an example of circuit operation. When the red drive signal from the output of U196 goes low, Q245 and Q255 are turned on allowing a given amount of red signal current to flow through the R-Y and B-Y Filters and become modulated by subcarrier at the Modulator (see Diagram 2). Conversely, when the drive signal goes high, current is steered from the transistor, cutting off signal current drive to the Modulator.

Composite blanking, chrominance disable, and B-Y, R-Y front panel control through U222B and (Diagram 1a) also disables signal current drive to the Modulator.

Thus, the red, green, and blue logic signals are combined to make up the necessary ±(B-Y) and ±(R-Y) chrominance elements for use in the Modulator. Circuit operation is similar to the Luminance Drive section on Diagram 1a, including the emitter returns to the variable color bar voltage.

IQW Logic and IQW Drive

The IQW Logic gates, U192A, B, and C, combine the chrominance and luminance timing signals to provide the IQW timing drive to signal current sources Q232, Q223, Q254, Q263, and Q274 to generate +(B-Y), ±(R-Y), and W currents respectively. U192A, B, and C are gated on by split field timing from U142A (Diagram 1a). The W signal current amplitude, set by R279, is shaped by the Narrow Band Filter and summed with other luminance current at the Luminance Output Amplitude.

Color Bar Setup/Amplitude

U169, a CMOS Quad Bilateral switch, and related circuitry, provide the color bar voltage used in the Chrominance Drive and Luminance Drive circuits. In the EIA mode the correct EIA color bar drive voltage is generated at the collector of Q199. Q148 is turned on by U126A when the EIA switch is engaged or the Remote line goes low, allowing the voltage at the function of R158 and R159 to appear at the input (pin 2) of U179. U179 and Q199 act as a voltage source which follows the input voltage of U179. In the non-EIA modes, the color bar amplitude and setup are controlled by the front-panel pushbuttons; their positions determining the reference voltage at pin 4 of U169.

DIAGRAM ②
COLOR BAR OUTPUT

Wide Band and Narrow Band Filters

The W_{IQ} signal current from Q274 is coupled by Q462 to the Narrow Band Filter, whose sin-squared response risetime is 260 ns. The color bar luminance levels, setup and composite sync signals are coupled by Q492 to the Wide Band Filter, whose sin-squared response 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 Gain controls. 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.

Q314 provides isolation from the subcarrier source. L317 and C318 provide adustment 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 T355's secondary is of constant amplitude and shape.

Quad Phase

The subcarrier signal is coupled from T355 through the Quad Phase network to the R-Y Modulator carrier input. In passing through the network, the subcarrier is shifted 90° in phase. Thus, the subcarrier drive for U382 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) rate, turning Q341 and Q342 on and off alternately; C351 balances out the subcarrier phase at 180°. The R-Y component of output chrominance thus is shifted by 180° on successive fields or lines.

R-Y and R-Y Filters

These identical filters are linear phase networks with approximately 1.5 MHz bandwidth. They are adjusted for identical bandwidths and delays.

B-Y and R-Y Modulators

Except for the phase shifting of the subcarrier input to the Modulator, the two Modulators are identical. The following describes the operation of the B-Y Modulator.

The Modulator stage utilizes a double-balanced modulator IC that produces at its output, pins 6 and 9, sidebands proportional to the product of the input signal voltages at pins 1 and 4, and the carrier signal at pins 7 and 8. The balanced output is coupled by T375 to the Bandpass Filter. R402, R403 and C373 are adjusted for residual subcarrier null.

Bandpass Filter

The Bandpass Filter, with a passband of approximately 1.5 MHz, is adjusted by L357 and L367 to center around 3.58 MHz. The chrominance signal then drives the Chrominance Output Amplifier.

Chrominance Output Amplifier

This circuit is similar to the Luminance Output Amplifier previously described. Amplifier gain is set by R379. The output is capable of driving two 75 Ω loads.

The luminance and chrominance signals are matrixed by R408, R429, R407, and R428 at the output pins to provide the composite signal.

MAINTENANCE

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

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

MAINTENANCE

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

Cleaning

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

CAUTION

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

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

Visual Inspection

Visually inspect the circuit board or boards during the preventive maintenance routine for such defects as broken connectors, loose or disconnected pin connectors, improperly seated transistors and integrated circuits, and damaged components. Make sure that the boards are properly seated on the 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.

Multi-Pin Connectors

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

Transistor and Integrated Circuit Checks

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

Recalibration

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

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

A Performance Check/Calibration Procedure is given in Section 4.

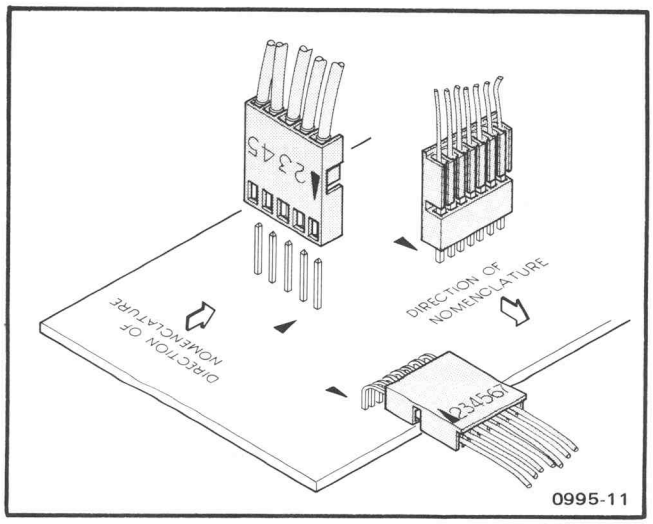


Fig. 6-1. Multiple pin connector holders.

TROUBLESHOOTING

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

Diagrams

Circuit diagrams are shown on the foldout pages in Section 9. The circuit number and electrical value of each component are shown on the diagrams. Important waveforms are also shown.

Circuit Boards

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

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

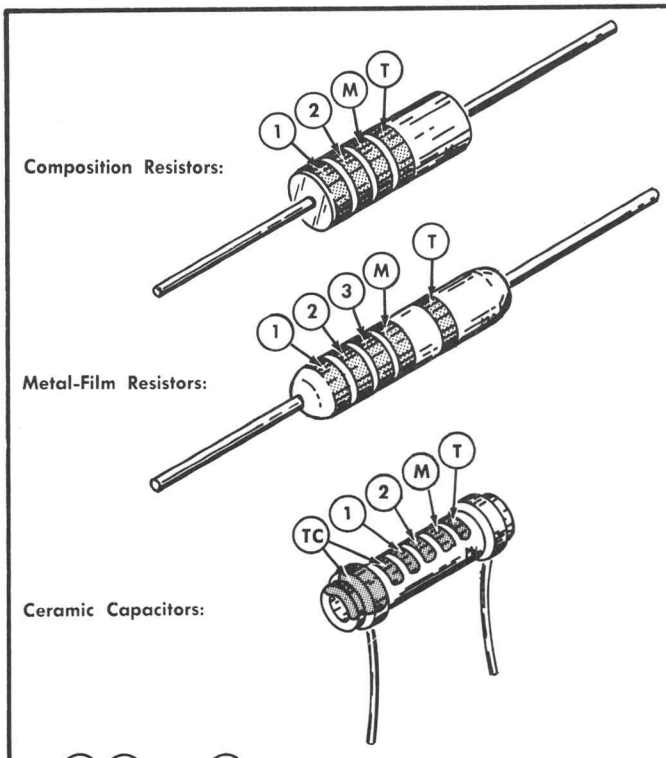
Circuit numbers are assigned on a grid system to facilitate component location. Low numbers start at the lower-front corner of the board increasing to the rear and top.

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 (see Fig. 6-2). Resistors not color-coded usually have the value imprinted on the body.



(1) (2) and (3) —1st, 2nd and 3rd significant figures;
(M) —multiplier; (T) —tolerance;
(TC) —temperature coefficient.

Resistor and Capacitor Color Code

Color	Significant Figures	Multiplier		Tolerance	
		Resistors	Capacitors	Resistors	Capacitors
Silver	---	10^{-2}	---	±10%	---
Gold	---	10^{-1}	---	±5%	---
Black	0	1	1	---	±20% or 2 pF*
Brown	1	10	10	±1%	±1% or 0.1 pF*
Red	2	10^{2}	10^{2}	±2%	±2%
Orange	3	10^{3}	10^{3}	±3%	±3%
Yellow	4	10^{4}	10^{4}	±4%	+100% −0%
Green	5	10^{5}	10^{5}	±0.5%	±5% or 0.5 pF*
Blue	6	10^{6}	10^{6}	---	---
Violet	7	---	---	---	---
Gray	8	---	10^{-2}	---	+80% −20% or 0.25 pF*
White	9	---	10^{-1}	---	±10% or 1 pF*
(none)	---	---	---	±20%	±10% or 1 pF*

*For capacitance of 10 pF or less.

NOTE: (T) and/or (TC) color code for capacitors depends upon manufacturer and capacitor type. May not be present in some cases.

Fig. 6-2. Standard EIA color coding for resistors and capacitors.

Rated Voltage VDC 25°C	Color	CODE FOR CAPACITANCE IN PICOFARADS		
		1st Figure	2nd Figure	Multiplier—pF
4	Black	0	0	None
6	Brown	1	1	X 10
10	Red	2	2	X 10^2
15	Orange	3	3	X 10^3
20	Yellow	4	4	X 10^4
25	Green	5	5	X 10^5
35	Blue	6	6	X 10^6
50	Violet	7	7	X 10^7
	Gray	8	8	
3	White	9	9	

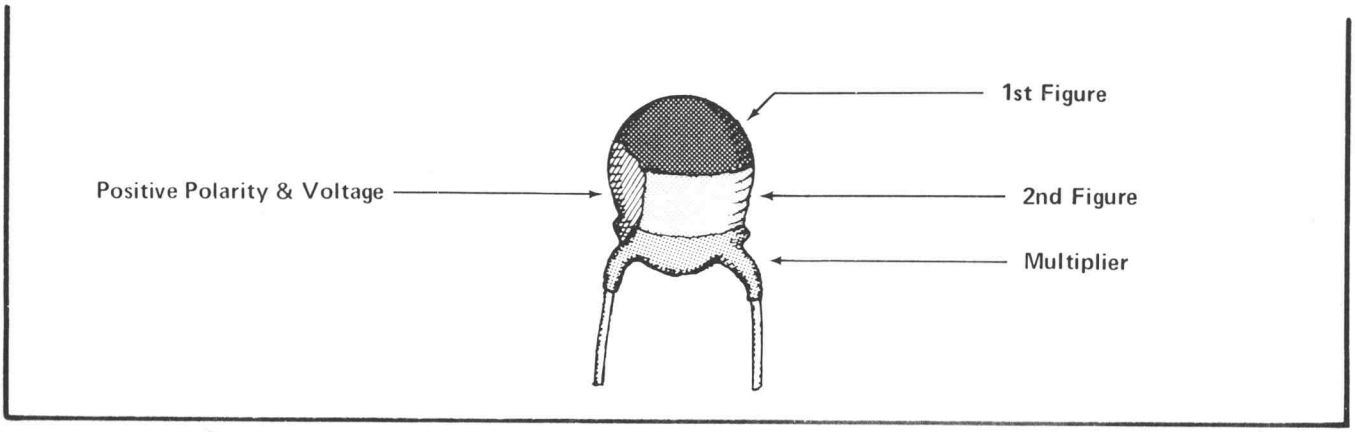


Fig. 6-3. Color coding for dipped tantalum capacitors.

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 (see Fig. 6-2). The "tear drop" capacitors are color-coded in microfarads using a modified EIA code, with the dot indicating both temperature and positive (+) side. See Fig. 6-3.

Transistor and Integrated Circuit Lead Configurations. Fig. 6-4 illustrates the lead configurations for the socket-mounted transistors and integrated circuits (IC) used on the circuit boards.

IC Diagrams

Positive logic functions of the IC's are shown in Section 9 of this manual.

Troubleshooting Equipment

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

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

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

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

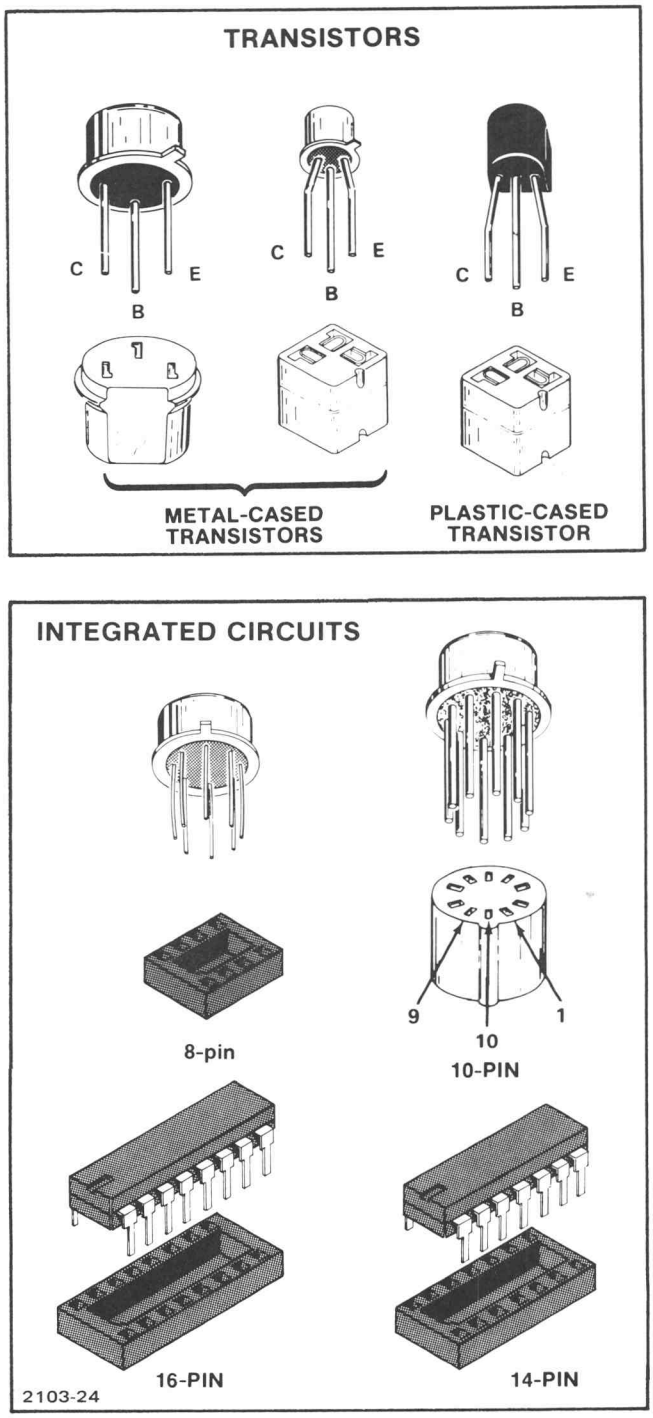


Fig. 6-4. Semiconductor Basing Illustration.

Troubleshooting Procedure

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

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

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

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

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

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

CAUTION

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

WARNING

"Ground lugs" are not always at ground potential. Check the diagrams before using such connections as ground for meter prods or oscilloscope probes. Some transistor cases may be elevated from ground potential.

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

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

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

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

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

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

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

REPAIR

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

Soldering Techniques

WARNING

Disconnect the instrument power cord before soldering.

Reliability and optimum performance of circuit boards can be maintained only if proper soldering techniques are used when repairing or replacing parts. Soldering techniques that apply to maintenance of precision electronic equipment should be used when working on the boards. Use only 60/40 rosin-core, electronic grade solder. The choice of soldering iron is determined by the repair to be made. When soldering on circuit boards, use a 15- to 25-watt pencil-type soldering iron with a 1/8-inch wide, wedge-shaped tip. Keep the tip properly tinned for best heat transfer to the solder joint. A higher wattage soldering iron may separate the etched wiring from the base material. Avoid excessive heat; apply only enough heat to remove the component or to make a good solder joint. Also, apply only enough solder to make a firm solder joint; do not apply too much solder. Use a desoldering tool or other device when it is necessary to remove excess solder.

The pencil-type soldering iron used on the circuit boards can be used for soldering to switch terminals, potentiometers, or metal terminals mounted in plastic holders. For ground lugs that are connected to the chassis, or other metal terminals that are connected to a large heat-radiating surface, use a higher wattage-rating soldering iron with a larger tip.

After soldering is completed, clean the area around the solder connection with a flux-remover solvent. Be careful not to remove any information printed in the area.

Location Guide for Replacing Parts

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

Pushbutton Switch Replacement

Before removing a pushbutton switch, disengage the pushbutton actuating arm so that it does not project beyond the rear of the switch. Next, carefully pry back the plastic retainer clip at the rear of the switch with the tip of a small screwdriver. See Fig. 6-5. Remove by lifting the switch body up and back from the front retainer clip.

Reverse the removal procedure to install the replacement switch.

Circuit Board Replacement

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

Circuit Board Removal.

