TEKTRONIX®

SPG3
NTSC TIMING GENERATOR MODULE

INSTRUCTION MANUAL

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

Serial Number _____

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WARRANTY

This Tektronix instrument is 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.

Products of Tektronix, Inc. and its subsidiaries are covered by U.S. and foreign patents and/or pending patents.

TABLE OF CONTENTS

This manual is divided into two parts for safety purposes. Part I should be used by both operating and service personnel. Part II instructions necessarily expose personnel to electrical shock hazards, therefore they are to be used by qualified service personnel only. The service technician should be familiar with the Safety Summary in Part I.

WARNING

SERVICE INFORMATION IS FOR USE BY QUALIFIED PERSONNEL ONLY. TO AVOID ELECTRIC SHOCK, DO NOT PERFORM ANY SERVICING OTHER THAN THAT CONTAINED IN THE OPERATING INSTRUCTIONS UNLESS QUALIFIED TO DO SO.

FRONT-PANEL CONTROLS (Refer to Fig. 1-2)

(1) HORIZ UNLOCK—This pushbutton switch unlocks the horizontal sync from the subcarrier. The Horizontal Unlock mode can be used when measuring subcarrier packet risetimes.

(2) HORIZ/VERT Trigger—This pushbutton switch selects either the vertical drive (button out), or horizontal drive (button in) for output at the front-panel TRIGGER connector.

CONNECTORS

(3) SUBCARRIER—This output provides 2 volts peak-to-peak (when into 75 Ω) of 3.579545 MHz subcarrier, from the 1410 internal subcarrier oscillator or external subcarrier source, whichever is selected. (Internal/external source selection is done by grounding pin 25 of REMOTE connector J41 to pin 36 of the REMOTE connector.)

(4) TRIGGER—This output provides 1 volt (at 1 kΩ source impedance) of vertical drive or horizontal drive, whichever is selected by the HORIZ/VERT trigger switch. The TRIGGER signal is intended for use as a test oscilloscope external trigger.

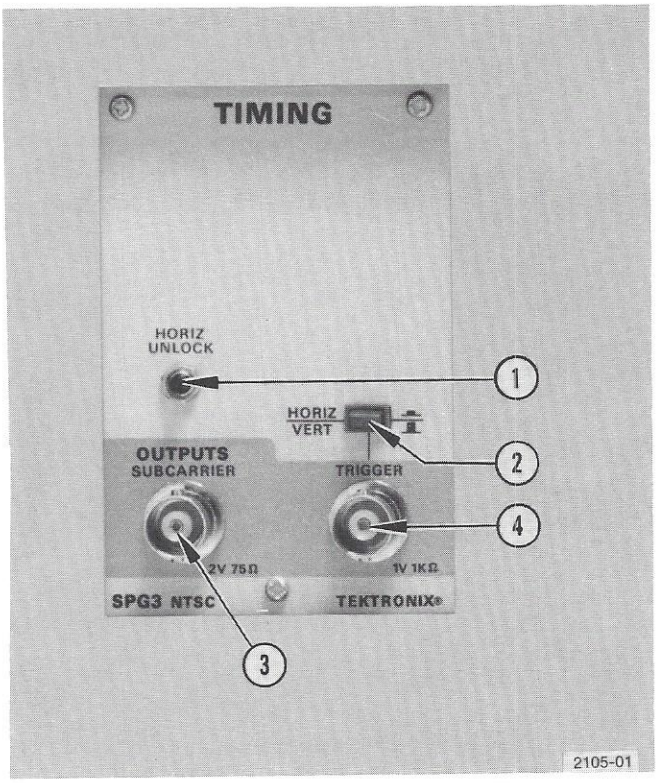

Fig. 1-2. SPG3 Front-panel controls.

PERFORMANCE CHECK

This procedure is to be used to verify that the SPG3 is performing to specifications.

Control and connector names on the SPG3 will be capitalized in this procedure, for example: HORIZ UNLOCK. Controls and connectors on test equipment or the 1410 mainframe have only the first letter capitalized, for example: Test Oscilloscope Time/Div, or 1410 rear-panel Subcarrier loop-through connector.

TEST EQUIPMENT

The test equipment listed here was used in preparing this procedure. The measurement capabilities described are the minimum required to verify the performance of the instrument. Each piece of test equipment is assumed to be operating within its stated specifications. If alternative test equipment is used, it must meet or exceed these re-

1. Leveled Sine Wave Generator

Capable of amplitudes from 0.2 volt peak-to-peak to 5 volts peak-to-peak; frequency range from 50 kHz (reference) to 10 MHz. For example, a Tektronix SG 503 in a TM 500-series mainframe.

2. Test Oscilloscope

A Tektronix 7603 with 7B53A Option 5 Dual Time Base, 7A13 Differential Comparator, and 7A18 Dual Trace Amplifier was used for this procedure. Minimum specifications for substitute equipment are as follows:

Dual Time Base. Range from 50 ns/Div to 5 s/Div with provisions for delaying sweep and television triggering.

Differential Comparator. Bandwidth, dc to 30 MHz; minimum deflection factor, 1 mV/Div; two channels capable of differential operation.

Dual Trace Amplifier. Vertical amplifier independent of the Differential Comparator. Bandwidth, dc to 30 MHz; minimum deflection factor, 5 mV/Div.

3. Return Loss Bridge

Tektronix Part Number 015-0149-00.

4. 75 Ω Cable with bnc connectors (2)

42 inches long. Tektronix Part Number 012-0074-00.

5. 75 Ω End-Line Termination with bnc connectors

Tektronix Part Number 011-0102-00.

6. 75 Ω Feed-Through Termination (2) with bnc connectors

Matched within 0.2%. Supplied as accessories with Return Loss Bridge (item 3). Tektronix Part Numbers 011-0103-00 (red) and 011-0103-01 (green).

7. 50 Ω to 75 Ω Minimum Loss Attenuator with bnc connectors

Tektronix Part Number 011-0057-00.

EQUIPMENT SETUP

1. 1410 with SPG3 and a test signal module (TSG1, TSG2, TSG3, or TSG4)

1410

Power	On
Test Signal Module	Set for normal, full-field signal output

SPG3

HORIZ/VERT trigger	HORIZ (In)
HORIZ UNLOCK	Open (Out)

2. Test Oscilloscope

(A 7603 with the 7B53A Option 5 in the right compartment, the 7A18 in the left compartment, and the 7A13 in the center compartment.)

7603

Power	On
Readout, Intensity, Grat Illum, Focus	Best Display
Vert Mode	Left
Trig Source	Left

7A13

+Input	DC
−Input	DC
Volts/Div	.1
Variable	Cal
BW	Full

7B53A

Main Triggering	
Mode	Auto
Coupling	AC
Source	Int
Time/Div	10 μs
Variable	Cal
Mag	X1

7A18

CH 1 and CH 2	
Volts/Div	.5
Variable	Cal
Coupling	DC
Trigger Source	CH 1
Display Mode	Alt
CH 2 Polarity	+Up

PROCEDURE

1. Check Subcarrier Amplitude

a. Connect the SUBCARRIER output through 75 Ω cable and a 75 Ω termination to the Test Oscilloscope Dual Trace Amplifier CH 1 Input.

b. Check—The amplitude of the SUBCARRIER output signal should be 1.8 to 2.2 volts peak-to-peak.

c. Disconnect the SUBCARRIER signal from the Test Oscilloscope.

2. Check Trigger Amplitude

a. Connect the TRIGGER output through a 75 Ω cable to the Test Oscilloscope Dual Trace Amplifier CH 1 Input. Do not use a termination.

b. Check—The amplitude of the TRIGGER output signal should be approximately 1 volt.

3. Check Trigger Timing and Duration

a. Connect the TRIGGER output to the Test Oscilloscope Dual Trace Amplifier CH 1 Input.

b. Connect the Test Signal Module output from the 1410 rear panel to the Test Oscilloscope Dual Trace Amplifier CH 2 Input.

c. Check—The HORIZ trigger should begin at the start of line blanking and end at the end of line sync.

d. Release the HORIZ/VERT trigger switch.

e. Using the Test Oscillscope Dual Time Base delaying sweep function, display the vertical interval of the Test Signal Module signal.

f. Check—The VERT trigger should be nine lines in duration, beginning at vertical blanking.

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SPECIFICATIONS

The performance requirements listed here apply over an ambient temperature range of 0° C to +50° C. The rated accuracies are valid when the instrument is calibrated at +20° C to +30° C with ten minutes warm-up time. A twenty minute warm-up is required for rated accuracies at 0° C ambient temperature.

ELECTRICAL

Input Requirements (External Subcarrier mode only)

Characteristics	Requirements
SUBCARRIER INPUT	
Amplitude	1.0 V to 4.0 V P-P.
Frequency	3.579545 MHz ±10 Hz.
Return Loss	At least 46 dB to 3.579545 MHz.

Outputs

SUBCARRIER	
Source	1410 Mainframe
Frequency	3.579545 MHz, ±10 Hz (±1 Hz with 1410, Option 1)
Amplitude into 75 Ω	2 V P-P ±10%.
Return Loss	At least 30 dB.
TRIGGER	
Output Level	≈1 V (for test oscilloscope triggering only).
Duration	
H Drive	Start of Line Blanking to end of Line Sync.
V Drive	9 lines.

ENVIRONMENTAL

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

WARNING

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PART II
SERVICE INFORMATION

WARNING

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INSTALLATION

INSTALLATION IN THE MAINFRAME

CAUTION

Disconnect the power input before removing or installing any circuit boards in a mainframe.

The SPG3 consists of circuit board A28, a single-location-wide panel, and an interconnecting cable. In the event that an SPG3 needs to be installed in a 1410 mainframe for the first time, use the following procedure.

Install the cable first. Connect the 7-wide housing from the main cable to row P53. Align the index marker on the housing to pin 87 of P53. Connect the 8-wide housing of the interconnect cable to P412 of the 1410 mainframe Subcarrier Input board A13.

At the end of the black-striped cable, connect the 2-wide housing to pins 29 and 30 of row P52, with the center conductor on pin 29. This brings subcarrier to the 1410 Interface board A1 for distribution to the Test Signal Module locations.

At one end of the orange-striped cable, connect the coaxial shield housing to pin 45 of row P52 and the center conductor in the 3-pin housing to pin 55 of P52. This provides a grounding circuit for the HORIZ UNLOCK function.

Connect the black-striped wire in the 3-pin housingbetween pins 56 and 87 of row P52. This completes a circuit between REMOTE connector J41, pin 25, and switching circuits for remotely selecting internal or external subcarrier referenced operation.

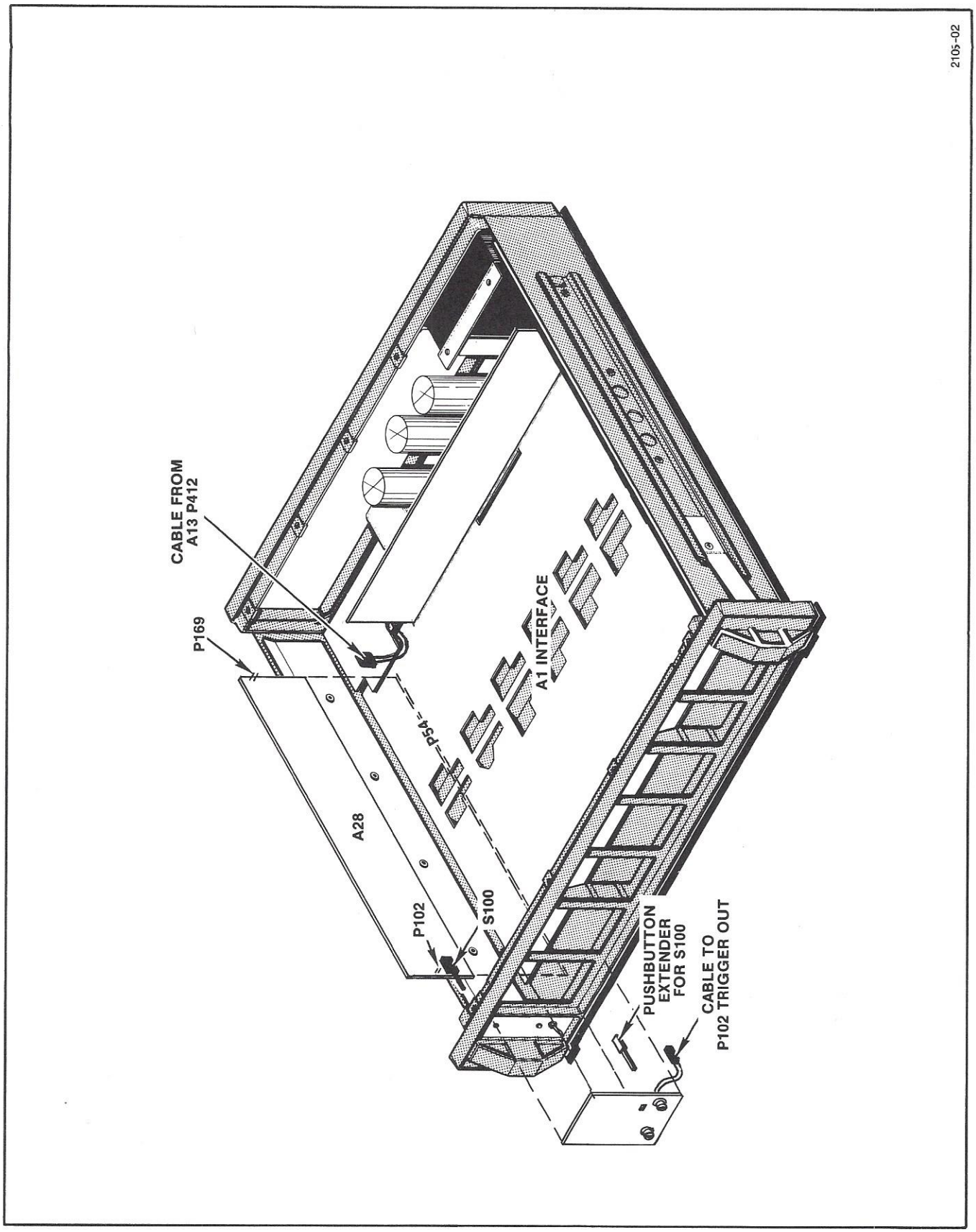

Fig. 3-1. SPG3 Installation.

Install the circuit board A28 next. The board must be installed on row P54 of the Interface board A1. Align the board guides over the three black guidepins and set the board firmly down on the Interface board. Check all pins for proper alignment and connection. Referring to Fig. 3-1, connect the brown-striped coaxial cable to P169 on the Timing Drive board A28. This brings subcarrier to the Timing Drive board. Connect the red-striped wire coaxial cable to P102 of A28. Install the pushbutton extender on the shaft of S100.

Before mounting the front panel on the 1410 mainframe, solder the red-striped coaxial cable to the TRIGGER connector, the plain white calbe to the SUBCARRIER connector, and the orange-striped cable to the HORIZ UNLOCK pushbutton switch. Center-conductor orientation is not critical on the HORIZ UNLOCK switch. Place the front panel in position, guiding the pushbutton extender through the panel slot, and secure to the mainframe with the two screws provided.

After installation, proper operation of the SPG3 can be verified using the Performance Check Procedure in Part I.

OPERATING MODE SELECTIONS

There are three plug-jumpers on Timing Drive board A28 that can be used to alter the operating mode of the generator system. This portion of the section explains their use.