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

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

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

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

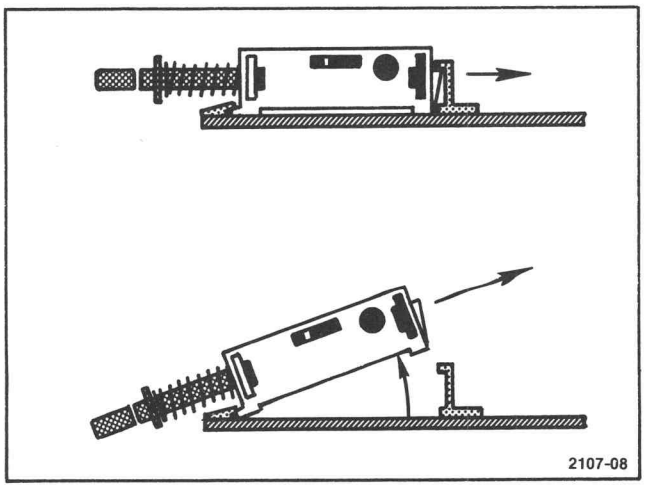


Fig. 6-5. Pushbutton switch replacement.

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

NOTE

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

Transistors and ICs

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

CAUTION

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

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

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

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.

SPECIAL NOTES AND SYMBOLS

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

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

CROSS INDEX—MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip
000AK	DAU CO., GES, M.B.H. & CO., KG.	A-8563	LIGIST, AUSTRIA
0000L	MATSUHITA ELECTRIC	200 PARK AVENUE, 54TH FLOOR	NEW YORK, NY 10017
00213	NYTRONICS, COMPONENTS GROUP, INC.	ORANGE STREET	DARLINGTON, SC 29532
00853	SANGAMO ELECTRIC CO., S. CAROLINA DIV.	P O BOX 128	PICKENS, SC 29671
01121	ALLEN-BRADLEY COMPANY	1201 2ND STREET SOUTH	MILWAUKEE, WI 53204
01295	TEXAS INSTRUMENTS, INC., SEMICONDUCTOR GROUP	P O BOX 5012, 13500 N CENTRAL EXPRESSWAY	DALLAS, TX 75222
02735	RCA Corp., Solid State Division	Route 202	Somerville, NY 08876
04222	AVX Ceramic Corporation	P.O. Box 867	Murtle Beach, SC 29577
04713	Motorola, Inc., Semiconductor Products Div.	5005 E. McDowell Rd.	Phoenix, AZ 85008
07263	Fairchild Semiconductor, A Div. of Fairchild Camera and Instrument Corp.	464 Ellis St.	Mountain View, CA 94040
07910	Teledyne Semiconductor	12515 Chadron Ave.	Hawthorne, CA 90250
27014	National Semi-Conductor Corp.	2900 San Ysidro Way	Santa Clara, CA 95051
56289	Sprague Electric Co.		North Adams, MA 01247
72982	Erie Technological Products, Inc.	644 W. 12th St.	Erie, PA 16512
73138	Beckman Instruments, Inc., Helipot Div.	2500 Harbor Blvd.	Fullerton, CA 92634
74970	Johnson, E. F., Co.	299 10th Ave. S. W.	Waseca, MN 56093
80009	Tektronix, Inc.	P. O. Box 500	Beaverton, OR 97005
90201	Mallory Capacitor Co., Div. of P. R. Mallory Co., Inc.	3029 E. Washington St.	Indianapolis, IN 46206
91637	Dale Electronics, Inc.	P. O. Box 609	Columbus, NB 68601

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A30	670-4455-00			CKT CARD ASSY:COLOR BAR LOGIC	80009	670-4455-00
A31	670-4456-00			CKT CARD ASSY:COLOR BAR OUTPUT	80009	670-4456-00
C104	290-0745-00			CAP.,FXD,ELCTLT:22UF,+50-10%,25V	0000L	ECE-A25V22L
C149	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	72982	831-516E102P
C153	281-0770-00			CAP.,FXD,CER DI:0.001UF,20%,100V	72982	314022X5P0102M
C156	283-0634-00			CAP.,FXD,MICA D:65PF,1%,100V	00853	D151E650F0
C166	283-0623-00			CAP.,FXD,MICA D:1200PF,1%,100V	00853	D191F122F0
C172	281-0770-00			CAP.,FXD,CER DI:0.001UF,20%,100V	72982	314022X5P0102M
C176	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C179	283-0597-00			CAP.,FXD,MICA D:470PF,10%,300V	00853	D153E471K0
C189	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	72982	831-516E102P
C212	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C232	283-0081-00			CAP.,FXD,CER DI:0.1UF,+80-20%,25V	56289	36C600
C261	290-0745-00			CAP.,FXD,ELCTLT:22UF,+50-10%,25V	0000L	ECE-A25V22L
C290	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C291	290-0534-00			CAP.,FXD,ELCTLT:1UF,20%,35V	56289	196D105X0035HA1
C313	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855558Z5U0103Z
C316	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	72982	831-516E102P
C318	281-0226-00			CAP.,VAR,PLSTC:5.5-65PF,100V	000AK	009-3801-065
C324	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	72982	831-516E102P
C325	283-0648-00			CAP.,FXD,MICA D:10PF,5%,100V	00853	D151C100DC
C329	283-0341-00			CAP.,FXD,CER DI:0.047UF,10%,100V	72982	8131N145W5R473K
C335	283-0084-00			CAP.,FXD,CER DI:270PF,5%,1000V	72982	838-533B271J
C336	283-0084-00			CAP.,FXD,CER DI:270PF,5%,1000V	72982	838-533B271J
C339	283-0084-00			CAP.,FXD,CER DI:270PF,5%,1000V	72982	838-533B271J
C340	283-0081-00			CAP.,FXD,CER DI:0.1UF,+80-20%,25V	56289	36C600
C341	283-0081-00			CAP.,FXD,CER DI:0.1UF,+80-20%,25V	56289	36C600
C342	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855558Z5U0103Z
C344	283-0081-00			CAP.,FXD,CER DI:0.1UF,+80-20%,25V	56289	36C600
C345	283-0084-00			CAP.,FXD,CER DI:270PF,5%,1000V	72982	838-533B271J
C346	283-0084-00			CAP.,FXD,CER DI:270PF,5%,1000V	72982	838-533B271J
C347	283-0081-00			CAP.,FXD,CER DI:0.1UF,+80-20%,25V	56289	36C600
C348	283-0084-00			CAP.,FXD,CER DI:270PF,5%,1000V	72982	838-533B271J
C349	283-0081-00			CAP.,FXD,CER DI:0.1UF,+80-20%,25V	56289	36C600
C351	281-0116-00			CAP.,VAR,AIR DI:1.6-9.1PF,425V	74970	189-0354-075
C352	283-0081-00			CAP.,FXD,CER DI:0.1UF,+80-20%,25V	56289	36C600
C353	283-0598-00			CAP.,FXD,MICA D:253PF,5%,300V	00853	D153E2530J0
C363	283-0598-00			CAP.,FXD,MICA D:253PF,5%,300V	00853	D153E2530J0
C367	283-0618-00			CAP.,FXD,MICA D:130PF,2%,300V	00853	D155E131G0
C373	281-0064-00			CAP.,VAR,PLSTC:0.25-1.5PF,600V	72982	530-002
C374	281-0661-00			CAP.,FXD,CER DI:0.8PF,+/-0.1PF,500V	72982	301-000C0K0808B
C377	283-0601-00			CAP.,FXD,MICA D:22PF,10%,300V	00853	D153C220K0
C378	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C385	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855558Z5U0103Z
C396	283-0081-00			CAP.,FXD,CER DI:0.1UF,+80-20%,25V	56289	36C600
C397	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C398	281-0529-00			CAP.,FXD,CER DI:1.5PF,+/-0.25PF,500V	72982	301-000C0K0159C
C405	281-0577-00			CAP.,FXD,CER DI:14PF,5%,500V	72982	301-050C0G0140J
C406	283-0177-00			CAP.,FXD,CER DI:1UF,+80-20%,25V	72982	8131N039 E 105Z
C407	281-0524-00			CAP.,FXD,CER DI:150PF,+/-30PF,500V	04222	7001-1381
C413	290-0536-00			CAP.,FXD,ELCTLT:10UF,20%,25V	90201	TDC106M025FL
C414	283-0177-00			CAP.,FXD,CER DI:1UF,+80-20%,25V	72982	8131N039 E 105Z

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
C415	281-0577-00			CAP.,FXD,CER DI:14PF,5%,500V	72982	301-050C0G0140J
C422	283-0639-00			CAP.,FXD,MICA D:56PF,1%,100V	00853	D151E560F0
C424	283-0639-00			CAP.,FXD,MICA D:56PF,1%,100V	00853	D151E560F0
C425	281-0524-00			CAP.,FXD,CER DI:150PF,+/-30PF,500V	04222	7001-1381
C427	283-0081-00			CAP.,FXD,CER DI:0.1UF,+80-20%,25V	56289	36C600
C432	283-0598-00			CAP.,FXD,MICA D:253PF,5%,300V	00853	D153E2530J0
C433	283-0598-00			CAP.,FXD,MICA D:253PF,5%,300V	00853	D153E2530J0
C434	283-0639-00			CAP.,FXD,MICA D:56PF,1%,100V	00853	D151E560F0
C442	283-0639-00			CAP.,FXD,MICA D:56PF,1%,100V	00853	D151E560F0
C444	283-0598-00			CAP.,FXD,MICA D:253PF,5%,300V	00853	D153E2530J0
C445	281-0529-00			CAP.,FXD,CER DI:1.5PF,+/-0.25PF,500V	72982	301-000C0K0159C
C451	290-0745-00			CAP.,FXD,ELCTLT:22UF,+50-10%,25V	0000L	ECE-A25V22L
C452	283-0598-00			CAP.,FXD,MICA D:253PF,5%,300V	00853	D153E2530J0
C453	290-0745-00			CAP.,FXD,ELCTLT:22UF,+50-10%,25V	0000L	ECE-A25V22L
C457	283-0081-00			CAP.,FXD,CER DI:0.1UF,+80-20%,25V	56289	36C600
C463	290-0745-00			CAP.,FXD,ELCTLT:22UF,+50-10%,25V	0000L	ECE-A25V22L
C464	283-0666-00			CAP.,FXD,MICA D:890PF,2%,100V	00853	D151F891G0
C465	283-0634-00			CAP.,FXD,MICA D:65PF,1%,100V	00853	D151E650F0
C466	283-0628-00			CAP.,FXD,MICA D:410PF,1%,500V	00853	D155F411F0
C468	283-0644-00			CAP.,FXD,MICA D:150PF,1%,500V	00853	D151E151F0
C483	283-0660-00			CAP.,FXD,MICA D:510PF,2%,500V	00853	D155F511G0
C485	283-0636-00			CAP.,FXD,MICA D:36PF,1.4%,100V	00853	D155E360G0
C486	283-0672-00			CAP.,FXD,MICA D:200PF,1%,500V	00853	D155F201F0
C488	283-0633-00			CAP.,FXD,MICA D:77PF,1%,100V	00853	D151E770F0
CR172	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR210	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR211	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR212	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR213	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR214	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR215	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR216	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR220	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR222	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR225	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR226	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR235	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR236	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR241	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR242	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR245	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR246	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR252	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR255	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR256	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR261	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR262	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR263	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR264	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR265	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR266	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR267	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR270	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
CR271	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR272	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR273	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR274	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR275	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR276	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR277	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR284	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR285	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR286	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR287	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR288	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR294	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR295	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR296	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR297	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR327	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
L317	114-0280-00			COIL,RF:12-43UH,CORE 276-0568-00	80009	114-0280-00
L357	114-0281-00			COIL,RF:35-70UH,CORE 276-0540-00	80009	114-0281-00
L365	114-0257-00			COIL,RF:6-11UF	80009	114-0257-00
L367	114-0281-00			COIL,RF:35-70UH,CORE 276-0540-00	80009	114-0281-00
L424	114-0254-00			COIL,RF:30-60UH,CORE NOT REPLACEABLE	80009	114-0254-00
L432	114-0254-00			COIL,RF:30-60UH,CORE NOT REPLACEABLE	80009	114-0254-00
L442	114-0254-00			COIL,RF:30-60UH,CORE NOT REPLACEABLE	80009	114-0254-00
L444	114-0254-00			COIL,RF:30-60UH,CORE NOT REPLACEABLE	80009	114-0254-00
L464	114-0278-00			COIL,RF:4.6-16.7UH,CORE 276-0568-00	80009	114-0278-00
L467	114-0278-00			COIL,RF:4.6-16.7UH,CORE 276-0568-00	80009	114-0278-00
L484	114-0257-00			COIL,RF:6-11UF	80009	114-0257-00
L487	114-0308-00			COIL,RF:2.9-6.5UH	80009	114-0308-00
Q148	151-0220-00			TRANSISTOR:SILICON,PNP	80009	151-0220-00
Q199	151-0302-00			TRANSISTOR:SILICON,NPN	04713	2N2222A
Q224	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS6521	80009	151-0192-00
Q232	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS6521	80009	151-0192-00
Q233	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS6521	80009	151-0192-00
Q234	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS6521	80009	151-0192-00
Q244	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS6521	80009	151-0192-00
Q245	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS6521	80009	151-0192-00
Q254	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS6521	80009	151-0192-00
Q255	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS6521	80009	151-0192-00
Q263	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS6521	80009	151-0192-00
Q264	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS6521	80009	151-0192-00
Q265	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS6521	80009	151-0192-00
Q274	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS6521	80009	151-0192-00
Q280	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS6521	80009	151-0192-00
Q281	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS6521	80009	151-0192-00
Q282	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS6521	80009	151-0192-00
Q283	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS6521	80009	151-0192-00
Q291	151-0220-00			TRANSISTOR:SILICON,PNP	80009	151-0220-00
Q292	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS6521	80009	151-0192-00
Q293	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS6521	80009	151-0192-00
Q314	151-0456-00			TRANSISTOR:SILICON,NPN	80009	151-0456-00
Q322	151-0302-00			TRANSISTOR:SILICON,NPN	04713	2N2222A

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
Q331	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q333	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q337	151-0456-00			TRANSISTOR:SILICON,NPN	80009	151-0456-00
Q338	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q341	151-0225-00			TRANSISTOR:SILICON,NPN	07910	CS23365
Q342	151-0225-00			TRANSISTOR:SILICON,NPN	07910	CS23365
Q344	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q345	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q348	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q377	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q386	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q387	151-0220-00			TRANSISTOR:SILICON,PNP	80009	151-0220-00
Q397	151-0220-00			TRANSISTOR:SILICON,PNP	80009	151-0220-00
Q398	151-0103-00			TRANSISTOR:SILICON,NPN	04713	2N2219A
Q426	151-0103-00			TRANSISTOR:SILICON,NPN	04713	2N2219A
Q427	151-0220-00			TRANSISTOR:SILICON,PNP	80009	151-0220-00
Q436	151-0220-00			TRANSISTOR:SILICON,PNP	80009	151-0220-00
Q446	151-0460-00			TRANSISTOR:SILICON,NPN	07263	2N3947
Q447	151-0459-00			TRANSISTOR:SILICON,PNP	04713	2N3251
Q462	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS6521	80009	151-0192-00
Q482	151-0220-00			TRANSISTOR:SILICON,PNP	80009	151-0220-00
Q492	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS6521	80009	151-0192-00
R101	321-0259-03			RES.,FXD,FILM:4.87K OHM,0.25%,0.125W	91637	MFF1816D48700C
R102	321-0130-00			RES.,FXD,FILM:221 OHM,1%,0.125W	91637	MFF1816G221R0F
R103	321-0168-02			RES.,FXD,FILM:549 OHM,0.5%,0.125W	91637	MFF1816D549R0D
R104	321-0213-03			RES.,FXD,FILM:.162K OHM,0.25%,0.125W	91637	MFF1816D16201C
R114	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R116	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R117	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R118	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R119	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R127	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R128	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R129	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R132	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R133	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R135	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R136	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R137	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R138	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R139	315-0752-00			RES.,FXD,CMPSN:7.5K OHM,5%,0.25W	01121	CB7525
R145	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R146	321-0222-00			RES.,FXD,FILM:2K OHM,1%,0.125W	91637	MFF1816G20000F
R149	311-1917-00			RES.,VAR,NONWIR:TRMR,5K OHM,10%,0.5W	73138	72-198-0
R151	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R154	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R157	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R158	321-1704-03			RES.,FXD,FILM:2.386K OHM,0.25%,0.125W	91637	MFF1816D23860C
R159	321-0259-03			RES.,FXD,FILM:4.87K OHM,0.25%,0.125W	91637	MFF1816D48700C
R172	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R176	321-0362-00			RES.,FXD,FILM:57.6K OHM,1%,0.125W	91637	MFF1816G57601F
R179	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R182	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R187	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R188	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R189	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R190	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R194	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R196	315-0681-00			RES.,FXD,CMPSN:680 OHM,5%,0.25W	01121	CB6815
R200	315-0681-00			RES.,FXD,CMPSN:680 OHM,5%,0.25W	01121	CB6815
R201	315-0331-00			RES.,FXD,CMPSN:330 OHM,5%,0.25W	01121	CB3315
R202	315-0681-00			RES.,FXD,CMPSN:680 OHM,5%,0.25W	01121	CB6815
R203	315-0331-00			RES.,FXD,CMPSN:330 OHM,5%,0.25W	01121	CB3315
R204	315-0331-00			RES.,FXD,CMPSN:330 OHM,5%,0.25W	01121	CB3315
R205	315-0331-00			RES.,FXD,CMPSN:330 OHM,5%,0.25W	01121	CB3315
R206	315-0751-00			RES.,FXD,CMPSN:750 OHM,5%,0.25W	01121	CB7515
R207	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R208	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R221	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R222	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R223	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R224	321-0263-00			RES.,FXD,FILM:5.36K OHM,1%,0.125W	91637	MFF1816G53600F
R225	321-0322-00			RES.,FXD,FILM:22.1K OHM,1%,0.125W	91637	MFF1816G22101F
R228	311-1919-00			RES.,VAR,NONWIR:TRMR,1K OHM,10%,0.5W	73138	72-200-0
R229	311-1917-00			RES.,VAR,NONWIR:TRMR,5K OHM,10%,0.5W	73138	72-198-0
R234	321-0281-00			RES.,FXD,FILM:8.25K OHM,1%,0.125W	91637	MFF1816G82500F
R235	321-0305-00			RES.,FXD,FILM:14.7K OHM,1%,0.125W	91637	MFF1816G14701F
R238	311-1919-00			RES.,VAR,NONWIR:TRMR,1K OHM,10%,0.5W	73138	72-200-0
R239	311-1918-00			RES.,VAR,NONWIR:TRMR,2K OHM,10%,0.5W	73138	72-199-0
R241	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R242	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R245	321-0309-00			RES.,FXD,FILM:16.2K OHM,1%,0.125W	91637	MFF1816G16201F
R248	311-1918-00			RES.,VAR,NONWIR:TRMR,2K OHM,10%,0.5W	73138	72-199-0
R249	311-1918-00			RES.,VAR,NONWIR:TRMR,2K OHM,10%,0.5W	73138	72-199-0
R251	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R252	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R254	321-0297-00			RES.,FXD,FILM:12.1K OHM,1%,0.125W	91637	MFF1816G12101F
R255	321-0250-00			RES.,FXD,FILM:3.92K OHM,1%,0.125W	91637	MFF1816G39200F
R256	321-0322-00			RES.,FXD,FILM:22.1K OHM,1%,0.125W	91637	MFF1816G22101F
R258	311-1920-00			RES.,VAR,NONWIR:TRMR,500 OHM,10%,0.5W	73138	72-190-0
R259	311-1917-00			RES.,VAR,NONWIR:TRMR,5K OHM,10%,0.5W	73138	72-198-0
R262	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R263	321-0257-00			RES.,FXD,FILM:4.64K OHM,1%,0.125W	91637	MFF1816G46400F
R264	321-0305-00			RES.,FXD,FILM:14.7K OHM,1%,0.125W	91637	MFF1816G14701F
R265	321-0327-00			RES.,FXD,FILM:24.9K OHM,1%,0.125W	91637	MFF1816G24901F
R268	311-1920-00			RES.,VAR,NONWIR:TRMR,500 OHM,10%,0.5W	73138	72-190-0
R269	311-1918-00			RES.,VAR,NONWIR:TRMR,2K OHM,10%,0.5W	73138	72-199-0
R271	321-0370-00			RES.,FXD,FILM:69.8K OHM,1%,0.125W	91637	MFF1816G69801F
R274	311-1918-00			RES.,VAR,NONWIR:TRMR,2K OHM,10%,0.5W	73138	72-199-0
R275	321-0263-00			RES.,FXD,FILM:5.36K OHM,1%,0.125W	91637	MFF1816G53600F
R276	315-0681-00			RES.,FXD,CMPSN:680 OHM,5%,0.25W	01121	CB6815
R277	315-0681-00			RES.,FXD,CMPSN:680 OHM,5%,0.25W	01121	CB6815
R278	315-0681-00			RES.,FXD,CMPSN:680 OHM,5%,0.25W	01121	CB6815
R279	311-1920-00			RES.,VAR,NONWIR:TRMR,500 OHM,10%,0.5W	73138	72-190-0
R280	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R281	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R282	321-1702-03			RES.,FXD,FILM:13.05K OHM,0.25%,0.125W	91637	MFF1816D13051C
R283	321-0304-00			RES.,FXD,FILM:14.3K OHM,1%,0.125W	91637	MFF1816G14301F
R284	321-0308-00			RES.,FXD,FILM:15.8K OHM,1%,0.125W	91637	MFF1816G15801F
R285	311-1918-00			RES.,VAR,NONWIR:TRMR,2K OHM,10%,0.5W	73138	72-199-0
R286	311-1918-00			RES.,VAR,NONWIR:TRMR,2K OHM,10%,0.5W	73138	72-199-0
R287	315-0681-00			RES.,FXD,CMPSN:680 OHM,5%,0.25W	01121	CB6815
R288	315-0681-00			RES.,FXD,CMPSN:680 OHM,5%,0.25W	01121	CB6815
R291	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R294	321-0280-00			RES.,FXD,FILM:8.06K OHM,1%,0.125W	91637	MFF1816G80600F
R295	321-0349-00			RES.,FXD,FILM:42.2K OHM,1%,0.125W	91637	MFF1816G42201F
R296	311-1916-00			RES.,VAR,NONWIR:TRMR,10K OHM,10%,0.5W	73138	72-197-0
R298	311-1919-00			RES.,VAR,NONWIR:TRMR,1K OHM,10%,0.5W	73138	72-200-0
R311	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R312	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R313	315-0154-00			RES.,FXD,CMPSN:150K OHM,5%,0.25W	01121	CB1545
R314	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R315	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R316	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R317	321-0222-00			RES.,FXD,FILM:2K OHM,1%,0.125W	91637	MFF1816G20000F
R320	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R322	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R323	315-0512-00			RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
R324	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R325	321-0193-00			RES.,FXD,FILM:1K OHM,1%,0.125W	91637	MFF1816G10000F
R326	321-0222-00			RES.,FXD,FILM:2K OHM,1%,0.125W	91637	MFF1816G20000F
R327	321-0260-00			RES.,FXD,FILM:4.99K OHM,1%,0.125W	91637	MFF1816G49900F
R328	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R329	315-0512-00			RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
R331	315-0392-00			RES.,FXD,CMPSN:3.9K OHM,5%,0.25W	01121	CB3925
R332	315-0392-00			RES.,FXD,CMPSN:3.9K OHM,5%,0.25W	01121	CB3925
R333	315-0752-00			RES.,FXD,CMPSN:7.5K OHM,5%,0.25W	01121	CB7525
R334	315-0392-00			RES.,FXD,CMPSN:3.9K OHM,5%,0.25W	01121	CB3925
R335	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R336	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R337	315-0512-00			RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
R338	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R339	315-0302-00			RES.,FXD,CMPSN:3K OHM,5%,0.25W	01121	CB3025
R342	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R343	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R344	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R345	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R346	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R347	315-0512-00			RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
R348	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R349	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R354	321-0154-00			RES.,FXD,FILM:392 OHM,1%,0.125W	91637	MFF1816G392R0F
R357	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R358	321-0193-00			RES.,FXD,FILM:1K OHM,1%,0.125W	91637	MFF1816G10000F
R359	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R362	321-0126-00			RES.,FXD,FILM:200 OHM,1%,0.125W	91637	MFF1816G200R0F
R363	321-0126-00			RES.,FXD,FILM:200 OHM,1%,0.125W	91637	MFF1816G200R0F
R368	321-0193-00			RES.,FXD,FILM:1K OHM,1%,0.125W	91637	MFF1816G10000F

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R369	321-0271-00			RES.,FXD,FILM:6.49K OHM,1%,0.125W	91637	MFF1816G64900F
R371	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R372	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R373	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R374	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R378	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R379	311-1920-00			RES.,VAR,NONWIR:TRMR,500 OHM,10%,0.5W	73138	72-190-0
R382	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R383	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R385	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R387	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R388	321-0256-00			RES.,FXD,FILM:4.53K OHM,1%,0.125W	91637	MFF1816G45300F
R389	321-0213-00			RES.,FXD,FILM:1.62K OHM,1%,0.125W	91637	MFF1816G16200F
R390	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R391	321-0812-07			RES.,FXD,FILM:455 OHM,0.1%,0.125W	91637	MFF1816C455R0B
R392	321-0812-07			RES.,FXD,FILM:455 OHM,0.1%,0.125W	91637	MFF1816C455R0B
R393	321-0812-07			RES.,FXD,FILM:455 OHM,0.1%,0.125W	91637	MFF1816C455R0B
R394	321-0812-07			RES.,FXD,FILM:455 OHM,0.1%,0.125W	91637	MFF1816C455R0B
R395	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R396	315-0154-00			RES.,FXD,CMPSN:150K OHM,5%,0.25W	01121	CB1545
R397	315-0911-00			RES.,FXD,CMPSN:910 OHM,5%,0.25W	01121	CB9115
R398	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R400	315-0302-00			RES.,FXD,CMPSN:3K OHM,5%,0.25W	01121	CB3025
R401	315-0154-00			RES.,FXD,CMPSN:150K OHM,5%,0.25W	01121	CB1545
R402	311-1915-00			RES.,VAR,NONWIR:TRMR,20K OHM,10%,0.5W	73138	72-196-0
R403	311-1915-00			RES.,VAR,NONWIR:TRMR,20K OHM,10%,0.5W	73138	72-196-0
R404	315-0302-00			RES.,FXD,CMPSN:3K OHM,5%,0.25W	01121	CB3025
R405	315-0221-00			RES.,FXD,CMPSN:220 OHM,5%,0.25W	01121	CB2215
R406	315-0302-00			RES.,FXD,CMPSN:3K OHM,5%,0.25W	01121	CB3025
R407	321-0114-00			RES.,FXD,FILM:150 OHM,1%,0.125W	91637	MFF1816G150R0F
R408	321-0114-00			RES.,FXD,FILM:150 OHM,1%,0.125W	91637	MFF1816G150R0F
R409	308-0252-00			RES.,FXD,WW:390 OHM,5%,3W	91637	CW2B-B390R0J
R410	321-0961-07			RES.,FXD,FILM:500.5 OHM,0.1%,0.125W	91637	MFF1816C500R5B
R411	321-0961-07			RES.,FXD,FILM:500.5 OHM,0.1%,0.125W	91637	MFF1816C500R5B
R412	321-0961-07			RES.,FXD,FILM:500.5 OHM,0.1%,0.125W	91637	MFF1816C500R5B
R413	321-0961-07			RES.,FXD,FILM:500.5 OHM,0.1%,0.125W	91637	MFF1816C500R5B
R414	131-0566-00			LINK,TERM.CONNE:0.086 DIA X 2.375 INCH L	0000L	ERD-18TO
R425	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R427	315-0302-00			RES.,FXD,CMPSN:3K OHM,5%,0.25W	01121	CB3025
R428	321-0114-00			RES.,FXD,FILM:150 OHM,1%,0.125W	91637	MFF1816G150R0F
R429	321-0114-00			RES.,FXD,FILM:150 OHM,1%,0.125W	91637	MFF1816G150R0F
R435	315-0221-00			RES.,FXD,CMPSN:220 OHM,5%,0.25W	01121	CB2215
R438	321-0188-00			RES.,FXD,FILM:887 OHM,1%,0.125W	91637	MFF1816G887R0F
R439	308-0426-00			RES.,FXD,WW:470 OHM,5%,3W	00213	12405-470R0J
R446	315-0681-00			RES.,FXD,CMPSN:680 OHM,5%,0.25W	01121	CB6815
R447	321-0277-00			RES.,FXD,FILM:7.5K OHM,1%,0.125W	91637	MFF1816G75000F
R448	321-0277-00			RES.,FXD,FILM:7.5K OHM,1%,0.125W	91637	MFF1816G75000F
R449	311-1921-00			RES.,VAR,NONWIR:TRMR,250 OHM,10%,0.5W	73138	72-191-0
R454	321-0256-00			RES.,FXD,FILM:4.53K OHM,1%,0.125W	91637	MFF1816G45300F
R455	321-0251-00			RES.,FXD,FILM:4.02K OHM,1%,0.125W	91637	MFF1816G40200F
R456	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R457	315-0622-00			RES.,FXD,CMPSN:6.2K OHM,5%,0.25W	01121	CB6225
R458	321-0218-00			RES.,FXD,FILM:1.82K OHM,1%,0.125W	91637	MFF1816G18200F

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R459	311-1920-00			RES.,VAR,NONWIR:TRMR,500 OHM,10%,0.5W	73138	72-190-0
R460	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R461	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R469	321-0117-00			RES.,FXD,FILM:162 OHM,1%,0.125W	91637	MFF1816G162R0F
R470	321-0322-00			RES.,FXD,FILM:22.1K OHM,1%,0.125W	91637	MFF1816G22101F
R471	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R472	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R473	321-0193-00			RES.,FXD,FILM:1K OHM,1%,0.125W	91637	MFF1816G10000F
R481	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R489	321-0117-00			RES.,FXD,FILM:162 OHM,1%,0.125W	91637	MFF1816G162R0F
R490	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R491	321-0322-00			RES.,FXD,FILM:22.1K OHM,1%,0.125W	91637	MFF1816G22101F
S101	263-0010-00			ACTR ASSY,PB:	80009	263-0010-00
S102	263-0010-00			ACTR ASSY,PB:	80009	263-0010-00
S103 S104 S105 S106	263-0023-01			ACTR ASSY,PB:5 LATCH,7.5MM,8 CONTACTS	80009	263-0023-01
S107						
S301	263-0010-00			ACTR ASSY,PB:	80009	263-0010-00
S302	263-0010-00			ACTR ASSY,PB:	80009	263-0010-00
S303	263-0010-00			ACTR ASSY,PB:	80009	263-0010-00
S304	263-0010-00			ACTR ASSY,PB:	80009	263-0010-00
S305	263-0010-00			ACTR ASSY,PB:	80009	263-0010-00
S306	263-0010-00			ACTR ASSY,PB:	80009	263-0010-00
S307	263-0010-00			ACTR ASSY,PB:	80009	263-0010-00
T355	120-1071-00			TRANSFORMER,RF:TOROID,10 TURNS TRIFILAR	80009	120-1071-00
T375	120-1070-00			TRANSFORMER,RF:TOROID,12 TURNS QUADFILAR	80009	120-1070-00
TP185	214-0579-00			TERM.,TEST PT:0.40 INCH LONG	80009	214-0579-00
TP190	214-0579-00			TERM.,TEST PT:0.40 INCH LONG	80009	214-0579-00
TP191	214-0579-00			TERM.,TEST PT:0.40 INCH LONG	80009	214-0579-00
TP192	214-0579-00			TERM.,TEST PT:0.40 INCH LONG	80009	214-0579-00
TP195	214-0579-00			TERM.,TEST PT:0.40 INCH LONG	80009	214-0579-00
TP196	214-0579-00			TERM.,TEST PT:0.40 INCH LONG	80009	214-0579-00
TP197	214-0579-00			TERM.,TEST PT:0.40 INCH LONG	80009	214-0579-00
TP198	214-0579-00			TERM.,TEST PT:0.40 INCH LONG	80009	214-0579-00
TP208	214-0579-00			TERM.,TEST PT:0.40 INCH LONG	80009	214-0579-00
TP218	214-0579-00			TERM.,TEST PT:0.40 INCH LONG	80009	214-0579-00
TP279	214-0579-00			TERM.,TEST PT:0.40 INCH LONG	80009	214-0579-00
TP289	214-0579-00			TERM.,TEST PT:0.40 INCH LONG	80009	214-0579-00
TP369	214-0579-00			TERM.,TEST PT:0.40 INCH LONG	80009	214-0579-00
TP399	214-0579-00			TERM.,TEST PT:0.40 INCH LONG	80009	214-0579-00
TP414	214-0579-00			TERM.,TEST PT:0.40 INCH LONG	80009	214-0579-00
TP422	214-0579-00			TERM.,TEST PT:0.40 INCH LONG	80009	214-0579-00
TP423	214-0579-00			TERM.,TEST PT:0.40 INCH LONG	80009	214-0579-00
TP429	214-0579-00			TERM.,TEST PT:0.40 INCH LONG	80009	214-0579-00
TP442	214-0579-00			TERM.,TEST PT:0.40 INCH LONG	80009	214-0579-00
TP469	214-0579-00			TERM.,TEST PT:0.40 INCH LONG	80009	214-0579-00
TP479	214-0579-00			TERM.,TEST PT:0.40 INCH LONG	80009	214-0579-00
TP489	214-0579-00			TERM.,TEST PT:0.40 INCH LONG	80009	214-0579-00
U109	156-0383-00			MICROCIRCUIT,DI:QUAD 2-INPUT NOR GATE	01295	SN74LS02N

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
U122	156-0479-00			MICROCIRCUIT,DI:QUAD 2-INPUT OR GATE	01295	SN74LS32N
U124	156-0383-00			MICROCIRCUIT,DI:QUAD 2-INPUT NOR GATE	01295	SN74LS02N
U126	156-0030-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND GATE	01295	SN7400N
U142	156-0383-00			MICROCIRCUIT,DI:QUAD 2-INPUT NOR GATE	01295	SN74LS02N
U144	156-0381-00			MICROCIRCUIT,DI:QUAD 2-INPUT EXCL OR GATES	01295	SN74LS86N
U156	156-0733-00			MICROCIRCUIT,DI:DUAL MONOSTABLE MV W/ST INP	27014	DM74LS221N
U162	156-0479-00			MICROCIRCUIT,DI:QUAD 2-INPUT OR GATE	01295	SN74LS32N
U164	156-0383-00			MICROCIRCUIT,DI:QUAD 2-INPUT NOR GATE	01295	SN74LS02N
U169	156-0644-00			MICROCIRCUIT,DI:QUAD BILATERAL SWITCH	02735	CD4066AE
U179	156-0686-00			MICROCIRCUIT,LI:OPNL AMPL,HIGH IMPEDANCE	02735	CA3135
U182	156-0479-00			MICROCIRCUIT,DI:QUAD 2-INPUT OR GATE	01295	SN74LS32N
U184	156-0383-00			MICROCIRCUIT,DI:QUAD 2-INPUT NOR GATE	01295	SN74LS02N
U186	156-0412-00			MICROCIRCUIT,DI:4-BIT BIN UP/DOWN COUNTER	01295	SN74LS193N
U192	156-0386-00			MICROCIRCUIT,DI:TRIPLE 3-INPUT NAND GATE	01295	SN74LS10N
U194	156-0718-00			MICROCIRCUIT,DI:TRIPLE 3-INPUT POS-NOR GATES	07263	9LS27PC
U196	156-0422-00			MICROCIRCUIT,DI:UP/DOWN SYNC BINARY COUNTER	01295	SN74LS191N
U199	156-0422-00			MICROCIRCUIT,DI:UP/DOWN SYNC BINARY COUNTER	01295	SN74LS191N
U216	156-0535-00			MICROCIRCUIT,DI:TRI-STATE HEXBUFF	27014	DM8097M
U222	156-0479-00			MICROCIRCUIT,DI:QUAD 2-INPUT OR GATE	01295	SN74LS32N
U382	156-0130-00			MICROCIRCUIT,LI:BALANCED MODEM	04713	MC1496G
U384	156-0130-00			MICROCIRCUIT,LI:BALANCED MODEM	04713	MC1496G
VR343	152-0279-00			SEMICOND DEVICE:ZENER,0.4W,5.1V,5%	07910	CD332305

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.