P134 Split Field

The Color Bars Test Signal Generator Module generates several split field displays. In all cases, these split field displays have color bars in the first portion of the field and some other signal component (such as −I, white, Q and black, or red signal, etc.) in the second portion of the field. P134 is used to select the time duration of the second portion of the field. With pins 1 and 2 connected together, the split is one-half of the field in the first portion and one-half in the second except for EIA Color Bars, which are always split three-fourths in the first and one-fourth in the second. With P134 pins 2 and 3 connected, the field is split three-fourths in the first portion and one-fourth in the second.

P112 PAL Pulse, P113 PAL Pulse Phase

P112 and P113 control features not presently used in NTSC systems. P112 selects either a pulse occurring at sync time on alternate lines, or a square-wave that alternates polarity on alternate lines. P113 selects either the set of alternate lines the pulse appears on, or for which set of alternate lines the square-wave is high.

Internal/External Subcarrier Reference

A wire is installed on 1410 Interface board, row P52, between pins 56 and 87. This allows switching from internal to external subcarrier reference. To select external subcarrier reference, ground 1410 rear-panel Remote connector pin 25. With Remote connector pin 25 open, internal subcarrier reference is selected.

To reference the SPG3 to an external subcarrier continuously without using the 1410 Remote connector, ground P52, pin 56 by moving the strap from pin 87 to pin 80.

RECALIBRATION PROCEDURE

INTRODUCTION

This procedure can be used to either verify that the instrument is performing to rated specifications, or to recalibrate it after repairs or long periods of operation. A short form procedure precedes the Recalibration Procedure and can be used as a calibration record and as an index to the complete procedure.

In the complete procedure, steps or parts of steps that relate to performance checks only are identified by the word "Check" in the step heading. Those steps that pertain both to performance checks and calibration steps are headed "Check/Adjust".

Front-panel control and connector names on the SPG3 are capitalized, for example: HORIZ/VERT trigger. Control and connector names on test equipment or the 1410 mainframe and internal controls in the SPG3 have only the first letter capitalized, for example: Test Oscilloscope Time/Div, 1410 rear-panel Subcarrier input, or SPG3 Line Frequency control.

See the circuit board illustration in Section 8, Servicing Illustrations for adjustment locations.

TEST EQUIPMENT

The test equipment listed here was used in preparing this procedure. The measurement capabilities described are the minimum required to recalibrate the instrument. Each piece of test equipment is assumed to be operating within its stated specifications. If alternative equipment is used, it must meet or exceed these requirements.

1. Test Oscilloscope

A Tektronix 7603 with 7B53A Option 5 Dual Time Base, 7A13 Differential Comparator, and 7A18 Dual Trace Amplifier was used for this procedure, minimum specifications for substitute equipment are as follows:

Dual Time Base. Range from 50 ns/Div to 5 s/Div with provisions for a delaying sweep and television triggering.

Differential Comparator. Bandwidth, dc to 30 MHz; minimum deflection factor, 1 mV/Div; two channels capable of differential operation.

Dual Trace Amplifier. Vertical amplifier independent of the Differential Comparator. Bandwidth, dc to 30 MHz; minimum deflection factor, 5 mV/Div.

2. 75 Ω Feed-Through Termination with bnc connectors

Tektronix Part Number 011-0103-02.

3. 75 Ω Cable with bnc connectors

42 inches long. Tektronix Part Number 012-0074-00.

4. P6053B 10X Probe

Tektronix Part Number 010-6053-11.

5. Test Signal Generator

A test signal generator module (TSG1, TSG2, TSG3, TSG4) mounted in the 1410 along with the SPG3. The test signal generator signal must contain a subcarrier portion of 0 APL with more than 19 cycles of subcarrier.

6. Video Signal Source

Capable of generating a 2 volt peak-to-peak subcarrier signal (for example, a Tektronix 1410 with SPG1, SPG2, or SPG3; or a Tektronix 146).

7. Waveform Monitor

Capable of overlaying one portion of a line sweep display on another portion and having sweep magnification to at least .1 μs/Div (for example, a Tektronix 1480-series).

EQUIPMENT SETUP

1. Test Oscilloscope

(A 7603 with the 7B53A Option 5 in the right compartment, the 7A18 in the left compartment, and the 7A13 in the center compartment.)

7603

Power	On
Readout, Intensity, Grat Illum, Focus	Best Display
Vert Mode	Left
Trig Source	Left

7A13

+Input	DC
−Input	DC
Volts/Div	.1
Variable	Cal
BW	Full

7A18

CH 1 and CH 2	
Volts/Div	1
Variable	Cal
Coupling	DC
Trigger Source	CH 1
Display Mode	Alt
CH 2 Polarity	+Up

7B53A

Main Triggering	
Mode	Auto
Coupling	AC
Source	Int
Time/Div	10 μs
Variable	Cal
Mag	X1

2. 1410 with SPG3 and Test Signal Module

1410

Power	On
Test Signal Module	Set for signal containing subcarrier at 0 APL

SPG3

HORIZ/VERT trigger	Pressed (HORIZ)
HORIZ UNLOCK	Open

Before starting the Recalibration Procedure, mount Timing Drive board A28 on 1410 Extender board A2. The Extender board allows easy access to the controls on the Timing Drive board.

SHORT FORM PROCEDURE

PROCEDURE

1. Check/Adjust Line Frequency (C149)

a. Connect the 10X probe from the Test Oscilloscope CH 1 Vertical Input to line 55 on the 1410 Interface board.

b. Connect the Video Signal Source Subcarrier output to the 1410 rear-panel Subcarrier loop-through input.

c. Ground 1410 Interface line 56 in the vicinity of Timing Drive board A28 (P53 or P55, line 80, for example). This references the SPG3 to external subcarrier.

d. Check—The dc level at line 55 as displayed on the Test Oscilloscope should be about +2 V.

e. Adjust—C149 (Line Frequency) for about +2 V dc level on line 55.

f. Display composite video signals from the Test Signal module in the 1410 and from the Video Signal source simultaneously on the Test Oscilloscope. Externally trigger the Test Oscilloscope from the Video Signal source.

g. Check—Line sync on the two displayed signals should be locked but not coincident because it is only subcarrier locked.

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2. Check/Adjust Burst Gate Timing (R114, R118)

a. Remove the ground from 1410 Interface line 56.

b. Display the SPG3 SUBCARRIER and the signal from the Test Signal module simultaneously on the Test Oscilloscope. Trigger the Test Oscilloscope externally with the SPG3 VERT TRIGGER.

c. Using the Test Oscilloscope delayed sweep function, view the line sync area with the main sweep at a field rate and the delayed sweep at about 2 μs/Div.

d. Check—There should be 19 cycles of subcarrier between the leading edge of line sync and the start of burst.

e. Adjust—R114 (Burst Delay) for 19 cycles of subcarrier between the leading edge of line sync and the start of burst.

f. Check—Burst should be 9 cycles of subcarrier in width.

g. Adjust—R118 (Burst Width) for 9 cycles of subcarrier burst width.

3. Check/Adjust Color Bars Horizontal Shift (R113)

a. Connect the 10X probe from the Test Oscilloscope to 1410 Interface line eight.

b. View the horizontal blanking portion of the display at about 2 μs/Div. Use HORIZ TRIGGER to externally trigger the Test Oscilloscope.

c. Rotate R113 (Color Bars Horiz Shift) throughout its range. Note that at one end of the range a spike appears just before the falling edge of the blanking portion of the waveform, and at the other end of the range the first timing pulse jumps in 100 ns increments.

d. Adjust—R113 (Color Bars Horiz Shift) so that the spike just disappears. Note the position of R113 at this point. Continue rotating the control until the timing pulses jump. Set R113 half-way between these two points.

4. Check/Adjust SCH Phasing (R159)

a. Connect the Test Signal module output to the Waveform Monitor A Video Input. Set the Waveform Monitor to view two video lines.

b. Using the Waveform Monitor Waveform Comparison controls, overlay the second display line sync pulse on the first displayed color burst.

c. Set the Waveform Monitor Mag to 2 μs/Div.

d. Rotate the Waveform Monitor Horizontal Position control to view the spot on the display where the second color burst overlays the 0 APL subcarrier portion of the signal.

e. Adjust the Waveform Monitor Waveform Comparison Overlay control so that the second color burst and 0 APL subcarrier are exactly in phase.

f. Rotate the Waveform Monitor Horizontal Position control to view the portion of the display where the second line sync pulse and color subcarrier overlay.

g. Check—The 50% point on the leading edge of the line sync pulse should coincide in time with a zero crossing of the color subcarrier.

h. Adjust—R159 (SCH Phasing) for time coincidence of the leading edge of line sync and a zero crossing of the color subcarrier.

5. Check TRIGGER Amplitude

a. Connect the TRIGGER output to the Test Oscilloscope vertical CH 1 input.

b. Check—The displayed amplitude should be approximately 1 volt.

6. Check TRIGGER Timing

a. Connect the Test Signal module output to the Test Oscilloscope vertical CH 2 input.

b. Select HORIZ TRIGGER (button pressed in).

c. Check—The HORIZ TRIGGER signal duration should be from the start of line blanking to the end of line sync.

d. Release the HORIZ/VERT trigger button.

e. Set the Test Oscilloscope Dual Time Base main sweep speed to 2 ms, and the delayed sweep speed to .1 ms.

f. Using the delayed sweep function view the vertical interval region of the display.

g. Check—The VERT TRIGGER signal duration should be nine lines starting at vertical blanking.

7. Check SUBCARRIER Amplitude

a. Connect the SUBCARRIER output through 75 Ω cable and 75 Ω termination to the Test Oscilloscope vertical input.

b. Check—The SUBCARRIER amplitude should be 2 volts ±0.2 volt.

8. Check HORIZ UNLOCK

a. Display the Test Signal module output on the Test Oscilloscope.

b. Press the HORIZ UNLOCK button.

c. Check—The subcarrier portion of the signal should free run.

9. Check Timing Outputs

a. Check—Using the 10X probe from the Test Oscilloscope, check for proper outputs at the following Interface lines.

Interface line	Signal	Interface line	Signal
2	PAL Pulse	25	Comp Sync
3	Delayed H	26	Vert Blanking
7	H Drive	27	1/2-3/4 V
8	CB Timing	33	Field Sq. Wave
9	H Blanking	34	H*
10	Comp Blanking	35	H
11	Burst Gate	36	V/2
12	Vert Drive	37	V/4
13	Burst Gate Start	38	16H
		39	Window
		40	5 MHz
21	H/4	41	1 MHz
22	H/2	42	2H
23	H Crosshatch	43	4H
24	V Crosshatch	44	8H

NOTE

If U119 (40-pin MOS-LSI package) is replaced, check for TTL-switching spikes in the timing outputs H, H, 2H, 4H, 8H, and 16H (use Extender board A2). If spikes are present and greater than +0.4 V on any of the outputs, add capacitors or resistors, or both, to the appropriate signal lines, at the locations designated on Diagram 1a, according to the following guidelines:*

Signal	Circuit Numbers	Suggested Values and Ratings
H H* 2H 4H 8H 16H	U118A, C113 U118B, C115 U135A, C132 U135B, C133 U135C, C134 U135D, C135	Use axial lead, tubular ceramic caps of 100 V, 10% ratings. Start with small values. Nominal value should be 47 pF. Maximum value should not exceed 150 pF. Mount caps on back side of board.
4H 8H 16H	U119, R134 U119, R135 U119, R111	Use 5%, 0.25 W rated resistors. Nominal value should be 39 kΩ but can be smaller. Retain some resistance for pull-down on these outputs of the MOS device.

Retain any factory installed parts for the replaced device.

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THEORY OF OPERATION

This section is divided into two main parts. First is a basic overview of instrument operation that describes circuit relationships and signal flow as illustrated by the Block Diagram. Second is a more detailed discussion of each of the circuit diagrams.

The circuit diagrams are blocked off according to circuit function. These circuit block titles are used as indices 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.

BLOCK DIAGRAM DESCRIPTION

The 10 MHz (640H) oscillator output is divided by two to provide the 5 MHz (320H), two-phase clock required by the sync generator circuit. The sync generator circuit is actually driven by the clock driver circuit which steps the 5 MHz signal up to about 30 volts in amplitude.

The sync generator generates the sync and timing signals needed by the rest of the system and routes them either to other circuits on this board or to the 1410 Interface board for distribution.

The trigger output circuit accepts V drive and H drive signals from the sync generator and buffers them for routing to the front-panel TRIGGER connector. This signal output is present mainly for use as an external trigger for a Test Oscilloscope.

The phasing pulse control circuit generates an alternate line, selectable pulse, or square-wave. In European PAL television, this signal is known as the PAL pulse, and is used to ensure proper burst phasing on consecutive television lines. In the NTSC system this phasing pulse is not used.

The Gray coding circuit alters some pulses derived from 64H into a Gray code reflection of the original signals. These Gray coded 64H derivatives are used to drive a programmable read-only memory circuit in the color bars timing circuit.

The burst timing circuit delays and sets the pulse width of the burst gate start pulse from the sync generator. This output provides timing information for the generation of color burst in other modules.

The color bars timing circuit receives the Gray coded 64H derivatives and generates the proper timing and split-field information for the Color Bars Test Signal Generator module, TSG1.

The SCH phase processing circuit receives subcarrier either from the 1410 subcarrier oscillator, or from an external source, multiplies it by two and divides it by 455. The divider output is compared to U119's output by a phase-locked loop and an error signal is applied to the 640H oscillator as a control voltage.

CIRCUIT DESCRIPTION

Diagram 1a

Oscillator

Q146 is the active component of a Pierce Oscillator operating at a 640H rate (approximately 10 MHz). The frequency is determined by C149, C143, and L148. C149 provides frequency tuning of the oscillator with fine-tuning done by varicap CR145. The setting of C149 determines the pull-in range of the oscillator.

Clock Drivers

The 640H oscillator output is divided by two and phase-split by U136A and applied to two push-pull amplifiers. The amplifiers receive the TTL-amplitude 320H clock pulses and step the signal up to nearly 30 volts, as required by U119.

Sync Generator and Output Buffers

U119 is a MOS LSI circuit that accepts the 320H clock pulses and generates timing pulses as required for operation of the rest of the system.

The 320H clock is counted down in U119 to 64H (1 MHz). The 64H output is then counted down in U119 to H. Each interval of the count down from 64H to H is an individual output of U119 (pins 17, 18, 19, 20, 22, 23, 24).