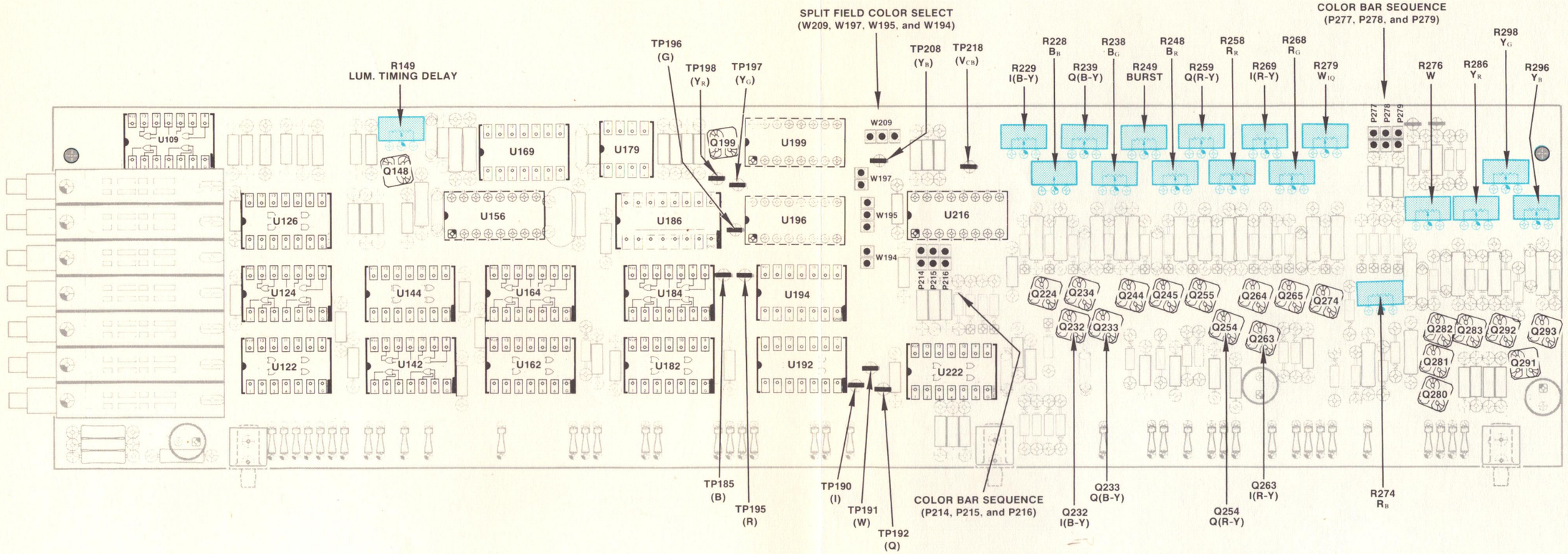


FIG. 8-1 A30 COLOR BAR LOGIC BOARD ADJUSTMENT AND JUMPERS LOCATIONS

2103-26

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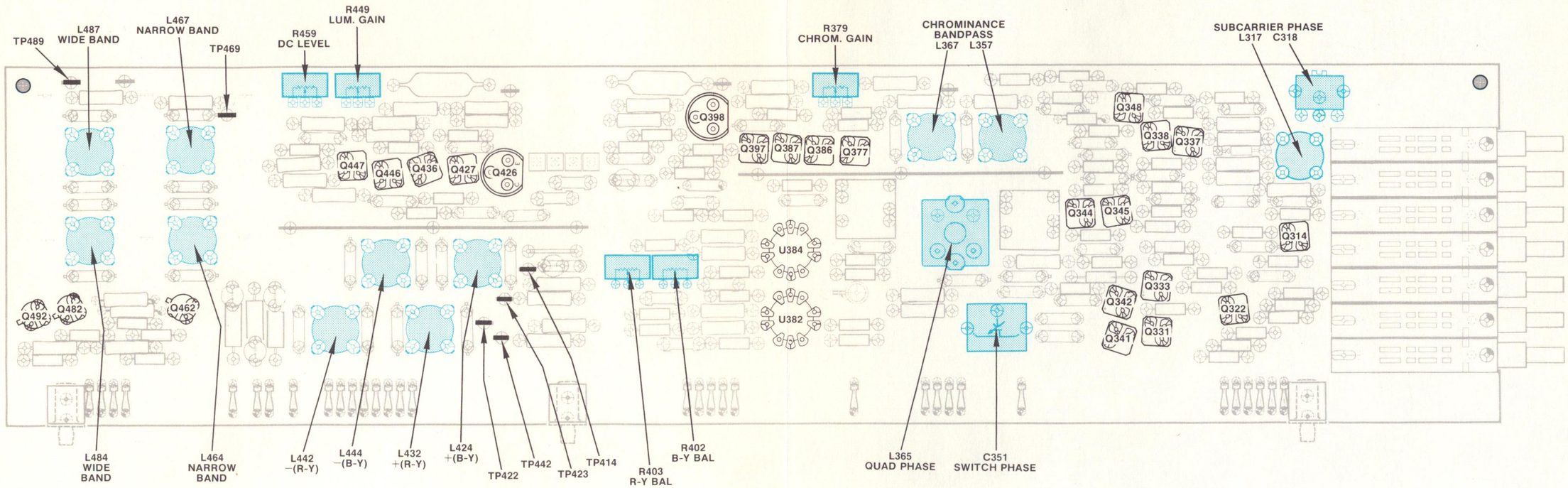

FIG. 8-2 A31 COLOR BAR OUTPUT BOARD ADJUSTMENT LOCATIONS

2103-27

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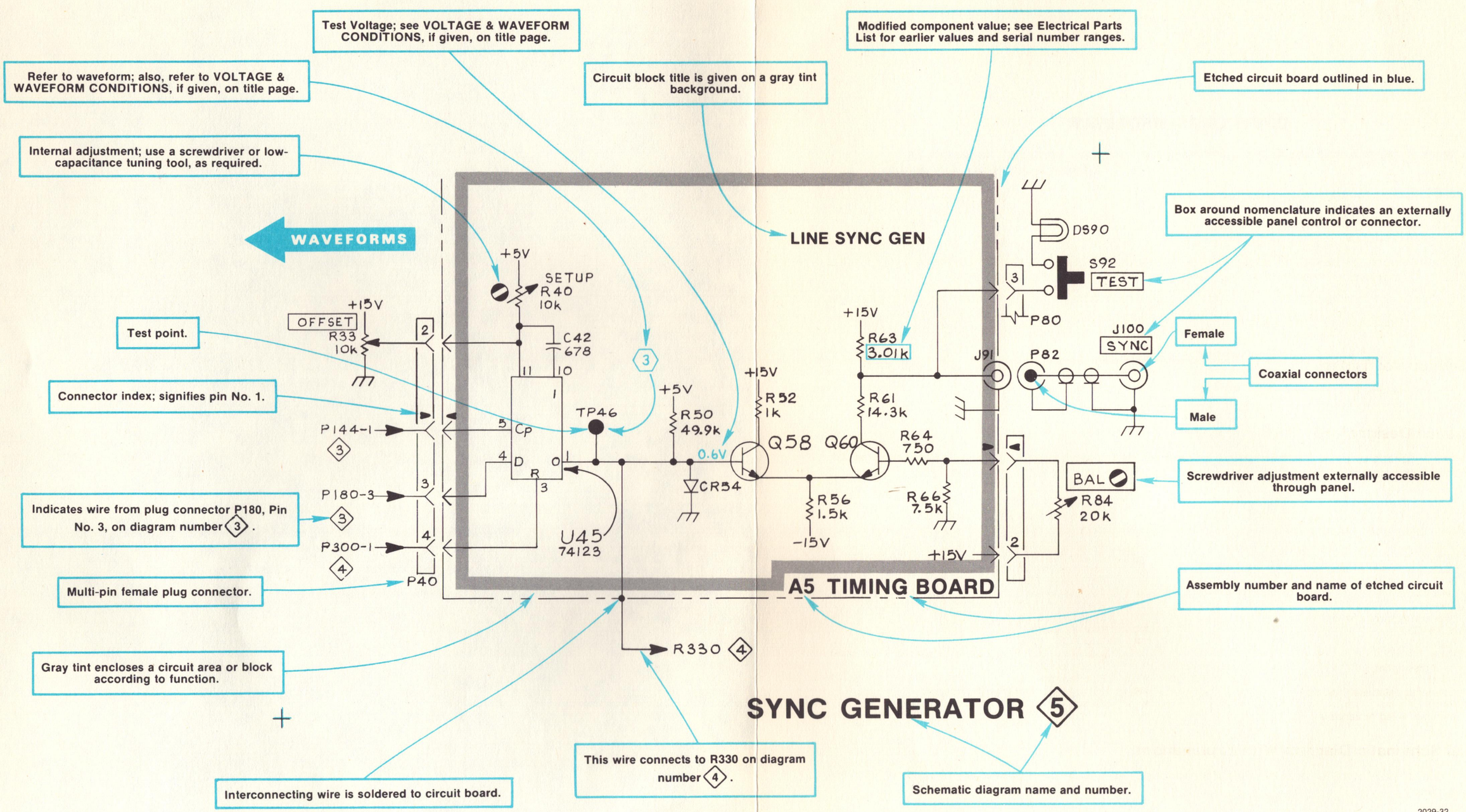

SCHEMATIC EXAMPLE

DIAGRAMS AND CIRCUIT BOARD ILLUSTRATIONS

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

Symbols

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

Component Values

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

Capacitors = Values one or greater are in picofarads (pF).
Values less than one are in micofarads (μF).

Resistors = Ohms (Ω).

Semiconductor Types

Refer to the Electrical Parts List.

Reference Designators

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

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

Partial Schematic Diagram With Explanations

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

Transformer Wiring

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

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

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WAVEFORM CONDITIONS

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

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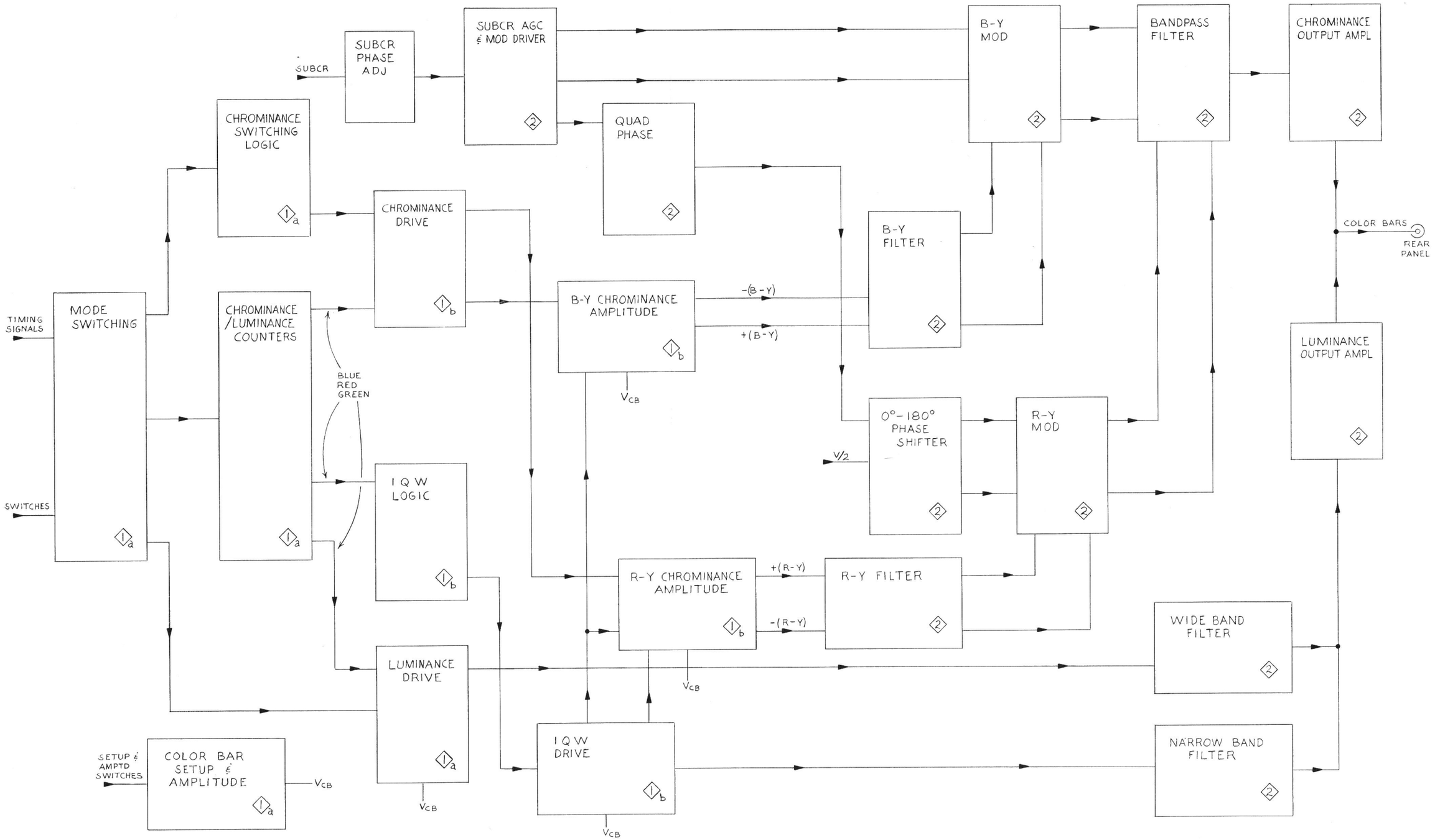
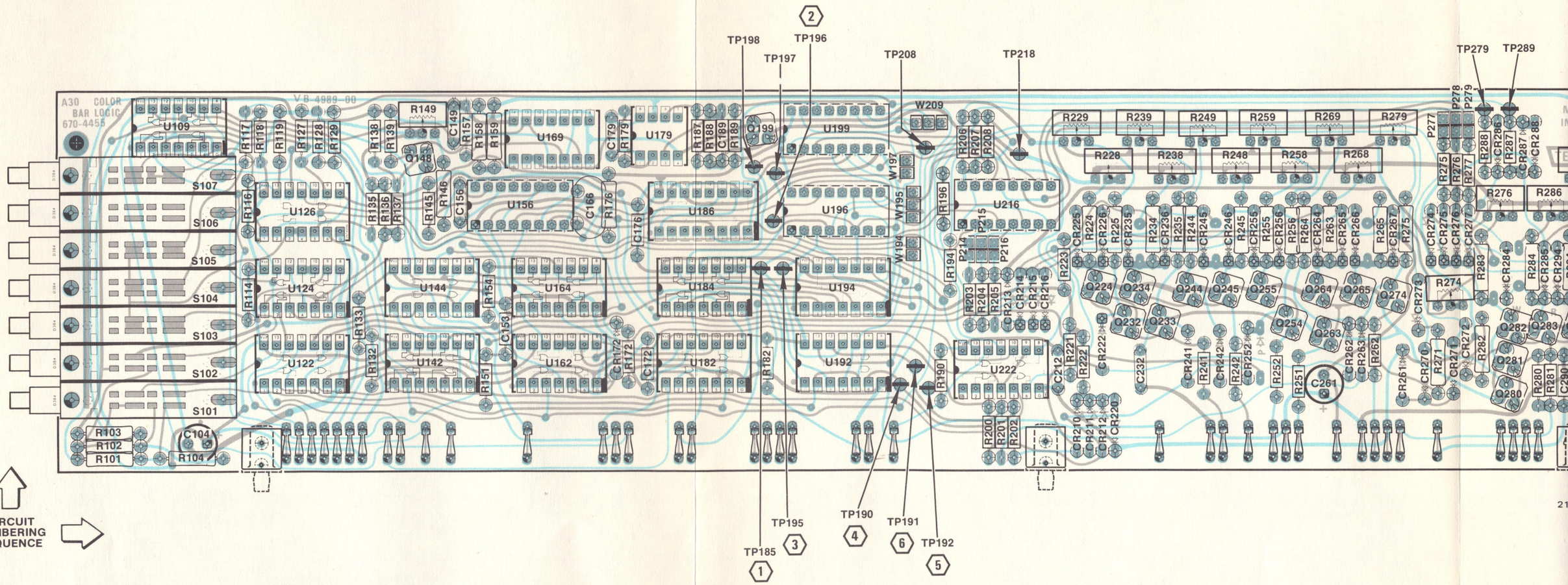
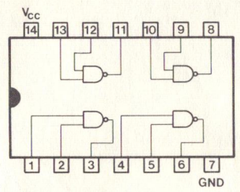