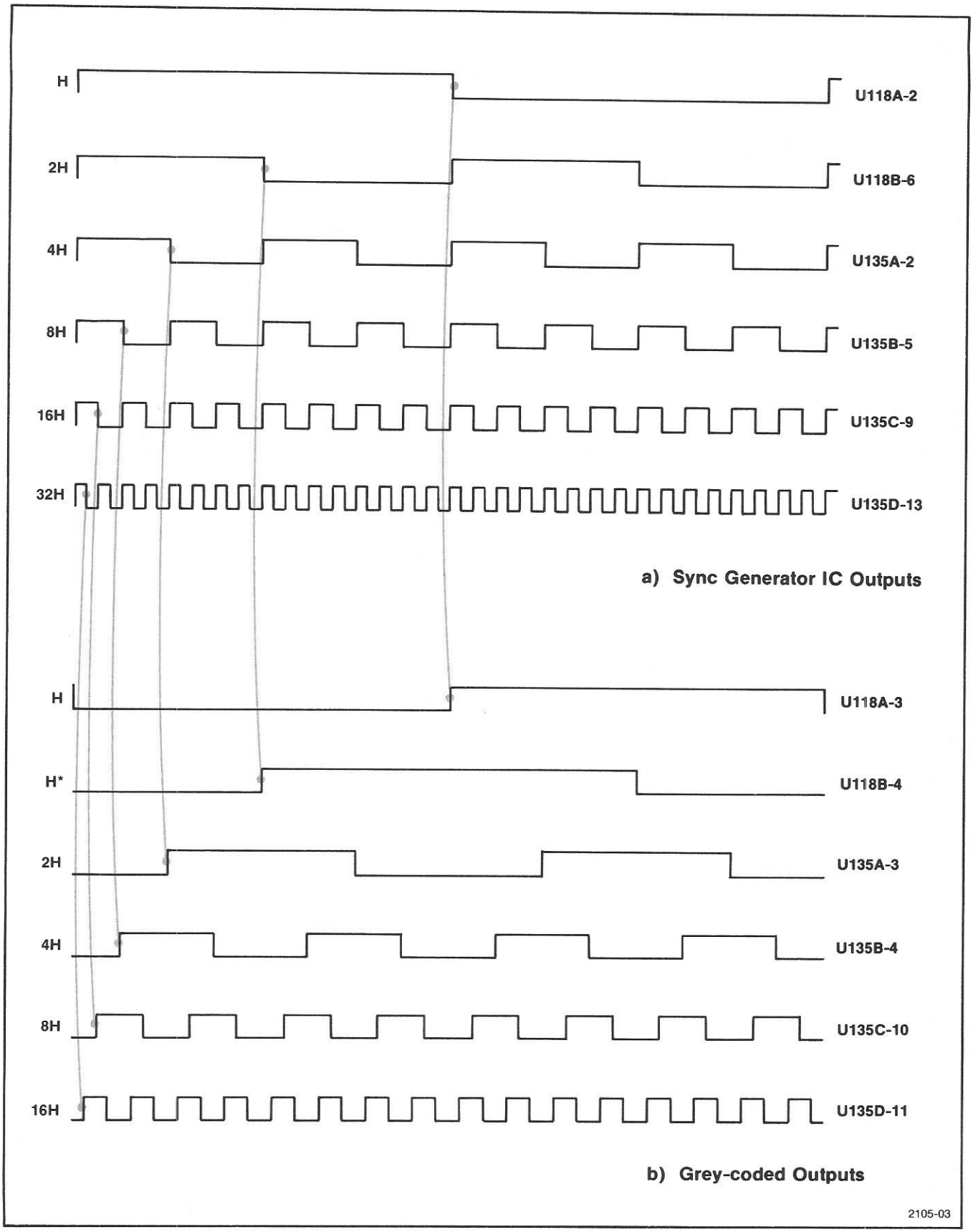


Fig. 5-1. H Timing Diagram.

The 64H derivatives, from 32H to H, are applied to a series of exclusive-or gates prior to the buffer amplifiers. The exclusive-or gates modify the sync generator outputs (Fig. 5-1a) into a Gray code (Fig. 5-1b) reflection of the original signals. See H Timing Diagram, Fig. 5-1.

Each of the timing signals from U119 is applied to a buffer amplifier that reduces signal amplitude, making it compatible with the TTL logic that follows.

The outputs of the Output Buffers are applied to the 1410 Interface board for routing.

Burst Timing

The positive-going leading edge of the burst gate start pulse from U119 pin 32 clocks U116A. U116A is one-half of a dual monostable multivibrator with variable output pulse width as controlled by the external timing components, C116, R115, and R114, the Burst Delay control. R114 is adjusted for breezeway width.

The trailing edge of the pulse from U116A pin 4 clocks U116B, the second half of the dual monostable multivibrator package. C117, R117, and R118, the Burst Width control, are the external timing components for this device. R118 is adjusted for burst width. The output from U116B is applied to the 1410 Interface board through U110A, which is connected as an inverter.

Trigger Output

H drive from U119 pin 33 and V drive from pin 36 are applied to a pair of exclusive-or gates U118D and U118C, which act as buffers. The front-panel HORIZ/VERT trigger switch S100 is used to select which of the two signals appears at the front-panel TRIGGER connector.

Phasing Pulse Control

U115A generates a signal of the type normally used in PAL television systems to regulate subcarrier phase on alternate lines. The output can be either a pulse or a square wave. H/2 is a square wave with its starting point at the start of H blanking. This signal drives U115A's D input, determining U115A's output phase. U115A is clocked by a signal from U119 pin 24 that is coincident with line sync. If a square wave is desired, P112 is open (pins 1 and 2 connected), leaving U115A's preset input high. If a pulse output is desired, P112 connects U115A's preset input to the H drive pulse (pins 2 and 3 connected) and U115A is reset at the end of H drive.

Diagram 1b

Color Bars Timing

This circuit generates a series of pulses related to horizontal line timing used by the Color Bars Test Signal Generator module, TSG1, to time the individual bars sequence.

A two-stage seven-bit binary counter, U141 and U142, counts down from the 640H clock to provide proper timing. The output timing is altered by command from the TSG1 when EIA color bars are desired.

U141 and U142 are data-loaded to counts determined by U132B and U132D, and U122A and U122B. In the full-field mode, the data load is a count of 63. The counter then divides by 65, resulting in a time between output pulses of 6.5 μs. The TSG1 module then uses the timing pulses to generate color bars with a bar width of 6.5 μs.

In the EIA mode, Interface line 47 is set low by the EIA switch in the TSG1 module. U132C and U136B alter the data count three-fourths of the way through the field. For the first three-fourths of the field, the counter is loaded to a count of 53. The counter divides by 75, resulting in 7.5 μs bar widths. For the last one-fourth of the field, the data load is changed to 34, the counter divides by 94, and the −I, W, and Q bars are generated. The Q output of U136B is also used by the TSG1 module to time the split field displays. P134 determines the timing, either one-half field or three-fourths, one-fourth field split. If the TSG1 is in the EIA mode, a low on 1410 Interface line 47 ensures a three-fourths, one-fourth field split.

SCH Phase Processing

U166, U162, and U161A, B, and C form a X2 multiplier. Subcarrier from the 1410 Subcarrier Oscillator or from an external source is phase-split by analog voltage comparator U166. Each of U166's outputs is applied to a pulse narrowing network formed by a 'nand' gate and three inverters. The three inverters delay the pulses by about one-fourth of a subcarrier cycle.

The outputs of U161A and U161B are at the subcarrier rate, but only one-fourth of a subcarrier cycle in duration. These two outputs are applied to U161C which acts as a negative-input 'or' gate. The output of U161C is twice the subcarrier rate with a 50% duty cycle and becomes the clock for the divide-by-455 counter.

The counter divides the twice-subcarrier-rate clock by 455, generating an accurate H-rate signal at U152 pin 14. U156, U165, and U152 are loaded to a count of 1,592 by the command fed back from U152 pin 15. Following the load command, the counter counts to 2048, dividing the clock by 455.

The counter output clocks a monostable multivibrator, U155, which delays the H-rate signal by an amount determined by R159. The output of U155 is applied to phase-locked loop U151, where it is compared with H blanking. The phase-locked loop output is routed as a control voltage back to the 640H oscillator on Diagram 1a to maintain accurate oscillator control.

MAINTENANCE

INTRODUCTION

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 maintenance schedule can improve instrument reliability. How often the maintenance is performed should be determined by the severity of the operating environment. Turn off the instrument power and disconnect the power cord before cleaning the module.

Cleaning

Dust accumulating on the circuit board 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.

CAUTION

Some chemical cleaning agents can damage the plastics used in this instrument. Do not use chemicals that contain benzene, toluene, xylene, or similar solvents.

The best way to remove heavy accumulation 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 board is properly seated on the 1410 Mainframe Interconnect jacks. 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-damage 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.

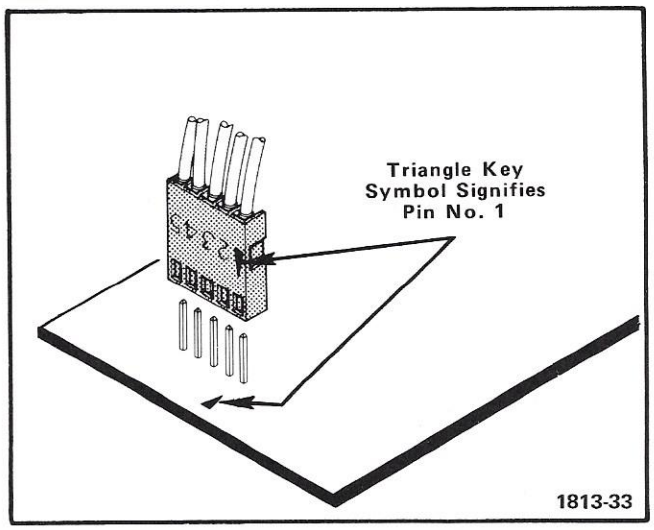


Fig. 6-1. Multipin circuit board connector.

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.

TROUBLESHOOTING

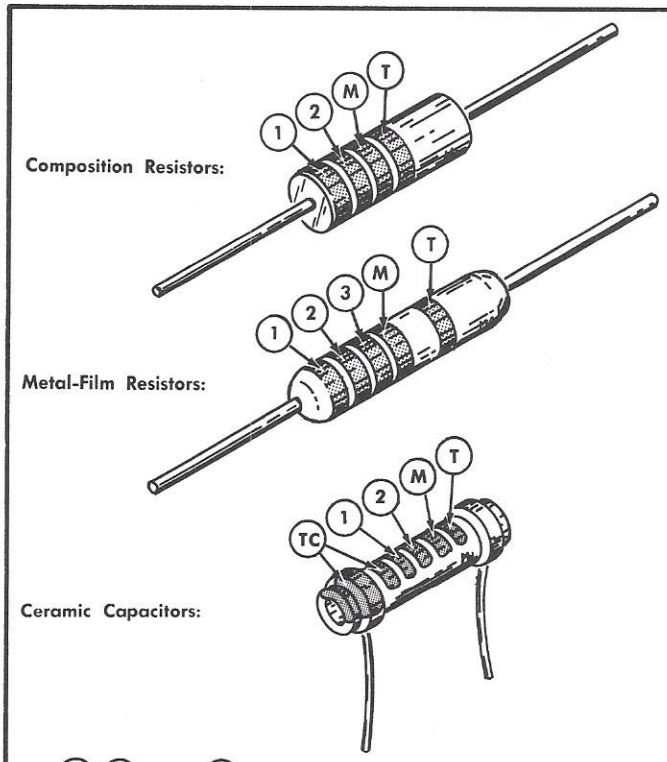
Information contained here may be used as a guide in locating circuit failures. The schematic diagrams, circuit description, and calibration sections should be referred to for fast, efficient location and repair of defects.

Diagram

The circuit diagram is shown on the foldout page in Section 9. The circuit number and electrical value of each component are shown on the diagram. Important waveforms are also shown.

Circuit Board

The circuit board is outlined in blue on the schematic diagram. The circuit board illustration is provided on the back of the foldout page that precedes the relevant diagram. The assembly number assigned to the circuit board is an abbreviated method of identifying the board.



(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. Color code for resistors and ceramic capacitors.

The circuit board is illustrated on the back of the Block Diagram foldout page. Circuit numbers are assigned on a grid system to faciliatate component location. Low numbers start at the lower front corner of the board increasing from front to rear and bottom to top.

When troubleshooting the circuit board in the instrument, the use of an extender board facilitates access to the board connections and components. Removing the circuit board to the extender board will save time in looking for faults.

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.

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.

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	

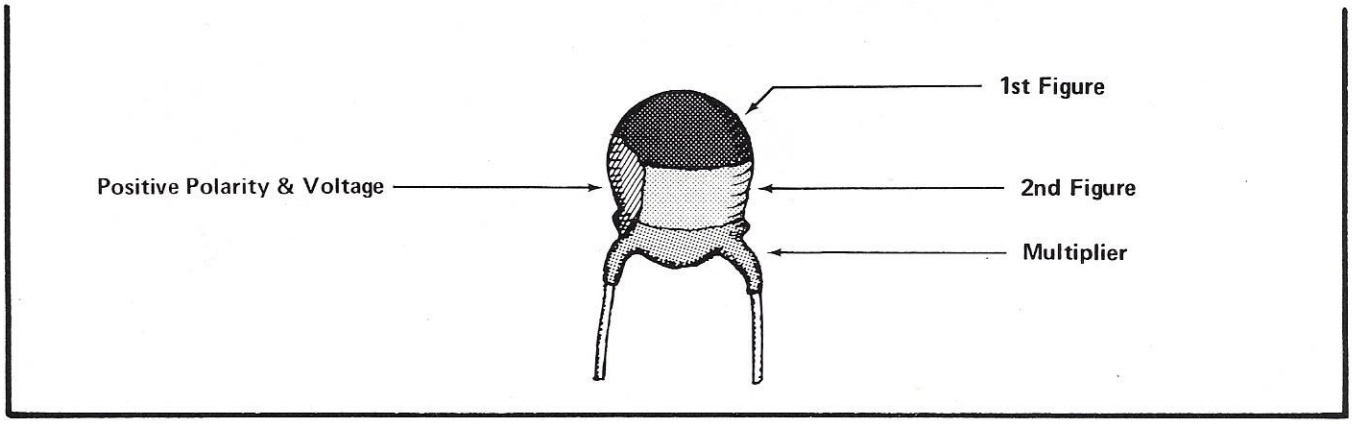


Fig. 6-3. Color coding for dipped tantalum "tear-drop" capacitors.

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 board.

IC Diagrams

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

Troubleshooting Equipment

The following test equipment is useful for troubleshooting the generator circuits.

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 576 will give the most complete information.

Troubleshooting Procedure

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

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

2. Check Associated Boards. Before troubleshooting a board, make sure that other boards on the Interconnect 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.

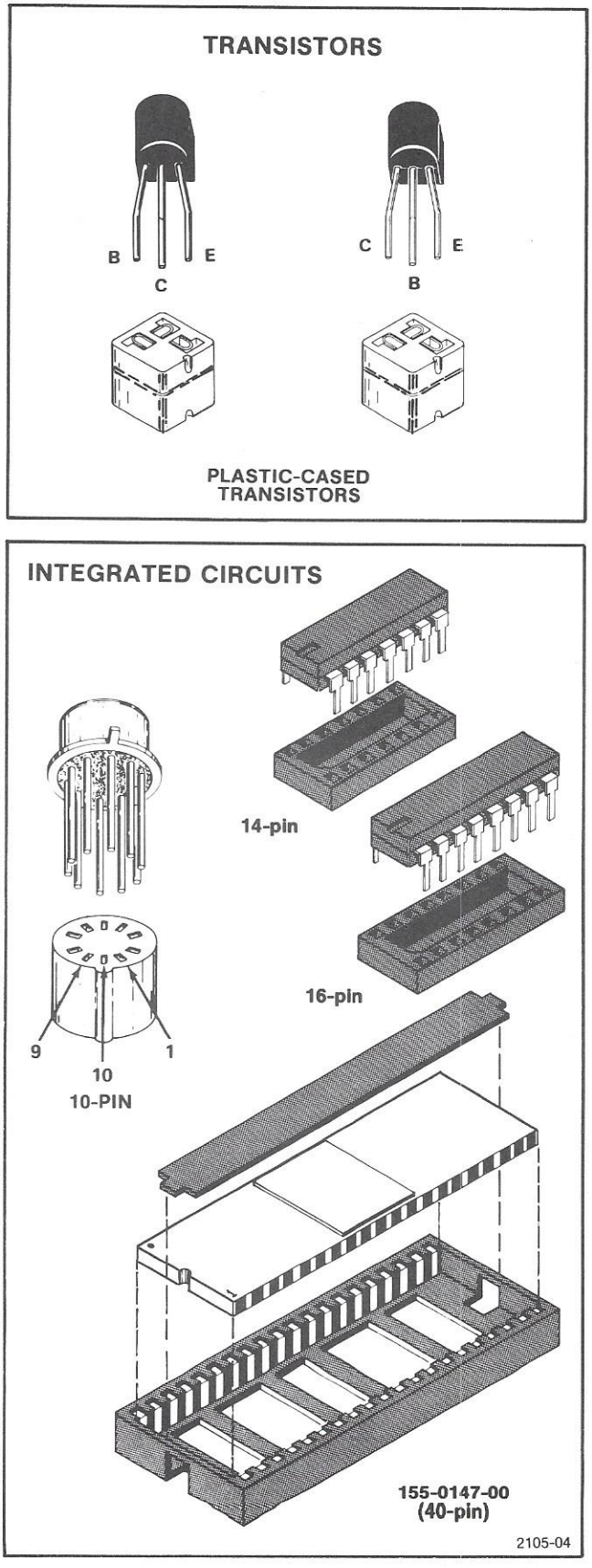


Fig. 6-4. Basing diagrams for semiconductors.

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

CAUTION

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

WARNING

'Ground lugs' are not always at ground potential. Check the diagram before using such connections as a 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 576) 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

Repair 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 power input from the mainframe 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 Section 9 fo this manual.

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 pushbutton extenders by pulling them straight out from the front panel until the board controls are free. Remove the plastic retaining clips from the top of the boards.

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

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

Interconnecting Pins. To replace a pin which is mounted on a circuit board, first disconnect any pin connectors. Then, unsolder the damaged pin and pull it out of the board with a pair of pliers. Be careful not to damage the wiring on the board with too much heat. Ream out the hole in the circuit board with a 0.032-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 IC's

Transistors and IC's 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

Disconnect the power input from the mainframe before removing or replacing semiconductors.

Any replacement component should be of the original type or a direct replacment. 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.

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

CROSS INDEX—MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip
00853	SANGAMO ELECTRIC CO., S. CAROLINA DIV.	P O BOX 128	PICKENS, SC 29671
01121	ALLEN-BRADLEY COMPANY	1201 2ND STREET SOUTH	MILWAUKEE, WI 53204
01295	TEXAS INSTRUMENTS, INC., SEMICONDUCTOR GROUP	P O BOX 5012, 13500 N CENTRAL EXPRESSWAY	DALLAS, TX 75222
02735	RCA CORPORATION, SOLID STATE DIVISION	ROUTE 202	SOMERVILLE, NY 08876
04713	MOTOROLA, INC., SEMICONDUCTOR PROD. DIV.	5005 E MCDOWELL RD,PO BOX 20923	PHOENIX, AZ 85036
07910	TELEDYNE SEMICONDUCTOR	12515 CHADRON AVE.	HAWTHORNE, CA 90250
18324	SIGNETICS CORP.	811 E. ARQUES	SUNNYVALE, CA 94086
24931	SPECIALTY CONNECTOR CO., INC.	3560 MADISON AVE.	INDIANAPOLIS, IN 46227
27014	NATIONAL SEMI-CONDUCTOR CORP.	2900 SAN YSIDRO WAY	SANTA CLARA, CA 95051
34371	HARRIS SEMICONDUCTOR, DIV. OF HARRIS-INTERTYPE CORP.	P. O. BOX 883	MELBOURNE, FL 32901
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
80009	TEKTRONIX, INC.	P. O. BOX 500	BEAVERTON, OR 97005
80031	MEPCO/ELECTA INC., A NORTH AMERICAN PHILLIPS CO.	COLUMBIA RD.	MORRISTOWN, NJ 07960
81073	GRAYHILL, INC.	561 HILLGROVE AVE.	LA GRANGE, IL 60525
90201	MALLORY CAPACITOR CO., DIV. OF P. R. MALLORY CO., INC.	3029 E. WASHINGTON ST.	INDIANAPOLIS, IN 46206
91418	RADIO MATERIALS CO.	4242 W. BRYN MAWR	CHICAGO, IL 60646
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
A28	670-4454-00			CKT CARD ASSY:TIMING DRIVE	80009	670-4454-00
C100	283-0023-00			CAP.,FXD,CER DI:0.1UF,+80-20%,10V	91418	MX104Z1201R0
C101	281-0662-00			CAP.,FXD,CER DI:10PF,+/-0.5PF,500V	72982	301-000H3M0100D
C111	283-0023-00			CAP.,FXD,CER DI:0.1UF,+80-20%,10V	91418	MX104Z1201R0
C112	283-0649-00			CAP.,FXD,MICA D:105PF,1%,300V	00853	D153F1050F0
C114	290-0782-00			CAP.,FXD,ELCTLT:4.7UF,+75-10%,35V	56289	503D475G035AS
C116	283-0649-00			CAP.,FXD,MICA D:105PF,1%,300V	00853	D153F1050F0
C117	283-0644-00			CAP.,FXD,MICA D:150PF,1%,500V	00853	D151E151F0
C118	283-0081-00			CAP.,FXD,CER DI:0.1UF,+80-20%,25V	56289	36C600
C119	283-0081-00			CAP.,FXD,CER DI:0.1UF,+80-20%,25V	56289	36C600
C121	290-0782-00			CAP.,FXD,ELCTLT:4.7UF,+75-10%,35V	56289	503D475G035AS
C125	283-0081-00			CAP.,FXD,CER DI:0.1UF,+80-20%,25V	56289	36C600
C126	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	72982	831-516E102P
C127	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	72982	831-516E102P
C128	281-0791-00			CAP.,FXD,CER DI:270PF,10%,100V	80009	281-0791-00
C129	281-0791-00			CAP.,FXD,CER DI:270PF,10%,100V	80009	281-0791-00
C131	283-0023-00			CAP.,FXD,CER DI:0.1UF,+80-20%,10V	91418	MX104Z1201R0
C141	283-0081-00			CAP.,FXD,CER DI:0.1UF,+80-20%,25V	56289	36C600
C143	283-0634-00			CAP.,FXD,MICA D:65PF,1%,100V	00853	D151E650F0
C144	283-0615-00			CAP.,FXD,MICA D:33PF,5%,500V	00853	D155E330J0
C146	283-0645-00			CAP.,FXD,MICA D:790PF,1%,100V	00853	D151E791F0
C147	283-0692-00			CAP.,FXD,MICA D:670PF,1%,300V	00853	D15-3F671F0
C149	281-0204-00			CAP.,VAR,PLSTC:2-22PF,100V	80031	C010EA-20E
C150	283-0081-00			CAP.,FXD,CER DI:0.1UF,+80-20%,25V	56289	36C600
C151	283-0023-00			CAP.,FXD,CER DI:0.1UF,+80-20%,10V	91418	MX104Z1201R0
C152	283-0081-00			CAP.,FXD,CER DI:0.1UF,+80-20%,25V	56289	36C600
C153	283-0198-00			CAP.,FXD,CER DI:0.22UF,20%,50V	72982	8131N075 E224M
C154	290-0536-00			CAP.,FXD,ELCTLT:10UF,20%,25V	90201	TDC106M025FL
C155	283-0023-00			CAP.,FXD,CER DI:0.1UF,+80-20%,10V	91418	MX104Z1201R0
C158	283-0649-00			CAP.,FXD,MICA D:105PF,1%,300V	00853	D153F1050F0
C160	281-0792-00			CAP.,FXD,CER DI:82PF,10%,100V	72982	390-043X5P820K
C161	281-0788-00			CAP.,FXD,CER DI:470PF,10%,100V	72982	8005H9AADW5R471K
C162	281-0788-00			CAP.,FXD,CER DI:470PF,10%,100V	72982	8005H9AADW5R471K
C163	283-0023-00			CAP.,FXD,CER DI:0.1UF,+80-20%,10V	91418	MX104Z1201R0
C164	283-0023-00			CAP.,FXD,CER DI:0.1UF,+80-20%,10V	91418	MX104Z1201R0
C169	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
CR101	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR102	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR145	152-0269-00			SEMICOND DEVICE:SILICON,VAR VCAP.,4V,33PF	80009	152-0269-00
J101	131-0955-00			CONNECTOR,RCPT:BNC,FEMALE	24931	28JR200-1
J102	131-0955-00			CONNECTOR,RCPT:BNC,FEMALE	24931	28JR200-1
L148	108-0088-00			COIL,RF:3.2UH	80009	108-0088-00
Q121	151-0402-00			TRANSISTOR:SILICON,NPN,SEL FROM 3571TP	80009	151-0402-00
Q122	151-0220-00			TRANSISTOR:SILICON,PNP	80009	151-0220-00
Q123	151-0402-00			TRANSISTOR:SILICON,NPN,SEL FROM 3571TP	80009	151-0402-00
Q124	151-0220-00			TRANSISTOR:SILICON,PNP	80009	151-0220-00
Q125	151-0220-00			TRANSISTOR:SILICON,PNP	80009	151-0220-00
Q126	151-0402-00			TRANSISTOR:SILICON,NPN,SEL FROM 3571TP	80009	151-0402-00
Q127	151-0220-00			TRANSISTOR:SILICON,PNP	80009	151-0220-00
Q128	151-0402-00			TRANSISTOR:SILICON,NPN,SEL FROM 3571TP	80009	151-0402-00
Q146	151-0188-00			TRANSISTOR:SILICON,PNP	01295	2N3906
R100	315-0112-00			RES.,FXD,CMPSN:1.1K OHM,5%,0.25W	01121	CB1125
R101	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035

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Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R102	315-0392-00			RES.,FXD,CMPSN:3.9K OHM,5%,0.25W	01121	CB3925
R111	315-0393-00			RES.,FXD,CMPSN:39K OHM,5%,0.25W	01121	CB3935
R112	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R113	311-1916-00			RES.,VAR,NONWIR:10K OHM,10%,0.5W	73138	72XL-R10K
R114	311-1916-00			RES.,VAR,NONWIR:10K OHM,10%,0.5W	73138	72XL-R10K
R115	321-0222-00			RES.,FXD,FILM:2K OHM,1%,0.125W	91637	MFF1816G20000F
R116	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R117	321-0318-00			RES.,FXD,FILM:20K OHM,1%,0.125W	91637	MFF1816G20001F
R118	311-1916-00			RES.,VAR,NONWIR:10K OHM,10%,0.5W	73138	72XL-R01K
R122	315-0150-00			RES.,FXD,CMPSN:15 OHM,5%,0.25W	01121	CB1505
R123	315-0150-00			RES.,FXD,CMPSN:15 OHM,5%,0.25W	01121	CB1505
R124	315-0181-00			RES.,FXD,CMPSN:180 OHM,5%,0.25W	01121	CB1815
R125	315-0181-00			RES.,FXD,CMPSN:180 OHM,5%,0.25W	01121	CB1815
R126	315-0150-00			RES.,FXD,CMPSN:15 OHM,5%,0.25W	01121	CB1505
R127	315-0150-00			RES.,FXD,CMPSN:15 OHM,5%,0.25W	01121	CB1505
R128	315-0181-00			RES.,FXD,CMPSN:180 OHM,5%,0.25W	01121	CB1815
R129	315-0181-00			RES.,FXD,CMPSN:180 OHM,5%,0.25W	01121	CB1815
R132	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R133	315-0272-00			RES.,FXD,CMPSN:2.7K OHM,5%,0.25W	01121	CB2725
R134	315-0393-00			RES.,FXD,CMPSN:39K OHM,5%,0.25W	01121	CB3935
R135	315-0393-00			RES.,FXD,CMPSN:39K OHM,5%,0.25W	01121	CB3935
R136	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R137	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R138	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R139	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R140	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R141	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R142	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R143	315-0151-00			RES.,FXD,CMPSN:150 OHM,5%,0.25W	01121	CB1515
R144	315-0473-00			RES.,FXD,CMPSN:47K OHM,5%,0.25W	01121	CB4735
R145	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R146	315-0621-00			RES.,FXD,CMPSN:620 OHM,5%,0.25W	01121	CB6215
R147	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R148	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R153	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R154	315-0512-00			RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
R155	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R158	321-0222-00			RES.,FXD,FILM:2K OHM,1%,0.125W	91637	MFF1816G20000F
R159	311-1916-00			RES.,VAR,NONWIR:10K OHM,10%,0.5W	73138	72XL-R10K
R165	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R166	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R167	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R168	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R169	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
S100	260-1132-00			SWITCH,PUSH:1 BUTTON,DOUBLE POLE	80009	260-1132-00
S142	260-0735-00			SWITCH,PUSH:SPST	81073	39-5
TP141	214-0579-00			TERM.,TEST PT:0.40 INCH LONG	80009	214-0579-00
TP144	214-0579-00			TERM.,TEST PT:0.40 INCH LONG	80009	214-0579-00
TP155	214-0579-00			TERM.,TEST PT:0.40 INCH LONG	80009	214-0579-00
TP164	214-0579-00			TERM.,TEST PT:0.40 INCH LONG	80009	214-0579-00
TP165	214-0579-00			TERM.,TEST PT:0.40 INCH LONG	80009	214-0579-00
U101	156-0733-00			MICROCIRCUIT,DI:DUAL MONOSTABLE MV,INP	01295	SN74LS221N
U107	156-0785-00			MICROCIRCUIT,DI:256 BIT PROM W/3 STATE OUT	01295	SN74LS163N

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
U110	156-0043-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NOR GATE	80009	156-0043-00
U111	156-0385-00			MICROCIRCUIT,DI:HEX.INVERTER	01295	SN74LS04N
U112	156-0504-00			MICROCIRCUIT,DI:HEX BUFFER	34371	HD1-4010-9
U113	156-0504-00			MICROCIRCUIT,DI:HEX BUFFER	34371	HD1-4010-9
U115	156-0388-00			MICROCIRCUIT,DI:DUAL D-TYPE FLIP-FLOP	01295	SN74LS74N
U116	156-0733-00			MICROCIRCUIT,DI:DUAL MONOSTABLE MV,INP	01295	SN74LS221N
U118	156-0786-00			MICROCIRCUIT,DI:QUAD EXCLUSIVE OR GATE	02735	CD4070BF
U119	155-0147-00			MICROCIRCUIT,DI:CIRCUIT TVGEN,40 LEAD	80009	155-0147-00
U121	156-0504-00			MICROCIRCUIT,DI:HEX BUFFER	34371	HD1-4010-9
U122	156-0385-00			MICROCIRCUIT,DI:HEX.INVERTER	01295	SN74LS04N
U131	156-0504-00			MICROCIRCUIT,DI:HEX BUFFER	34371	HD1-4010-9
U132	156-0043-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NOR GATE	80009	156-0043-00
U135	156-0786-00			MICROCIRCUIT,DI:QUAD EXCLUSIVE OR GATE	02735	CD4070BF
U136	156-0041-00			MICROCIRCUIT,DI:DUAL D-TYPE FLIP-FLOP	27014	DM7474N
U141	156-0784-00			MICROCIRCUIT,DI:SYNC 4-BIT BINARY COUNTER	01295	SN74LS163N
U142	156-0784-00			MICROCIRCUIT,DI:SYNC 4-BIT BINARY COUNTER	01295	SN74LS163N
U149	156-0112-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND GATE	01295	SN7426N
U151	156-0704-00			MICROCIRCUIT,LI:PHASE LOCK LOOP	04713	MC14046CP
U152	156-0784-00			MICROCIRCUIT,DI:SYNC 4-BIT BINARY COUNTER	01295	S75LS163N
U155	156-0072-00			MICROCIRCUIT,DI:MONOSTABLE MV,TTL	27014	DM74121N
U156	156-0784-00			MICROCIRCUIT,DI:SYNC 4-BIT BINARY COUNTER	01295	S74LS163N
U161	156-0030-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND GATE	01295	SN7400N
U162	156-0385-00			MICROCIRCUIT,DI:HEX.INVERTER	01295	SN74LS04N
U165	156-0784-00			MICROCIRCUIT,DI:SYNC 4-BIT BINARY COUNTER	01295	2N74LS163N
U166	156-0251-00			MICROCIRCUIT,DI:VOLTAGE COMPENSATOR	18324	E5059K/NE529K

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.