SUBCR
SUBCR PHASE ADJ
SUBCR AGC & MOD DRIVER
B-Y MOD
BANDPASS FILTER
CHROMINANCE OUTPUT AMPL
CHROMINANCE SWITCHING LOGIC
QUAD PHASE
CHROMINANCE DRIVE
B-Y FILTER
COLOR BARS
REAR PANEL
TIMING SIGNALS
MODE SWITCHING
CHROMINANCE /LUMINANCE COUNTERS
BLUE
RED
GREEN
B-Y CHROMINANCE AMPLITUDE
-(B-Y)
+(B-Y)
V_{CB}
LUMINANCE OUTPUT AMPL
V/2
0°-180° PHASE SHIFTER
R-Y MOD
SWITCHES
I Q W LOGIC
R-Y CHROMINANCE AMPLITUDE
+(R-Y)
-(R-Y)
R-Y FILTER
WIDE BAND FILTER
LUMINANCE DRIVE
SETUP & AMPTD SWITCHES
COLOR BAR SETUP & AMPLITUDE
I Q W DRIVE
NARROW BAND FILTER

TSG1



CIRCUIT NUMBERING SEQUENCE

A30 COLOR BAR LOGIC BOARD



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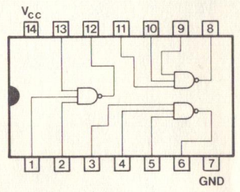

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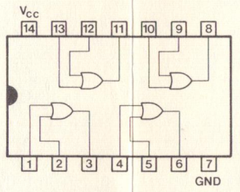

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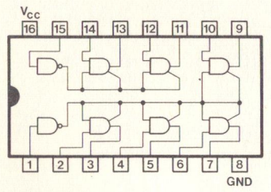

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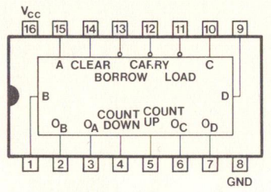

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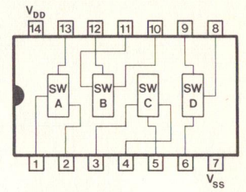

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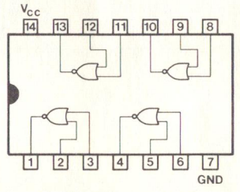

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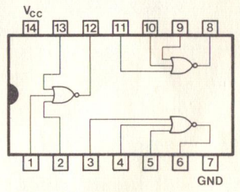

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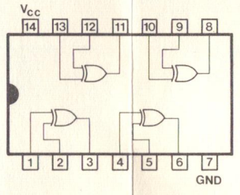

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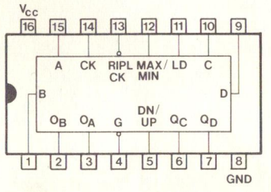

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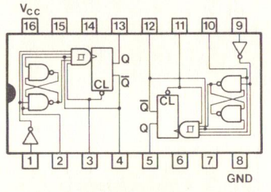

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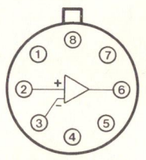

CA3130

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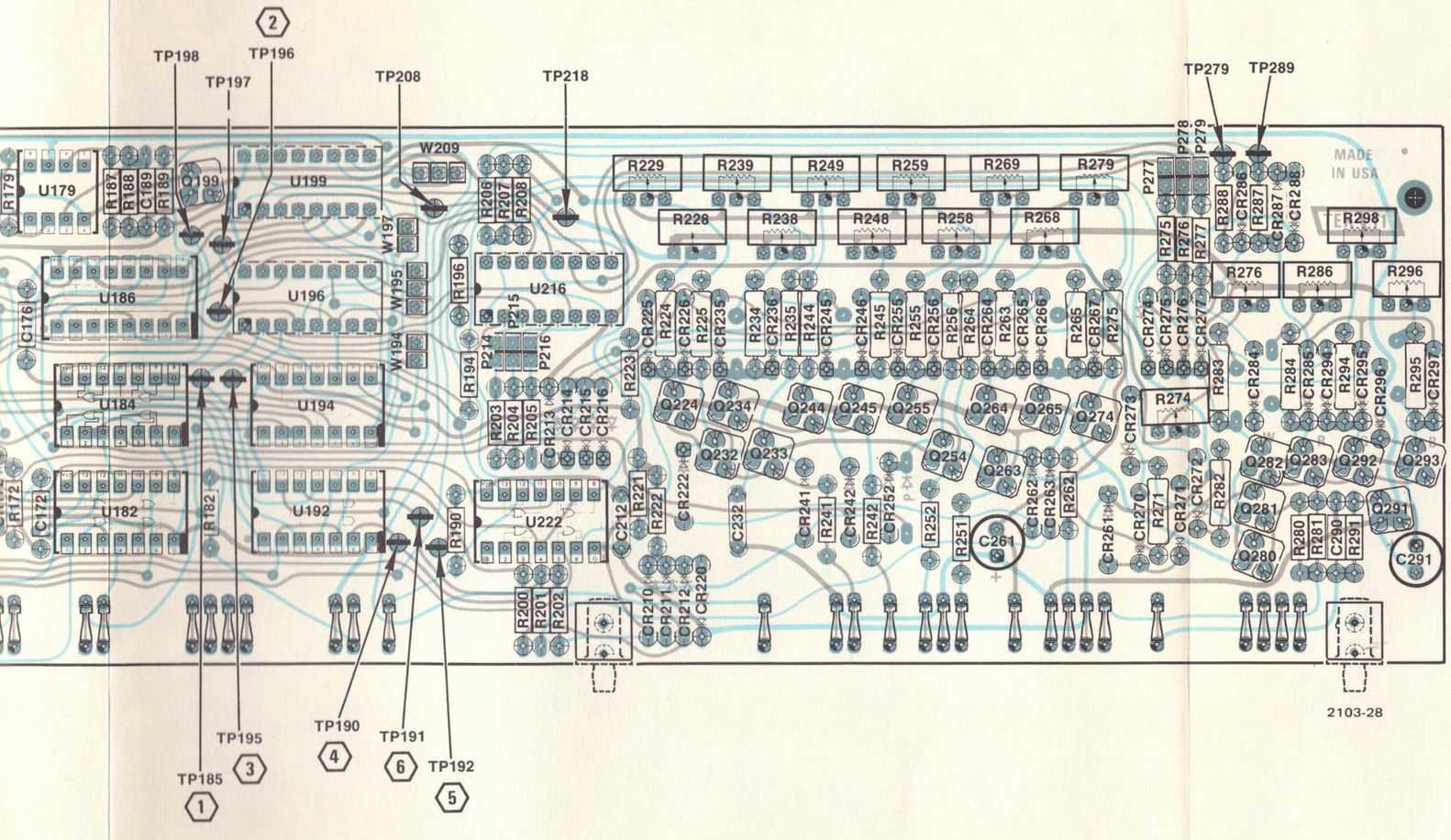

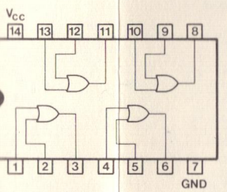

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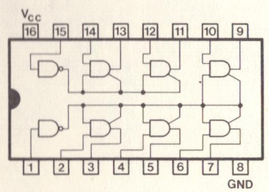

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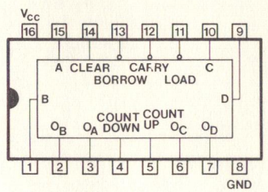

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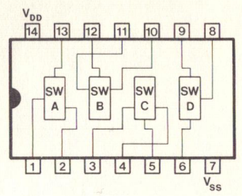

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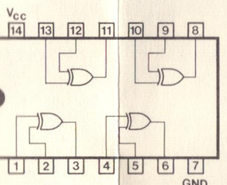

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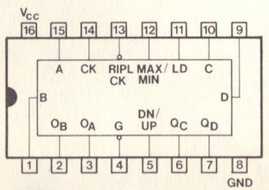

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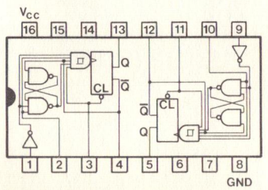

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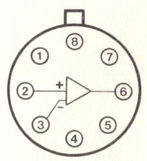
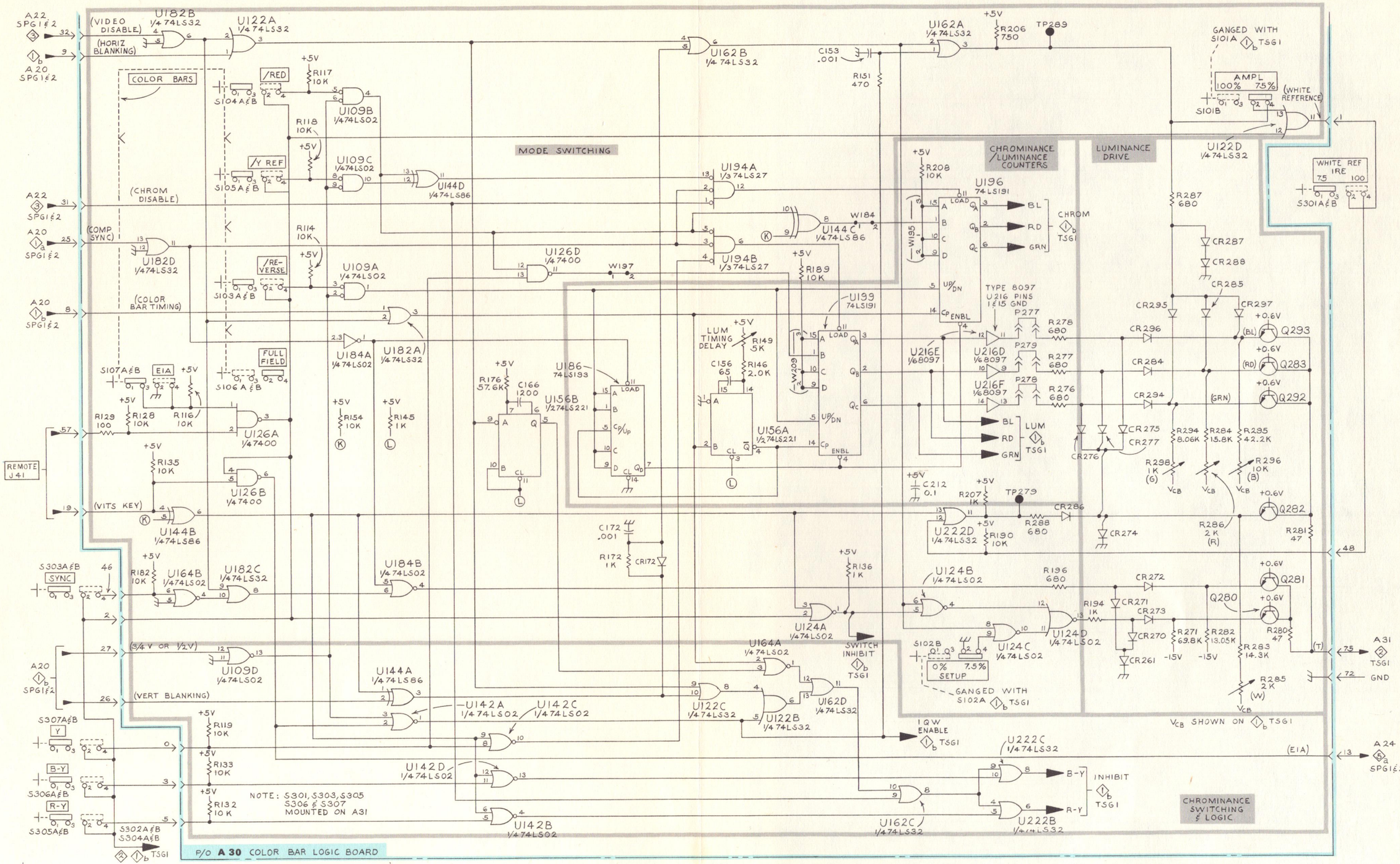


CA3130

1a
COLOR BAR LOGIC PARTS LOCATING CHART

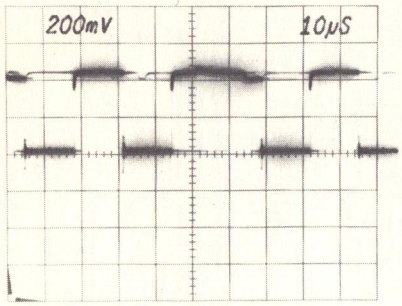
C153	4A
C156	3B
C166	2B
C172	3C
C212	4C
CR172	3C
CR261	5D
CR270	5D
CR271	5C
CR272	5C
CR273	5C
CR274	5C
CR275	5C
CR276	4C
CR277	5C
CR284	5B
CR285	5B
CR286	4C
CR287	5B
CR288	5B
CR294	5B
CR295	5B
CR296	5B
CR297	5B
P277	4B
P278	4B
P279	4B
Q280	5C
Q281	5C
Q282	5C
Q283	5B
Q292	5B
Q293	5B
R114	2B
R116	1B
R117	2A
R118	2A
R119	1D
R128	1B
R129	1B
R132	1D
R133	1D
R135	1C
R136	4C
R145	2B
R146	3B
R149	3B
R151	4A
R154	2B
R172	3C
R176	2B
R182	1C
R189	3B
R190	4C
R194	4C
R196	4C
R206	4A
R207	4C
R208	4A
R271	5C
R276	4B
R277	4B
R278	4B
R280	5C
R281	5C
R282	5C
R283	5D
R284	5C
R285	5D
R286	5C
R287	4A
R288	4C
R294	5C
R295	5C
R296	5C
R298	5C
S101B	5A
S102B	4D
S103A,B	1B
S104A,B	1A
S105A,B	1A
S106A,B	1B
S107A,B	1B
S301A,B	5A
S303A,B	1C
S305A,B	1D
S306A,B	1D
S307A,B	1D
TP279	4A
TP289	4C
U109A	2B
U109B	2A
U109D	2D
U122A	1A
U122B	3D
U122C	3D
U122D	5A
U124A	3C
U124B	4C
U124C	4C
U124D	4C
U126A	1B
U126B	1C
U126D	2B
U142A	2D
U142C	2D
U142D	2D
U144A	2D
U144B	1C
U144C	4B
U144D	2A
U156A	3B
U156B	2B
U162A	4A
U162B	3A
U162C	4D
U162D	3D
U164A	3D
U164B	1C
U182A	2B
U182B	1A
U182C	1C
U182D	1B
U184A	2A
U184B	2C
U186	3B
U194A	3A
U194B	3B
U196	4A
U199	4B
U216D	4B
U216E	4B
U216F	4B
U222B	4D
U222C	4D
U222D	4C
W184	4A
W195	4B
W197	3B
W209	3B