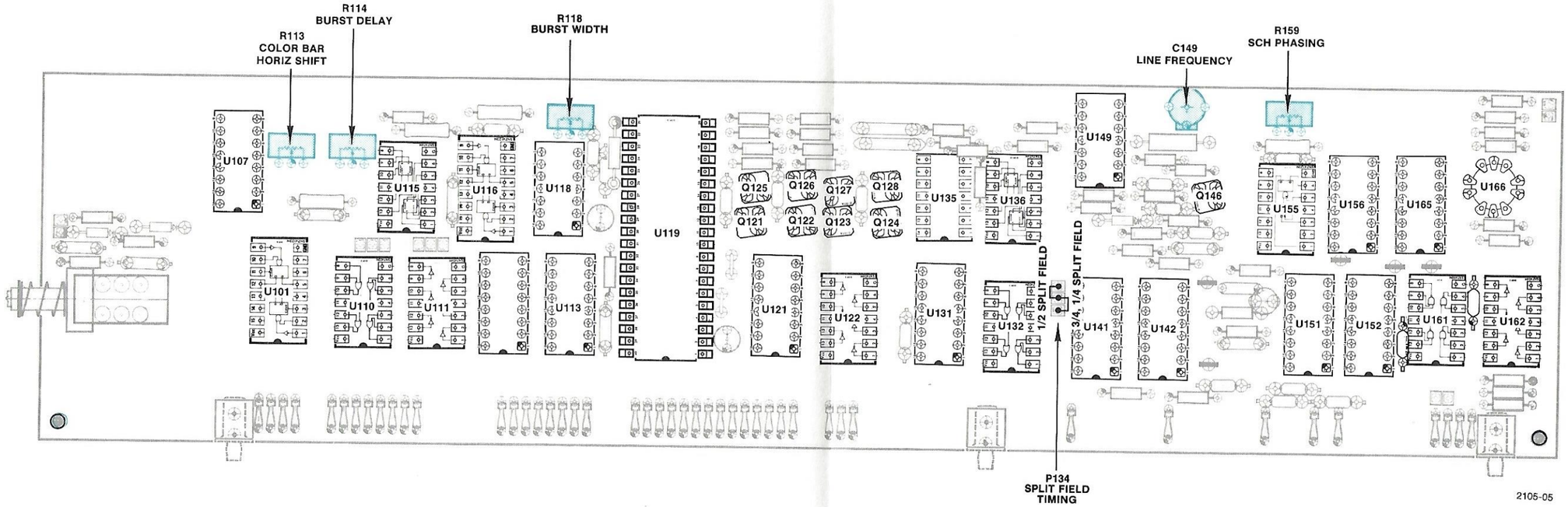
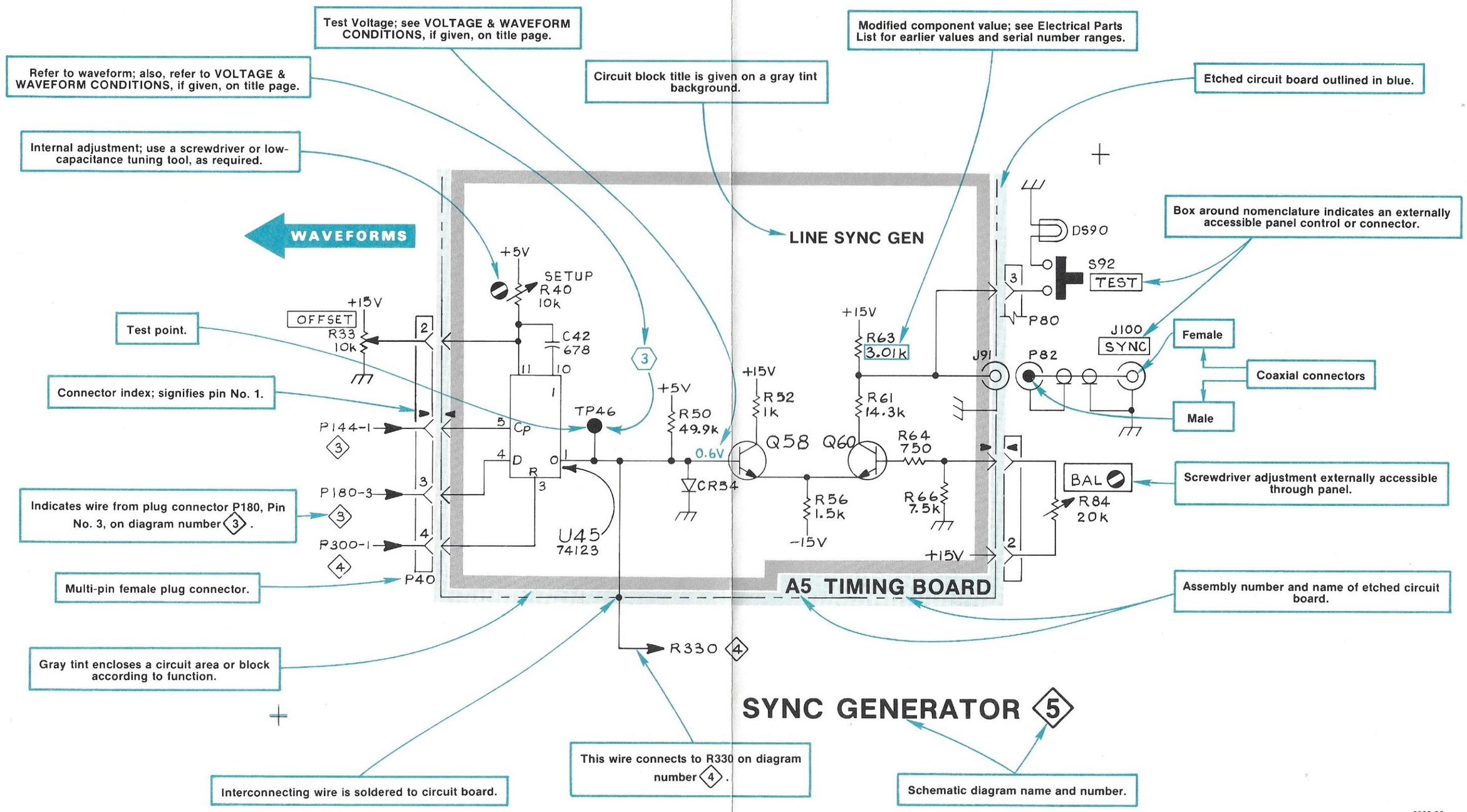


FIG. 8-1. A28 TIMING DRIVE ADJUSTMENT LOCATIONS AND JUMPERS



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

Waveform photographs in this section were taken with a TEKTRONIX C-59 Oscilloscope Camera mounted on a TEKTRONIX 7603 Oscilloscope with 7B53A Time Base and 7A13 Differential Comparator plug-ins.

The vertical input was dc coupled except for those waveforms identified as ac coupled.

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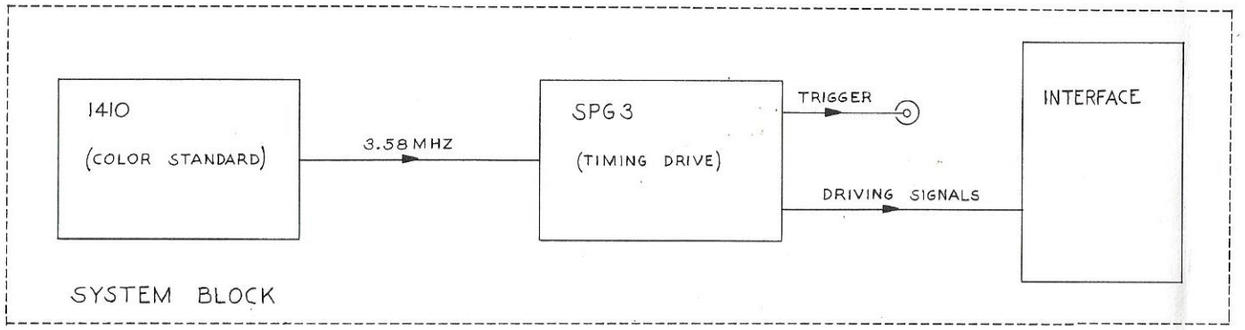
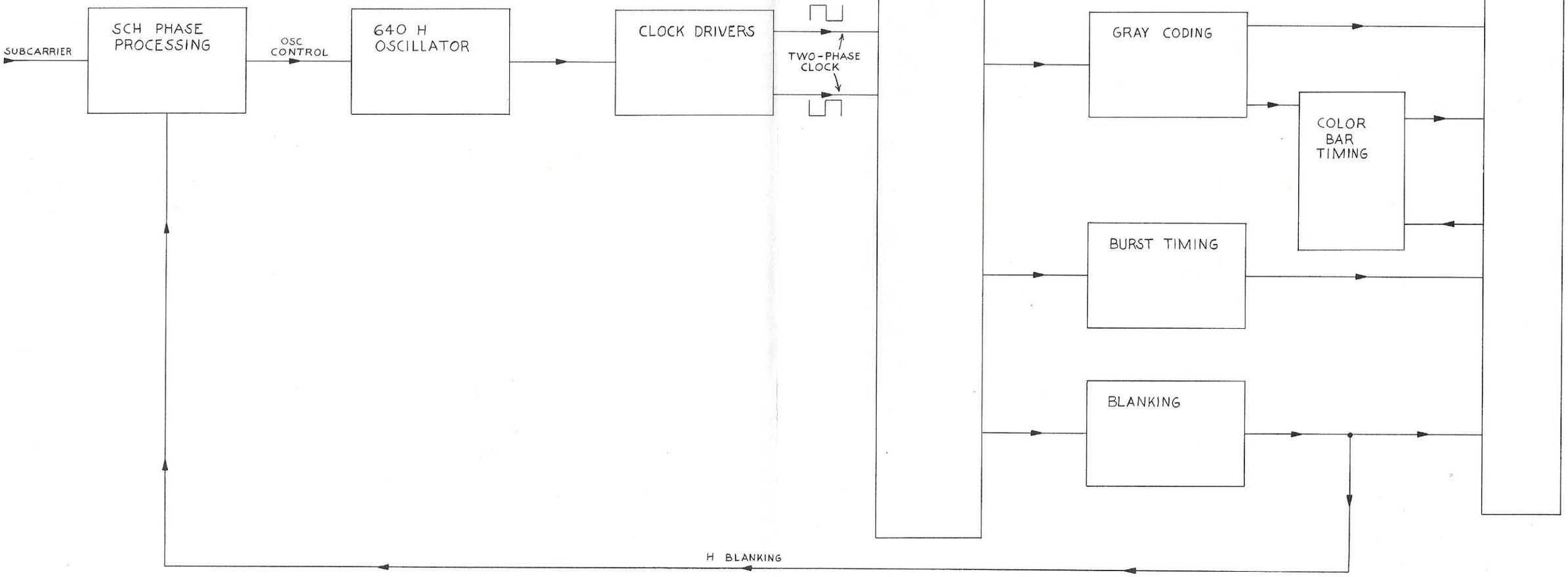
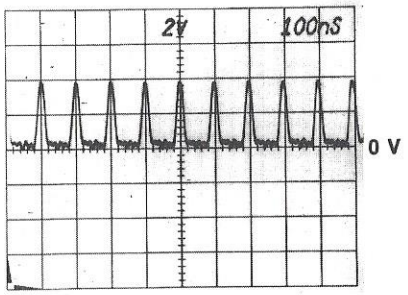




SPG 3 @ GEM 6/76 BLOCK DIAGRAM

BLOCK DIAGRAM

1 a



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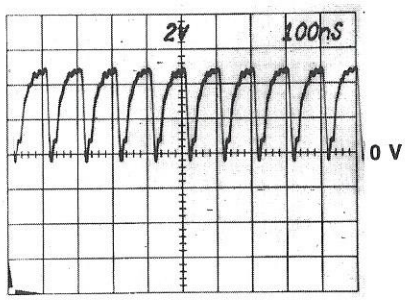

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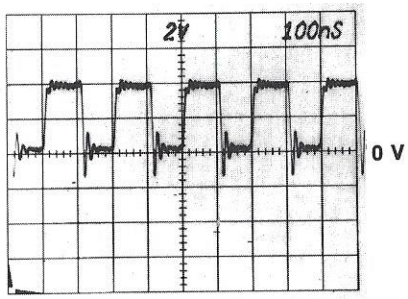

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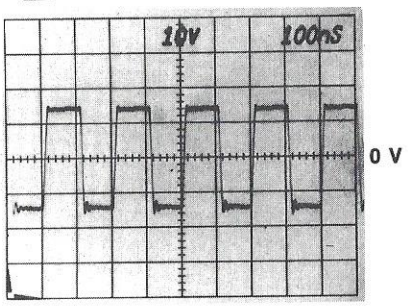

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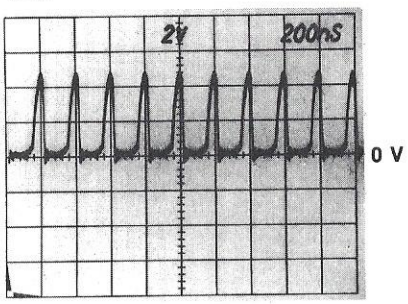

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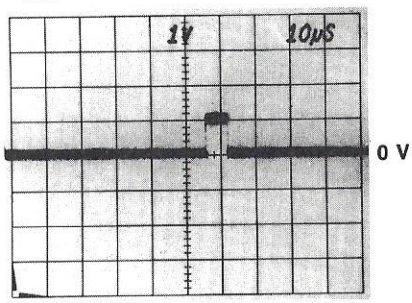
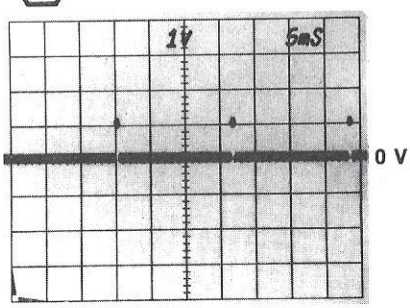
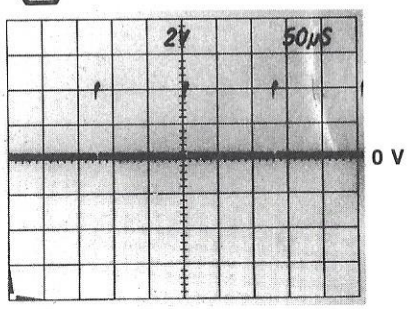


6 a



6 b



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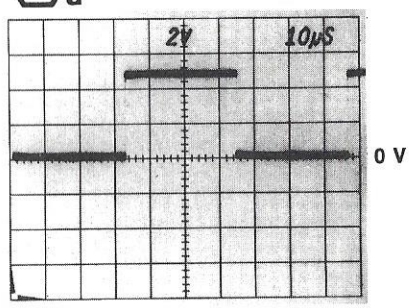

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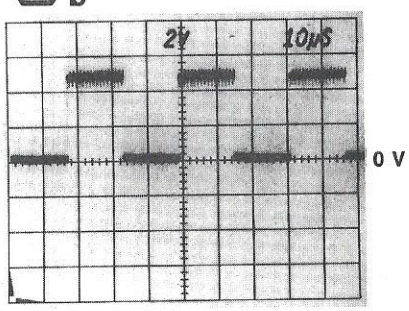

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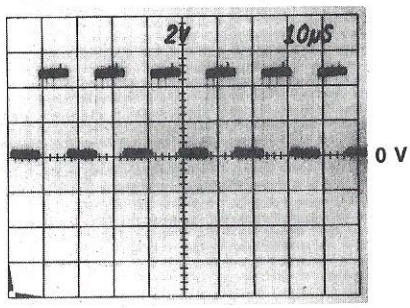

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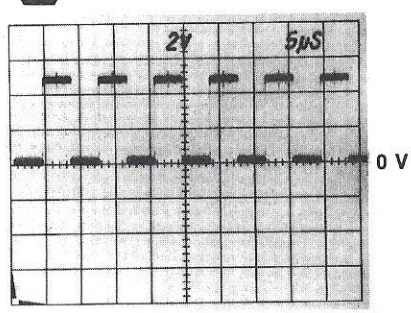

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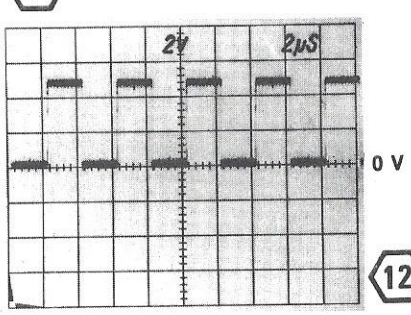

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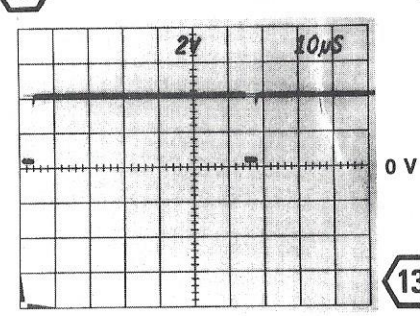

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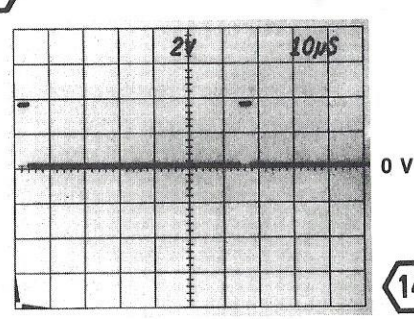

14

A28 TIMING DRIVE BOARD
AND WAVEFORMS FOR 1 a

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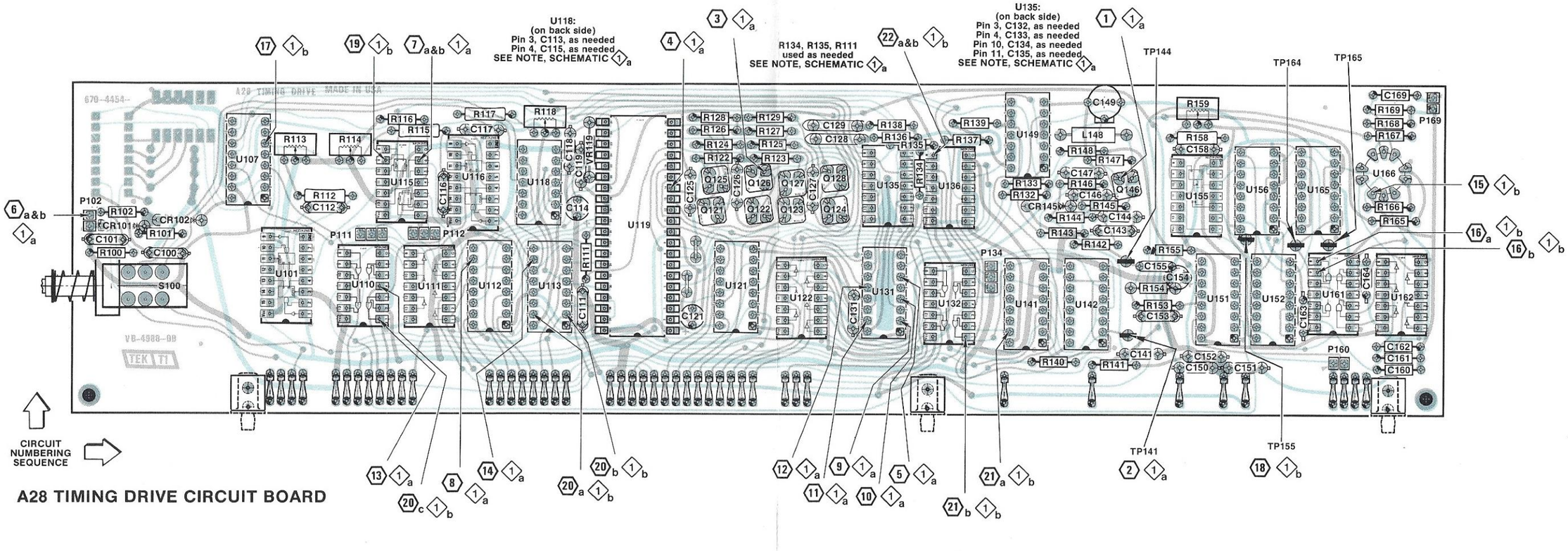
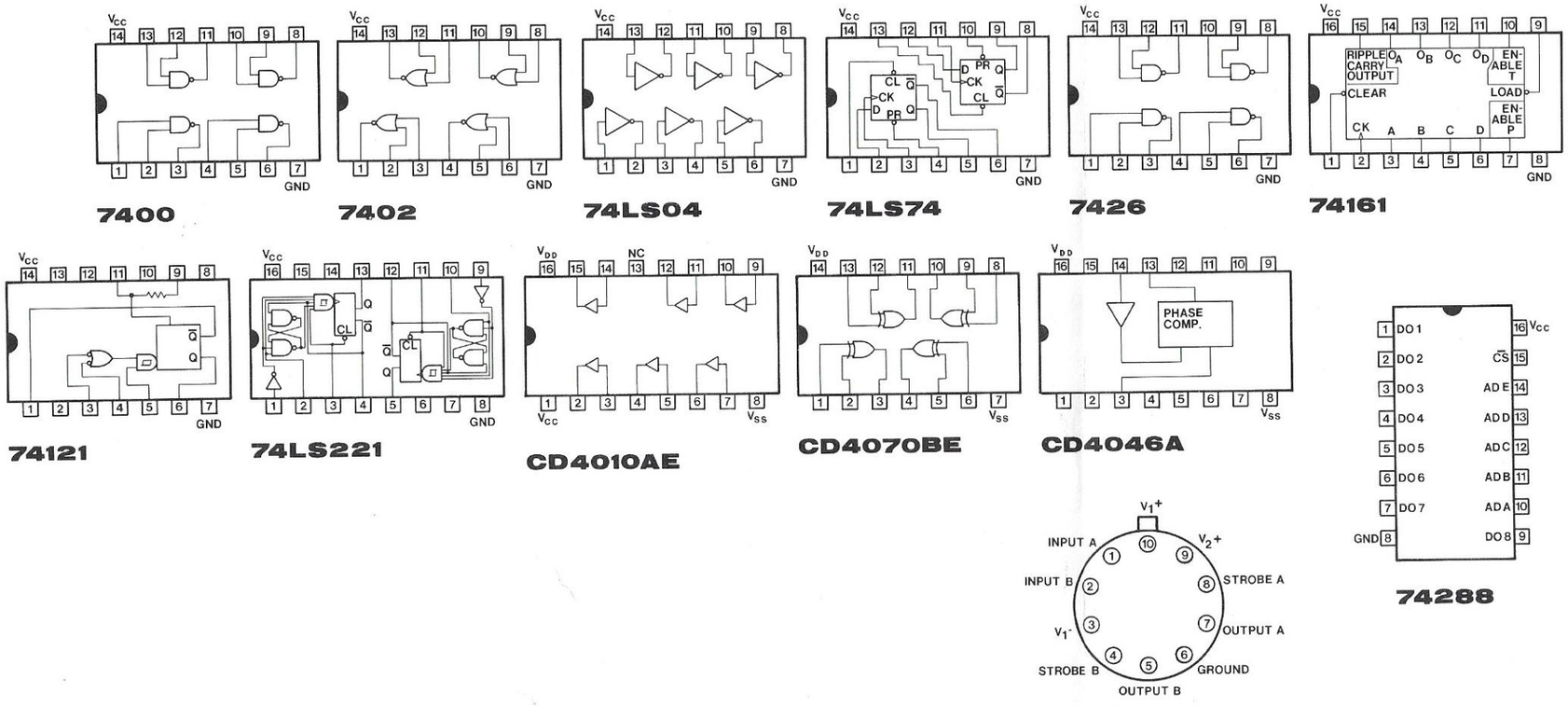


A28 TIMING DRIVE CIRCUIT BOARD



2105-06

1a
TIMING DRIVE
PARTS LOCATING CHART

C100	B5	R100	B5	U112B	A3
C101	B5	R101	B4	U112C	B3
C111	B3	R102	B5	U112D	CD
C114	C3	R111	D3	U112E	CD
C116	D4	R114	D4	U112F	A3
C117	D5	R115	D4	U113B	B3
C118	B1	R116	B5	U113C	A3
C119	B1	R117	D5	U113D	D4
C121	C3	R118	D5	U113E	B3
C125	B3	R122	B3	U115A	C5
C126	B3	R123	A3	U116A	D4
C127	A3	R124	B2	U116B	D5
C128	B3	R125	A2	U118A	C3
C129	A3	R126	C3	U118B	C3
C131	D4	R127	B3	U118C	B4
C141	B1	R128	C2	U118D	B4
C143	A1	R129	B2	U119	D3
C144	A1	R133	A2	U121D	A3
C146	A1	R134	C3	U121E	B3
C147	A1	R135	D3	U121F	A3
C149	A2	R136	B3	U122C	C5
C150	B1	R137	A2	U122D	C5
C151	C1	R138	A3	U122E	C5
C152	B2	R141	B1	U131A	C4
		R142	A1	U131B	C4
CR101	B4	R143	A2	U131C	A3
CR102	B4	R144	A1	U131D	A3
CR145	A1	R145	A2	U131E	D4
		R146	A2	U131F	D4
L148	A1	R147	A1	U135A	C3
				U135B	C3
P102	B5	S100	B4	U135C	D3
P111	B4			U135D	D3
		TP141	A2	U136A	A2
Q121	C3			U149A	A2
Q122	C2	U110A	D5	U149D	A2
Q123	B3	U110C	B4		
Q124	A2	U111A	C4	VR119	B1
Q125	B3	U111B	C4		
Q126	B2	U111C	C3	W123	D3
Q127	A3	U111D	B4	W124	D3
Q128	A2	U112A	A3		
Q146	A2				

WAVEFORMS

OSC CONTROL 1b R153
R142 100K
C144 33
CR145
C149 2 to 22
LINE FREQUENCY
L148 3.2μH
C143 65
R144 47K
C146 790
R147 100K
+15V
R146 620
C147 670
R145 10
Q146
R143 150
U149A 1/4 7400
640 H OSCILLATOR
+5V
R137 470
TP141
2
10MHZ PINS 2, U142 & U141 1b

+15V1
R133 2.7K
U149D 1/4 7426
12,13
+5V
U136A 1/2 7474
CLOCK DRIVERS
Q127 R123 15
Q128 R125 180
C127 .001
C129 270
R138 47
Q124
Q123 R127 15
R129 180
-15V
+15V
C125 0.1
Q125 R122 15
Q126 R124 180
C126 .001
C128 270
R136 47
Q122
Q121 R126 15
R128 180

HORIZ UNLOCK 5142
55
45
62
70
76
74
A3 2 1410 & 1410-1
R141 10
C152 0.1
C141 0.1
C150 0.1
C119 0.1
C118 0.1
VR119 3V NOMINAL (SEL)
C151 0.1
POWER

NOT USED 2,11,12
+15V1 1,40
C121 4.7μF 10
C114 4.7μF
-12V 21
(NTSC) 8
W124
(PAL) 6
W123
-15V 28,29
P/O U119 155-0147-00

P/O SYNC GENERATOR & OUTPUT BUFFERS

† NOTE:

U118A, PIN 3:	SELECT	C113	AS	NEEDED.	SEE	CAL	PROC	FOR	A28.	
" B, " 4:	"	C115	"	"	.	"	"	"	"	" .
U135A, " 3:	"	C132	"	"	.	"	"	"	"	" .
" B, " 4:	"	C133	"	"	.	"	"	"	"	" .
" C, " 10:	"	C134	"	"	.	"	"	"	"	" .
" D, " 11:	"	C135	"	"	.	"	"	"	"	" .
U119 " 18:	"	R111	"	"	.	"	"	"	"	" .
" " 19:	"	R135	"	"	.	"	"	"	"	" .
" " 20:	"	R134	"	"	.	"	"	"	"	" .