1 2 3 4 5
A B C D
COLOR BAR LOGIC 1a
MODE SWITCHING
CHROMINANCE / LUMINANCE COUNTERS
LUMINANCE DRIVE
COLOR BARS
(VIDEO DISABLE)
(HORIZ BLANKING)
(CHROM DISABLE)
(COMP SYNC)
(COLOR BAR TIMING)
(VITS KEY)
(3/4 V OR 1/2 V)
(VERT BLANKING)
REMOTE J41
/RED
/Y REF
/REVERSE
FULL FIELD
EIA
SYNC
Y
B-Y
R-Y
S104 A&B
S105 A&B
S103 A&B
S106 A&B
S107 A&B
S303 A&B
S306 A&B
S305 A&B
S302 A&B
S304 A&B
S101 A
S101 B
S301 A&B
S102 B
S102 A
GANGED WITH S101A 1b TSG1
AMPL 100% 75%
(WHITE REFERENCE)
WHITE REF IRE 75 100
0% 7.5% SETUP
GANGED WITH S102A 1b TSG1
U182B 1/4 74LS32
U122A 1/4 74LS32
U109B 1/4 74LS02
U109C 1/4 74LS02
U144D 1/4 74LS86
U182D 1/4 74LS32
U109A 1/4 74LS02
U182A 1/4 74LS32
U184A 1/4 74LS02
U126A 1/4 7400
U126B 1/4 7400
U144B 1/4 74LS86
U164B 1/4 74LS02
U182C 1/4 74LS32
U184B 1/4 74LS02
U109D 1/4 74LS02
U144A 1/4 74LS86
U142A 1/4 74LS02
U142C 1/4 74LS02
U142D 1/4 74LS02
U142B 1/4 74LS02
U126D 1/4 7400
U162B 1/4 74LS32
U194A 1/3 74LS27
U144C 1/4 74LS86
U194B 1/3 74LS27
U186 74LS193
U156B 1/2 74LS221
U156A 1/2 74LS221
U199 74LS191
U162A 1/4 74LS32
U196 74LS191
U216E 1/6 8097
U216D 1/6 8097
U216F 1/6 8097
TYPE 8097 U216 PINS 1 & 15 GND
U222D 1/4 74LS32
U124B 1/4 74LS02
U124A 1/4 74LS02
U124C 1/4 74LS02
U124D 1/4 74LS02
U164A 1/4 74LS02
U122C 1/4 74LS32
U122B 1/4 74LS32
U162D 1/4 74LS32
U162C 1/4 74LS32
U222C 1/4 74LS32
U222B 1/4 74LS32
U122D 1/4 74LS32
R117 10K
R118 10K
R114 10K
R129 100
R128 10K
R116 10K
R135 10K
R154 10K
R145 1K
R176 57.6K
C166 1200
R146 2.0K
C156 65
R149 .5K
C153 .001
R151 470
R206 750
TP289
R208 10K
R189 10K
R136 1K
R182 10K
R119 10K
R133 10K
R132 10K
R172 1K
C172 .001
CR172
C212 0.1
R207 1K
TP279
R190 10K
R287 680
CR287
CR288
CR285
CR295
CR297
CR296
CR284
CR294
CR275
CR277
CR276
CR274
CR286
CR272
CR271
CR273
CR270
CR261
R278 680
R277 680
R276 680
R288 680
R196 680
R194 1K
R298 1K (G)
R294 8.06K
R284 15.8K
R295 42.2K
R296 10K (B)
R286 2K (R)
R288 680
R281 47
R280 47
R271 69.8K
R282 13.05K
R283 14.3K
R285 2K (W)
Q293
Q283
Q292
Q282
Q281
Q280
+0.6V
-15V
W184
W197
W209
W195
CHROM 1b TSG1
LUM 1b TSG1
BL
RD
GRN
P277
P279
P278
SWITCH INHIBIT 1b TSG1
1QW ENABLE 1b TSG1
INHIBIT 1b TSG1
VCB SHOWN ON 1b TSG1
CHROMINANCE SWITCHING & LOGIC
A31 2a TSG1
A24 5a SPG1&2
A20 3a SPG1&2
A22 3 SPG1&2
A20 1b SPG1&2
A20 1a SPG1&2
A20 1b SPG1&2
A20 1b SPG1&2
A20 1b SPG1&2
A20 1b SPG1&2
NOTE: S301, S303, S305 S306 & S307 MOUNTED ON A31
P/O A 30 COLOR BAR LOGIC BOARD
TSG1
@ GEM 8/76
COLOR BAR LOGIC COUNTERS 1a

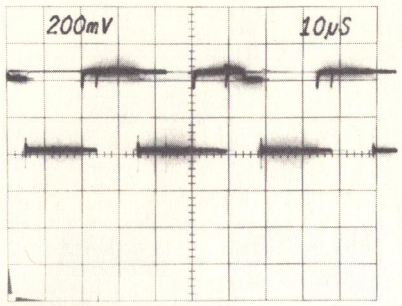
TSG1

WAVEFORMS FOR 1 b

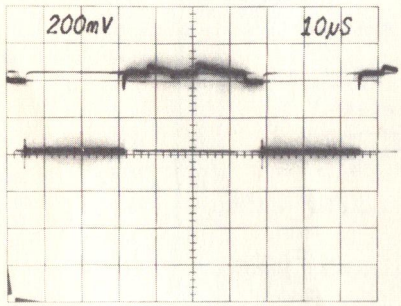
1



1



1 EIA



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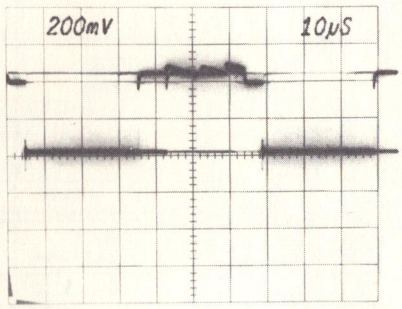
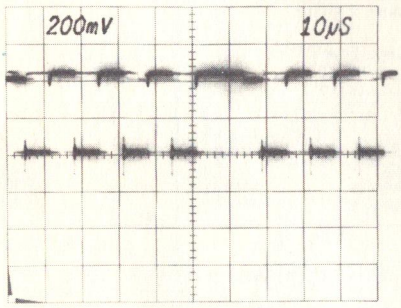


2 EIA



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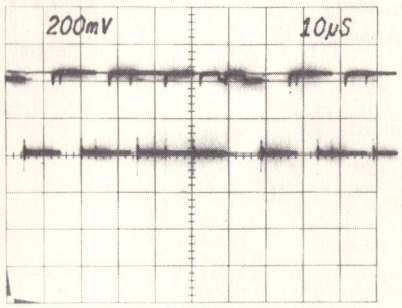
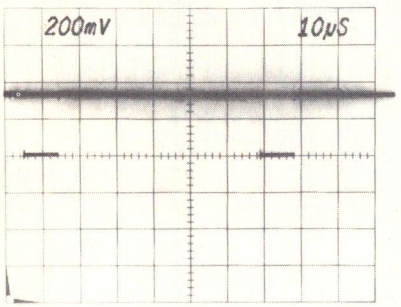


3 EIA



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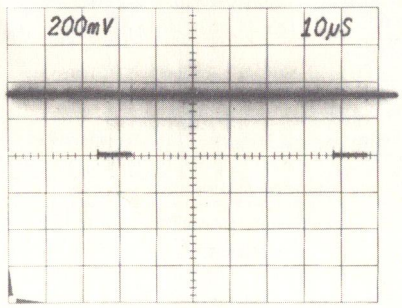
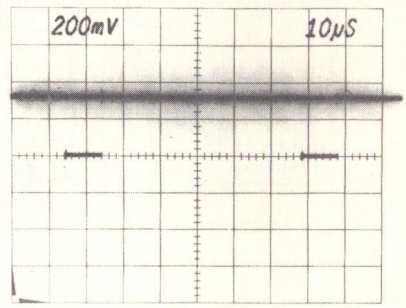


5 EIA



6 EIA

@

1b
COLOR BAR LOGIC
PARTS LOCATING CHART

C104	2C
C149	2D
C176	2B
C179	3D
C189	3C
C232	5B
C261	1B
C290	1B
C291	3C
CR210	3B
CR211	3B
CR212	3B
CR213	3B
CR214	3A
CR215	3A
CR216	3B
CR220	3C
CR222	4B
CR225	4A
CR226	4B
CR235	4A
CR236	4A
CR241	4B
CR242	4A
CR245	4A
CR246	4A
CR252	4C
CR555	4C
CR256	4C
CR262	4D
CR263	4B
CR264	4C
CR265	4C
CR266	4C
CR267	4C
P214	3A
P215	3A
P216	3A
Q148	2C
Q199	3D
Q224	5B
Q232	5B
Q233	5B
Q234	5A
Q244	5A
Q245	5A
Q254	5C
Q255	5C
Q263	5D
Q264	5C
Q265	5C
Q274	5B
Q291	3C
R101	2C
R102	2C
R103	2C
R104	2C
R127	1A
R137	2C
R138	2C
R139	2C
R157	2C
R158	2C
R159	2C
R179	2D
R187	2D
R188	3C
R200	3B
R201	3B
R202	3B
R203	3A
R204	3B
R205	3B
R221	4C
R222	3B
R223	4A
R224	4B
R225	5B
R228	4B
R229	5B
R234	5A
R235	5B
R238	5A
R239	5B
R241	5B
R242	5A
R243	5A
R248	5B
R249	4A
R251	5C
R252	5C
R254	4A
R255	5C
R256	5C
R258	5C
R259	5C
R262	5B
R263	5D
R264	5D
R265	5D
R268	5D
R269	5D
R274	5D
R275	5B
R279	5B
R291	3C
S101A	1C
S102A	1C
S304A,B	1A
TP185	2A
TP190	3B
TP191	3B
TP192	3B
TP195	2A
TP196	2A
TP197	2B
TP198	2C
TP209	2B
TP218	3C
U126C	2A
U169	3C
U179	3D
U184C	2B
U184D	2B
U192A	3B
U192B	3B
U192C	3B
U194C	2B
U216A	2A
U216B	2B
U216C	2A

WAVEFORMS

MOUNTED ON A31
S304A&B
BURST
INTERFACE PIN 2 TSG1 ◇1a
A20 ◇1a SPG1&2

+5V
R127 10K
U126C 1/4 7400
(BURST GATE)

TYPE 8097
U216 PINS 1&15 GND

CHROMINANCE DRIVE

RED
GREEN
BLUE
CHROMINANCE ◇1a TSG1

TP185 ①
TP196 ②
TP195 ③

U216A 1/6 8097 P214
U216C 1/6 8097 P215
U216B 1/6 8097 P216

R203 330
R204 330
R205 330

CR214
CR215
CR216
CR213
CR210
CR212
CR211
CR220

④
U192B 1/3 74LS10
TP190 (I)
R202 680
⑤
TP192 (Q)
U192C 1/3 74LS10
R200 680
⑥
TP191 (W)
R201 330
U192A 1/3 74LS10

U184C 1/4 74LS02
U194C 1/3 74LS27

IQW LOGIC

LUMINANCE ◇1a TSG1
BLUE
TP209
IQW ENABLE ◇1a TSG1
GREEN
TP197
RED
TP198
U184D 1/4 74LS02
+5V
C176 .01

A3 ◇2 1410 & 1410-1
+5V 78 → +5V
GND 66 → C267 22μF → -15V
-15V 70
+5V 5 → +5V → DIGITAL
GND 74/45

POWER

GANGED WITH S101B ◇1a TSG1

S101A AMPL 100% 75%
SETUP 0% 7.5%
R101 4.87K
R104 1.62K
R102 221
R103 549
-15V
+5V C104 22μF
GANGED WITH S102B ◇1a TSG1

SWITCH INHIBIT ◇1a TSG1
R137 2K
Q148
R138 15K
R158 2.386K
R159 4.87K
R139 7.5K
U169 4066
A
CONTROL
B
C
R157 10K
R291 1K
Q291
+0.6V
C291 1μF

C189 .001
TP218
R188 2K
R187 1K
Q199
U179 CA3130
PIN 7 GND
PIN 4 -15V
PIN 1
C179 470
PIN 8
R179 2K
C149 .001

COLOR BAR SETUP/AMPLITUDE

B-Y INHIBIT ◇1a
R225 1K
CR245
CR246
CR236
CR235
CR225
CR226

R-Y INHIBIT ◇1a TSG1
R222 1K
CR256
CR255
CR265
CR264
CR266
CR267

IQW DRIVE

CR242
CR222
CR241
CR263
CR252
CR262

(RED)
(GREEN)
(BLUE)

Q244 Q245 Q234 Q224 Q232 Q223 Q274 Q254 Q255 Q264 Q265 Q263
+0.6V

R242 100 → -(B-Y) → 63 → A31 ◇2a TSG1
R241 100 → +(B-Y) → 61 → A31 ◇2a TSG1
R262 100 → (2T) → 73 → A31 ◇2a TSG1
R252 100 → +(R-Y) → 65 → A31 ◇2a TSG1
R251 100 → -(R-Y) → 67 → A31 ◇2a TSG1

B-Y CHROM AMPTD
R254 12.1K
R245 16.2K
R243 8.25K
R238 1K
R249 2K (BURST) -15V
(R_B) (G_B) Vcb
R248 2K
R224 5.36K
R225 22.1K
R235 14.7K
R228 1K
R239 2K
(B_B) (I_B) (Q_B) -15V
C232 0.1
R229 5K
R275 5.36K
R279 500 (W_IQ) -15V

R-Y CHROM AMPTD
R256 22.1K
R255 3.92K
R259 5K (Q_R) -15V
R258 500 (R_R) Vcb
R263 4.64K
R265 24.9K
R264 14.7K
R268 500 (G_R) Vcb
R274 2K (B_R) Vcb
R269 2K (I_R) -15V

+5V
R222 1K
R-Y INHIBIT TSG1 ◇1a

+0.6V
C291 1μF

60 GND
66 GND

P/O **A30** COLOR BAR LOGIC BOARD

TSG1

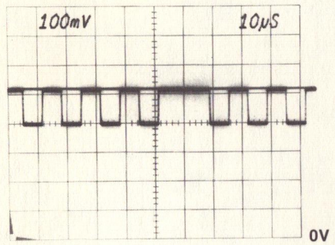
@ GEM 8/76

COLOR BAR LOGIC DRIVERS ◇1b

COLOR BAR LOGIC ◇1b

TSG1

2



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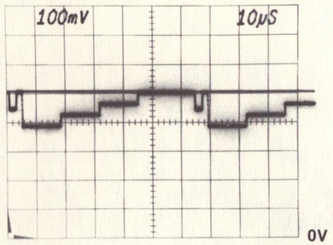
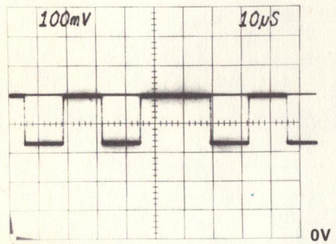


2



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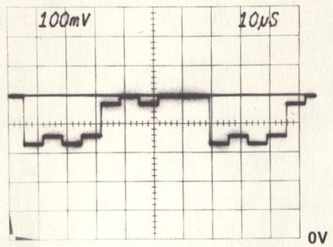
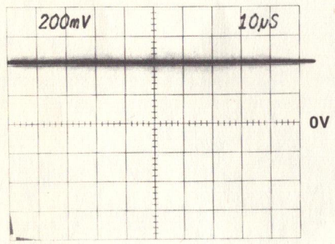


4



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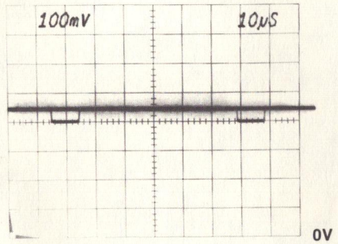
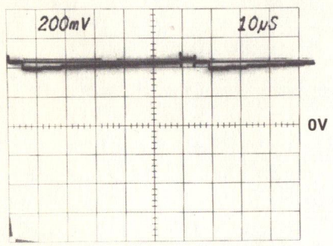


5 EIA



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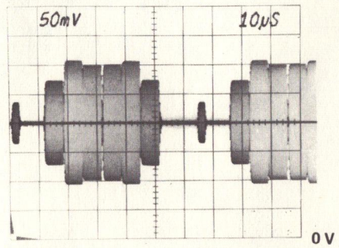
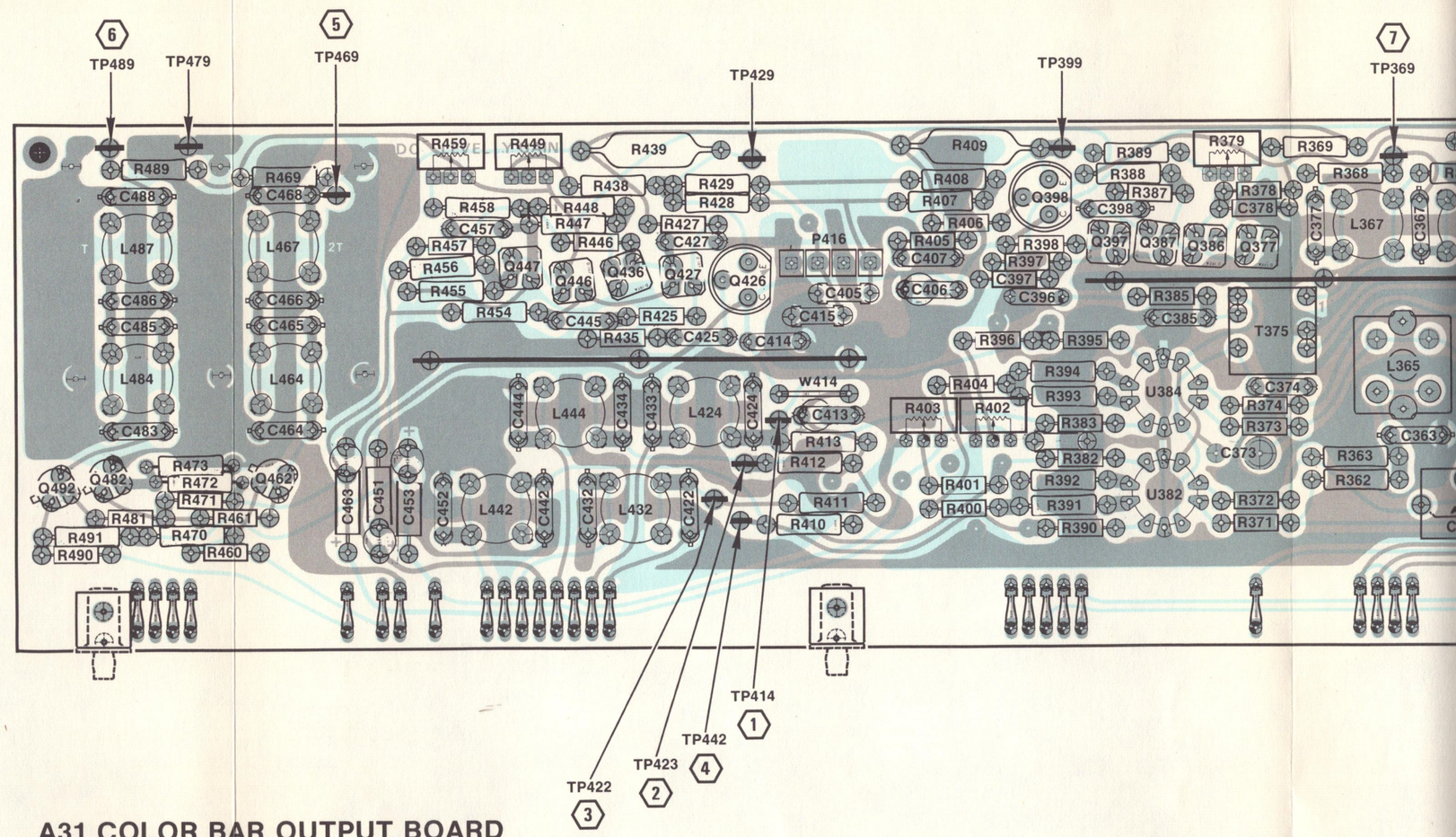
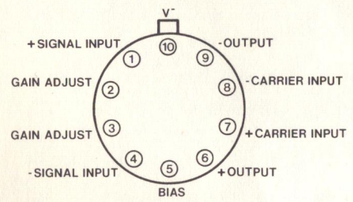