U131C 1/6 CD4010 5 (5MHZ) 40
U121D 1/6 CD4010 (FIELD SQUARE WAVE) 33
U131D 1/6 CD4010 (WINDOW) 39
U121F 1/6 CD4010 (V/4, V/8) 37
U112F 1/6 CD4010 (H/4) 21
U112B 1/6 CD4010 (H CROSSHATCH) 23
U112A 1/6 CD4010 (V CROSSHATCH) 24
U113C 1/6 CD4010 (COMP SYNC) 25
U121E 1/6 CD4010 (V/2) 36
TEST MODULES

U113B 1/6 CD4010 (V DRIVE) 12
U118C 1/4 4070
U118D 1/4 4070
TRIGGER OUTPUT
U113E 1/6 CD4010
S100 VERT/HORIZ
R101 10K
CR101
CR102
+5V
R102 3.9K
R100 1.1K
C100 0.1
C101 10
6 (H OR V DRIVE)
P102 2 TRIGGER FRONT PANEL
(H DRIVE) 7 TEST MODULES

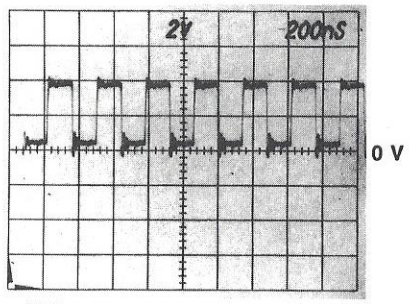
U110C 1/4 7402
U111D 1/6 74LS04
P111 1 & 2 SQUARE 2 & 3 PULSE
R116 4.7K
PHASING PULSE CONTROL
U107 PIN 4 1b
U112C 1/6 CD4010
U111C 1/6 74LS04
P112 1 & 2 270° 2 & 3 90°
U115A 1/2 74LS74
U111A 1/6 4010
7 (PAL PULSE)
(H/2) 22 TEST MODULES
H 1b
(H) 35 TEST MODULES

U118A 1/4 4070
U112E 1/6 4010
U111B 1/6 74LS04
H* 1b
8 (H*)
U118B 1/4 4070
U112D 1/6 CD4010
U122E 1/6 74LS04
2H 1b
9 (2 H) 42
U135A 1/4 4070
U131A 1/6 CD4010
U122D 1/6 74LS04
4H 1b
10 (4H) 43
U135B 1/4 4070
U131B 1/6 CD4010
U122C 1/6 74LS04
8H 1b
11 (8H) 44
U135C 1/4 4070
U131F 1/6 CD4010
C131 0.1
BURST DELAY
BURST WIDTH
12 (16H) 38 TEST MODULES
U135D 1/4 4070
U131E 1/6 CD4010
GRAY CODING
35 NOT USED
C116 105
R115 2K
R114 10K
C117 150
R117 20K
R118 10K
BURST TIMING
U116A 1/2 74LS221
U116B 1/2 74LS221
13 (BURST GATE)
U110A 1/4 7402
14 (BURST GATE START)
U113D 1/6 CD4010

P/O A28 TIMING DRIVE BOARD

SPG 3 @ GEM 6/76 TIMING DRIVE 1a

1 b



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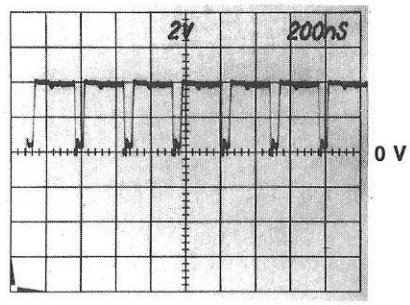

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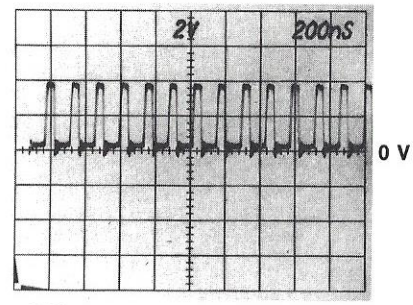
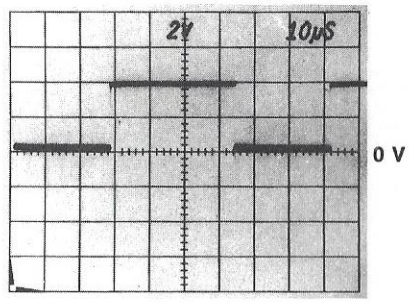


16 b



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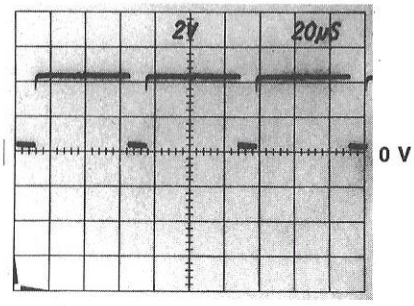

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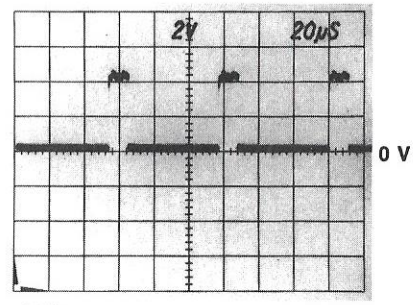

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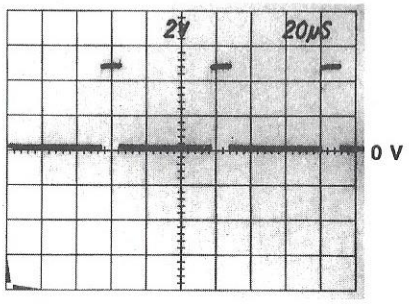

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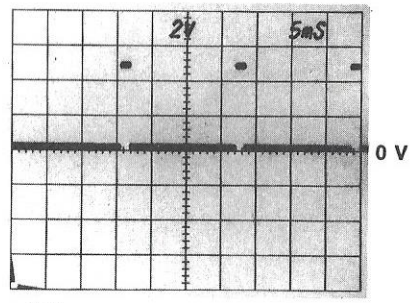

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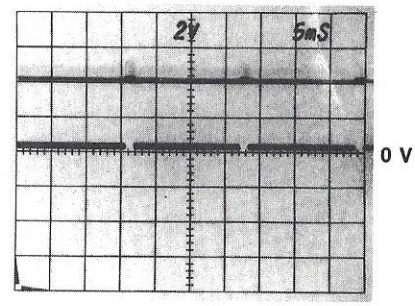

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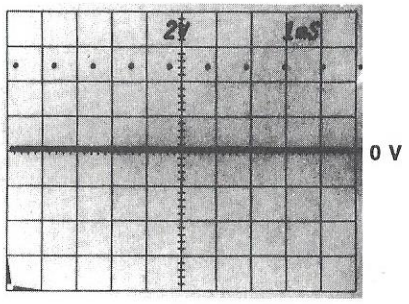
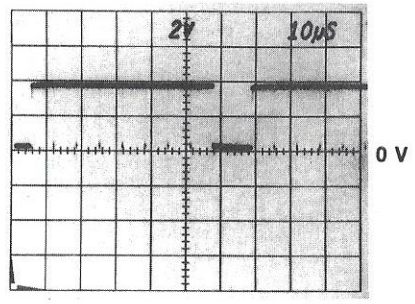
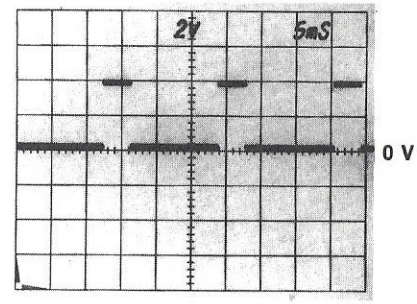


21 a



21 b



22

① b
TIMING DRIVE
PARTS LOCATING CHART

C112	C4	U101A	C4
C153	A5	U107	C4
C154	B5	U110B	D5
C155	B5	U110D	D5
C158	A4	U113A	D3
C160	B4	U113F	C3
C161	A2	U115B	C4
C162	B2	U119	C3
C163	B2	U121A	D3
C164	B2	U121B	D2
C169	A1	U121C	D2
		U122A	C2
P134	D1	U122B	D2
P160	B5	U132A	D4
P169	A1	U132B	D2
		U132C	D1
R112	C4	U132D	D2
R113	C4	U136B	D1
R132	C2	U141	C3
R139	C2	U142	D2
R140	C1	U151	B5
R148	C2	U152	B4
R153	A5	U155	B5
R154	B5	U156	B3
R155	C2	U161A	B2
R158	A4	U161B	A2
R165	A1	U161C	A2
R166	A4	U161D	B4
R167	B1	U162AB&C	A2
R168	A1	U162EF&D	B2
R169	B1	U165	A4
		U166	B1
TP144	A5		
TP155	B4		
TP164	A4		
TP165	B4		

WAVEFORMS

SCH PHASE PROCESSING

P169 (SUBCR) C169 .01 R168 1K R169 1K R165 470 R167 470 -15V U166 NE529K U162A, B, & C 74LS04 U161B 1/4 7400 U161C 1/4 7400 C161 470 C162 470 U162F, E, & D 74LS04 U161A 1/4 7400 C163 0.1 C164 0.1 +5V

A13 (3) 1410 & 1410-1 P414-7

A13 (3) 1410 & 1410-1 P414-4

75 Ω 29 30

LOCATED ON ANY UNUSED PIN 29 & 30 OF A1 INTERFACE P70, P71 OR P72

U156 74LS163 U165 74LS163 U152 74LS163 TP164 TP165 R166 1K U161D 1/4 7400 C160 82

SCH PHASING R159 10K C158 105 R158 2.0K U155 74121 P160 U151 4046 C153 0.22 R153 2K R154 3.1K C154 10 C155 0.1 TP144 TP155 OSCILLATOR CONTROL R142

P/O SYNC GENERATOR & OUTPUT BUFFERS

P/O U119 155-0147-00

(VERTICAL PRESET) 48 7 R155 4.7K U149B 7426 R132 4.7K

(HORIZONTAL PRESET) 49 27 R139 4.7K U149C 7426 R148 4.7K

U141 74LS163 R140 1K

TEST MODULES 47 (EIA)

U132B 1/4 7402 U122A 1/6 74LS04 U122B 1/6 74LS04 U132D 1/4 7402 U132C 1/4 7402 U136B 1/2 7474 10 MHZ U149 PIN 3 P134 2, & 3. 1/2 SPLIT FIELD 1. & 2. 3/4, 1/4 SPLIT FIELD U111A PIN 2

U121B 1/6 CD4010 U121C 1/6 CD4010 U113F 1/6 CD4010 U113A 1/6 CD4010 U121A 1/6 CD4010

37,39 4 (3/4 V) 3 (1/2 V) 38 17

P/O A28 TIMING DRIVE BOARD

COLOR BAR TIMING

U107 74S288 U110 PIN 8 COLOR BAR HORIZ SHIFT R113 10K R112 10K C112 105 U101A 1/2 74LS221 U115B 1/2 74LS74

BLANKING OUTPUTS

U132A 1/4 7402 U110D 1/4 7402 U110B 1/4 7402

(COMP BLANKING) (H BLANKING) (V BLANKING) (1 MHZ) (CB TIMING) (1/2 V, 3/4 V)

TEST MODULES 9 10 26 41 8 27

TIMING DRIVE 1b

SPG 3 @ GEM 5/76 TIMING DRIVE 1b

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.

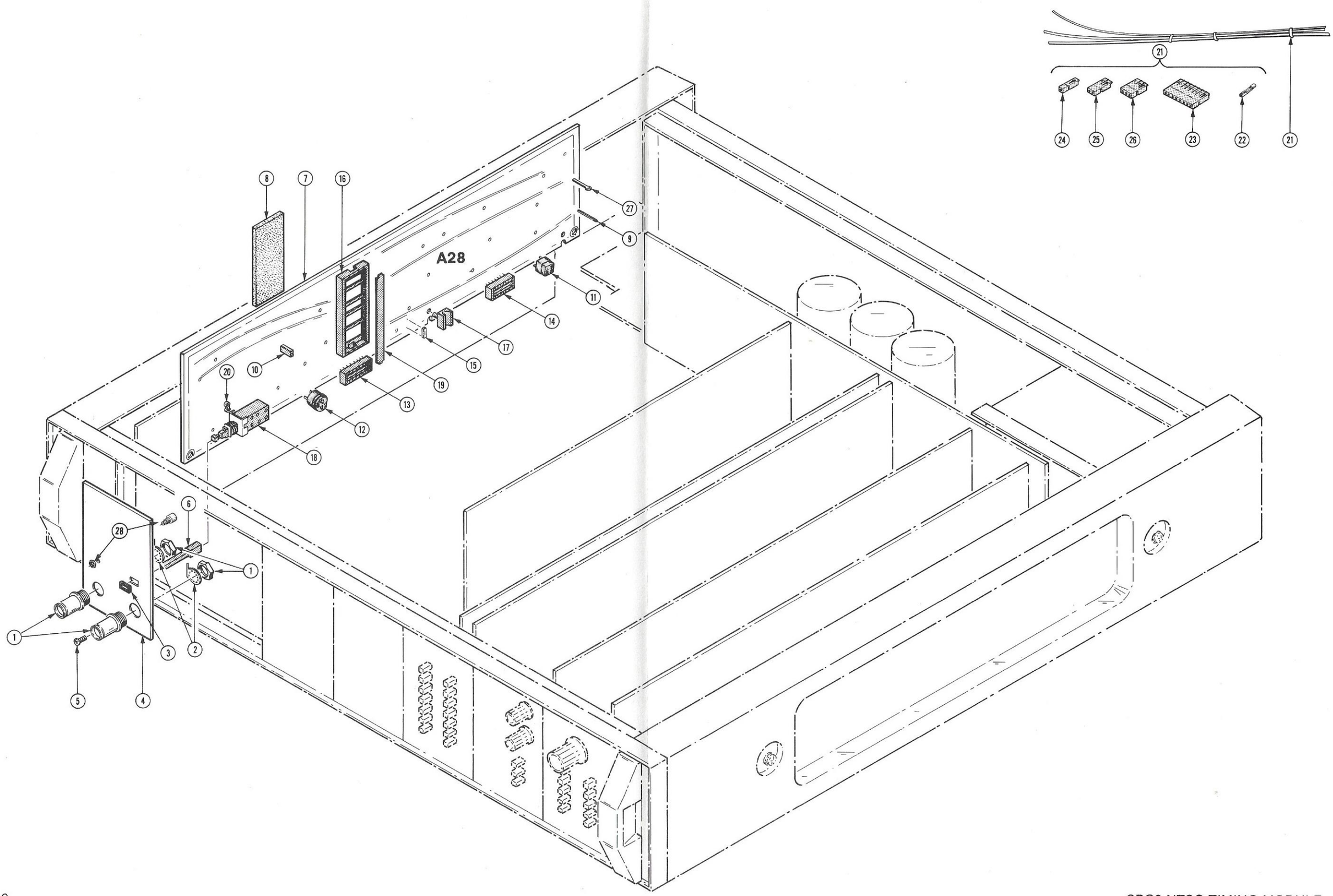
ABBREVIATIONS

"	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
000AJ	WESCORP, DIVISION DAL INDUSTIRES, INC.	1601 STIERLIN ROAD	MT VIEW, CA 94043
00779	AMP, INC.	P O BOX 3608	HARRISBURG, PA 17105
01295	TEXAS INSTRUMENTS, INC., SEMICONDUCTOR GROUP	P O BOX 5012, 13500 N CENTRAL EXPRESSWAY	DALLAS, TX 75222
22526	BERG ELECTRONICS, INC.	YOUK EXPRESSWAY	NEW CUMBERLAND, PA 17070
24931	SPECIALTY CONNECTOR CO., INC.	3560 MADISON AVE.	INDIANAPOLIS, IN 46227
71590	CENTRALAB ELECTRONICS, DIV. OF GLOBE-UNION, INC.	5757 N. GREEN BAY AVE.	MILWAUKEE, WI 53201
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
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	131-0955-00			2		CONNECTOR,RCPT,:BNC,FEMALE	24931	28JR200-1
-2	210-0255-00			2		TERMINAL,LUG:0.391" ID INT TOOTH	80009	210-0255-00
-3	426-1206-00			1		FRAME,PUSH BTN:MOMENTARY,GRAY PLASTIC	80009	426-1206-00
-4	333-2173-00			1		PANEL,FRONT:SPG3 1410	80009	333-2173-00
						(ATTACHING PARTS)		
-5	213-0120-00			3		SCR,TPG,THD FOR:2-32 X 0.250 INCH,PNH STL	83385	OBD
						- - - * - - -		
-6	366-1691-00			1		PUSH BUTTON:GRAY,1.20 INCH LONG	80009	366-1691-00
-7	----- -----			1		CKT CARD ASSY:TIMING DRIVE(SEE A28 EPL)		
-8	006-2358-00			1		. FOAM,CONDUCTIVE:0.75 X 2 X 2.25 INCH	000AJ	W-1102
-9	131-0608-00			15		. CONTACT,ELEC:0.365 INCH LONG	22526	47357
-10	131-0993-00			4		. LINK,TERM.CONN:2 WIRE BLACK	00779	530153-2
-11	136-0220-00			9		. SOCKET,PLUG-IN:3 PIN,SQUARE	71785	133-23-11-034
-12	136-0241-00			1		. SOCKET,PLUG-IN:10 CONTACT,ROUND	71785	133-99-12-064
-13	136-0260-02			13		. SOCKET,PLUG-IN:16 CONTACT,LOW CLEARANCE	01295	C931602
-14	136-0269-02			11		. SOCKET,PLUG-IN:14 CONTACT,LOW CLEARANCE	01295	C931402
-15	136-0328-03			46		. SOCKET,PIN TERM:FOR 0.025 DIA PIN	22526	47710
-16	136-0641-00			1		. SOCKET,PLUG-IN:40 CONTACT	00779	1-485169-2
-17	214-2440-00			3		. RECEPTACLE,PIN:CIRCUIT CARD	80009	214-2440-00
-18	260-1132-00			1		. SWITCH,PUSH:1 BUTTON,DOUBLE POLE	80009	260-1132-00
-19	346-0130-00			1		. STRAP,RETAINING:FOR 40 CONTACT SBSTR SKT	00779	350894-1
-20	361-0542-00			2		. SPACER,SWITCH:PLASTIC	71590	J-64281
-21	179-2470-00			1		WIRING HARNESS:COAXIAL	80009	179-2470-00
-22	131-0707-00			9		. CONTACT,ELEC:0.48 L,22-26 A	22526	47439
	131-0708-00			7		. CONTACT,ELEC:0.48 L,28-32 A	22526	47437
-23	352-0166-00			1		. CONN BODY,PL,EL:8 WIRE BLACK	80009	352-0166-00
-24	352-0171-01			2		. CONN BODY,PL,EL:1 WIRE BROWN	80009	352-0171-00
-25	352-0169-01			3		. CONN BODY,PL,EL:2 WIRE BROWN	80009	352-0169-01
-26	352-0161-01			1		. CONN BODY,PL,EL:3 WIRE BROWN	80009	352-0161-01
-27	214-0579-00			5		. TERM,TEST PT:0.40 INCH LONG	80009	214-0579-00
-28	----- -----			-		SWITCH,PUSH:SPST(SEE S142 EPL)		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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.

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MANUAL CHANGE INFORMATION

PRODUCT SPG3
070-2105-00

CHANGE REFERENCE M32515
DATE 1-25-78

CHANGE:	DESCRIPTION

EFF SN B010520

ELECTRICAL PARTS LIST AND SCHEMATIC CHANGES

CHANGE TO:

U119 155-0147-02 MICROCIRCUIT,DI:CIRCUIT TV GEN,40 LEAD

MECHANICAL PARTS LIST CHANGES

Page 10-3

CHANGE TO:

Fig. 1-16 136-0623-00 SOCKET,PLUG-IN:40 CONTACT

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MANUAL CHANGE INFORMATION

PRODUCT SPG3
070-2105-00

CHANGE REFERENCE M33761
DATE 5-15-78

CHANGE:	DESCRIPTION

EFF SN B010176

ELECTRICAL PARTS LIST CHANGES

CHANGE TO:

CR145	152-0269-01	SEMICOND DEVICE:SILICON,VAR VCAP.,4V,33PF,SEL

CR145 is located on the TIMING DRIVE circuit board assembly and shown on diagram  .

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MANUAL CHANGE INFORMATION

Date: 1-9-80 Change Reference: M38570

Product: SPG3 and SPG13 Manual Part No.: see below

DESCRIPTION

EFF SN B020159 (SPG3) 070-2105-00

EFF SN B020123 (SPG13) 070-2325-00

ELECTRICAL PARTS LIST AND SCHEMATIC CHANGES

ADD:

R120	315-0202-00	RES.,FXD,CMPSN:2K OHM,5%,0.25W

R120 is added to the TIMING DRIVE circuit board between pin 16 and pin 3 of U121 shown on diagrams ◇1◇$_a$ and ◇1◇$_b$.

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MANUAL CHANGE INFORMATION

Change Reference: M34510 Date: 4-16-79

Product: SPG3 070-2105-00 EFF SN B020000

CHANGE	DESCRIPTION

ELECTRICAL PARTS LIST AND SCHEMATIC CHANGES

CHANGE TO:

A28	670-4926-01	CKT CARD ASSY:TIMING DRIVE
C112	283-0638-00	CAP.,FXD,MICA D:130PF,1%,100V
C116	283-0647-00	CAP.,FXD,MICA D:70PF,1%,100V
C125	283-0111-00	CAP.,FXD,CER DI:0.1UF,20%,50V
C143	283-0198-00	CAP.,FXD,MICA D:0.22UF,20%,50V
C144	290-0536-00	CAP.,FXD,ELCTLT:10UF,20%,25V
C147	283-0615-00	CAP.,FXD,MICA D:33PF,5%,500V
C151	283-0081-00	CAP.,FXD,CER DI:0.1UF,+80-20%,25V
C153	283-0023-00	CAP.,FXD,CER DI:0.1UF,+80-20%,12V
C155	283-0649-00	CAP.,FXD,CER DI:105PF,1%,300V
C162	283-0023-00	CAP.,FXD,CER DI:0.1UF,+80-20%,12V
R113	311-1917-00	RES.,VAR,NONWIR:5K OHM,10%,0.5W
R123	315-0102-00	RES.,FXD,CMPSN:1K OHM,5%,0.25W
R132	315-0104-00	RES.,FXD,CMPSN:100K OHM,5%,0.25W
R137	315-0472-00	RES.,FXD,CMPSN:4.7K OHM,5%,0.25W
R141	315-0202-00	RES.,FXD,CMPSN:2K OHM,5%,0.25W
R143	315-0393-00	RES.,FXD,CMPSN:39K OHM,5%,0.25W
R144	315-0472-00	RES.,FXD,CMPSN:4.7K OHM,5%,0.25W
R145	315-0151-00	RES.,FXD,CMPSN:150 OHM,5%,0.25W
R146	315-0472-00	RES.,FXD,CMPSN:4.7K OHM,5%,0.25W
R147	315-0102-00	RES.,FXD,CMPSN:1K OHM,5%,0.25W
R148	315-0202-00	RES.,FXD,CMPSN:2K OHM,5%,0.25W
R154	315-0100-00	RES.,FXD,CMPSN:10 OHM,5%,0.25W

CHANGE		DESCRIPTION
CHANGE TO:		
R155	315-0621-00	RES.,FXD,CMPSN:620 OHM,5%,0.25W
R159	315-0100-00	RES.,FXD,CMPSN:10 OHM,5%,0.25W
R167	315-0102-00	RES.,FXD,CMPSN:1K OHM,5%,0.25W
R168	315-0471-00	RES.,FXD,CMPSN:470 OHM,5%,0.25W
U110	156-0383-00	MICROCIRCUIT,DI:QUAD 2 INPUT NOR GATE,74LS02
U132	156-0383-00	MICROCIRCUIT,DI:QUAD 2 INPUT NOR GATE,74LS02
U136	156-0331-00	MICROCIRCUIT,DI:DUAL D-TYPE FLIP-FLOP,74S74
U161	156-0382-00	MICROCIRCUIT,DI:QUAD 2 INPUT NAND GATE,74LS00
U162	156-0382-00	MICROCIRCUIT,DI:QUAD 2 INPUT NAND GATE,74LS00
REMOVE:		
C114	290-0782-00	CAP.,FXD,ELCTLT:4.7UF,+75-10%,35V
C118	283-0081-00	CAP.,FXD,CER DI:0.1UF,+80-20%,25V
C119	283-0081-00	CAP.,FXD,CER DI:0.1UF,+80-20%,25V
C127	283-0000-00	CAP.,FXD,CER DI:0.001UF,+100-0%,500V
C129	281-0791-00	CAP.,FXD,CER DI:270PF,10%,100V
C131	283-0023-00	CAP.,FXD,CER DI:0.1UF,+80-20%,10V
C141	283-0081-00	CAP.,FXD,CER DI:0.1UF,+80-20%,25V
C146	283-0645-00	CAP.,FXD,MICA D:790PF,1%,100V
C154	290-0536-00	CAP.,FXD,ELCTLT:10UF,20%,25V
C158	283-0649-00	CAP.,FXD,MICA D:105PF,1%,300V
C160	281-0792-00	CAP.,FXD,CER DI:82PF,10%,100V
C161	281-0788-00	CAP.,FXD,CER DI:470PF,10%,100V
C163	283-0023-00	CAP.,FXD,CER DI:0.1UF,+80-20%,10V
C164	283-0023-00	CAP.,FXD,CER DI:0.1UF,+80-20%,10V

CHANGE		DESCRIPTION
REMOVE:		
Q123	151-0402-00	TRANSISTOR:SILICON,NPN,SEL FROM 3571TP
Q124	151-0220-00	TRANSISTOR:SILICON,PNP
Q127	151-0220-00	TRANSISTOR:SILICON,PNP
Q128	151-0402-00	TRANSISTOR:SILICON,NPN,SEL FROM 3571TP
R111	315-0393-00	RES.,FXD,CMPSN:39K OHM,5%,0.25W
R125	315-0181-00	RES.,FXD,CMPSN:180 OHM,5%,0.25W
R127	315-0150-00	RES.,FXD,CMPSN:15 OHM,5%,0.25W
R129	315-0181-00	RES.,FXD,CMPSN:180 OHM,5%,0.25W
R133	315-0272-00	RES.,FXD,CMPSN:2.7K OHM,5%,0.25W
R134	315-0393-00	RES.,FXD,CMPSN:39K OHM,5%,0.25W
R135	315-0393-00	RES.,FXD,CMPSN:39K OHM,5%,0.25W
R138	315-0470-00	RES.,FXD,CMPSN:47 OHM,5%,0.25W
R140	315-0102-00	RES.,FXD,CMPSN:1K OHM,5%,0.25W
R153	315-0202-00	RES.,FXD,CMPSN:2K OHM,5%,0.25W
R158	321-0222-00	RES.,FXD,FILM:2K OHM,1%,0.125W
R169	315-0102-00	RES.,FXD,CMPSN:1K OHM,5%,0.25W
U135	156-0786-00	MICROCIRCUIT,DI:QUAD EXCLUSIVE OR GATE,CD4070BF
U152	156-0784-00	MICROCIRCUIT,DI:SYNC 4-BIT BINARY COUNTER,S75LS163N
U156	156-0784-00	MICROCIRCUIT,DI:SYNC 4-BIT BINARY COUNTER,S74LS163N
ADD:		
C120	283-0023-00	CAP.,FXD,CER DI:0.1UF,+80-20%,12V
C142	283-0003-00	CAP.,FXD,CER DI:0.01UF,+80-20%,150V
C145	283-0692-00	CAP.,FXD,MICA D:670PF,1%,300V
C148	283-0634-00	CAP.,FXD,MICA D:65PF,1%,100V
C156	283-0045-00	CAP.,FXD,MICA D:790PF,1%,100V

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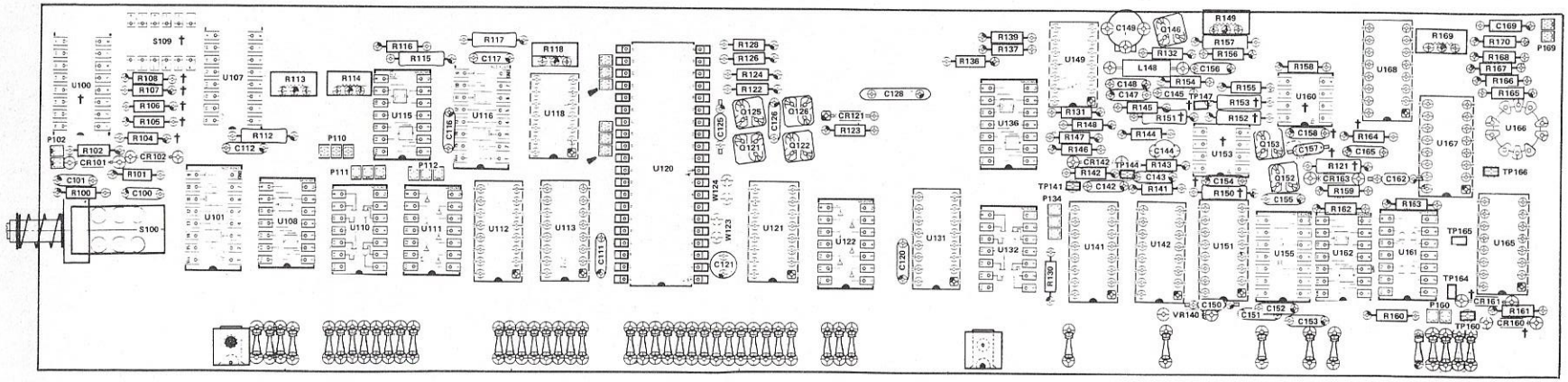
CHANGE		DESCRIPTION
ADD:		
C165	283-0644-00	CAP.,FXD,MICA D:150PF,1%,500V
CR121	152-0141-02	SEMICOND DEVICE:SILICON,30V,150MA,1N4152
R130	315-0472-00	RES.,FXD,CMPSN:4.7K OHM,5%,0.25W
R131	315-0471-00	RES.,FXD,CMPSN:470 OHM,5%,0.25W
R149	311-1916-00	RES.,VAR,NONWIR:10K OHM,10%,0.5W
R156	315-0473-00	RES.,FXD,CMPSN:47K OHM,5%,0.25W
R157	321-0222-00	RES.,FXD,FILM:2K OHM,1%,0.125W
R160	315-0102-00	RES.,FXD,CMPSN:1K OHM,5%,0.25W
R161	315-0102-00	RES.,FXD,CMPSN:1K OHM,5%,0.25W
R162	315-0471-00	RES.,FXD,CMPSN:470 OHM,5%,0.25W
R163	315-0102-00	RES.,FXD,CMPSN:1K OHM,5%,0.25W
R170	315-0102-00	RES.,FXD,CMPSN:1K OHM,5%,0.25W
U108	156-0388-00	MICROCIRCUIT,DI:DUAL D-TYPE, FLIP-FLOP,74LS74
U120	155-0188-00	MICROCIRCUIT,DI:SYNC GEN,M192, MOS
U167	156-0784-00	MICROCIRCUIT,DI:SYNC 4-BIT BINARY COUNTER,SN74LS163N
U168	156-0784-00	MICROCIRCUIT,DI:SYNC 4-BIT BINARY COUNTER,SN74LS163N
VR140	152-0226-00	SEMICOND DEVICE:ZENER,0.4W,5.1V,5%,1N751A



† NOT USED IN THIS INSTRUMENT

SPG3