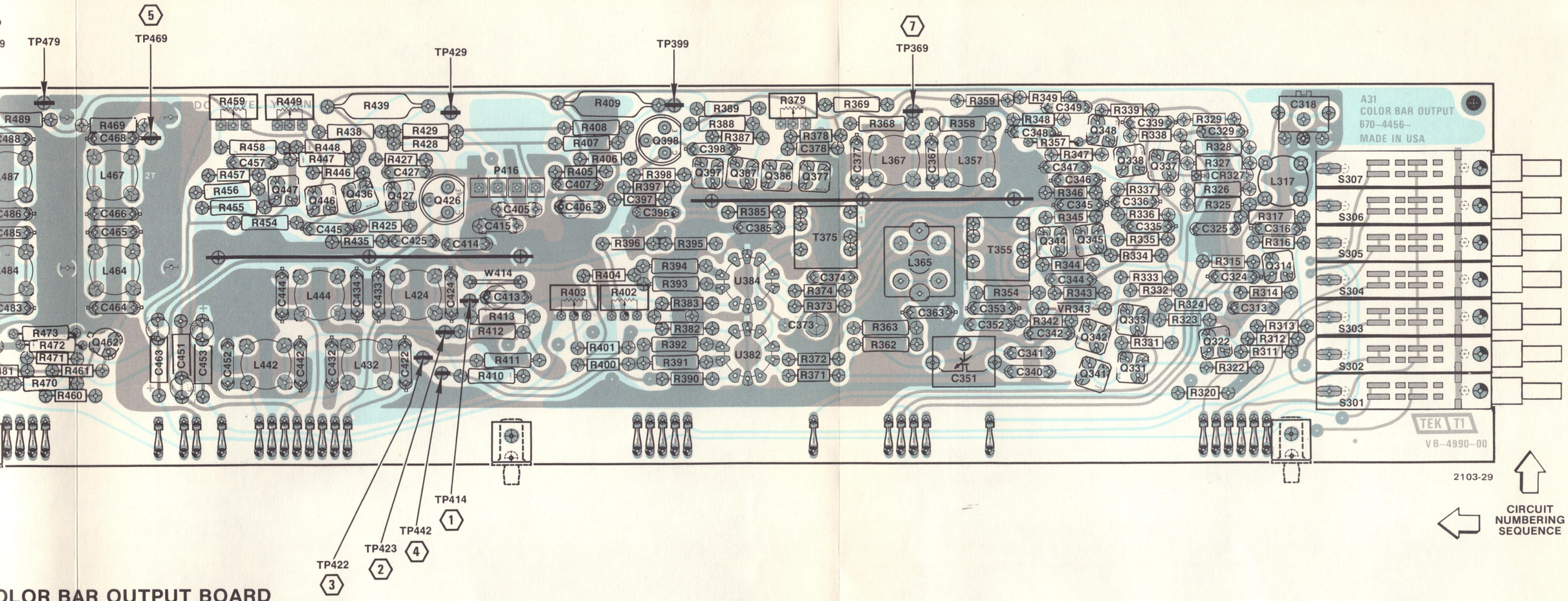
7



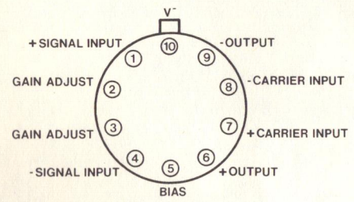
A31 COLOR BAR OUTPUT BOARD



MC1496G



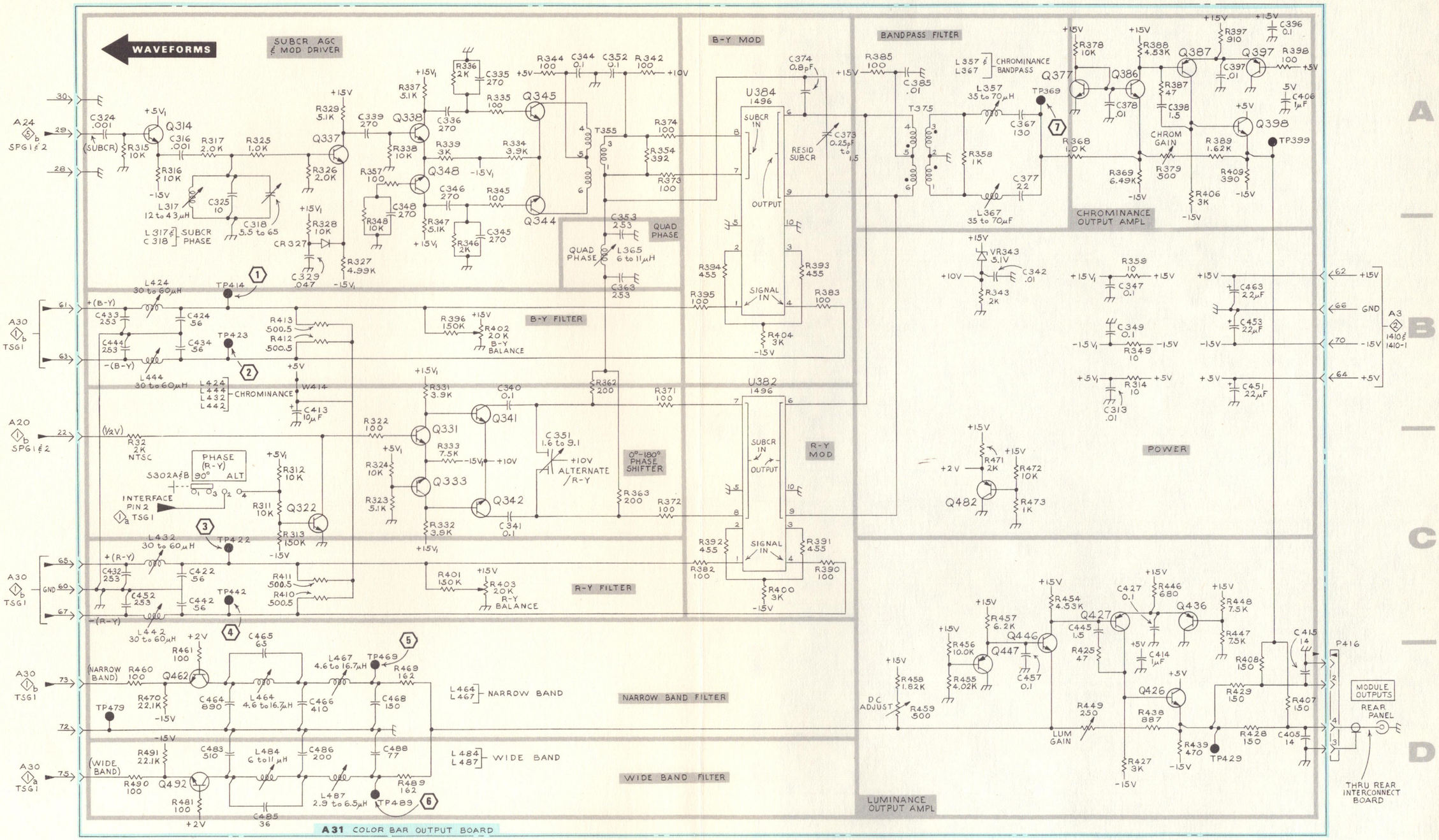
OLOR BAR OUTPUT BOARD



MC1496G

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		
C373	4A	L484	2D	R338	2A	R412	2B				
C374	4A	L487	2D	R339	2A	R413	2B	W414	2B		
C377	4A			R342	3A	R425	5D				
C378	5A	Q314	1A	R343	4B	R427	5D				
C385	4A	Q322	2C	R344	3A	R428	5D				
C396	5A	Q331	2C	R345	2A	R429	5D				
C397	5A	Q333	2C	R346	2B	R438	5D				
C398	5A	Q337	2A	R347	2B	R439	5D				
C405	5D	Q338	2A	R348	2A	R446	5C				
C406	5A	Q341	2B	R349	5B	R447	5C				
C413	2B	Q342	2C	R354	3A	R448	5C				
C414	5D	Q344	3A	R357	2A	R449	5D				
C415	5D	Q345	3A	R358	4A	R454	4C				
C422	1C	Q348	2A	R359	5B	R455	4D				
C424	1B	Q377	5A	R362	3B	R456	4D				
C427	5C	Q386	5A	R363	3C	R457	4C				
C432	1C	Q387	5A	R368	4A	R458	4D				
C433	1B	Q397	5A	R369	5A	R459	4D				
C434	1B	Q398	5A	R371	3B	R460	1D				
C442	1C	Q426	5D	R372	3C	R461	1D				
C444	1B	Q427	5C	R373	3A	R469	2D				
C445	5C	Q436	5C	R374	3A	R470	1D				
C451	5B	Q446	4C	R378	5A	R471	4C				
C452	1C	Q447	4D	R379	5A	R472	4C				
C453	5B	Q462	1D	R382	3C	R473	4C				
		Q482	4C	R383	4B	R481	1D				
		Q492	1D	R385	4A	R489	2D				



TSG1 @ GEM 8/76 COLOR BAR OUTPUTS ②

REPLACEABLE MECHANICAL PARTS

PARTS ORDERING INFORMATION

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

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

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

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

SPECIAL NOTES AND SYMBOLS

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

FIGURE AND INDEX NUMBERS

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

INDENTATION SYSTEM

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

1 2 3 4 5 *Name & Description*

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

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

Attaching parts must be purchased separately, unless otherwise specified.

ITEM NAME

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

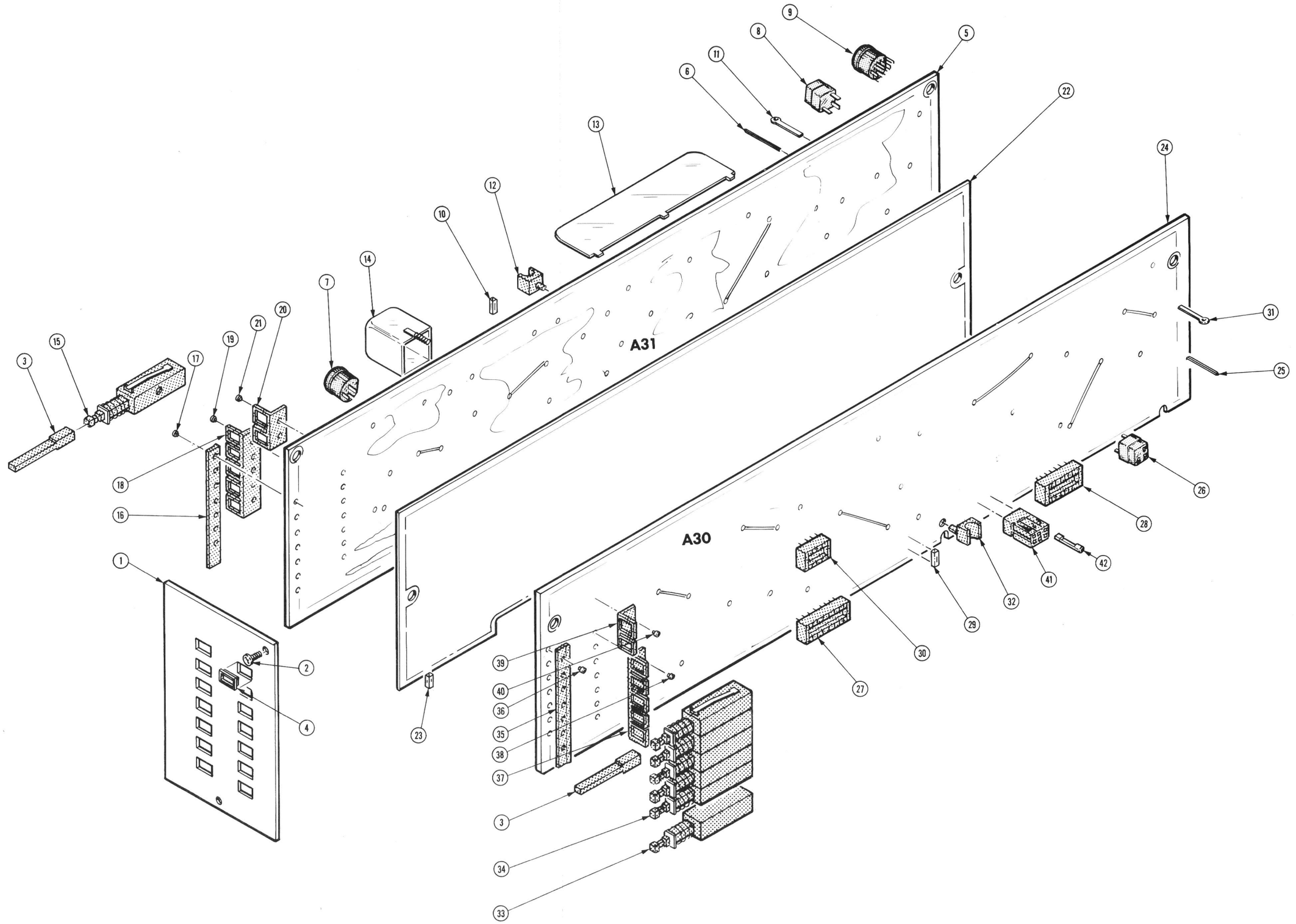
ABBREVIATIONS

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

CROSS INDEX—MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip
01295	Texas Instruments, Inc., Components Group	P. O. Box 5012	Dallas, TX 75222
07707	USM Corp., USM Fastener Div.	510 River Rd.	Shelton, CT 06484
22526	Berg Electronics, Inc.	Youk Expressway	New Cumberland, PA 17070
71785	TRW Electronic Components, Cinch Connector Operations	1501 Morse Ave.	Elk Grove Village, IL 60007
80009	Tektronix, Inc.	P. O. Box 500	Beaverton, OR 97005
82647	Texas Instruments, Inc., Control Products Div.	34 Forest St.	Attleboro, MA 02703
83385	Central Screw Co.	2530 Crescent Dr.	Broadview, IL 60153

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
1-1	333-2163-00			1		PANEL,FRONT:COLOR BARS	80009	333-2163-00
						(ATTACHING PARTS)		
-2	213-0120-00			2		SCR,TPG,THD FOR:2-32 X 0.250 INCH,PNH STL	83385	OBD
						- - - * - - -		
-3	366-1691-00			14		PUSH BUTTON:GY,1.2 L	80009	366-1691-00
-4	426-1206-00			14		FRAME,PUSH BTN:MOMENTARY,GRAY PLASTIC	80009	426-1206-00
-5	----- -----			1		CKT CARD ASSY:COLOR BAR OUTPUT(SEE A31 EPL)		
-6	131-0589-00			4		. CONTACT,ELEC:0.46 INCH LONG	22526	47350
-7	136-0183-00			2		. SOCKET,PLUG-IN:3 PIN,ROUND	80009	136-0183-00
-8	136-0220-00			22		. SOCKET,PLUG-IN:3 PIN,SQUARE	71785	133-23-11-034
-9	136-0241-00			2		. SOCKET,PLUG-IN:10 CONTACT,ROUND	71785	133-99-12-064
-10	136-0328-03			32		. CONTACT,ELEC:HORIZ SQ PIN RCPT	22526	47710
-11	214-0579-00			10		. TERM.,TEST PT:0.40 INCH LONG	80009	214-0579-00
-12	214-2440-00			3		. RECEPTACLE,PIN:CKT CARD	80009	214-2440-00
-13	337-1456-00			2		. SHLD,ELECTRICAL:CKT BOARD MOUNT	80009	337-1456-00
-14	337-1417-00			1		. SHLD,ELECTRICAL:0.55 SQ X 0.685 INCH HIGH	80009	337-1417-00
-15	263-0010-00			7		. ACTR ASSY,PB:1 PUSH,7.5MM W/2 CONTACTS	80009	263-0010-00
-16	343-0495-07			1		. CLIP,SWITCH:FRONT,7.5 MM X 7 UNIT	80009	343-0495-07
						(ATTACHING PARTS)		
-17	210-3033-00			7		. EYELET,METALLIC:0.59 OD X 0.156 INCH LONG	07707	SE-25
						- - - * - - -		
-18	343-0499-05			1		. CLIP,SWITCH:REAR,7.5 MM X 5 UNIT	80009	343-0499-05
						(ATTACHING PARTS)		
-19	210-3033-00			5		. EYELET,METALLIC:0.59 OD X 0.156 INCH LONG	07707	SE-25
						- - - * - - -		
-20	343-0499-02			1		. CLIP,SWITCH:REAR,7.5 MM X 2 UNIT	80009	343-0499-02
						(ATTACHING PARTS)		
-21	210-3033-00			2		. EYELET,METALLIC:0.59 OD X 0.156 INCH LONG	07707	SE-25
						- - - * - - -		
-22	670-4459-00			1		CKT CARD ASSY:SHIELD	80009	670-4459-00
-23	136-0328-03			4		. CONTACT,ELEC:HORIZ SQ PIN RCPT	22526	47710
-24	------ -----			1		CKT CARD ASSY:COLOR BAR LOGIC(SEE A30 EPL)		
-25	131-0608-00			12		. CONTACT,ELEC:0.365 INCH LONG	22526	47357
-26	136-0220-00			23		. SOCKET,PLUG-IN:3 PIN,SQUARE	71785	133-23-11-034
-27	136-0260-02			4		. SOCKET,PLUG-IN:16 CONTACT,LOW CLEARANCE	01295	C931602
-28	136-0269-02			13		. SOCKET,PLUG-IN:14 CONTACT,LOW CLEARANCE	01295	C931402
-29	136-0328-03			41		. CONTACT,ELEC:HORIZ SQ PIN RCPT	22526	47710
-30	136-0514-00			1		. SOCKET,PLUG-IN:MICROCIRCUIT,8 CONTACT	82647	C930802
-31	214-0579-00			12		. TERM.,TEST PT:0.40 INCH LONG	80009	214-0579-00
-32	214-2440-00			3		. RECEPTACLE,PIN:CKT CARD	80009	214-2440-00
-35	263-0010-00			2		. ACTR ASSY,PB:1 PUSH,7.5MM W/2 CONTACTS	80009	263-0010-00
-34	263-0023-01			1		. ACTR ASSY,PB:5 LATCH,7.5 MM,8 CONTACTS	80009	263-0023-01
-35	343-0495-07			1		. CLIP,SWITCH:FRONT,7.5 MM X 7 UNIT	80009	343-0495-07
						(ATTACHING PARTS)		
-36	210-3033-00			7		. EYELET,METALLIC:0.59 OD X 0.156 INCH LONG	07707	SE-25
						- - - * - - -		
-37	343-0499-05			1		. CLIP,SWITCH:REAR,7.5 MM X 5 UNIT	80009	343-0499-05
						(ATTACHING PARTS)		
-38	210-3033-00			5		. EYELET,METALLIC:0.59 OD X 0.156 INCH LONG	07707	SE-25
						- - - * - - -		
-39	343-0499-02			1		. CLIP,SWITCH:REAR,7.5 MM X 2 UNIT	80009	343-0499-02
						(ATTACHING PARTS)		
-40	210-3033-00			2		. EYELET,METALLIC:0.59 OD X 0.156 INCH LONG	07707	SE-25
						- - - * - - -		
	198-3227-00			1		. WIRE SET,ELEC:	80009	198-3227-00
	----- -----			-		. . TERMINAL LINK:P214,P215,P216		
-42	352-0177-00			1		. . . CONN BODY,PL,EL:6 WIRE,DBL ROW BLACK	80009	352-0177-00
-43	131-0707-00			6		. . . CONTACT,ELEC:0.48"L,22-26 AWG WIRE	22526	47439
	----- -----			-		. . TERMINAL LINK:P277,P278,P279		
	352-0177-00			1		. . . CONN BODY,PL,EL:6 WIRE,DBL ROW BLACK	80009	352-0177-00
	131-0707-00			6		. . . CONTACT,ELEC:0.48"L,22-26 AWG WIRE	22526	47439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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.

SERVICE NOTE

Because of the universal parts procurement problem, some electrical parts in your instrument may be different from those described in the Replaceable Electrical Parts List. The parts used will in no way alter or compromise the performance or reliability of this instrument. They are installed when necessary to ensure prompt delivery to the customer. Order replacement parts from the Replaceable Electrical Parts List.

CALIBRATION TEST EQUIPMENT REPLACEMENT

Calibration Test Equipment Chart

This chart compares TM 500 product performance to that of older Tektronix equipment. Only those characteristics where significant specification differences occur, are listed. In some cases the new instrument may not be a total functional replacement. Additional support instrumentation may be needed or a change in calibration procedure may be necessary.

Comparison of Main Characteristics

DM 501 replaces 7D13		
PG 501 replaces 107	PG 501 - Risetime less than 3.5 ns into 50 Ω.	107 - Risetime less than 3.0 ns into 50 Ω.
108	PG 501 - 5 V output pulse; 3.5 ns Risetime.	108 - 10 V output pulse; 1 ns Risetime.
111	PG 501 - Risetime less than 3.5 ns; 8 ns Pretrigger pulse delay.	111 - Risetime 0.5 ns; 30 to 250 ns Pretrigger Pulse delay.
114	PG 501 - ±5 V output.	114 - ±10 V output. Short proof output.
115	PG 501 - Does not have Paired, Burst, Gated, or Delayed pulse mode; ±5 V dc Offset. Has ±5 V output.	115 - Paired, Burst, Gated, and Delayed pulse mode; ±10 V output. Short-proof output.
PG 502 replaces 107		
108	PG 502 - 5 V output	108 - 10 V output.
111	PG 502 - Risetime less than 1 ns; 10 ns Pretrigger pulse delay.	111 - Risetime 0.5 ns; 30 to 250 ns Pretrigger pulse delay.
114	PG 502 - ±5 V output	114 - ±10 V output. Short proof output.
115	PG 502 - Does not have Paired, Burst, Gated, Delayed & Undelayed pulse mode; Has ±5 V output.	115 - Paired, Burst, Gated, Delayed & Undelayed pulse mode; ±10 V output. Short-proof output.
2101	PG 502 - Does not have Paired or Delayed pulse. Has ±5 V output.	2101 - Paired and Delayed pulse; 10 V output.
PG 506 replaces 106	PG 506 - Positive-going trigger output signal at least 1 V; High Amplitude output, 60 V.	106 - Positive and Negative-going trigger output signal, 50 ns and 1 V; High Amplitude output, 100 V.
067-0502-01	PG 506 - Does not have chopped feature.	0502-01 - Comparator output can be alternately chopped to a reference voltage.
SG 503 replaces 190, 190A, 190B	SG 503 - Amplitude range 5 mV to 5.5 V p-p.	190B - Amplitude range 40 mV to 10 V p-p.
191	SG 503 - Frequency range 250 kHz to 250 MHz.	191 - Frequency range 350 kHz to 100 MHz.
067-0532-01	SG 503 - Frequency range 250 kHz to 250 MHz.	0532-01 - Frequency range 65 MHz to 500 MHz.
TG 501 replaces 180, 180A	TG 501 - Marker outputs, 5 sec to 1 ns. Sinewave available at 5, 2, and 1 ns. Trigger output - slaved to marker output from 5 sec through 100 ns. One time-mark can be generated at a time.	180A - Marker outputs, 5 sec to 1 μs. Sinewave available at 20, 10, and 2 ns. Trigger pulses 1, 10, 100 Hz; 1, 10, and 100 kHz. Multiple time-marks can be generated simultaneously.
181	TG 501 - Marker outputs, 5 sec to 1 ns. Sinewave available at 5, 2, and 1 ns.	181 - Marker outputs, 1, 10, 100, 1000, and 10,000 μs, plus 10 ns sinewave.
184	TG 501 - Marker outputs, 5 sec to 1 ns. Sinewave available at 5, 2, and 1 ns. Trigger output - slaved to marker output from 5 sec through 100 ns. One time-mark can be generated at a time.	184 - Marker outputs, 5 sec to 2 ns. Sinewave available at 50, 20, 10, 5, and 2 ns. Separate trigger pulses of 1 and .1 sec; 10, 1, and .1 ms; 10 and 1 μs. Marker amplifier provides positive or negative time marks of 25 V min. Marker intervals of 1 and .1 sec; 10, 1, and .1 ms; 10 and 1 μs.
2901	TG 501 - Marker outputs, 5 sec to 1 ns. Sinewave available at 5, 2, and 1 ns. Trigger output - slaved to marker output from 5 sec through 100 ns. One time-mark can be generated at a time.	2901 - Marker outputs, 5 sec to 0.1 μs. Sinewave available to 50, 10, and 5 ns. Separate trigger pulses, from 5 sec to 0.1 μs. Multiple time-marks can be generated simultaneously.

NOTE: All TM 500 generator outputs are short-proof. All TM 500 plug-in instruments require TM 500-Series Power Module.

TEKTRONIX®
committed to technical excellence

MANUAL CHANGE INFORMATION

PRODUCT TSG1
070-2103-00

CHANGE REFERENCE C1/1176 REV.
DATE Dec. 16, 1976

CHANGE:	DESCRIPTION

TEXT CHANGES

Section 2, SPECIFICATION, Page 2-1
Characteristic - Chrominance Accuracy, Relative Amplitudes

CHANGE TO READ:

Relative Amplitudes ----Within 1% or 1 mV plus the p-p residual subcarrier amplitude, whichever is greater, with the red chrominance bar as reference.

Page 2-2, Characteristic - Split Field Displays Timing, -I,W,Q,B Duration

CHANGE TO READ:

-I,W,Q Duration ----9.4 µs each.

Page 2-3, Characteristic - Residual Subcarrier, White and Blanking

CHANGE TO READ:

Residual Subcarrier
White and Blanking ---- 52 dB below 1 V (±2.5 mV)

Section 3, SERVICE INFORMATION, INSTALLATION, Operating Mode Selection
Page 3-1, VITS Key

CHANGE TO READ:

VITS Key

Insert a low at selected line time on the VITS Key line to operate the module during VITS time. See the 1410 manual for location of appropriate VITS line.

EIA Mode Selection

CHANGE TO READ:

EIA Mode Selection

Insert a low on the Remote line to switch the module to EIA mode. See the 1410 manual for location of the appropriate Remote line.

CHANGE:	DESCRIPTION

TEXT CHANGES (cont'd)

Section 3, SERVICE INFORMATION, INSTALLATION, Page 3-3, Fig. 3-2 and Page 3-4, Fig. 3-3.

INTERCHANGE:

Illustration above caption for Fig. 3-2 and illustration above caption for Fig. 3-3.

Section 4, PERFORMANCE CHECK/CALIBRATION PROCEDURE, Page 4-4, Step 5

CHANGE part c. TO READ:

c. Check - Vcb should be -10.1 V, ±2% (-9.9 to -10.3 V)

CHANGE Example under NOTE TO READ:

Example: Assume that the 75%, 7.5% Vcb voltage measures -10.2 V. ...etc.

CHANGE parts e., g., and i. TO READ (respectively):

e. Check - Vcb should be -13.4 V, ±2%.

g. Check - Vcb should be -14.6 V, ±2%.

i. Check - Vcb should be -10.9 V, ±2%.

Page 4-5, Step 8, part a. CHANGE TO READ:

a. Push in the EIA pushbutton and place the 10X Test Oscilloscope probe on TP429.

Page 4-6, Step 9, parts a. and b. CHANGE TO READ:

a. Push in the FULL FIELD pushbutton and disengage the B-Y and R-Y pushbuttons. Connect the Test Oscilloscope 10X probe to the test point (TP) under test.

b. Check - Signals at the following test points should have square corners and minimum aberrations: TP414, TP422, TP423, and TP442.

Page 4-8, Step 13, part a. CHANGE TO READ:

a. Push in the TSG1 FULL FIELD, Y, and PHASE (R-Y) pushbuttons. Disengage the B-Y pushbutton. Set the 1480 Response to 3.58 MHz and VFS to 0.2.

Page 4-9, Step 17, part d., formula in EXAMPLE, CHANGE TO READ:

$$\frac{454.0\ \text{mV}}{444.2\ \text{mV}} \times 100 = 102\%$$

CHANGE:	DESCRIPTION

TEXT CHANGES (cont'd)

Section 4, PERFORMANCE CHECK/CALIBRATION PROCEDURE, Page 4-9, Step 18

CHANGE parts b. and e. TO READ (respectively):

b. Adjust - R-Y chrominance amplitudes within 1% or 1 mV plus p-p residual subcarrier, whichever is greater, with the red chrominance bar as reference.

e. Adjust - B-Y chrominance amplitudes within 1% or 1 mV plus p-p residual subcarrier, whichever is greater, with the red chrominance bar as reference.

Page 4-10, Step 21, part a., CHANGE TO READ:

a. Push in AMPL and WHITE REF pushbuttons, and disengage the Y pushbutton.

Page 4-10, Table 4-6, White Color, R-Y P-P column, CHANGE TO READ:

Adjust R258 for modulation null on white bar

Page 4-11, Fig. 4-8, INTERCHANGE: Waveform photos above caption a. and caption b.

Page 4-11, Step 27, part a., first line, CHANGE TO READ:

a. Connect the 1410 Mainframe rear-panel subcarrier output.....

Section 5, THEORY OF OPERATION, Page 5-1, Mode Control, last sentence
CHANGE TO READ:

All test signals except the EIA signal and VITS may be modified by front-panel pushbuttons.

Page 5-2, Luminance Drive, first paragraph, 4th and 8th lines, CHANGE TO READ:

.....provided by R286, R296, and R298. These potentiometers.....

.....means for selecting color bar amplitude from the rear panel and setup from..

Page 5-3, left column, second paragraph, 7th line, CHANGE TO READ:

.....off in the EIA and VITS modes. R285 provides adjustable.....

Page 5-3, left column, third paragraph, second line, CHANGE TO READ:

.....signal by Q281 and Q280, respectively. Steering diodes.....

CHANGE:	DESCRIPTION

TEXT CHANGES (cont'd)

Section 5, THEORY OF OPERATION, Page 5-5, Wide Band and Narrow Band Filters, third line, CHANGE TO READ:

.....risetime is 250 ns. The color bar luminance levels, setup.....

Page 5-6, R-Y and R-Y Filters, CHANGE TO READ: B-Y and R-Y Filters

SCHEMATIC and CIRCUIT BOARD CHANGES

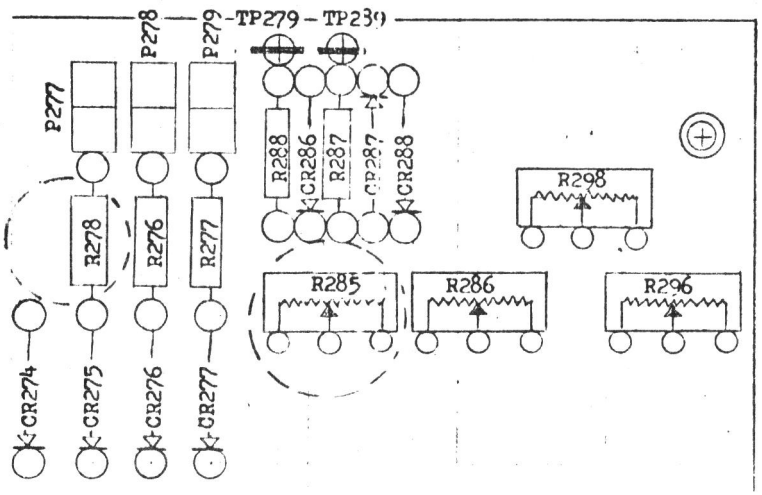
Section 9, DIAGRAMS AND CIRCUIT BOARD ILLUSTRATIONS, Block Diagram, COLOR BAR SETUP & AMPLITUDE block, CHANGE: schematic reference TO READ: ◇1▷b

IQW DRIVE block, DELETE: lead at bottom of block showing connection to Vcb.

A30 COLOR BAR LOGIC BD (rear side of Block Diagram), CHANGE: labeling of all 7400-series IC basing diagrams TO READ (respectively):

74LS00 - 74LS02 - 74LS10 - 74LS27 - 74LS32 - 74LS86 - 74LS191 - and 74LS193

CHANGE: Labeling of R276 TO: R285, and R275 TO: R278 (as indicated below);



Upper right-hand corner A30 COLOR BAR LOGIC BD.

COLOR BAR LOGIC ◇1▷a schematic, CHANGE: W184 TO READ: W194

INTERCHANGE: Numbering of pins 14 & 15 on U156A (Chrominance/Luminance Counters)

COLOR BAR LOGIC ◇1▷b schematic, RE-LOCATE: R-Y CHROM AMPTD circuit designation to area boxing in Q255, Q264, and Q265.

COLOR BAR OUTPUT ◇2▷ schematic, DELETE: NTSC label on R32 (0°-180° PHASE SHIFTER)